National Marine Fisheries Service
Endangered Species Act Section 7 Consultation

Final Biological Opinion

Environmental Protection Agency
Registration of Pesticides
Oryzalin, Pendimethalin, Trifluralin

May 31, 2012

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Agency: United States Environmental Protection Agency

Activities Considered: Authorization of pesticide products (as described by product labels) containing the active ingredients oryzalin, pendimethalin, and trifluralin and their formulations in the United States and its affiliated territories.

Consultation Conducted by: Endangered Species Act Interagency Cooperation Division of the Office of Protected Resources, National Marine Fisheries Service

Approved by: ______________________

Date: MAY 31 2012

Section 7(a)(2) of the Endangered Species Act of 1973, as amended (ESA; 16 U.S.C. §1531 *et seq.*) requires each federal agency, in this case the Environmental Protection Agency (EPA), to insure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. When a federal agency's action "may affect" a protected species, that agency is required to consult formally with the National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service (USFWS), depending upon the endangered species, threatened species, or designated critical habitat that may be affected by the action (50 CFR §402.14(a)). Federal agencies are exempt from this general requirement if they have concluded, with written concurrence from the U.S. Fish and Wildlife Service, NMFS or both, that an action "may affect but is not likely to adversely affect" any endangered species, threatened species or designated critical habitat (50 CFR §402.14(b)).

On April 1, 2003, EPA initiated consultation with NMFS on the re-registration of pesticide products containing the active ingredients (a.i.s) oryzalin and trifluralin pursuant to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), 7 U.S.C. 136 *et seq.* On December 1, 2004, EPA initiated consultation with NMFS on the re-registration of pesticide products containing the active ingredients (a.i.) pendimethalin pursuant to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), 7 U.S.C. 136 *et seq.* EPA authorization of pesticide uses are categorized as FIFRA sections 3 (new product registrations), 4 (reregistrations and special review), 18 (emergency use), or 24(c) [Special Local Needs (SLN)] actions. In the Biological Evaluation (BE) transmitted, EPA determined uses of pesticide products containing oryzalin would have no effect on 9 and may affect but were not likely to adversely affect 17 of the 26 Evolutionarily Significant Units/ Distinct Population Segments (ESUs/DPSs) of Pacific salmonids listed at that time (Table 1). Lower Columbia River coho and Puget Sound steelhead were listed later. In the pendimethalin BE, EPA determined uses of pesticide products containing pendimethalin would have no effect on 22 and may affect but were not likely to adversely affect 4 of the 26 ESUs/DPSs. In the trifluralin BE, EPA determined uses of pesticide products containing pendimethalin would have no effect on 11 ESUs/DPSs, may affect but were not likely to adversely affect 4, and may affect 11 of the 26 ESUs/DPSs. EPA did not make adverse modification determinations for any of the a.i.s for any of the ESUs/DPSs which had designated critical habitat. NMFS does not concur with any of the not likely to adversely affect (NLAA) determinations made by EPA and therefore has conducted formal consultation.

This document states NMFS' biological opinion (Opinion) regarding effects of EPA's authorizations of pesticide products containing the above-mentioned a.i.s on the listed ESUs, plus on two newly listed salmonids. This is a partial consultation because, pursuant to the court's order, EPA sought consultations on only this group of listed species under NMFS' jurisdiction. Even though the court's order did not address the two more recently listed salmonids (Lower Columbia River coho and Puget Sound steelhead), NMFS analyzed the impacts of EPA's action to them because they belong to the same taxon. Other listed species under NMFS jurisdiction are not considered in this Opinion. NMFS' analysis requires consideration of the same information. ESA consultation with NMFS will be complete when EPA makes effect determinations on all remaining species and consults with NMFS as necessary.

This Opinion is prepared in accordance with section 7(a)(2) of the ESA and implementing regulations at 50 CFR Part 402. However, consistent with the decision in Gifford Pinchot Task Force v. USFWS, 378 F.3d 1059 (Ninth Cir. 2004), we did not apply the regulatory definition of "destruction or adverse modification of critical habitat" at 50 CFR §402.02. Instead, we relied on the statutory provisions of the ESA to complete our analysis of the effects of the action on designated critical habitat.

This Opinion is based on NMFS' review of the package of information the EPA submitted with its 2003 and 2004 requests for consultation on the proposed authorizations of the above a.i.s. It also includes our review of recovery plans for listed Pacific salmonids, past and current research and population dynamics modeling efforts, monitoring reports, Opinions on similar actions, published and unpublished scientific information on the biology and ecology of threatened and endangered salmonids, and other sources of information gathered and evaluated during the consultation on the proposed authorizations of the a.i.s oryzalin, pendimethalin, and trifluralin. Because the BEs for salmon are outdated, and do not necessarily include the most recent label information, exposure modeling, or toxicity data, NMFS has relied heavily on more recent BEs produced by EPA for other listed species. NMFS also reviewed pesticide labels, available monitoring data and other local, county, and state information, online toxicity databases, incident reports, data generated by pesticide registrants (applicants), and exposure models run by NMFS and EPA. NMFS also considered information and comments on the Draft Opinion provided by EPA, applicants, and other stakeholders.

Background

On January 30, 2001, the Washington Toxics Coalition, Northwest Coalition for Alternatives to Pesticides, Pacific Coast Federation of Fishermen's Associations, and Institute for Fisheries

Resources filed a lawsuit against EPA in the U.S. District Court for the Western District of Washington, Civ. No. 01-132. This lawsuit alleged that EPA violated section 7(a)(2) of the ESA by failing to consult on the effects to 26 ESUs of listed Pacific salmonids of its continuing approval of 54 pesticide a.i.s.

On July 2, 2002, the court ruled that EPA had violated ESA section 7(a)(2) and ordered EPA to initiate interagency consultation and make determinations regarding effects to the salmonids on all 54 a.i.s by December 2004. *Washington Toxics Coalition v. EPA*, C01-132C (W.D. Wash. 7/2/2002).

On January 22, 2004, the court enjoined application of pesticides within 20 (for ground) and 100 (for aerial) feet (ft) of streams supporting salmon. *Washington Toxics Coalition v. EPA*, C01-132C (W.D. Wash. 1/22/2004). The court imposed several additional restrictions on pesticide use in specific settings.

On November 5, 2007, the Northwest Coalition for Alternatives to Pesticides and others filed a lawsuit in the U.S. District Court for the Western District of Washington, Civ. No. 07-1791, against NMFS for its unreasonable delay in completing the section 7 consultations for EPA's registration of 54 pesticide a.i.s.

On July 30, 2008, NMFS and the plaintiffs entered into a settlement agreement with the Northwest Coalition for Alternatives to Pesticides. NMFS agreed to complete consultation within four years on 37 a.i.s. (EPA had concluded that 17 of the 54 a.i.s at issue in the first litigation would not affect any listed salmonid species or any of their designated critical habitat, and so did not initiate consultation on those a.i.s.)

On November 18, 2008, NMFS issued its first Opinion for three organophosphates: chlorpyrifos, diazinon, and malathion.

On April 20, 2009, NMFS issued its second Opinion for three carbamates: carbaryl, carbofuran, and methomyl.

On August 31, 2010, NMFS issued its third Opinion. This third consultation evaluated 12 organophosphate insecticides: azinphos methyl, bensulide, dimethoate, disulfoton, ethoprop, fenamiphos, methamidophos, methidathion, methyl parathion, naled, phorate, and phosmet.

On June 30, 2011, NMFS issued a fourth Opinion addressing the effects of four herbicides (2,4-D, triclopyr BEE, diuron and linuron) and two fungicides (captan and chlorothalonil).

The current Opinion addresses three dinitroanaline pesticides, oryzalin, trifluralin, and pendimethalin. EPA consultations on pesticide products currently focus on their effects to listed Pacific salmonids. EPA's ESA consultations with NMFS remain incomplete until EPA has consulted for these a.i.s on all protected species and designated critical habitat under NMFS' jurisdiction.

Consultation History

Between April 1, 2003, and December 1, 2004, the EPA transmitted letters to NMFS' Office of Protected Resources (OPR) requesting section 7(a)(2) consultation for the registration of the a.i.s oryzalin, pendimethalin, and trifluralin. EPA's Biological Evaluations (BEs) detailed the effects determinations on the 26 ESUs of Pacific salmonids that were listed at that time. EPA's Office of Pesticide Programs (OPP) determined that the use of oryzalin may affect but is not likely to adversely affect 17 ESUs, and will have no effect on nine ESUs. EPA determined that the continued use of pendimethalin may affect but is not likely to adversely affect four ESUs, and will have no effect on 22 ESUs. Finally, EPA determined that the continued use of trifluralin may affect 11 listed ESUs, may affect but is not likely to adversely affect four ESUs, and will have no effect on 11 ESUs.

On June 28, 2005, NMFS listed the Lower Columbia River coho salmon ESU as threatened. As EPA's 2003 and 2004 effects determinations for oryzalin, pendimethalin, and trifluralin pre-date this listing they lack an effects determination for the Lower Columbia River coho salmon.

On May 22, 2007, NMFS listed the Puget Sound Steelhead Distinct Population Segment (DPS) as threatened. As EPA's 2003 and 2004 effects determinations for oryzalin, pendimethalin, and trifluralin pre-date this listing they lack an effects determination for the Lower Columbia River coho salmon.

On December 10-12, 2007, EPA and the Services met and discussed approaches for moving forward with ESA consultations and pesticide registrations. The agencies agreed that the federal action for purposes of consultation on EPA's FIFRA registrations would be "the authorization for use or uses described in labeling of a pesticide product containing a particular pesticide ingredient." The agencies agreed to develop methodologies for filling existing data gaps. In the interim, the Services will develop approaches within their Opinions to address these gaps. The agencies identified communication and coordination mechanisms to address technical and policy issues and procedures for conflict resolution.

On February 11, 2008, NMFS listed the Oregon Coast coho salmon evolutionarily significant unit (ESU) as threatened. This ESU was considered in EPA's BEs for the three a.i.s.

On August 20, 2008, NMFS met with EPA and requested EPA to identify applicants for this and subsequent pesticide consultations.

On September 17, 2008, NMFS requested EPA approval of Confidential Business Information (CBI) clearance for certain staff members in accordance with FIFRA regulations and access to EPA's incident database so NMFS staff may evaluate CBI materials from the applicants and incident reports for the a.i.s under consultation. EPA conveyed to NMFS that no access to the incident database would be authorized and the reports will be sent directly from EPA to NMFS.

On September 23, 2008, NMFS staff received notification of CBI clearance from EPA. NMFS staff members have continued to renew their CBI clearance throughout the consultation process.

On September 26, 2008, NMFS sent correspondence to EPA regarding the roles of the federal action agency and identified applicants by such agency during formal consultation. NMFS also requested incident reports and label information for subsequent pesticide consultations from EPA. The specified timeline for NMFS' receipt of incident reports and label information for the three a.i.s considered in this Opinion was December 1, 2010.

On October 29, 2010, the U. S. District Court approved the agreed-upon 90-day extension to complete the Opinion, and allowed flexibility in the number of Opinions NMFS issued to complete for the batch of six chemicals under consultation.

On March 29, 2011, NMFS received grower-provided use information data from the Washington State Department of Agriculture (supplemented by the USDA's National Agricultural Statistics Service (NASS)) on the known use of Washington State during the 2009 growing season for a few commodities.

On April 26, 2011, EPA informed NMFS that they were sending the labels for all remaining batches on DVD via courier. The DVD arrived the following day.

On June 30, 2011, NMFS received a schedule for the initial Batch 5 applicant meetings from EPA. This includes applicants for oryzalin, trifluralin, and thiobencarb.

On July 1, 2011, NMFS received a package from Dow and Dintec, including a cover letter, CD with electronic copies of the master labels, and a hard copy summary of a fathead minnow exposure study (Hoberg, 2006). NMFS also received a second package from Dow containing a CD. This CD included the full Hogberg fathead minnow study, Master labels, spreadsheets from Stone Environmental, and market research.

On July 19, 2011, NMFS met with EPA and the applicants for the consultation on oryzalin. The applicant representatives were from MANA and Pyxis – an organization representing both MANA and UPI. At the meeting Pyxis presented information on the GESTF GIS database. The presentation was also sent to NMFS via email the same day.

On July 19, 2011, NMFS received CFSs from BASF for pendimethalin products via registered mail. The CFSs are CBI and were treated accordingly.

On July 22, 2011, NMFS met with EPA and applicants for the consultation on trifluralin. There were representatives from Dow Agrosciences and Dintec Agrichemicals in attendance.

On August 2, 2011, NMFS received an email from EPA that included BEAD's review of oryzalin use data.

On August 4, 2011, NMFS received an email from EPA containing an electronic copy of the presentation given by Dow at the July 22, 2011 meeting. On the same date, NMFS also received an email from Steve Kay (Pyxis) containing four documents: a cover letter with additional information about oryzalin, report on work done by GESTF, GESTF crop use summaries, and an overview of the methodology and data.

On August 8, 2011, NMFS sent email to EPA with several questions regarding the trifluralin labels. EPA provided answers to these questions on September 28, 2011.

On August 31, 2011, NMFS received an email from EPA confirming meeting dates for the remaining applicants. These meetings addressed the following a.i.s: 1,3-D, bromoxynil, diflubenzuron, fenbutain-oxide, pendimethalin, prometryn, propargite and racemic metolachlor.

On September 14, 2011, NMFS received a technical critique from Dow, concerning NMFS' Pacific salmon population model used in previous pesticide Opinions. On the same day, NMFS also received a full life-cycle toxicity test on midges from Dow.

On September 27, 2011, NMFS met with EPA and representatives from BASF, the applicant for the consultation on pendimethalin. The BASF presentation was also provided electronically.

On September 27, 2011, NMFS contacted EPA with additional questions regarding trifluralin labels. NMFS received responses from Dow Agrosciences, via EPA, on October 12, 2012.

On September 30, 2011, NMFS received a revised CSF for one of the BASF pendimethalin products via certified mail. The CFSs are CBI and were treated accordingly.

On September 29, 2011, NMFS also received electronic files relating to pendimethalin. EPA provided a copy of the sign-in sheet, as well as an additional copy of the presentation given by BASF at the September 27th meeting. BASF provided a copy of a presentation given at the Denver ACS Endangered Species Symposium.

On October 13, 2011, NMFS decided to divide the remaining chemicals into four Opinions. The team decided to move pendimethalin to the current Opinion in order to address all three dinitroanilines at the same time. Molinate and Thiobencarb were split off into a stand-alone Opinion, now called Batch 6.

On October 18, 2011, NMFS contacted EPA with questions regarding the pendimethalin labels. EPA replied answering the questions that same day.

On December 16, 2011, NMFS contacted EPA with questions regarding the pendimethalin labels. NMFS was informed that that EPA would work on the label clarifications.

On January 17, 2012, EPA contacted NMFS with answers to the questions NMFS has sent on December 16, 2011.

On February 21, 2012, the court in the case of NCAP v. NMFS granted NMFS' and NCAP's agreed-upon request for a 30 day extension for this Opinion, a 60 day extension for the Opinion on thiobencarb, and 14 month extension for consultation on the seven remaining a.i.s. NMFS informed EPA of the extension on February 23, 2012.

On March 8, 2012, EPA contacted NMFS to schedule a meeting to discuss the draft Opinion with the pendimethalin applicants.

On March 9, 2012, NMFS sent EPA several questions regarding maximum application limits on oryzalin labels. Several emails were exchanged between March 12 and March 15, 2012.

On March 13, 2012, NMFS contacted EPA to schedule meetings to discuss the draft Opinion with the oryzalin and trifluralin applicants.

On March 26, 2012, NMFS staff held a conference call with EPA staff from EFED and PRD to discuss proposed RPAs. Based on this discussion, NMFS made some modifications to RPAs.

On March 30, 2012, NMFS transmitted the draft Opinion to EPA. EPA posted the draft Opinion on their docket later that afternoon. EPA provided a public comment period for 30 days, with all comments to be submitted to EPA by April 30, 2012. Between March 30 and April 30, 2012, NMFS evaluated applicant and other stakeholder comments on RPAs that were available on EPA's regulatory docket, and made revisions as necessary. EPA requested an additional 10 days to review public comments, and provide an agency response to NMFS by May 11, 2012.

On April 11, 2012, NMFS met with EPA and applicants for the consultation on trifluralin to discuss the draft Opinion and RPAs. Representatives Dow Agrosciences and Dintec Agrochemicals in attended. Applicants provided a written request for an extension on the Batch 5 final issuance date, and requested additional time to review the opinion. Comments on the opinion and RPAs were provided to NMFS in a Powerpoint presentation. In the presentation applicants cited several studies conducted in support of European registrations in their presentation. These studies had not previously been submitted to EPA. Applicants stated they would provide the studies to EPA and NMFS. Applicants also cited some studies by Francis *et al.*, 1985 in the presentation, and said those studies had been submitted to EPA, and NMFS could get them from EPA.

On April 12, 2012, NMFS met with EPA and applicants for the consultation on pendimethalin to discuss the draft Opinion and RPAs. Representatives from BASF were present. A representative from USDA also attended this meeting. BASF did not have a formal presentation, but did provide verbal comments on the RPAs.

On April 12, 2012, NMFS met with EPA and applicants for the consultation on oryzalin to discuss the draft Opinion and RPAs. Applicants, United Phosphorus, Inc, and Celsius BV were represented by Pyxis, Inc at this meeting. Comments on the opinion and RPAs were provided to NMFS in a Powerpoint presentation.

On April 16, 2012, BASF sent an email to NMFS and EPA with informal comments on the RPAs.

On April 26, 2012, NMFS sent an email to EPA requesting additional information on potential drift/off-target deposition of granulars, effective width of vegetated buffers, and confirmation of typical application methods for the three dinitroanilines.

On April 27, 2012, EPA sent two emails providing information about potential drift/off-target deposition of granulars, effective width of vegetated buffers, and typical application methods for the three dinitroanilines.

On April 30, 2012, NMFS received an email from EPA with comments from pendimethalin applicants.

On May 1, 2012, NMFS contacted EPA to arrange a conference call to discuss RPA revisions.

On May 1, NMFS emailed EPA to inquire about the European studies referenced by trifluralin applicants in their presentation, and to request the Francis et al 1985 study also referenced by the applicants in their presentation.

On May 1, 2012, NMFS received an email from EPA with comments from oryzalin applicants.

On May 2, 2012, NMFS received an email from EPA with comments from trifluralin applicants. The European studies referenced by trifluralin applicants in their presentation and in the comments were not included. The Francis et al 1985 study referenced by the applicants in their presentation and two additional Francis et al 1985 studies referenced by the applicants the comments were not included. Studies were conducted for applicants by contract laboratories and are only available from applicants or from EPA if applicants have submitted them to EPA.

On May 7, 2012, NMFS staff held a conference call with EPA staff from EFED, PRD, and BEAD to discuss proposed RPAs. Based on this discussion, NMFS made additional modifications to RPAs.

On May 11, 2012, EPA provided formal comments on the draft Opinion and RPAs.

On May 14, 2012, EPA advised NMFS several additional comments had been posted to their docket. These comments arrived at EPA before the deadline. Comments were provided to and considered byNMFS.

On May 16, 2012, Dow AgroSciences, applicant for trifluralin, sent five additional studies to NMFS. These studies, conducted between 1992 and 2004 in support of European registrations, had not been previously submitted to either EPA or NMFS. NMFS evaluated the studies to see if information contained therein changed the analysis or risk conclusions. Some information was included in the Opinon directly; other evaluations are included in the administrative record.

On May 18, 2012, NMFS again requested the Francis et al 1985 study referenced in the trfiluralin applicants presentation and also requested the other Francis et al 1985 studies from EPA.

On May 23, 2012, EPA emailed NMFS copies of the three Francis et al 1985 studies referenced in the trifluralin applicant’s formal comments. NMFS evaluated and documented this information. It was consistent with existing analyses and was not incorporated into the Opinion.

On May 31, 2012, NMFS transmitted the final Biological Opinion on oryzalin, pendimethalin, and trifluralin to EPA.

Species Addressed in the BEs

EPA’s BEs considered the effects of pesticides containing the three a.i.s to 26 species of listed Pacific salmonids and their designated critical habitat (EPA, 2003b, 2004b, 2004c). Two listed species, the Lower Columbia River coho and the Puget Sound steelhead, were not considered in the BEs. EPA’s determinations for the listed species are summarized in the table below (

Table 1). Trifluralin was the only a.i. which EPA determined may adversely affect listed salmonids ESUs. EPA determined that oryzalin and pendimethalin may affect, but are not likely to adversely affect (NLAA) several ESUs or DPSs. Based on the analysis described in this opinion, NMFS does not concur with any of the NLAA determinations made by EPA for any of these three registrations.

When an action agency concludes that its action will not affect any listed species or critical habitat, no consultation is required (NMFS & USFWS, 1998). However, when an action may adversely affect listed species or designated critical habitat, or NMFS does not concur with the action agencies' NLAA determinations, NMFS conducts a formal consultation. During the consultation, NMFS determines whether the action is likely to jeopardize listed species or destroy or adversely modify critical habitat, then issues a biological opinion explaining the analytical process and its determinations. NMFS conducted a formal consultation because EPA concluded that registration of the trifluralin may adversely affect some listed Pacific salmonids, and NMFS did not concur with any of the NLAA determinations for oryzalin and pendimethalin.

Once NMFS enters into formal consultation it considers all species and critical habitat that are potentially affected by the action. In this Opinion, NMFS will analyze the impacts to all ESUs/DPSs of Pacific salmonids present in the action area as well as to the two species of salmonid listed after EPA provided its BEs to NMFS.

Table 1 Determinations made by EPA for the three a.i.s (EPA, 2003b, 2004b, 2004c). NLAA indicates that a "may affect, but not likely to adversely affect" determination was reached. The two species that were not evaluated were not ESA listed at the time the BEs were issued.

Species	**ESU**	Oryzalin	Pendimethalin	Trifluralin
Chinook	Puget Sound	No Effect	No Effect	No Effect
	Lower Columbia River	NLAA	No Effect	NLAA
	Upper Columbia River Spring - Run	NLAA	No Effect	May Affect
	Snake River Fall - Run	NLAA	No Effect	May Affect
	Snake River Spring/Summer - Run	NLAA	No Effect	May Affect
	Upper Willamette River	NLAA	NLAA	May Affect
	California Coastal	No Effect	No Effect	No Effect
	Central Valley Spring - Run	NLAA	No Effect	May Affect
	Sacramento River Winter - Run	NLAA	No Effect	NLAA
Chum	Hood Canal Summer - Run	No Effect	No Effect	No Effect
	Columbia River	No Effect	No Effect	No Effect
Coho	Lower Columbia River	*not evaluated*	*not evaluated*	*not evaluated*
	Oregon Coast	No Effect	No Effect	NLAA
	Southern Oregon and Northern California Coast	No Effect	No Effect	No Effect
	Central California Coast	NLAA	No Effect	No Effect
Sockeye	Ozette Lake	No Effect	No Effect	No Effect
	Snake River	No Effect	NLAA	May Affect
Steelhead	Puget Sound	*not evaluated*	*not evaluated*	*not evaluated*
	Lower Columbia River	NLAA	No Effect	NLAA
	Upper Willamette River	NLAA	No Effect	May Affect
	Middle Columbia River	NLAA	NLAA	May Affect
	Upper Columbia River	NLAA	NLAA	May Affect
	Snake River	NLAA	No Effect	May Affect
	Northern California	No Effect	No Effect	No Effect
	Central California Coast	NLAA	No Effect	No Effect
	California Central Valley	NLAA	No Effect	May Affect
	South-Central California Coast	NLAA	No Effect	No Effect
	Southern California	NLAA	No Effect	No Effect

Description of the Proposed Action

The Federal Action

The proposed action encompasses EPA's registration of the uses (as described by product labels) of all pesticides containing oryzalin, pendimethalin, and trifluralin.[1] The purpose of the proposed action is to provide tools for pest control throughout the U.S. and its affiliated territories. Pursuant to FIFRA, before a pesticide product may be sold or distributed in the U.S. it must be exempted or registered with a label identifying approved uses by EPA's OPP. Once registered, a pesticide may not legally be used unless the use is consistent with directions on the approved label(s) (http:www.epa.gov/pesticides/regulating/registering/index.htm). EPA authorization of pesticide uses are categorized as FIFRA sections 3 (new product registrations), 4 (reregistrations and special review), 18 (emergency use), or 24(c) Special Local Needs (SLN).

EPA's pesticide registration process involves an examination of the ingredients of a pesticide, the site or crop on which it will be used, the amount, frequency and timing of its use, and its storage and disposal practices. Pesticide products may include a.i.s and other ingredients, such as adjuvants and surfactants. The FIFRA standard for registration is pesticides which "do not cause unreasonable adverse effects to the environment." An unreasonable adverse effect on the environment is defined in FIFRA as, "(1) any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of the pesticide, or (2) a human dietary risk from residues that result from a use of a pesticide in or on any food inconsistent with the standard under section 408 of the FFDCA (21 U.S.C. §346a)" 7 U.S.C. 136(b). EPA evaluates effects of the pesticide on human health via written human health and ecological risk assessments, then publishes a registration decision based on these risk assessments.

After registering a pesticide, EPA retains discretionary involvement and control over such registration. EPA must periodically review the registration to ensure compliance with FIFRA

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[1] EPA submitted three separate actions, one for each of the active ingredients. Because these a.i.s have a similar mode of action, we chose to consider each a.i. in one document and use the term "action" to refer to all three actions. However, we considered EPA's action with respect to each a.i. independently.

and other federal laws (7 U.S.C. §136d). A pesticide registration can be canceled whenever "a pesticide or its labeling or other material does not comply with the provisions of FIFRA or, when used in accordance with widespread and commonly recognized practice, generally causes unreasonable adverse effects on the environment".

On December 12, 2007, EPA, NMFS, and FWS agreed that the federal action for EPA's FIFRA registration actions will be defined as the "authorization for use or uses described in labeling of a pesticide product containing a particular pesticide ingredient". In order to ensure that EPA's action will not jeopardize listed species or destroy or adversely modify critical habitat, NMFS' analysis encompasses the impacts to listed Pacific salmonid ESUs/DPSs of all uses authorized by EPA, regardless of whether those uses have historically occurred.

Pesticide Labels. For this consultation, EPA's proposed action encompasses all approved product labels containing the a.i.s oryzalin, pendimethalin, and trifluralin; their degradates, metabolites, and formulations, including other ingredients within the formulations; adjuvants; and tank mixtures. These activities comprise the stressors of the action (Figure 1). The BEs indicate that the subject a.i.s are labeled for a variety of uses including applications to residential areas, industrial areas, pastures, tree farms, and crop lands (EPA, 2003b, 2004b, 2004c)

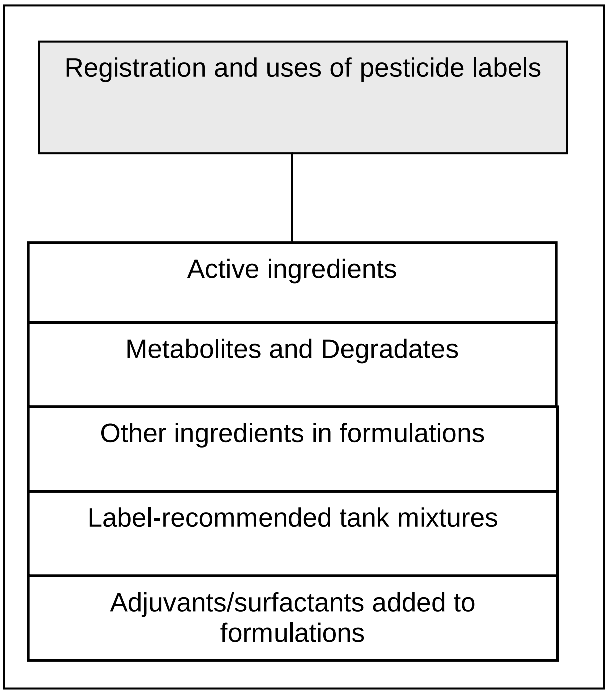

Figure 1 Stressors of the Action

Active and Other Ingredients. Oryzalin, pendimethalin, and trifluralin are the a.i.s that kill or otherwise affect targeted organisms (listed on the label). Pesticide products that contain these a.i.s also contain other ingredients that EPA defines as not “pesticidally active”. In the past these have been referred to as “inert” ingredients. The specific identification of the compounds that make up the inert fraction of a pesticide is not required on the label. However, this does not necessarily imply that “other” ingredients are non-toxic, non-flammable, or otherwise non-reactive. EPA authorizes the use of chemical adjuvants to make pesticide products more efficacious. An adjuvant aides the operation or improves the effectiveness of a pesticide. Examples include wetting agents, spreaders, emulsifiers, dispersing agents, solvents, solubilizers, stickers, and surfactants. A surfactant is a substance that reduces surface tension of a system, allowing oil-based and water-based substances to mix more readily. A common group of non-ionic surfactants is the alkylphenol polyethoxylates (APEs), which may be used in pesticides or pesticide tank mixes, and also are used in many common household products. Nonylphenol (NP), one of the APEs, has been linked to endocrine-disrupting effects in aquatic animals.

Formulations. Pesticide products come in a variety of solid and liquid formulations. Examples of formulation types include dusts, dry flowables, emulsifiable concentrates, granulars, solutions, soluble powders, ultra-low volume concentrates, water-soluble bags, powders, and baits. The formulation type can have implications for product efficacy and exposure to humans and other non-target organisms.

Tank Mix. A tank mix is a combination by the user of two or more pesticide formulations as well as any adjuvants or surfactants added to the same tank prior to application. Typically, formulations are combined to reduce the number of spray operations or to obtain better pest control than if the individual products were applied alone. The compatibility section of a label may advise on tank mixes known to be incompatible or provide specific mixing instructions for use with compatible mixes. Labels may also recommend specific tank mixes. Pursuant to FIFRA, EPA has the discretion to prohibit tank mixtures. Applicators are permitted to include any combination of pesticides in a tank mix as long as each pesticide in the mixture is permitted for use on the application site and the label does not explicitly prohibit the mix.

Pesticide Registration. The Pesticide Registration Improvement Act (PRIA) of 2003 became effective on March 23, 2004. The PRIA directed EPA to complete REDs for pesticides with food uses/tolerances by August 3, 2006, and to complete REDs for all remaining non-food pesticides by October 3, 2008. The goal of the reregistration program is to mitigate risks associated with the use of older pesticides while preserving their benefits. Pesticides that meet today's scientific and regulatory standards may be declared "eligible" for reregistration. The eligibility for continued registration may be contingent on label modifications to mitigate risk and can include phase-out and cancelation of uses and pesticide products. The terms of EPA's regulatory decisions are summarized in RED documents (EPA, 1994, 1996, 1997)

Registrants can submit applications for the registration of new products and new uses following reregistration of an a.i. Several types of products are registered, including the pure (or nearly pure) active ingredient, often referred to as technical grade active ingredient (TGAI), technical, or technical product. This is generally used in manufacturing and testing, and not applied directly to crops or other use sites. Products that are applied to crops, either on their own or in conjunction with other products or surfactants in tank mixes are called end-use products (EUPs). Sometimes companies will also register the pesticide in a manufacturing formulation, intended for sale to another registrant who then includes it into a separately registered EUP. Manufacturing formulations are not intended for application directly to use sites.

The EPA may also cancel product registrations. EPA typically allows the use of canceled products, and products that do not reflect RED label mitigation requirements, until those products have been exhausted. Some cancelations include specific phase-out restrictions such as a final sale or final use date. Labels that reflect current EPA mitigation requirements are referred to as "active labels." Products that do not reflect current label requirements are referred to as "existing stocks." EPA's action includes all authorizations for use of pesticide products (existing stocks, and active labels) containing the three a.i.s for the duration of the proposed action. None of the a.i.s in this consultation are in the cancelation process. Some individual labels have recently been proposed for cancelation, but no other details are available.

Duration of the Proposed Action. EPA's goal for reassessing currently registered pesticide a.i.s is every 15 years. Given EPA's timeframe for pesticide registration reviews, NMFS' evaluation of the proposed action is also 15 years.

Interrelated and Interdependent Activities. No interrelated and interdependent activities are associated with the proposed action.

Registration Information of Pesticide a.i.s under Consultation. The proposed action encompasses EPA's registration of the uses (as described by product labels) of all pesticides containing oryzalin, pendimethalin, and trifluralin. EPA provided copies of active product labels for these three a.i.s. The following descriptions represent information acquired from review of these labels as well as information conveyed in the EPA BEs, REDs, and other documents.

Oryzalin

Oryzalin is a dinitroaniline herbicide that is registered nationally for the control of certain annual grasses and broadleaf weeds. It inhibits microtubule polymerization/function of cell division, preventing seed germination and cellular respiration. Oryzalin is registered for use in fruit and nut crops, vineyards, Christmas tree plantations, ornamentals, turf, and several other non-crop sites.

Currently, 16 companies have pending or active registrations with EPA to manufacture end-use products containing oryzalin. There are two registered technical products, two registered formulation intermediates, and 32 end-use products. These end-use products are registered for use on urban, residential, and commercial areas in addition to agricultural crops (EPA, 2003b). No forestry uses are registered. There are no Special Local Needs (SLN, Section 24c) or emergency use registrations (Section 18) in California, Idaho, Oregon, or Washington for oryzalin.

Usage Information.

Nation-wide estimates. Oryzalin use sites include agricultural food and feed crops, residential ornamentals such as shrubs, lawn and turf, and commercial sites such as nurseries, golf courses and rights-of-ways. EPA's RED provides usage data for 1991, indicating that between 1.46 and 1.92 million pounds of a.i. was applied to 1 million to 1.86 million acres of turf and crops (EPA, 1994). EPA estimated 1.4 million pounds of oryzalin are applied annually in the United States for agricultural uses. Agricultural use of oryzalin is heavily concentrated in California. California accounted for 91% of national use between 1998 and 2008 (EPA, 2010a). It is followed by Washington (5%), Florida (1%), and Oregon (1%). EPA estimated 156,000 lbs. of oryzalin are applied annually for non-agricultural purposes (EPA, 2010a).

The 2002 estimated use map provided by EPA's Pesticide National Synthesis Project shows oryzalin use is heavy in some areas of California, Oregon, and Washington[2]. The highest estimated amount of oryzalin was applied to citrus fruits, followed by grapes and apples. These three uses account for nearly 70% of national oryzalin use. Crops categories tracked by NASS in 2003 show a total nation-wide use of 157,000 lbs(NASS, 2011). Of that total, 127,000 lbs were applied to grapes.

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[2] Map available at http://water.usgs.gov/nawqa/pnsp/usage/maps/show_map.php?year=02&map=m1873

State estimates. California's PUR program tracks all agricultural use of pesticides. Between 2002 and 2005, oryzalin was used in 54 counties in California. Annual use in California has ranged from 110,122 to 787,725 lbs (CAL-DPR, 2010). In 2010, 601,809.91 lbs of oryzalin was applied; it was ranked 32 on the list of most-used pesticides[3]. Overall, the agricultural crops representing the highest volume of oryzalin used are almonds (199,196 lbs) and pistachios (74,875 lbs) followed by grapes, wine grapes, kiwi, and walnuts (roughly 43,000 lbs each). Applicators are not required to report non-agricultural applications, so figures are likely to be under estimates. Of those voluntarily reported, the major contributors are landscape maintenance (42,474 lbs) and rights-of-way (52,576 lbs).

Washington State Department of Agriculture estimates that a total of approximately 100,000 lbs of oryzalin were applied to seven crops in 2010 (WSDA, 2011a). Statistics were not available for most of the other registered uses in the state. In 2009 certified applicators reported use of 23,119 lbs of oryzalin for landscaping (WSDA, 2011a). There were no other estimates found for the amount of oryzalin used for non-agricultural uses.

Market Data. Based on private market pesticide usage data from 1998-2008, the nationwide annual agricultural usage was approximately 1.4 million pounds of oryzalin for almost 500,000 acres treated (EPA, 2010a). This analysis also identified almonds, grapes, and pistachios as the major national markets.

For this consultation, the Action consists of the labeled uses of oryzalin. The use data provided above will help to inform our analysis and identify the potential sources of risk to salmonids. However, because use of pesticides fluctuates based on pest pressure, pest resistance to these and other a.i.s, and environmental conditions including climate change, past use is not a reliable predictor of use patterns that may occur over the next fifteen years.

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[3] See Calif. Dept. of Pesticide Programs: http://www.cdpr.ca.gov/docs/pur/pur10rep/top_100_ais_lbs10.pdf

Agricultural Uses. Orchard and vineyard crops including almonds, pistachio, grapes, apples, apricots, cherries, citrus, lemon, nectarine, orange, peach, pear, plum, prune, quince, avocado, figs, olive and walnuts, Christmas trees

Non-agricultural Uses. Landscape maintenance, golf courses, cemeteries, athletic fields, rights-of-ways, residential areas/lawns, ornamentals, ornamental bulbs, and warm season turf grass.

Registered Formulation Types. Oryzalin products are formulated as dry flowable, liquid, emulsifiable concentrate, wettable powder, dispersable granulars, soluable concentrates, ready-to-use solutions and dust. Some products of oryzalin also contain benefin (benfluralin) a preemergent herbicide, isoxaben an ingredient in one turf product, or oxyfluofen an herbicide for preemergent or post emergent weed control used on ornamentals. Some turf products also contain fertilizer.

Methods and Rates of Application.

Methods. Oryzalin can be ground applied using a variety of methods and equipment. It may be applied as a spot treatment or broadcast application using ground boom sprayers, granule spreaders, hand held nozzle sprayers, wick applicators, and by chemigation. Oryzalin is not approved for aerial application. Depending on the formulation, the registered products are applied to the soil surface prior to the emergence of weeds (prior to germination), or immediately after cultivation. To facilitate activation and movement of the chemical, a single ½ to 1 inch rainfall or sprinkler irrigation is recommended (EPA, 2010a). Applications to residential turf and lawn are required to be watered in immediately.

Application Rates. Application rates are limited to 4-6 lbs of oryzalin/A on the majority of agricultural use sites (Table 2). Sites with the greatest application rates (6 lbs a.i./A) include crop and non-crop uses: orchards, vineyards, Christmas tree farms, industrial sites, and rights-of-way. Multiple applications are permitted on several use sites. Typically, either the maximum number of applications and/or maximum seasonal rate is specified. Up to 12 lbs a.i./A may be used on industrial sites, utility substations, highway guardrails, sign posts and delineators (EPA, 2003b).

Table 2. Oryzalin use patterns in the action area

Use(s)	Use Site	Land Use category	Max. Single App. Rate (lbs a.i./A)	Number of App. per Year	Annual App. Rate (lbs a.i./A)	App. Interval (days)	App. Method	Label Number
Perennial flowers	Home owner	Developed	0.2	3	0.6	120	Hand spray	802-565
Container and landscape grown ornamentals	Crop Landscape	Agricultural Developed	6.0	2	12.0	120	Hand or drop spreader	5905-556[2]
Ground covers	Non-crop	Developed	6.0	2	12.0	120	Hand or drop spreader	5905-556[2]
Established Flowers	Crop	Agriculture	6.0	2	12.0	120	Hand or drop spreader	5905-556[2]
Ornamental bulbs	Crop	Agriculture	6.0	2	12.0	120	Hand or drop spreader	5905-556[2]
Non- bearing fruit and nut trees	Crop	Agriculture	6.0	2	12.0	120	Hand or drop spreader	5905-556[2]
Non-bearing vineyards	Crop	Agriculture	6.0	2	12.0	120	Hand or drop spreader	5905-556[2]
Non-bearing berries	Crop	Agriculture	6.0	2	12.0	120	Hand or drop spreader	5905-556[2]
Christmas tree plantations	Crop	Agriculture	6.0	2	12.0	120	Hand or drop spreader Broadcast spray	5905-556[2] 53883-168
Industrial sites, utility sub-stations, highway guard rails, sign posts, delineators	Urban Rights-of-way	Developed	6.0	2	12.0	120	Hand or drop spreader	5905-556[2]
Established tall fescue	Urban	Developed	1.5	2	3.0	120	Hand or drop spreader	5905-556[2]
Warm season turf	Urban	Developed	3.0	2	6.0	120	Hand or drop spreader	5905-556[2]
Avocado	Crop	Agriculture	6	2	12	75	Ground and chemigation	54705-11

Use(s)	Use Site	Land Use category	Max. Single App. Rate (lbs a.i./A)	Number of App. per Year	Annual App. Rate (lbs a.i./A)	App. Interval (days)	App. Method	Label Number
Fig	Crop	Agriculture	6	2	12	75	Ground and chemigation	54705-11
Guava	Crop	Agriculture	6	2	12	75	Ground and chemigation	54705-11
Kiwi	Crop	Agriculture	6	2	12	75	Ground and chemigation	54705-11
Olive	Crop	Agriculture	6	2	12	75	Ground and chemigation	54705-11
Papaya	Crop	Agriculture	6	2	12	75	Ground and chemigation	54705-11
Pomegranate	Crop	Agriculture	6	2	12	75	Ground and chemigation	54705-11
Citrus	Crop	Agriculture	6	2	12	75	Ground and chemigation	34704-865
Bahiagrass	Turf	Developed	2	NS	NS	NS	Granular spreader	8660-150
Bermudagrass	Turf	Developed	2	NS	NS	NS	Granular spreader	8660-150
Centipedegrass	Turf	Developed	2	NS	NS	NS	Granular spreader	8660-150
Tall fescue	Turf	Developed	2	NS	NS	NS	Granular spreader	8660-150
St. Augustine grass	Turf	Developed	2	NS	NS	NS	Granular spreader	8660-150
Warm season perennial turf grasses	Turf	Developed	2.7	NS	8.0	90	Drop or rotary-type granular spreader	70506-55; Also contains isoxaben (0.29%) and premixed with fertilizer.
Ornamental trees and shrubs	Landscape	Developed	4	3	12	120	Hand held or backpack sprayer	54705-5

Use(s)	Use Site	Land Use category	Max. Single App. Rate (lbs a.i./A)	Number of App. per Year	Annual App. Rate (lbs a.i./A)	App. Interval (days)	App. Method	Label Number
Cemeteries, parks, golf courses, athletic fields	Turf	Developed	2	3	6	90	Drop or rotary-type granular spreader	70506-51

1. NS = not specified on label, applicants indicate it is intended for one application/year

2. This product contains 1% oryzalin and 1% benefin by weight; amount of a.i. given includes both chemicals.

Note: The stamped label for 34704-823 provided by EPA had a maximum annual application rate of 15 lb ai/A. This value is greater than the authorized 12 lb ai/A and the label is under amendment to reduce the annual application rate.

Metabolites and Degradates.

Oryzalin degrades quickly via aqueous photolysis (hours), but more slowly by other pathways (days to weeks). A total of 12 degradates have been identified, consisting mostly of benzenesulfonamides and benzimidazole sulfonamides. No single degradate represents more than 10% of the applied parent. A number of the benzenesulfonamides retain the characteristic dinitroaniline structure, but the benzimisazole sulfonamides and other compounds do not. According to EPA, available data on degradates of oryzalin are insufficient to assess their runoff characteristics or persistence in surface waters (EPA, 1994). EPA states there is no information on degradates of dinitroaniline in information submitted by applicants or in open literature (EPA, 2009a, 2009b, 2010b).

Pendimethalin

Pendimethalin is a selective pre-emergent herbicide dinitroaniline herbicide used to control grassy and broadleaf weed species (EPA, 2004b). It is a microtubule disruptor, inhibiting cell growth in the roots of pre-emergent plants. Pendimethalin is used primarily in agricultural settings, but is also registered for use on ornamentals, rights-of- way, and homeowner turf (EPA, 2004b). The primary registrant is BASF Corporation, with Dintec Agrichemicals, Drexel Chemical Company, and REPAR Corp also holding technical registrations. There are 82 end-use products sold by 17 companies. There are also 17 SLN labels registered in California, Idaho, Oregon and Washington.

Usage Information.

Nation-wide estimates. Pendimethalin is registered for use in California, Idaho, Oregon and Washington for a variety of crop and non-crop uses. The 2002 pesticide estimated use map provided by USGS's Pesticide National Synthesis Project shows that California's Central Valley is the area of highest use within the four-state area[4]. The USGS data indicates that, nationally, the majority of pendimethalin is used on soybeans (39.6%), cotton (20.2%), corn, (19.4%), sugarcane (6.3%), and peanuts (3.3%). Other individual crops account for less than 2% of the total pounds of pendimethalin applied. Of the top uses, corn and cotton are the only crops

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[4] Map available at http://water.usgs.gov/nawqa/pnsp/usage/maps/show_map.php?year=02&map=m1629

typically grown in the four state area. Together, cotton and corn account for 39 % of the applied pendimethalin nationwide. These use patterns are also reflected in NASS's data. Between 1990 and 2006, soybeans, cotton, and corn have significantly higher total lb/year than other crops (NASS, 2011).

State level estimates. The NASS Agricultural Chemical Use Database gives us an idea of some of the use patterns within the states (NASS, 2011). While NASS only collects data on selected states and crops, some use patterns are clearly visible. The crop with the highest total application in California is upland cotton. The yearly total is generally over 100,000 lbs, and only one other crop is higher than 20,000 lbs. In 1999, 56,000 lbs of pendimethalin was used on California almonds; almond use was not reported for any other years. NASS has data on pendimethalin use for a limited number of crops in Idaho (potatoes), Oregon (onions, peas, potatoes), and Washington (lima beans, onions, peas, potatoes, sweet corn). The Oregon data demonstrate that very high percentages of bulb onions are treated; in three years over 90% of onion acres were treated. Similarly, a high percentage of Washington's lima beans were treated in the two years included in the database (69% in 1998 and 79% 2000).

Recent use estimates from Washington State also show 93- 97% of onion acres are treated with pendimethalin (WSDA, 2011b). This level of use equates to a total of 16,000 to 17,000 lbs pendimethalin applied to onions. The same report estimates between 1,845 and 17,737 lbs were applied to mint. Washington State also provided an analysis of NASS data, showing high use on alfalfa seed (40,225 lbs) and potatoes (46,778 lbs). Data were not available for any of the other authorized uses within Washington.

The California DPR gives us a clear picture of past uses in that state. The 2010 use report shows a 5% decrease in use from 2009. However, in 2009 pendimethalin use was 320,000 lbs greater than the previous year - this equates to a 22% increase from 2008(CAL-DPR, 2010). The reports hypothesize that growers may be using pendimethalin as an alternative to trifluralin or oryzalin in some crops. Both 2009 and 2010 reports link pendimethalin use to trends in acres of Round-up Ready™ alfalfa use. The number of alfalfa acres treated with pendimethalin rose from 4,578 in 2005 to 228,162 in 2009(CAL-DPR, 2010). This number dropped slightly in 2010 to 221,000 acres (CAL-DPR, 2011). Overall, the agricultural crops accounting for the greatest volume of pendimethalin were alfalfa (498,800 lbs), almonds (312,197 lbs), and wine grapes (141,972 lbs). It is not mandatory to report non-agricultural applications, though a number are reported anyway. Of those reported, the major contributors are landscape maintenance (36,820 lbs), rights-of-way (28,136 lbs), and ornamentals (6,616 lbs). The total reported pendimethalin use in 2010 was 1,722,158 lbs. In 2010, pendimethalin was sixteenth on the list of most-used pesticides (total lbs) and the second highest herbicide used (acreage).

Market Data. We do not have access to an analysis of marketing data for pendimethalin at this time.

For this consultation, the Action consists of the labeled uses of pendimethalin. The use data provided above will help to inform our analysis and identify the potential sources of risk to salmonids. However, because use of pesticides fluctuates based on pest pressure, pest resistance to these and other a.i.s, and environmental conditions including climate change, past use is not a reliable predictor of use patterns that may occur over the next fifteen years.

Agricultural Land, Crop Uses: Alfalfa, artichoke, asparagus, Bermuda grass (pasture), brassica head and stem vegetables, carrots, Christmas trees, clover, corn (field, pop, seed, and sweet), cotton, edible beans, fallow land, forage legumes, fruiting vegetables, garlic, grain sorghum, green onions, lentils and peas, mint, non-cropland areas, onions and shallots, orchards (citrus, pome, stone, and other fruits; olives and nuts), peanuts, perennial grasses, potatoes, rice, soybeans, strawberries, sugarcane, sunflowers, tobacco, vineyards, wheat

Developed Land, Urban / Residential: Turf grass, lawns, ornamentals (including non-bearing trees and vines), grounds maintenance, rights-of-way

Registered Formulation Types. Pendimethalin products are generally formulated as emulsifiable concentrates or granules. End-use products contain pendimethalin or a combination of pendimethalin and an additional a.i. or fertilizer. Two labels registered for use on agricultural areas within the four-state area contain an additional a.i.; one formulation contains glyphosate and the other sulfentrazone.

Mixtures. Most of the labels for agricultural crops recommend the use of additives. They suggest using surfactants, liquid fertilizer (28%, 30%, 32% Urea ammonium nitrate UAN, or ammonium sulfate), and crop oil concentrate. Several labels recommend tank mixtures for specific uses, including atrazine on corn and glyphosate on cotton. Labels also suggest a variety of tank mixtures for use on ornamentals, including Roundup Pro® (glyphosate), Finale® (glufosinate-ammonium), Ornamec® (fluazifop-P-butyl), Gallery® (isoxaben), and Princep® (simizine). For total vegetation control (*i.e.*, bare ground), a mixture with Arsenal® (imazapyr, not permitted in CA), Plateau® (imazapic), Roundup® (glyphosate), Karmex® (diuron), Finale® (glufosinate-ammonium), or Oust® (sulfometuron methyl) is recommended (label 241-360).

Methods and Rates of Application.

Methods. Pendimethalin is applied as a liquid spray formulation. Pendimethalin can be applied either by aerial equipment or using ground equipment to a variety of row crops, orchard crops, vineyards, sod, seed, and rice (EPA, 2009a). Many labels state that efficacy will be improved by a light rainfall, but do not require soil incorporation. Pendimethalin can also be applied to most crops through an irrigation system. Home owner products are often formulated with a fertilizer and are applied by push-spreaders.

All pendimethalin labels contain the following language to protect endangered plant species:

> If endangered plant species occur in proximity to the application site, the following mitigation measures are required:
>
> - If applied by ground, leave an untreated buffer zone of 200 feet. The product must be applied using a low boom (20 inches above the ground) and ASAE fine to medium/coarse nozzles.
> - If applied by air, leave an untreated buffer of zone of 170 feet. Must use straight-stream nozzles (D-6 or larger); wind can be no more than 8 mph, and release height must be 15 feet or less.

These measures are a good step toward endangered species protection, though they do not necessarily provide protection for listed salmonids.

Application Rates. Application rates range from a minimum of 0.48 to 4 lb of pendimethalin per acre for agricultural crops (Table 3). Agricultural uses are mostly limited to one application per year, though that is not always explicitly stated on the label. Orchard crops are the exception, allowing reapplication after 30 days. These are also the highest single application rates: 2-4 lb a.i./A with a yearly maximum of either 4 or 6 lb a.i./A. While not explicitly stated, the yearly maximum implies only 2 or 3 applications will occur. Ornamentals, non-crop land and Christmas trees have a maximum use rate of roughly 2-4 lbs a.i./A. Turf use rates range from 1-3 lbs a.i./A. The application rates, subsequent applications, and reapplication intervals vary depending on the species of grass and weeds.

Some end-use products include an additional active ingredient; each of these has multiple uses. The Herbicide BAS 756 00 has a mixture of pendimethalin and glyphosate and is registered for use on multiple crops (label 7969-254). Use rates range from 0.5 lbs a.i./A pendimethalin/ 0.28 lbs a.i./A glyphosate (alfalfa and cotton minimum) to 4.0 lbs a.i./A pendimethalin/ 2.24 lbs a.i./A glyphosate (long term control in orchard / vineyards) (Table 4). Similarly, F7488-1 Herbicide is a combination of pendimethalin and sulfentrazone (label 279-3359). Use rates for this product range from 0.55 lbs a.i./A pendimethalin/ 0.06 lbs a.i./A sulfentrazone (dry beans and peas minimum) to 2.95 lbs a.i./A pendimethalin/ 0.32 lbs a.i./A sulfentrazone (sugarcane) (Table 5).

Table 3. Pendimethalin use patterns in the action area

Use	Use Site	Land Use category	Max. Single App. Rate (lbs a.i./A)	Number of App. per Year	Annual App. Rate (lbs a.i./A)	App. Interval (days)	App. Method	Label Number
Alfalfa	Crop	Agriculture	4	NS[1,3]	4	NS	Ground, air, chemigation,flooded basin irrigation systems, on dry bulk fertilizer	241-337
Artichoke	Crop	Agriculture	4	1	4	NA[2]	Ground, air	241-418
Asparagus	Crop	Agriculture	4 (1.14 on sandy soil)	1	4	NA	Ground, air	241-418
Citrus Trees, bearing	Crop	Agriculture	2 – 4[4]	NS	6	30	Ground, chemigation, flooded basin irrigation system	241-337
Nut trees, bearing	Crop	Agriculture	2 – 4[4]	NS	6	30	Ground, chemigation, flooded basin irrigation system	241-337
Pome Fruit Trees, bearing	Crop	Agriculture	2 – 4[4]	NS	4	30	Ground, chemigation, flooded basin irrigation system	241-337
Stone Fruit Trees, bearing	Crop	Agriculture	2 – 4[4]	NS	4	30	Ground, chemigation, flooded basin irrigation system	241-337
Olive trees, bearing and non-bearing	Crop	Agriculture	2 – 4	NS	4	30	Ground, chemigation, flood, flooded basin, gravity flow irrigation	241-418
Other Fruit Trees, bearing	Crop	Agriculture	2 – 4[4]	NS	4	30	Ground, chemigation, flooded basin irrigation system	241-337
Bermuda grass (winter dormancy application)	Hay / Pasture[5]	Agriculture	1 – 4	2	4	Winter and spring	Ground, air, chemigation	241-418

Use	Use Site	Land Use category	Max. Single App. Rate (lbs a.i./A)	Number of App. per Year	Annual App. Rate (lbs a.i./A)	App. Interval (days)	App. Method	Label Number
Brassica Head and Stem vegetables	Crop	Agriculture	1	1	1	NA	Ground, air	241-418
Carrots	Crop	Agriculture	1	1	1	NA	Ground, air, chemigation	241-337
Carrots grown for seed	Crop	Agriculture	2	1	1	NA	Ground (layby application only)	241-337
Clover grown for seed (ID, OR)	Crop	Agriculture	0.95 - 3.8	NS	NS	NS	Ground	241-418
Corn (Field, Pop, Seed, Sweet)	Crop	Agriculture	0.5 - 2 Depending on soil qualities	NS[3]	2	NS	Ground, air, chemigation (Field corn only: culti-spray)	241-337
Cotton	Crop	Agriculture	0.5 - 2 Depending on soil qualities	NS[3]	2	NS CA allows app in late fall	Ground, air, chemigation	241-337
Edible Beans	Crop	Agriculture	0.7 - 1.5 Depending on soil qualities	1 / cropping season	0.7 – 1.5	NA	Ground, air	241-337
Fallow	Crop	Agriculture	1.4 (CA) 1.5 (ID, OR, WA)	1	1.4 – 1.5	NA	Ground, air, chemigation	241-418
Forage Legumes	Crop	Agriculture	0.5 – 1.2 Depending on soil qualities	NS	NS	NS	Ground, air	241-337

Use	Use Site	Land Use category	Max. Single App. Rate (lbs a.i./A)	Number of App. per Year	Annual App. Rate (lbs a.i./A)	App. Interval (days)	App. Method	Label Number
Fruiting Vegetables (Pepper, Tomato)	Crop	Agriculture	0.5 – 1.5 Depending on soil qualities	NS	1.5	NS	Ground, air	241-337
Garlic	Crop	Agriculture	0.7 – 1.5 Depending on soil qualities	NS	1.5 (CA)	NS	Ground, air, chemigation	241-337
Grain Sorghum	Crop	Agriculture	0.7 – 1.5 Depending on soil qualities and state	1	0.7 - 1.5	NA	Ground, air	241-337
Green Onions (Leeks, Spring Onions)	Crop	Agriculture	1	1	2	30	Ground, air	241-337
Lentils and Peas (Not CA)	Crop	Agriculture	0.7 – 1.5 Depending on soil qualities	1	0.7 – 1.5	NA	Ground, air	241-337
Mint (Not CA)	Crop	Agriculture	0.7 - 2 Depending on soil qualities	1	2	NA	Ground, air	241-337
Nonbearing Pome, Stone and other Fruit Trees	Crop	Agriculture	2 - 4	NS	4	30	Ground, air, chemigation, flooded basin irrigation system	241-337
Nonbearing Citrus Trees, Nut Trees, and Vineyards	Crop	Agriculture	2 - 4	NS	6	30	Ground, air, chemigation, flooded basin irrigation system	241-337

Use	Use Site	Land Use category	Max. Single App. Rate (lbs a.i./A)	Number of App. per Year	Annual App. Rate (lbs a.i./A)	App. Interval (days)	App. Method	Label Number
Onions and Shallots (Dry Bulb)	Crop	Agriculture	0.7 – 1.5 Depending on soil qualities ID, OR, WA: 1.5 – 2 to control dodder or on muck soil	CA: 1 ID,OR, WA: 2	CA: 1.5 ID, OR, WA: mineral soil 4, muck soil: 5.9	NS	Ground, air, chemigation	241-337
Peanuts (not CA)	Crop	Agriculture	1	NS	NS	NS	Ground, air, chemigation	241-337
Potatoes	Crop	Agriculture	0.7 - 1.5	1	0.7 - 1.5	NA	Ground, air, chemigation	241-337
Rice Dry Seeded	Crop	Agriculture	0.7 - 1	NS	NS	NS	Ground, air	241-337
Rice CA Wet Seeded	Crop	Agriculture	0.7 - 1	NS	NS	NS	Ground, air (Do not apply to fields with standing water)	241-418
Soybeans (not CA)	Crop	Agriculture	0.7 - 2 Depending on soil qualities	1	0.7 - 2	NA	Ground, air	241-337
Strawberries	Crop	Agriculture	0.7 - 1.5 Nonbearing 1st year: 1.6	2	3	NS	Ground, air, chemigation	241-337 241-418
Sugarcane	Crop	Agriculture	2 - 3	NS	6	NS	Ground	241-337
Sunflowers	Crop	Agriculture	0.7 - 1 Depending on soil qualities	1	0.7 – 1	NA	Ground, air (CA: Only pre-plant incorporated)	241-337

Use	Use Site	Land Use category	Max. Single App. Rate (lbs a.i./A)	Number of App. per Year	Annual App. Rate (lbs a.i./A)	App. Interval (days)	App. Method	Label Number
Tobacco	Crop	Agriculture	Layby: 1.5 – 2 Incorporated: 2 – 3	1	1.5 – 3	NS	Ground (preplant incorporated or layby application)	241-337
Wheat	Crop	Agriculture	1.5 – 3 Depending on soil qualities	NS	3	NS	Ground, air, chemigation	241-418
Perennial grasses grown for seed	Crop	Agriculture	2 – 4	2[3]	4	NS	Ground, air, chemigation	241-418
Grapevine, Bearing and non-bearing	Crop	Agriculture	6	NS	6	30	Ground, chemigation, and flood, flooded basin and gravity flow irrigation systems	241-418
Bermuda grass pasture (Winter dormant)	Pasture	Agriculture	1 - 4	1 2	4 2	winter, spring	Ground, air, chemigation	69361-32
Strawberries – First year non-bearing OR, WA	Crop	Agriculture	0.71 – 1.66	1	0.71 – 1.66	NA	Ground	OR 060007 WA 060018 (241-418)
Alfalfa for seed ID OR	Crop	Agriculture	0.99 – 3.6	1	3.6	NA	Ground (drop nozzles)	ID 060016 OR 070027 (34704-868) OR 080013 (1381-216)
Dry Bulb Onions CA	Crop	Agriculture	0.48 – 0.71	NS	1.52	NS	Ground	CA 060029 (241-418)

Use	Use Site	Land Use category	Max. Single App. Rate (lbs a.i./A)	Number of App. per Year	Annual App. Rate (lbs a.i./A)	App. Interval (days)	App. Method	Label Number
Dry Bulb Onions ID, OR, WA	Crop	Agriculture	0.48 – 1.43	NS	1.43	NS	Ground	ID 060009 OR 060008 WA 070004 (241 – 418)
Perennial Grass grown for seed ID, OR	Crop	Agriculture	1.98 – 2.97	NS	2.97	NS	Ground, Chemigation	ID 060020 OR 070026 (34704 – 868)
Clover grown for seed ID, OR	Crop	Agriculture	0.99 – 3.96	NS	3.96	NS	Ground	ID 060017 OR 070025 (34704-868)
Turf grass	Urban	Developed	1.07 – 2.97	1 or 2	Max: 4.95	35 - 56	Ground, aerial	241-360
Residential Turf (6)	Urban Residential	Developed	1.49 – 1.98	1 or 2	Max: 3.96	35 - 56	Ground, aerial	241-360
Kochia	Crop Pasture	Agriculture	1.98 -3.96[4]	NS	NS	NS	Ground, aerial	241-360
Ornamentals	Urban Residential	Developed	1.98 -3.96[4]	NS	NS	NS	Ground, aerial	241-360
Rights-of-way	Any	Any	1.07 – 2.97	1 or 2	Max: 4.95	35 - 56	Ground, aerial	241-360
Christmas trees	Crop	Agriculture	1.98 -3.96[4]	NS	NS	NS	Ground, aerial	241-360

1. NS = not specified
2. NA = not applicable
3. Sequential applications are permitted, but total applied per season cannot exceed the maximum single application rate.
4. Use rate is based on desired length of weed control, *e.g.*, short-term control vs. long-term control
5. Not permitted for use in range land
6. Residential is defined as turf in any residential situation as well as schools, parks, and playgrounds

Table 4. Pendimethalin/Glyphosate use patterns in the Action Area (7969-254). Applications must be soil incorporated via sprinkler or rainfall. Ranges are presented as use rate depends on soil texture and percent organic matter. Glyphosate application rates given in acid equivalents.

Use	Use Site	Land Use category	Max. Single App. Rate (lbs a.i./A)	Number of App. per Year	Annual App. Rate (lbs a.i./A)	App. Interval (days)	App. Method
Alfalfa	Crop	Agriculture	0.5 – 2.5 P 0.28 - 1.4G	NS[1]	4 P 2.24 G	NS	Ground, aerial
Fruit and Nut Trees (Bearing and Non-bearing) Vineyards (Non-bearing)	Crop	Agriculture	Short-term control: 2 P, 1.2 G Long-term control: 4 P, 2.24 G	NS	6 P 3.36 G	NS	Ground
Corn[3] (Field, Pop, Seed, Sweet)	Crop	Agriculture	0.75 – 2.0 P 0.42 – 1.12 G	1 per crop season	2.0 P 1.12 G	NA[2]	Ground, aerial, culti-spray (field corn only)
Cotton	Crop	Agriculture	0.5 – 2.0 P 0.28 – 1.2 G	NS	2.0 P 1.12 G	NS	Ground, aerial
Edible Beans	Crop	Agriculture	0.75 – 1.5 P 0.42 – 0.84 G	1	1.5 P 0.84 G	NA	Ground, aerial
Garlic	Crop	Agriculture	0.75 – 1.5 P 0.42 – 0.84 G	1	1.5 P 0.84 G	NA	Ground, aerial
Lentils and Peas (Not CA)	Crop	Agriculture	0.75 – 1.5 P 0.42 – 0.84 G	1	1.5 P 0.84 G	NA	Ground, aerial
Peanuts (not CA)	Crop	Agriculture	0.5 – 1.0 P 0.28 – 0.56 G	1	1.0 P 0.56 G	NA	Ground, aerial
Soybeans (not CA)	Crop	Agriculture	0.75 – 2.0 P 0.42 – 1.2 G	1	2.0 P 1.2 G	NA	Ground, aerial
Sugarcane	Crop	Agriculture	2 – 3 P 1.2 – 1.68 G	NS	6 P 3.36 G	NS	Ground, aerial
Sunflowers (not CA)	Crop	Agriculture	1 – 1.5 P 0.56 – 0.84	1	1.5 P 0.84 G	NA	Ground, aerial

1. NS = not specified
2. NA = not applicable
3. Recommends applying with up to 1.2 lb a.i. per acre of atrazine; Do not apply in no-till in CA

Table 5. Pendimethalin/Sulfentrazone use patterns in the Action Area (279-3359). Ranges are presented as use rate depends on soil texture and percent organic matter.

Use	Use Site	Land Use category	Max. Single App. Rate (lbs a.i./A)	Number of App. per Year	Annual App. Rate (lbs a.i./A)	App. Interval (days)	App. Method
Corn (Field, Pop, Seed)	Crop	Agriculture	0.62 - 1.89 P 0.07 – 0.21 S	NS	1.89 P 0.21 S	NS	Ground, aerial, chemigation, dry fertilizer impregnation
Peanuts	Crop	Agriculture	0.66 – 1.48 P 0.93 – 0.16 S	NS	1.48 P 0.16 S	NS	Ground, aerial, chemigation, dry fertilizer impregnation
Potatoes	Crop	Agriculture	0.71 – 1.43 P 0.08 – 0.16 S	NS	1.43 P 0.16 S	NS	Ground, aerial, chemigation, dry fertilizer impregnation
Soybeans	Crop	Agriculture	0.71 – 1.43 P 0.08 – 0.16 S	NS	1.43 P 0.16 S	NS	Ground, aerial, chemigation, dry fertilizer impregnation
Sugarcane	Crop	Agriculture	1.97 – 2.95 P 0.22 – 0.32 S	NS	2.95 P 0.32 S	NS	Ground, aerial
Sunflowers (not CA)	Crop	Agriculture	0.69 – 1.43 0.08 – 0.16	NS	1.43 P 0.16 S	NS	Ground, aerial, chemigation, dry fertilizer impregnation
Tobacco (not shade grown)	Crop	Agriculture	0.69 – 0.98 P 0.08 – 0.11 S	NS	1.43 P 0.16 S	NS	Ground, aerial, chemigation, dry fertilizer impregnation
Dry Beans and Peas	Crop	Agriculture	0.55 – 1.43 P 0.06 – 0.16 S	NS	1.43 P 0.16 S	NS	Ground, aerial
Mint (not CA)	Crop	Agriculture	0.69 – 1.43 0.08 – 0.16	NS	1.43 P 0.16 S	NS	Ground, aerial

Metabolites and Degradates.

Pendimethalin degrades very slowly via any pathway (weeks to months)(EPA, 2009a). Four degradates have been identified. One degradate is 9.3% of applied parent, all others are less than 2%. All degradates maintain the characteristic dinitroaniline structure. EPA states there is no information on degradates of dinitroaniline in information submitted by applicants or in open literature (EPA, 2009a, 2009b, 2010b). No fate information is available for any of the degradates.

Trifluralin

Trifluralin is a selective pre-emergent dinitroaniline herbicide used to control annual grasses and broadleaf weeds (EPA, 2004c). It has a variety of labeled uses, including numerous food crops, rights-of-ways, ornamentals, cottonwood plantations, turf, and home lawns and gardens. In this Opinion, "home owner uses" refers to products that can be applied by members of the general public, while "residential uses" covers products / rates that require special permitting or licensing. The technical registrants are Dow Agrosciences, Dintec, Drexel, Agan Chemical Manufacturers, Aceto Agricultural Chemicals Corp, Industria Prodotti Chimichi S.P.A., and Atanor S. A. There are over 100 end-use products containing trifluralin sold by 39 different companies. Dow Agrosciences also produces two formulated products for manufacturing use which are a combination of trifluralin and benefin (labels 62719-317 and 62719-318). There are also seven Special Local Needs (SLN, or Section 24c) registrations in California, Idaho, Oregon and Washington. There are no emergency use (Section 18) registrations for trifluralin.

Trifluralin is a foundation herbicide in many integrated weed management programs (DAS, 2011). It is used to control weeds early in the growing season, protecting the yield potential of crops by eliminating competitors. Trifluralin is also effective against weed species that have developed resistance to other commonly used herbicides (DAS, 2011). It plays a role in weed resistant management programs that require use of herbicides with different modes of action.

Usage Information.

Nation-wide estimates. Trifluralin is used in all four states covered by this action – California, Idaho, Oregon and Washington. The 2002 estimated use map provided by USGS's Pesticide National Synthesis Project shows trifluralin use is greater in California than in the other three states[5]. Nation-wide, the major agricultural uses for trifluralin are soybeans and cotton (EPA, 2004c, 2009b). Soybeans are not a significant crop within the four state area covered in this Opinion. Cotton is grown in California, but not the other states.

The NASS dataset also shows the greatest amount of trifluralin is used consistently on soybeans and upland cotton. The available information for California crops shows highest usage in upland cotton, followed by processing tomatoes. As with pendimethalin, there is limited information on Idaho, Oregon and Washington crops.

State level estimates. In 2010, a total of 472,479.85 lbs of trifluralin were applied in California (CAL-DPR, 2011). Alfalfa had the greatest use with 221,905 lbs applied, followed by processing tomatoes (83,022 lbs), safflower (26,126 lbs), cotton (24,546 lbs), and almond (20,376 lbs). All remaining uses had fewer than 10,000 lbs applied, and most were below 5,000 lbs. Non-agricultural uses that were reported include ornamentals (2,104 lbs), landscape maintenance (1,990 lbs), and rights-of-way (1,043 lbs).

Washington State estimated that trifluralin use in 2002 was roughly 50,000 lbs, with almost 40,000 lbs used on alfalfa, and the remainder on asparagus (9,000 lbs) and wheat (750 lbs) (EPA, 2004c). More recent estimates show application to alfalfa seed, asparagus, mint, potatoes, and green peas (WSDA, 2011c). Washington State Department of Agriculture provided estimated use rates and percentage of total crop-acres treated, but not the total amount applied. They did not have estimates for any of the other labeled uses. Use estimates are not available for Idaho or Oregon.

Market Data. At the July 22, 2011 meeting, Dow Agrosciences provided an analysis of the market data from a third party market research organization. Roughly 10% of the total trifluralin use in the US is in the four-state area (McMaster, Breaux, & Poletika, 2011). California uses the most at 9% of the nearly 6 million lb applied. The majority of it was used on alfalfa, tomatoes, and cotton (McMaster, et al., 2011). These uses are consistent with top uses reported by

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[5] Map is available at http://water.usgs.gov/nawqa/pnsp/usage/maps/show_map.php?year=02&map=m1361 accessed on August 12, 2011.

California DPR. In Idaho, trifluralin use was highest on dry beans and peas, followed by potatoes with minor use on sugar beets. Oregon had the highest use on potatoes, beans, and minor uses on other vegetables. Finally, Washington has the highest use on asparagus, followed by peas, potatoes, and carrots. There is some discrepancy between the Dow's data from the third party market research data and that provided by Washington State Dept of Agriculture – notably the absence of alfalfa in the market research data. This may be due to comparing data across years.

Dow presented information regarding non-crop uses of trifluralin. While there are a number of labels for turf products, their data show that turf is no longer a significant market for trifluralin. Third party market research data shows a decrease in turf uses over time, leveling off in the past few years. Dow believes this change is the result of the introduction of less expensive, more efficacious products coming on the market (applicant meeting, July 22, 2011). Other non-crop uses, such as rights-of-way, are also fairly uncommon for the same reasons. The soil incorporation requirement may make trifluralin a less desirable product for these uses.

For this consultation, the Action consists of the labeled uses of trifluralin. The use data provided above will help to inform our analysis and identify the potential sources of risk to salmonids. However, because use of pesticides fluctuates based on pest pressure, pest resistance to these and other a.i.s, and environmental conditions including climate change, past use is not a reliable predictor of use patterns that may occur over the next fifteen years.

Agricultural Crop Uses: alfalfa, asparagus, beans, Bermuda grass grown for seed, broccoli raab, cereal grains, field corn, carrots, celery, chickory, clover grown for seed (CA), cole crops, collards, cotton, cottonwood trees grown for pulp, crambe, cucurbits, durum, eggplant, flax, field grown roses, grain sorghum, greens (kale, mustard, turnip), guar, hops, kenaf, lupine, okra, onions, peas, peppers, peppermint, potatoes, radishes, rapeseed, safflower, soybeans, no-till soybeans, spearmint, sugar beets, sugarcane, tomatoes, citrus trees (bearing and non-bearing), stone fruit trees, nut trees, vineyards, wheat, Christmas tree plantations, ornamentals

Developed Land, Urban / Residential: Container grown ornamentals, nursery stock, ground cover, established flowers, ornamental bulbs, non-bearing trees and vines, turf, golf courses, graveyards, athletic fields, under paved surfaces, non-crop land (industrial sites, utility substations, highway rights-of-way), homeowner uses (ornamentals, home lawns, flower gardens, vegetable gardens)

Registered Formulation Types. Trifluralin products are generally formulated as emulsifiable concentrates or granules. There are a few specialized products that incorporate trifluralin into filters, landscaping fabrics, and mulches. Several trifluralin products are formulated with one or two additional a.i.s. These formulations are used almost exclusively on turf and ornamentals, though there are a few exceptions (Table 6). Formulations for turf and ornamental use which had multiple a.i.s had a lower percent by weight of trifluralin than those with only trifluralin; the overall amount of a.i. in the formulation was 1-2% regardless of the number of a.i.s. There is one formulation not included, label 241-307, as it is not permitted for use within the action area.

Table 6. Trifluralin formulations with additional a.i.s.

Formulation	Use	Label Number
Trifluralin 3% Triallate 10%	(ID, OR, WA) Barley, Green and Field Dried Peas, Durum Wheat, and Winter Wheat	10163-298
Trifluralin 32% Clomazone 21.8%	Soybeans and Cotton (not in CA)	279-3104
Trifluralin 0.375% Oxadiazon 0.5% Benefin 0.375% Fertilizer	Commercial turf uses (cemeteries, golf courses, etc.)	52287-10
Trifluralin 0.25% Benefin 0.25% Oxadiazon 0.75% Fertilizer	Commercial turf uses (cemeteries, golf courses, etc.), ornamental shrubs, vines, trees, ground covers	52287-11
Trifluralin 0.25% Benfluralin 0.25% Oxadiazon 1% Fertilizer	Commercial turf uses (cemeteries, golf courses, etc.), ornamental shrubs, vines, trees, ground covers	52287-12
Trifluralin 3% Oxyfluorfen 2%	Nursery stock, container grown ornamentals, landscape ornamentals	52287-15
Trifluralin 10% Indole-3-butyric acid 0.001%	Agricultural crops, Pot-In Pot Nursery production of trees and shrubs	5905-554

Formulation	Use	Label Number
Trifluralin 0.39% Benefin 0.76% Fertilizer	Turf grass	62719-150 62719-331
Trifluralin 0.31% Benefin 0.61% Fertilizer	Turf grass	62719-151 62719-332
Trifluralin 0.43% Benefin 0.82% Fertilizer	Turf grass	62719-152 62719-327
Trifluralin 0.67% Benefin 1.33%	Turf grass	62719-137
Trifluralin 2.0% Isoxaben and isomers 0.5%	Landscape ornamentals, Christmas tree plantations, container and field grown ornamentals, ground cover, established flowers, ornamental bulbs, non bearing fruit and nut trees and non bearing vineyards	62719-175 66222-224 9198-252
Trifluralin 0.27% Isoxaben and isomers 0.27% Benefin 0.53% Fertilizer	Turf grass	62719-192
Trifluralin 0.39% Isoxaben 0.38% Benefin 0.76% Fertilizer	Lawn and ornamental	62719-280
Trifluralin 0.43% Benefin 0.43% Fertilizer	Lawn and ornamental	62719-289
Trifluralin 0.29% Benefin 0.57% Fertilizer	Lawn and ornamental	62719-290
Trifluralin 2% Isoxaben and isomers 0.25% Oxyfluorfen 0.25%	Landscape ornamentals, ground cover, established flowers, ornamental bulbs, non bearing fruit and nut trees and non bearing vineyards	62719-516
Trifluralin 0.50% Benefin 0.50% Isoxaben and isomers 0.38% Fertilizer	Lawn and ornamental	62719-565
Trifluralin 0.38% Benefin 0.76% Fertilizer	Turf grass	8378-17
Trifluralin 0.43% Benfluralin 0.84% Fertilizer	Home lawns, golf courses, parks, ornamental and recreational turf	8378-18
Trifluralin 0.5% Benefin 1% Fertilizer	Home lawns, golf courses, parks, ornamental and recreational turf	8378-19

Formulation	Use	Label Number
Trifluralin 0.30% Benefin 0.62% Fertilizer	Lawn and golf course	8378-20 9198-94
Trifluralin 0.48% Benefin 0.93% Fertilizer	Apartment and condo complexes, home lawns, golf courses, parks, ornamental and recreational turf	8378-37
Trifluralin 0.38% Benefin 0.77% Fertilizer	Lawns and golf courses	9198-79
Trifluralin 0.385% Benefin 0.770% Fertilizer	Turf grass	961-346
Trifluralin 0.515% Benefin 1.03% Fertilizer	Turf grass	961-348
Trifluralin 1.5% Isoxaben 0.375%	Non-residential turf: sports fields, cemeteries, golf courses, industrial sites, non-cropland, parks, rights-of-way, roadsides	961-370
Trifluralin 0.43% Benefin 0.82% Triethylamine salt of triclopyr 0.5% Triethylamine salt of clopyralid 0.18%	Non-residential turf: sports fields, cemeteries, golf courses, industrial sites, non-cropland, parks, rights-of-way, roadsides	961-390 961-391

Mixtures

The trifluralin labels recommend a number of products that may be applied either concurrently or subsequently (Table 7). These suggestions are generally crop specific, with cotton and soybeans having the greatest number of combinations. It is important to note that these mixture suggestions only appear on labels that have trifluralin as the only a.i. The only formulation that includes an additional a.i. *and* has suggested mixtures with other pesticide products is not authorized for use within the action area (label 241-307).

Table 7 Product combinations suggested on trifluralin labels.

Crop	Type of mixture	Product[1]	Label[1]
Cotton	Tank Mix	Caparol, Prometryne, Cotoran (not CA), Zorial, Canopy, Lasso, Dual, Command, Command and Lexone, Command and Sencor, Fleumetron, Meturon, Riverside Prometryne, Riverside Fluometuron 4L (not CA)	10163-99 241-343 2749-542 279-3104 5905-519 5905-521 66330-222 66330-226 67959-4 9779-303 9779-341
	Overlay	Karmex 80W, Cotoran, Zorial, Diuron, Fluometuron, Aorial	10163-99 241-343 42750-34 5905-519 5905-521 9779-303 9779-326
Soybean	Tank Mix	Sencor, Lexone, Vernam, Scepter, Amiben, Preview, Canopy, Metribuzin, clomazone (not CA), metribuzin + clomazone (not CA), Command, Command + Sencor, Command + Lexone, Amiben + Sencor, Amiben + Lexone, dual, Dual II, Lasso, Fronteir, Micro-Tech, Partner, Preview, Pursuit	10163-99 19713-254 241-343 2749-542 34704-792 279-3104 5905-519 5905-521 66330-222 66330-226 67959-4 68156-4 9779-303 9779-341
	Overlay	Sencor, Canopy, Dual, Lasso, Lexone, Lorox, Lorox plus, Preview, Pursuit, Scepter, Sencor, Aciflurofen (Blazer or Tackle), chlorimuron ethyl + metribuzin, chlorimuron ethyl + linuron, metribuzin, metribuzin + chlorimuron products, alachlor, vernolate, metolochlor, linuron, imazethapyr, imazaquin, Gemini, Command, Dual II, Frontier, Micro-Tech, Partner, Judge, Amiben	2749-542 279-3104 35935-1 42750-34 5905-519 9779-326 9779-341

Crop	Type of mixture	Product[1]	Label[1]
	Post-emergence treatment following pre-plant incorporation (not in CA)	Basagran, Blazer, Classic, Cobra, Galaxy, Pinnacle, Pursuit, Reflex, Scepter, Storm, Bentazon, acifluorfen, chlorimuron, ethyl, lactofen, thifensulfuron, imazaquin, imazethapyr, fomesafen, Tackle, Canopy, Dual, Lasso, Lexone, Lorox, Lorox plus, Preview, Sencor, Concert, Flexstar, Reliance STS, Scepter QT, Synchrony STS	2749-542 35935-1 42750-34 5905-519 9779-303 9779-326
Dry Bean	Tank Mix	Eptam	10163-99 241-343 2749-542 5905-519 5905-521 66330-222 66330-226 9779-341
Corn	Tank Mix	Atrazine	10163-99 19713-254 2749-542 35935-1 5905-519 67959-4 9779-303 9779-341
Grain Sorghum	Tank Mix	Atrazine	10163-99 19713-254 2749-542 35935-1 5905-519 67959-4 9779-303 9779-341
Pea	Tank Mix	Far-Go (ID, OR, WA), Avadex	10163-99 241-343 2749-542 35935-1 5905-519 5905-521 66330-222 66330-226 67959-4 9779-341

Crop	Type of mixture	Product[1]	Label[1]
Potato	Tank Mix	Eptam (ID,OR, WA), EPTC	11773-17 2749-542 34704-853 35935-1 5905-519 66330-222 66330-226 67959-4 68156-4 9779-303 9779-341
Peanut	Tank Mix	Vernam	241-343 5905-521
Wheat	Tank Mix	Avadex	241-343
Sugar Beets	Tank Mix or Overspray	Eptam, EPTC	2749-542 35935-1 5905-519 9779-303
Durham	Tank Mix	Far-Go	34704-792 5905-519 66330-226 67959-4 9779-303 9779-341
Barley	Tank mix	Far-Go	34704-792 5905-519 5905-521 66330-226 67959-4 9779-303 9779-341
Sunflower	Tank Mix	EPTC, Amiben	35935-1 66330-222 66330-226
Spring Wheat	Tank Mix	Far-Go	5905-519 66330-222 66330-226 67959-4 9779-303 9779-341

1. Product and label columns are cumulative - each label suggests a subset of product combinations.

Methods and Rates of Application.

Methods. Trifluralin may be applied with a wide range of application equipment including aircraft, ground spray, drop or rotary spreader, hand held granule applicator, shaker jar and soil broadcast treatment. It may also be applied via chemigation for certain crops. Trifluralin must be soil incorporated, either mechanically or by watering the product into the soil. Mechanical incorporation is more prevalent than watered in products. Some labels require two separate incorporations, one within 24 hours of application and another five days after application. Trifluralin may be applied at various stages including pre-plant, pre-emergence, emergence, dormant stage, established plantings, post-emergence, and/or post harvest.

Application Rates. Application rates are generally 0.5 to 2 lb of trifluralin per acre for agricultural crop (Table 8)**.** Agricultural uses are mostly limited to one application per year. Ornamentals, non-crop land and Christmas trees have a maximum use rate of 4 lbs a.i./A, though reapplication is allowed after roughly two months. Turf uses have a maximum of 1 lb a.i./A, and homeowner uses are even lower at 0.4 – 0.6 lb a.i./A, also with a reapplication interval of roughly two months. The highest use rate is for a construction use, where an area is treated prior to paving at a rate of 16 lb a.i./A.

Table 8. Trifluralin use patterns in the Action Area.

Use	Use Site	Land Use category	Max. Single App. Rate (lbs a.i./A)	Number of App. per Year	Annual App. Rate (lbs a.i./A)	App. Interval (days)	App. Method	Label Number
Alfalfa	Crop	Agriculture	2	2	4 max	NS	Ground, aerial	62719-131
Asparagus	Crop	Agriculture	1-2	1	1-2	NA	Ground, aerial	62719-131
Barley	Crop	Agriculture	0.5 - 0.75	1	0.5 - 0.75	NS	Ground, aerial	62719-131
Beans (dry)	Crop	Agriculture	0.5 – 1	1	0.5-1	NA	Ground, aerial	62719-131
Beans (fresh)	Crop	Agriculture	0.5 – 1	1	0.5-1	NA	Ground, aerial	62719-131
Guar	Crop	Agriculture	0.5 – 0.75	1	0.5- 0.75	NA	Ground, aerial	62719-131
Carrot	Crop	Agriculture	0.5 – 1	1	0.5-1	NA	Ground, aerial	62719-131
Celery	Crop	Agriculture	0.5 – 1	1	0.5-1	NA	Ground, aerial	62719-131
Chicory	Crop	Agriculture	0.5 – 1	1	0.5-1	NA	Ground, aerial	62719-131
Cole Crops	Crop	Agriculture	0.5 – 1	1	0.5-1	NA	Ground, aerial	62719-131
Collard	Crop	Agriculture	0.5 - 0.75	1	0.5 - 0.75	NA	Ground, aerial	19713-254
Corn – field corn	Crop	Agriculture	0.375 - 1	1	0.375 - 1	NA	Ground, aerial chemigation	62719-131 68156-4
Cotton	Crop	Agriculture	2	NS	4	NS	Ground, aerial	62719-131
Cottonwood or Poplar trees grown for pulp	Crop	Agriculture	2	NS	NS	NS	Ground, aerial	68156-4
Crambe	Crop	Agriculture	0.5 – 1	1	0.5 – 1	NA	Ground, aerial	62719-131
Cucurbits	Crop	Agriculture	0.5 – 1	NS	NS	NS	Ground, aerial	62719-131
Durum	Crop	Agriculture	0.5 - .75	1	0.5 - 0.75	NS	Ground, aerial	62719-131
Eggplant	Crop	Agriculture	0.5 – 1	1	0.5 – 1	NA	Ground, Aerial, chemigation	66222-46
Flax	Crop	Agriculture	0.5 - 1	1	0.5 - 1	NA	Ground, aerial	62719-131
Grain sorghum (milo)	Crop	Agriculture	0.4 – 1	1	0.4 – 1	NA	Ground, aerial chemigation	62719-131 68516-4

Use	Use Site	Land Use category	Max. Single App. Rate (lbs a.i./A)	Number of App. per Year	Annual App. Rate (lbs a.i./A)	App. Interval (days)	App. Method	Label Number
Greens (Kale, Mustard, and Turnip)	Crop	Agriculture	0.5 - 0.75	1 / season	NS	NS	Ground, aerial	62719-131
Hops	Crop	Agriculture	0.5 - 0.75	1	0.5 - 0.75	NS	Ground, aerial	62719-131
Kenaf	Crop	Agriculture	0.5 - 0.75	1	0.5 - 0.75	NS	Ground, aerial	68516-4
Lupine	Crop	Agriculture	0.5 – 1	1	0.5 – 1	NA	Ground, aerial	66222-46
Okra	Crop	Agriculture	0.5 – 1	1	0.5 – 1	NS	Ground, aerial	68516-4
Onion	Crop	Agriculture	0.375 - 0.626	1	0.375 - 0.626	NA	Ground, aerial	62719-131
Peas	Crop	Agriculture	0.5 – 1	1	0.5 – 1	NA	Ground, aerial	62719-131
Pepper	Crop	Agriculture	0.5 – 1	1	0.5 – 1	NA	Ground, aerial	62719-131
Peppermint	Crop	Agriculture	0.5 - 0.75	1	0.5 - 0.75	NA	Aerial, ground, chemigation	68516-4
Potatoes	Crop	Agriculture	0.5 – 1	1	0.5 – 1	NA	Ground, aerial	62719-131
Potatoes (ID, OR, WA)	Crop	Agriculture	0.375 tank mix with Eptam	1	0.38	NS	Ground, aerial	68516-4
Radish	Crop	Agriculture	.05 - 0.75	1	0.5 - 0.75	NA	Ground, aerial	68516-4
Rapeseed (canola)	Crop	Agriculture	0.5 – 1	1	0.5 – 1	NA	Ground, aerial	62719-131
Safflower	Crop	Agriculture	0.5 – 1.25	1	0.5 – 1.25	NA	Ground, aerial	62719-131
Soybean	Crop	Agriculture	1.25 (1.50 applied with dry fertilizer)	1	1.25	NA	Ground, aerial	68516-4
No-till Soybeans Not CA	Crop	Agriculture	2[4]		2		Ground, aerial	68516-4
Spearmint	Crop	Agriculture	0.5 - 0.75	1	0.5 - 0.75	NA	Aerial, ground, chemigation	68516-4
Sugar Beets	Crop	Agriculture	0.5 - 0.75	1	0.5 - 0.75	NA	Ground, aerial	62719-131

Use	Use Site	Land Use category	Max. Single App. Rate (lbs a.i./A)	Number of App. per Year	Annual App. Rate (lbs a.i./A)	App. Interval (days)	App. Method	Label Number
Sugarcane	Crop	Agriculture	1 – 2	2	2 – 4	6 months	Ground, aerial	62719-131
Sunflower	Crop	Agriculture	0.5 – 1	1	0.5 – 1	NA	Ground, aerial	62719-131
Tomato	Crop	Agriculture	0.5 – 1	1	0.5 – 1	NA	Ground, aerial	62719-131
Non-bearing citrus trees	Crop	Agriculture	New: 0.5 - 1 Established: 1 - 2	NS	NS	NS	Ground, aerial	68516-4
Citrus Tree	Crop	Agriculture	New: 0.5 - 1 Established: 1 - 2	NS	NS	NS	Ground, aerial	68516-4
Stone Fruit Tree	Crop	Agriculture	New: 0.5 - 1 Established: 1 - 2	NS	NS	NS	Ground, aerial	68516-4
Nut Tree	Crop	Agriculture	New: 0.5 - 1 Established: 1 - 2	NS	NS	NS	Ground, aerial	68516-4
Vineyards	Crop	Agriculture	New: 0.5 – 2 Established: 1 - 2	NS	NS	NS	Ground, aerial	68516-4
Wheat	Crop	Agriculture	0.5 - 0.75	1	0.5 - 0.75	NS	Ground, aerial	62719-131
Winter Wheat (fallow application ID, OR, WA)	Crop	Agriculture	0.75 – 1	1	0.75 – 1	NS	Ground, aerial	62719-131
Wheat – Summer fallow for spring seeded wheat durum, or barley	Crop	Agriculture	0.5 – 1	1	0.5 – 1	NS	Ground, aerial	62719-131

Use	Use Site	Land Use category	Max. Single App. Rate (lbs a.i./A)	Number of App. per Year	Annual App. Rate (lbs a.i./A)	App. Interval (days)	App. Method	Label Number
Ornamentals	Landscape Crop	Developed / Agriculture	4	NS	12	60	Drop or Rotary Spreader	62719-98
Container Grown Ornamentals, Nursery Stock, Ground Cover, Established flowers, Ornamental Bulbs	Landscape Crop	Developed / Agriculture	4	NS	12	60	Drop or Rotary Spreader	62719-98 62719-175
Roses – field grown	Crop	Agriculture	2	NS	2	NS	Ground spray	62719-97
Christmas Tree Plantations	Crop	Agriculture	4	NS	12	60	Drop or Rotary Spreader	62719-98
Turf	Turf	Developed	Cool Season Turf Grass: 0.8 Warm Season Turf Grass: 1.0	2	Cool: 1.6 Warm: 2.0	Cool: 56 – 70 Warm: 70 - 84	Drop or Rotary Spreader	62719-137[2]
Non-Cropland	Industrial sites, Utility substation, Highway rights-of-way	Developed	4	NS	12	60	Drop or Rotary Spreader	62719-98
Under Paved Surfaces	Urban, Residential, Industrial sites	Developed	16	NA	NA	NA	Sprayer	62719-97
Home Lawns & Ornamentals	Residential, Home Owner Use	Developed	0.04 - 0.06	2	0.12	Cool: 56 – 70 Warm: 70 - 84	Drop or Rotary Spreader	62719-280

Use	Use Site	Land Use category	Max. Single App. Rate (lbs a.i./A)	Number of App. per Year	Annual App. Rate (lbs a.i./A)	App. Interval (days)	App. Method	Label Number
Vegetable Gardens	Home Owner Use	Developed	0.5	NS	NS	NS	Ground Spray	68516-4
ID, OR, WA: Alfalfa grown for seed	Crop	Agriculture	0.3 - 0.4	NS	NS	NS	Ground, aerial	ID 910001 OR 900019WA 900016
CA: Alfalfa	Crop	Agriculture	0.2	2	0.4	60	Ground, aerial	CA 870029
CA: Clover grown for seed	Crop	Agriculture	2	NS	NS	NS	Ground, aerial	CA 940002
CA: Bermuda Grass grown for seed	Crop	Agriculture	2	NS	NS	NS	Ground, aerial	CA 940003
CA: Broccoli Raab	Crop	Agriculture	0.5 – 0.75	1	0.5 – 0.75	NS	Ground	CA 010021

1. NS = not specified
2. The values are for amount trifluralin in product – also contains benefin
3. The values are for amount trifluralin in product – also contains benefin and isoxaben (and isomers)
4. This use rate is associated with a recommended tank mix that includes Canopy 75DF

Metabolites and Degradates.

Twelve degradates of trifluralin have been identified in guideline fate tests(EPA, 2009b). All of these degradates retain a ring structure and the trifluoro- sidechain. Two degradates, 5-trifluoromethyl-3-nitro-1,2-benzenediamine (TR-6) and 2-ethyl-7-nitro-5-(trifluoromethyl) benzimidazole (TR-15), are produced in significant quantities (up to 30% and 47% respectively) by aqueous photolysis. Other degradates are produced by a variety of degradation pathways, and range from < 1% to 13 % of applied parent. EPA has not identified any of those degradates as a toxicological concern.

Approach to this Assessment

Overview of NMFS' Assessment Framework

NMFS uses a series of steps to assess the effects of federal actions on endangered and threatened species and designated critical habitat. The first step of our analysis identifies those physical, chemical, or biotic aspects of proposed actions that are likely to have individual, interactive, or cumulative direct and indirect effects on the environment (we use the term "potential stressors" for these aspects of an action). These effects are described in risk hypotheses here in the *Approach*. We identify the spatial extent of any potential stressors and recognize that the spatial extent of those stressors may change with time. The spatial extent of these stressors is the "action area" for a consultation.

The second step of our analyses identifies the listed resources (endangered and threatened species and designated critical habitat) likely to occur in the same space and at the same time as these potential stressors. If we conclude such co-occurrence is likely, we then try to estimate the nature of co-occurrence (in *Exposure*). In the exposure analysis, we try to identify the life stage and life history of the individuals that are likely to be exposed to an action's effects. Spatial analyses are used to overlay each species' range with land types on which pesticides are used. We break land use types into four generic groups: agriculture, forestry, urban/residential, and rights-of-way.

In the third step of our analysis we examine the scientific and commercial data available to determine whether and how those listed resources are likely to respond given their exposure (in *Response*). We consider standard endpoints used in pesticide risk analyses (survival, growth, and reproduction). We also consider other endpoints, including sublethal and behavioral effects which may not affect the other endpoints, but do impair the salmonids and/or affect its environment. We also consider the response of the primary constituent elements (PCEs) present in designated critical habitat

In the fourth step, *Risk Characterization*, we integrate the exposure and response analyses to assess the risk to listed individuals and the PCEs in their habitat from the stressors of the action. We consider the overlap between the action and the listed species and their habitat, the range of anticipated environmental concentrations of the stressor, the types and extent of responses, and other factors affecting the overall risk picture.

In the fifth step of our analysis (*Integration and Synthesis),* we make a conclusion regarding risk to populations within each ESU/DPS and to the species overall and to their designated critical habitat. This determination is made in the context of the *Status* of each species, the existing *Environmental Baseline,* and the potential *Cumulative Effects.* We also determine if jeopardy (for species) or adverse modification (for designated critical habitat) is likely.

We present the risk conclusions and determinations for each species and its designated critical habitat in the *Conclusion* section separately for each chemical.

Factors Considered in the Analysis

Our jeopardy determinations for listed species must be based on an action's effects on the continued existence of threatened or endangered species as those "species" have been listed, which can include true biological species, subspecies, or distinct population segments of vertebrate species. Because the continued existence of listed species depends on the fate of the populations that comprise them, the viability (that is, the probability of extinction or probability of persistence) of listed species depends on the viability of the populations that comprise the species. Similarly, the continued existence of populations are determined by the fate of the individuals that comprise them; populations grow or decline as the individuals that comprise the population live, die, grow, mature, migrate, and reproduce (or fail to do so).

The structure of our risk analyses reflects the relationships between listed species, the populations that comprise each species, and the individuals that comprise each population. Our risk analyses begin by identifying the probable risks actions pose to listed individuals that are likely to be exposed to an action's effects. Our analyses then integrate those individual-level effects to identify consequences to the populations those individuals represent. Our analyses conclude by determining the consequences of those population-level risks to the species those populations comprise.

We evaluate risks to listed individuals by measuring the individual's "fitness" defined as changes in an individual's growth, survival, annual reproductive success, or lifetime reproductive success. In particular, we examine the scientific and commercial data available to determine if an individual's probable response to an action's effect on the environment (which we identify in our *Response Analyses*) are likely to have consequences for the individual's fitness.

Reductions in abundance, reproduction rates, or growth rates (or increased variance in one or more of these rates) of the populations those individuals represent is a *necessary* condition for reductions in a population's viability, which is itself a *necessary* condition for reductions in a species' viability. On the other hand, when listed plants or animals exposed to an action's effects are *not* expected to experience reductions in fitness, we would not expect that action to have adverse consequences on the viability of the population those individuals represent or the species those populations comprise ((B. S. Anderson et al., 2006), (Mills & Beatty, 1979), (Stearns, 1982)). If we conclude that listed species are *not* likely to experience reductions in their fitness, we would conclude our assessment because an action that is not likely to affect the fitness of individuals is not likely to jeopardize the continued existence of listed species.

If, however, we conclude that listed plants or animals are likely to experience reductions in their fitness, our assessment determines if those fitness reductions are likely to be sufficient to reduce the viability of the populations those individuals represent (measured using changes in the populations' abundance, reproduction, spatial structure and connectivity, growth rates, or variance in these measures to make inferences about the population's extinction risks). In this step of our analyses, we use the population's base condition (established in the *Status of Listed Resources* and *Environmental Baseline* sections of this Opinion) as our point of reference. Finally, our assessment determines if changes in population viability are likely to be sufficient to reduce the viability of the species those populations comprise.

The critical habitat analysis focuses on reductions in the quality, quantity, or availability of primary constituent elements (PCEs) from exposure to the stressors of the action. Since chemicals are the stressors of the action for this Opinion, PCEs potentially affected are freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, estuarine areas, and nearshore marine areas. The PCE attributes of prey availability and water quality are the primary assessment endpoints addressed when evaluating the effects of the action on designated critical habitat. Information evaluated for effects to prey include prey survival, prey growth, prey drift, prey reproduction, abundance of prey, health of invertebrate aquatic communities, and recovery of aquatic communities following pesticide exposure. Information evaluated for degradation of water quality include anticipated exposure concentrations leading to toxic responses within aquatic organisms (including salmonids and their prey) as well as instances of water bodies not meeting local, state, or federal water quality standards and criteria.

Evidence Available for the Consultation

We search, compile and use a variety of resources to conduct our analyses including:

- EPA’s BEs, REDs, IREDS, other documents developed by EPA
- Peer-reviewed literature
- Gray literature
- Books
- Available pesticide labels
- Any correspondence (with EPA or others)
- Available monitoring data and other local, county, and state information
- Pesticide registrant generated data
- Online toxicity databases (PAN, EXTOXNET, ECOTOX, USGS, NPIC)
- Pesticide exposure models run by NMFS
- Information and data provided by the registrants identified as applicants
- Comments on the draft Opinion from EPA, applicants, and stakeholders who submitted comments to EPA during EPA’s comment period
- Incident reports

Collectively, this information provides the basis for our determination as to whether and to what degree listed resources under our jurisdiction are likely to be exposed to EPA's action and whether and to what degree the EPA can ensure that its authorization of pesticides is not likely to jeopardize the continued existence of threatened and endangered species or is not likely to result in the destruction or adverse modification of designated critical habitat.

Application of Approach in this Consultation

For this consultation, we adapt our general approach to incorporate elements of EPA's ecological risk assessment (ERA) framework (EPA, 1998). Figure 2 shows the overall framework used in this Opinion. This risk assessment framework organizes the available information in three phases: problem formulation, analysis of exposure and response, and risk characterization (EPA, 1998). We adapted the EPA framework to address ESA-specific considerations. The NMFS framework follows a process for organizing, evaluating, and synthesizing the available information on listed resources and the stressors of the action. We separately evaluate the risk to listed species and the risk to designated critical habitat from the stressors of the action. Below, we briefly describe the problem formulation phase in the general framework.

Problem Formulation

Problem formulation includes conceptual models based on our initial evaluation of the relationships between stressors of the action (pesticides and other identified chemical stressors) and potential receptors (individuals of listed species and PCEs of critical habitat). Unlike OPP's pesticide ERAs[6], which begin with the use, fate, and toxicity properties of the a.i.s, and evaluate risk based on broad categories of taxa, NMFS analysis for listed species begins with the species' range and life history to determine relevant assessment endpoints, identifies if those endpoints are likely to be affected by the stressors of the action, and seeks data with which to evaluate those effects. In brief, we

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[6] Which may be referred to as ERAs, BEs (Biological Evaluations) or pesticide risk assessments in various locations throughout this document.

employ a species-centric approach, rather than a chemical-centric approach, developing risk hypotheses from a species life history perspective. Assessment endpoints and measures may vary by life stage and are presented in Table 9. Some of the relevant measures are not ones commonly considered in the field of toxicology, especially in a regulatory context. They may, however, be commonly used in the disciplines of fisheries management, conservation biology, or ecological assessment. The *Approach* section is the generic problem formulation for salmonids.

Table 9. Salmonid life stage and habitat assessment endpoints and measures.

Salmonid Life Stage	**Assessment Endpoint**	**Assessment Measure**
	Individual fitness	**Measures of changes in individual fitness**
Egg* * If egg appears permeable to pesticides, may vary by pesticide type, K_{ow}, or formulation	Development	Size, hatching success, morphological deformities
	Survival	Viability (percent survival)
Alevin (yolk-sac fry)	Respiration	Gas exchange, respiration rate
	Swimming: predator avoidance and/or site fidelity	Swimming speed, orientation, burst speed, predator avoidance assays
	Yolk-sac utilization,growth rate, size at first feeding	Rate of yolk absorption, growth weight and length
	Development	Morphology, histology
	Survival	LC_{50}, (dose-response slope), percent dead at a given concentration
Fry, juvenile, smolt	First exogenous feeding (fry)– post yolk-sac absorption	Time to first feeding, starvation
	Survival	LC_{50}, (dose-response slope). Percent dead at a given concentration
	Growth	Stomach contents, weight, length, starvation, prey capture rates
	Feeding	Stomach contents, weight, length, starvation, prey capture rates
	Swimming: predator avoidance behavior, migration, use of shelter	Swimming speed, orientation, burst swimming speed, predator avoidance assays,swimming rate, downstream migration rate, fish monitoring, bioassays

Salmonid Life Stage	Assessment Endpoint	Assessment Measure
	Individual fitness	**Measures of changes in individual fitness**
	Olfaction: kin recognition, predator avoidance, imprinting,feeding	Electro-olfactogram (EOG) measurements, behavioral assays
	Smoltification (smolt)	Na/K ATPase activity, sea water challenge tests
Returning adult	Development	Length, weight, malformations
	Survival	LC_{50}, (dose-response slope). Percent dead at a given concentration
	Feeding	Prey consumption rates, stomach contents, length and weight
	Swimming: predator avoidance, migration, spawning,feeding	Behavioral assays,numbers of adult returns, numbers of eggs fertilized or redds, stomach contents
	Sexual development	Histological assessment of ovaries/testis,measurements of intersex
	Olfaction: predator avoidance,homing, spawning	Electro-olfactogram (EOG) measurements, behavioral assays
Habitat	In-stream: Aquatic primary producers, salmonid prey abundance, dissolved oxygen and pH, natural cover for salmonids	Growth inhibition bioassays (EC_{25} or EC_{50}), prey survival (EC_{50}); field measured community metrics direct measurement
	Riparian zone: Riparian zone vegetation, natural cover for salmonids, sedimentation, temperature	Growth inhibition (EC_{25} or EC_{50}), salmonid monitoring (field) direct measurements

These assessment endpoints consider effects on all life stages of the salmon (direct effects), as well as effects on plants and prey items (indirect effects). Based on the assessment endpoints, NMFS evaluates the following risk hypotheses for the species.

Species Risk Hypotheses

1. Exposure to the stressors of the action is sufficient to:
    a. kill salmonids from direct, acute exposure;
    b. reduce salmonid survival through impacts to growth or development;
    c. reduce salmonid growth through impacts to salmonid prey;
    d. reduce survival, migration, and reproduction through impacts to olfactory-mediated behaviors; and
2. Exposure to the stressors of the action is sufficient to:
    a. reduce aquatic primary producers thereby affecting salmonid prey communities and salmonids and natural cover;
    b. reduce riparian vegetation to such an extent that stream temperatures are elevated, erosion increases, and reductions in natural coverage results through reduced inputs of woody debris and other organic matter.
3. Exposure to mixtures of oryzalin, pendimethalin, and trifluralin can act in combination to increase adverse effects to salmonids and salmonid habitat.
4. Exposure to active ingredient degradates, adjuvants, tank mixtures, additional active ingredients, and other ingredients in pesticide products containing oryzalin, pendimethalin, and trifluralin cause adverse effects to salmonids and their habitat.
5. Exposure to other pesticides present in the action area can act in combination with oryzalin, pendimethalin, and trifluralin to increase effects to salmonids and their habitat.
6. Exposure to elevated temperatures can enhance the toxicity of the stressors of the action.

Critical Habitat

When designated critical habitat for the species is identified, primary constituent elements (PCEs) of that habitat are also identified Table 10. To determine potential effects to designated critical habitat, NMFS evaluates the effects of the action by first looking at whether PCEs of critical habitat are affected by the stressors of the action. Effects to PCEs include changes to the functional condition of salmonid habitat caused by the action in the action area. Properly functioning salmonid PCEs are important to the conservation of the ESU/DPS. The stressors of the action for this Opinion are chemicals introduced into the environment by application of pesticide products containing the three a.i.s. Key PCEs potentially affected are freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, estuarine areas, and nearshore marine areas where exposure to those stressors is anticipated.

Table 10. Essential physical and biological features and PCEs for salmonid critical habitat

PCEs	Essential Physical and Biological features	Species Life Stage and Functional Developmental Response
Freshwater Spawning	Water quality, water quantity, and substrate	Spawning, incubation larval development
Freshwater rearing	Water quantity and floodplain connectivity	Juvenile growth and mobility
	Water quality and forage	Juvenile growth and development
	Natural cover[a]	Juvenile mobility and survival
Freshwater migration	Free of obstructions, water quality and quantity, and natural cover[a]	Juvenile and adult mobility and survival
	forage	Juvenile growth and development
Estuarine areas	Free of obstruction, water quality and quantity, and salinity	Juvenile and adult physiological transitions between salt and freshwater
	Natural cover[a] and forage[b] and water quantity	Growth and maturation
Nearshore Marine areas	Free of obstruction, water quality and quantity, natural cover[a] and forage[b]	Growth and maturation, survival
Offshore marine areas	Water quality and forage[b]	Growth and maturation

[a] Natural cover includes shade, large wood, log jams, beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.

[b] Forage includes aquatic and terrestrial invertebrates and fish and shellfish species that support growth and maturation.

Based on the PCEs and life stage potentially affected (Table 10), we developed risk hypotheses for critical habitat. Properly functioning salmonid PCEs are important to the conservation of the ESU/DPS. The stressors of the action for this Opinion are chemicals introduced into the environment by application of pesticide products.

Critical Habitat Risk Hypotheses

1. Exposure to the stressors of the action is sufficient to degrade water quality, and substrate in freshwater spawning sites;
2. Exposure to the stressors of the action is sufficient to degrade water quality, reduce prey availability (forage), and/or reduce natural cover in rearing sites;

3. Exposure to the stressors of the action is sufficient to degrade water quality, prey availability, and/or reduce natural cover in freshwater migration corridors;
4. Exposure to the stressors of the action is sufficient to degrade water quality, prey availability, and/or reduce natural cover in estuarine areas;
5. Exposure to the stressors of the action is sufficient to degrade water quality, prey availability and/or reduce natural cover in nearshore marine areas.

Evaluating Exposure and Response

As part of the problem formulation phase, we consider the toxic mode and mechanism of action of chemical stressors, particularly for the pesticide a.i.s, to provide insight into potential physiological consequences following exposure. Identification of the mode and mechanism of action allows us to identify other chemicals which might co-occur and affect the response (*i.e.*, identify potential toxic mixtures). We consider authorized pesticide use sites, and group them into landuse categories to determine spatial overlap between the use and the species or its designated critical habitat. We consider fate properties of the pesticides and evaluate how that affects exposure. Conceptual diagrams are shown in Figure 2 and Figure 3.

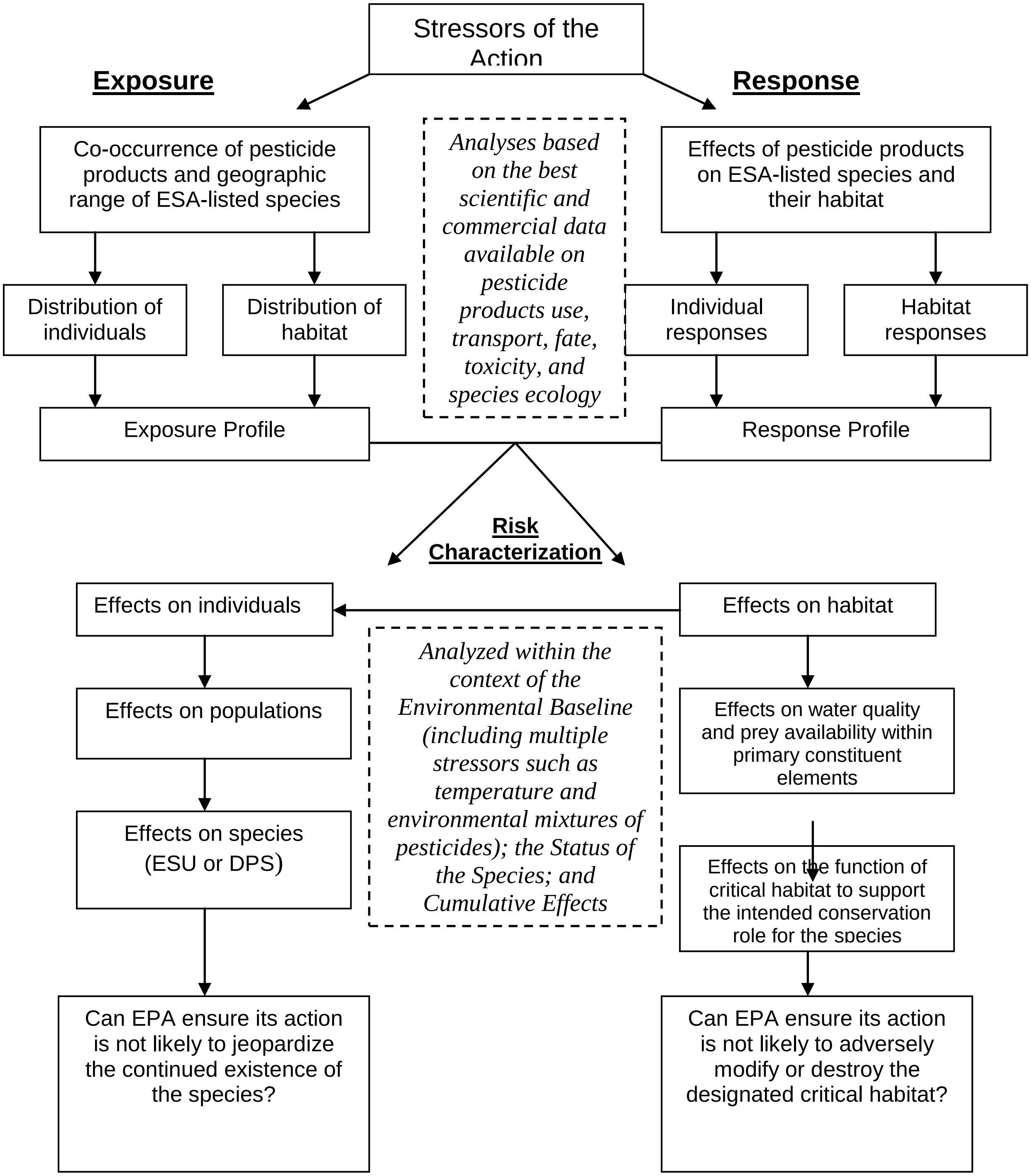

Figure 2. Conceptual framework for assessing risks of EPA's action to ESA listed resources.

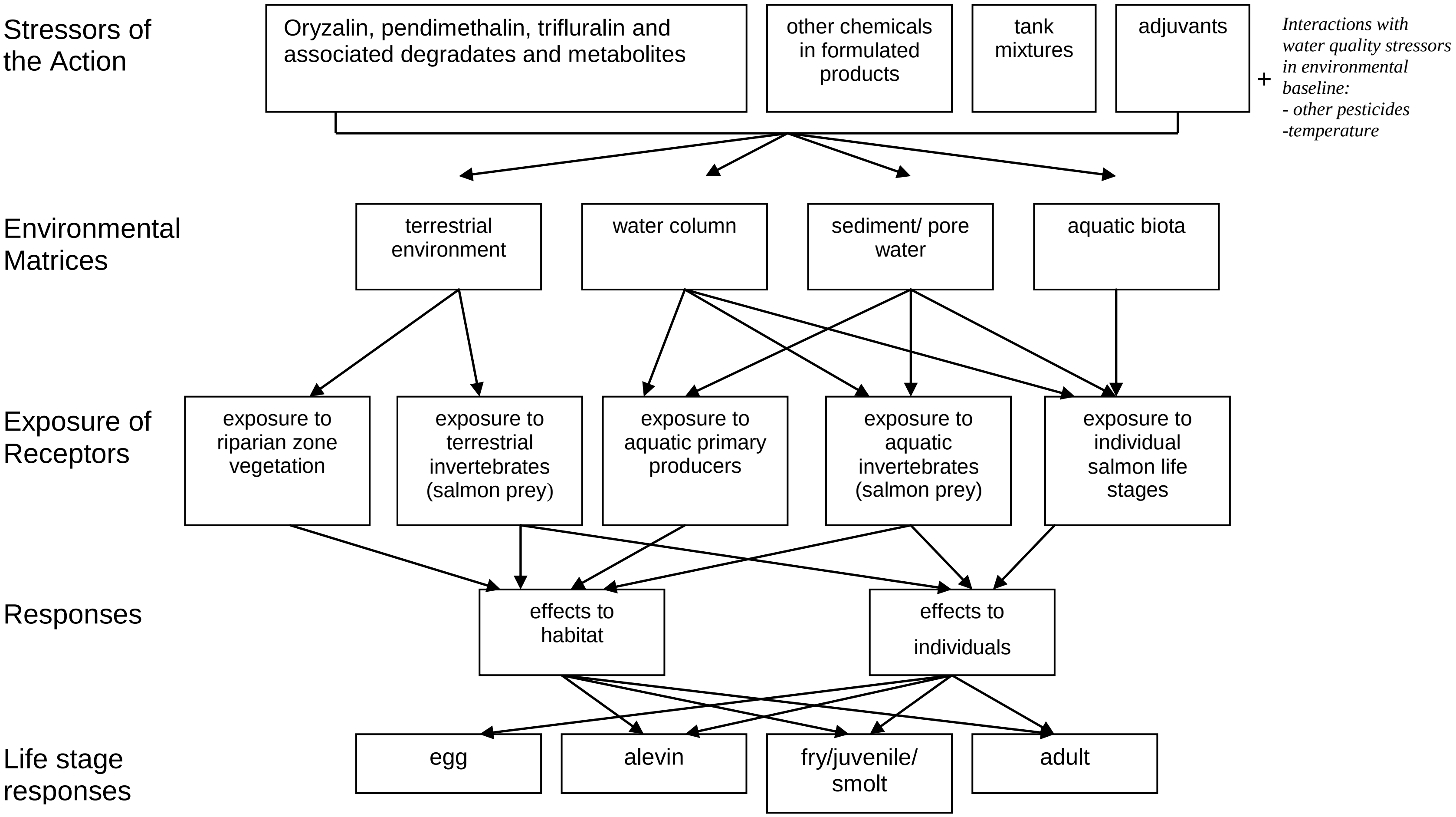

Figure 3. Exposure pathways for stressors of the action, and general response of Pacific salmonids and habitat.

Analysis Plan

Status of the Species

In this section, we present information regarding each of the ESUs and DPSs considered in this Opinion. We discuss life history, population abundance and trends and overall viability of the species. This provides part of the context in which we evaluate the effect of the proposed action.

Environmental Baseline

In this section we discuss all stressors affecting salmon populations including natural predators, events and disease; and anthropogenic effects such as pollution and habitat modification. This also provides part of the context in which we evaluate the effect of the proposed action.

Effects of the Proposed Action to Threatened and Endangered Pacific Salmonids

In the *Exposure* section we discuss life histories of the various species which may make them more or less likely to be exposed to stressors of the actions. In this section we also evaluate spatial and temporal co-occurrences of the use sites and salmon habitat. We discuss fate and transport properties of the chemicals. Then we evaluate measured and estimated environmental concentrations of the stressors from various sources. The *Response* section details toxicity information for the assessment endpoints identified in the problem formulation. In the *Risk Characterization* section, we summarize the risk factors associated with the a.i.s, integrate the exposure and response information, and evaluate the risk hypotheses. Separate analyses are done for the species and designated critical habitat.

Integration and Synthesis

We begin *Integration and Synthesis* with a discussion of how we evaluate effects and provide a summary of risk associated with each of the a.i.s. We then evaluate the likelihood of effects on every ESU/DPS and its designated critical habitat separately for each chemical. Likelihood of effects is evaluated in the context of the *Status of the Species* and *Environmental Baseline.*

Conclusion

Based on the potential effects for each species, we determine if the proposed action is likely to jeopardize the survival and recovery of the species or cause destruction or adverse modification of designated critical habitat.

Other Considerations – Weight of Evidence vs. Probabilistic Analyses

In this Opinion, we evaluate lines of evidence constructed as species-specific risk hypotheses to ensure relevant endpoints are addressed. The analysis weighs each line of evidence by evaluating the best commercial and scientific data available pertaining to a given risk hypothesis. Overall, the analysis is a qualitative approach which applies some quantitative tools. Multiple methods and tools currently exist for addressing contaminant-induced risk to the environment. Hazard-based assessments, probabilistic risk assessment techniques, combinations of the two, and deterministic approaches such as screening level assessments have been applied to questions of risk related to the environment and human health.

In recent pesticide risk assessments, probabilistic techniques have been used to evaluate the probability of exceeding a "toxic" threshold for aquatic organisms by combining pesticide monitoring data with species sensitivity distributions (Geisy et al., 1999; Giddings, 2009). There is utility in information generated by probabilistic approaches if supported by robust data. NMFS considered the use of probabilistic risk assessment techniques for addressing risk at population and species (ESU and DPS) scales for the stressors of the action. However, we encountered significant limitations in available data that suggested the information was not sufficient to define exposure and/or response probabilities necessary to determine the probability of risk. Probabilistic techniques were not used in the Opinion due to issues with data collection, paucity of data, non-normal distributions of data, and quality assurance and quality control. For example, it was not deemed appropriate to pair the salmonid prey responses with exposure probabilities based on monitoring results given the limitations of that data set discussed in the *Effects of the Proposed Action*. When we consider the data limitations coupled with the inherent complexity of EPA's proposed action in California, Idaho, Oregon, and Washington, we find that probabilistic assessments at population and species scales introduce an unquantifiable amount of uncertainty that undermines confidence in derived risk estimates. These same studies do not factor the status of the species and baseline conditions of the environment into their assessment. At this time, the best available data do not support such an analysis and conclusions from such an analysis would be highly speculative.

Status of Listed Resources

The purpose of this section is to characterize the condition of the 28 salmonid species[7] under consultation relative to their likelihood of viability and to describe the conservation role and function of their respective critical habitats. NMFS has determined that the following species and critical habitat designations may occur in the action area for EPA's registration of oryzalin, pendimethalin, and trifluralin - containing products (Table 11). More detailed information on the status of these species and critical habitat are found in a number of published documents including recent recovery plans, status reviews, stock assessment reports, and technical memorandums. Many are available on the Internet at http://www.nmfs.noaa.go/pr/species/.

Table 11. Listed Species and Critical Habitat (denoted by asterisk) in the Action Area.

Common Name (Distinct Population Segment or Evolutionarily Significant Unit)	***Scientific Name***	**Status**
Chinook salmon (Puget Sound*)	*Oncorhynchus tshawytscha*	Threatened
Chinook salmon (Lower Columbia River*)		Threatened
Chinook salmon (Upper Columbia River Spring-run*)		Endangered
Chinook salmon (Snake River Fall-run*)		Threatened
Chinook salmon (Snake River Spring/Summer-run*)		Threatened
Chinook salmon (Upper Willamette River*)		Threatened
Chinook salmon (California Coastal*)		Threatened
Chinook salmon (Central Valley Spring-run*)		Threatened
Chinook salmon (Sacramento River Winter-run*)		Endangered
Chum salmon (Hood Canal Summer-run*)	*Oncorhynchus keta*	Threatened
Chum salmon (Columbia River*)		Threatened
Coho salmon (Lower Columbia River)	*Oncorhynchus kisutch*	Threatened
Coho salmon (Oregon Coast*)		Threatened
Coho salmon (Southern Oregon & Northern California Coast*)		Threatened
Coho salmon (Central California Coast*)		Endangered
Sockeye salmon (Ozette Lake*)	*Oncorhynchus nerka*	Threatened
Sockeye salmon (Snake River*)		Endangered
Steelhead (Puget Sound)	*Oncorhynchus mykiss*	Threatened
Steelhead (Lower Columbia River*)		Threatened
Steelhead (Upper Willamette River*)		Threatened
Steelhead (Middle Columbia River*)		Threatened

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[7] We use the word "species" as it has been defined in section 3 of the ESA, which include "species, subspecies, and any distinct population segment (DPS) of any species of vertebrate fish or wildlife which interbreeds when mature (16 U.S. C 1533)." Pacific salmon other than steelhead that have been listed as endangered or threatened were listed as "evolutionarily significant units (ESU), which NMFS uses to identify distinct population segments of Pacific salmon. Any ESU or DPS is a "species" for the purposes of the ESA.

Common Name (Distinct Population Segment or Evolutionarily Significant Unit)	***Scientific Name***	**Status**
Steelhead (Upper Columbia River*)		Threatened
Steelhead (Snake River*)		Threatened
Steelhead (Northern California*)		Threatened
Steelhead (Central California Coast*)		Threatened
Steelhead (California Central Valley*)		Threatened
Steelhead (South-Central California Coast*)		Threatened
Steelhead (Southern California*)		Endangered

The following narratives summarize the biology and ecology of threatened and endangered Pacific salmonids that are relevant to EPA's proposed action. This includes a description of the timing and duration of each life stage such as adult river entry, spawning, egg incubation, freshwater rearing, smolt outmigration, and ocean migration. These summaries provide a foundation for NMFS' evaluation of the effects of the proposed action on listed salmonids. We also highlight information related to the viability of salmonid populations and the primary constituent elements (PCEs) of designated critical habitat.

Species Status

The status of an ESU or DPS is determined by the degree that it (1) maintains sufficient genetic and phenotypic diversity to ensure continued fitness in the face of environmental change, (2) maintains spatial distribution of populations so that not all populations would be affected by a catastrophic event, and (3) maintains sufficient connectivity among populations within the ESU or DPS to maintain long-term demographic and evolutionary processes (ICTRT, 2007; McElhany, Ruckleshaus, Ford, Wainwright, & Bjorkstedt, 2000; Brian C. Spence et al., 2008). We describe the current condition of the spatial structure and major life histories within the ESUs or DPSs. In order to maintain a spatial distribution and diversity that support a viable ESU or DPS, a species must maintain multiple viable populations that are sustainable in the long-term in the face of environmental variability.

Before assessing population viability, we first identify the historic and current populations that constitute a species. How NMFS defines a population and its function are found in McElhany *et al. (2000),* and in Bjorkstedt *et al.(2005),* NMFS' Pacific salmon Technical Recovery Teams (TRTs) have identified historic populations within ESUs/DPSs. These historical populations have been categorized based on their distribution and demographic role (*i.e.*, functionally independent, potentially independent, or dependent). Functionally independent populations were sufficiently large to be viable in isolation, (*i.e.*, a negligible extinction risk). Potentially independent populations were potentially viable in isolation, but were likely influenced by immigrants from adjacent populations. Dependent populations were unlikely to persist over a 100-year time period in isolation. However, immigration from other nearby populations reduced the extinction risk for dependent populations. The historical conditions of the populations for each ESU/DPS serve as a point of reference for evaluating the current viability of populations[8] and the status of the species. The current viability is used as the base condition from which the effects of the proposed action on individuals are evaluated to determine whether these effects are likely to increase the probability of extinction of the populations those individuals represent.

In our *Approach to the Assessment* section, NMFS introduced the VSP concept and its four criteria. We restate that a VSP is an independent population (a population of which extinction probability is not substantially affected by exchanges of individuals with other populations) with a negligible risk of extinction, over a 100-year period, when threats from random catastrophic events, local environmental variation, demographic variation, and genetic diversity changes are taken into account (McElhany, et al., 2000). The four factors defining a viable population are a population's: (1) spatial structure; (2) abundance; (3) annual growth rate, including trends and variability of annual growth rates; and (4) diversity (McElhany, et al., 2000).

A population's tendency to increase in abundance and its variation in annual population growth defines a viable population (McElhany, et al., 2000; Morris & Doak, 2002). A negative long-term trend in average annual population growth rate will eventually result in extinction. Further, a weak positive long-term growth rate will increase the risk of extinction as it maintains a small population at low abundances over a longer time frame. A large variation in the growth rates also increases the likelihood of extinction (Lande, 1993; Morris & Doak, 2002).

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[8] The TRTs did not propose that historical conditions are the criteria or benchmark for evaluating population or ESU viability (extinction risk).

Thus, in our status reviews of each listed salmonid species, we provide information on population abundance and annual growth rate of extant populations. We use the median annual population growth rate (denoted as lambda, λ) from available time series of abundance for independent populations (T. P. Good, Waples, & Adams, 2005). Several publications provide a detailed description of the calculation of lambda (T. P. Good, et al., 2005; McClure, Holmes, Sanderson, & Jordan, 2003). The lambda values for salmonid populations presented in these papers are summarized in *Appendix 1*.

Conservation Role of Critical Habitat for the Species

The action area for this consultation contains designated critical habitat. Critical habitat is defined as the specific areas within the geographical area occupied by the species, at the time it is listed, on which are found those physical or biological features that are essential to the conservation of the species, and which may require special management considerations or protection. Critical habitat can also include specific areas outside the geographical area occupied by the species at the time it is listed that are determined by the Secretary to be essential for the conservation of the species (ESA of 1973, as amended, section 3(5)(A)).

The primary purpose in evaluating the status of critical habitat is to identify for each ESU or DPS the function of the critical habitat to support the intended conservation role for each species. Such information is important for an adverse modification analysis as it establishes the context for evaluating whether the proposed action results in negative changes in the function and role of the critical habitat for species conservation. NMFS bases its critical habitat analysis on the areas of the critical habitat that are affected by the proposed action and the area's physical or biological features that are essential to the conservation of a given species, and not on how individuals of the species will respond to changes in habitat quantity and quality.

In evaluating the status of designated critical habitat, we consider the current quantity, quality, and distribution of those primary constituent elements or PCEs that are essential to the conservation of the species [50 CFR 424.12(b)]. NMFS has identified PCEs of critical habitat for each life stage (*e.g.*, migration, spawning, rearing, and estuary) common for each species. To fully understand the conservation role of these habitats, specific physical and biological habitat features (*e.g.,* water temperature, water quality, forage, natural cover, etc.) were identified for each life stage. Specifically, during all freshwater life stages, salmonids require cool water that is free of contaminants. During the juvenile life stage, salmonids also require stream habitat that provides excess forage (*i.e.*, prey abundance). Besides potential toxicity, water free of contaminants is important as contaminants can disrupt normal behavior necessary for successful migration, spawning, and juvenile rearing. Sufficient forage is necessary for juveniles to maintain growth that reduces freshwater predation mortality, increases overwintering success, initiates smoltification, and increases ocean survival. Natural cover such as submerged and overhanging large wood and aquatic vegetation provides shelter from predators, shades freshwater to prevent increase in water temperature, and creates important side channels. A description of the past, ongoing, and continuing activities that threaten the functional condition of PCEs and their attributes are described in the *Environmental Baseline* section of this Opinion.

NMFS has identified six common PCEs for 7 California listed Chinook salmon and steelhead (70 FR 52488, Sept. 2, 2005), 12 ESUs of Oregon, Washington, and Idaho salmon (chum, sockeye, Chinook) and steelhead (70 FR 52630, Sept. 2, 2005), and for the Oregon Coast coho salmon (73 FR 7816, Feb. 11, 2008). They are:

(1) Freshwater spawning sites with water quantity and quality, and suitable substrate size as attributes necessary to support spawning, incubation and larval development;

(2) Freshwater rearing sites with the following attributes: (i) Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; (ii) Water quality and forage supporting juvenile development; and (iii) Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.

(3) Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.

(4) Estuarine areas free of obstruction and excessive predation with:
(i) Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; (ii) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels; and (iii) Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

(5) Nearshore marine areas free of obstruction and excessive predation with:
(i) Water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and (ii) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.

(6) Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

NMFS similarly developed the following list of species habitat requirements and PCEs for coho salmon ESUs (64 FR 24049, May 5, 1999). They are:

1. Juvenile summer and winter rearing areas,
2. Juvenile migration corridors,
3. Areas for growth and development to adulthood,
4. Adult migration corridors, and
5. Spawning areas.

Within these areas, essential habitat attributes of coho salmon critical habitat include adequate: (1) substrate, (2) water quality, (3) water quantity, (4) water temperatures, (5) water velocity, (6) cover/shelter, (7) food, (8) riparian vegetation, (9) space, and (10) safe passage conditions. Riparian vegetation refers to its role in providing essential habitat for coho salmon such as instream woody debris and submerged vegetation for holding and shelter, low water temperature through shading, functional channel bottom substrate for development of eggs and alevins by stabilizing stream banks and capturing fine sediment in runoff, and food by providing nutrients to streams and production of terrestrial insects.

In this section, we also identify the conservation values of watersheds located within the critical habitat designated for a species. If the effects on PCEs are important at the watershed scale, then the conservation value for the watershed is used to assess the conservation role of that watershed in the context of range wide critical habitat. The conservation value of a particular watershed was determined by Critical Habitat Analytical Review Teams (CHARTs) for many of the ESU/DPSs. These teams considered the presence of PCEs within each occupied area of a watershed and the activities that potentially affect the PCEs, and assigned conservation values for watersheds within designated critical habitat.

Each watershed was scored as low, moderate, or high conservation value. High value watersheds/areas have a high likelihood of promoting species conservation, while low value watersheds/areas are less important for species conservation. Scores were based on: (1) a comparison of current quantity of PCEs within a watershed relative to other watersheds and probable historic quantity of PCEs within the watershed; (2) existing quality of PCEs in watersheds; (3) the likelihood of achieving PCE potential in a watershed; (4) the PCEs' support of rare genetic or life history characteristics or rare/important habitat types in the watershed; (5) considerations of the PCEs' support of variable-sized populations relative to other watersheds and the probable historical levels in the watershed; and (6) considerations of the PCE support of spawning or rearing of varying numbers of populations.

Chinook Salmon

Description of the Species

Chinook salmon are the largest of the Pacific salmon and historically ranged from the Ventura River in California to Point Hope, Alaska in North America, and in northeastern Asia from Hokkaido, Japan to the Anadyr River in Russia (M.C. Healey, 1991). Chinook salmon prefer streams that are deeper and larger than those used by other Pacific salmon species. We discuss the distribution, life history, status, and critical habitat of nine species[2] of endangered and threatened Chinook salmon separately.

Chinook salmon are generally described as one of two races, within which there is substantial variation (Groot & Margolis, 1991; M.C. Healey, 1991). One race, the “stream-type,” resides in fresh water for a year or more following emergence from gravel nests. Juveniles migrate to sea as yearlings. Stream-type Chinook salmon normally return in late winter and early spring (spring-run) as immature adults and reside in deep pools during summer before spawning in fall. The other race, the “ocean-type,” migrate to the ocean within their first year (sub-yearlings) and usually return as full mature adults in fall (fall-run). Fall-run adults spawn soon after river entry.

The timing of return to fresh water, and ultimately spawning, often provides a temporal isolating mechanism for populations with different life histories. Return timing is often related to spawning location. Thus, differences in the timing of spawning migration also serve as a geographic isolating mechanism. Fall-run Chinook salmon generally spawn in the mainstem of larger rivers and are less dependent on flow, although early autumn rains and a drop in water temperature often provide cues for movements to spawning areas. Spring-run Chinook salmon take advantage of high flows from snowmelt to access the upper reaches of rivers.

Successful incubation depends on several factors including dissolved oxygen (DO) levels, temperature, substrate size, amount of fine sediment, and water velocity. Chinook salmon egg incubation time is highly correlated with water temperature (McCullough, 1999). Spawning sites have larger gravel and more water flow up through the gravel than the sites used by other Pacific salmon. Maximum survival of incubating eggs and the pre-emergent alevins occurs at water temperatures between about 5.5° and 13.5°C. Development time is influenced by degree days with fertilization to emergence taking up to 325 days at 2°C and about 50 days at 16°C (McCullough, 1999). Fry emergence commonly begins in December and continues into mid April (R.A. Leidy, 1984). When emerging from the redd, fry move through the interstitial spaces in the redd substrate to escape the gravel. However, a high content of fines and sand in the redd substrate can severely hinder fry emergence and cause high mortality (T. C. Bjornn & Reiser, 1991). Optimal temperatures for both Chinook salmon fry and fingerlings range from 12° to

14°C (Boles, 1988). Temperatures above 15°C increase the risk of diseases and lower the tolerance to other stressors (McCullough, 1999). At about 19°C, Chinook salmon cease to eat. In the laboratory, 50% mortality during a 24 hour period is observed at 24° to 25°C (J. R. Brett, 1952; C. H. Hanson, 1997) the exact lethal temperature being somewhat dependent on the temperature that the fish has been acclimated to.

Chinook salmon alevins, as is the case for other salmonids, rely on yolk for nutrition until the onset of active feeding. It is important that the young start feeding at the proper time since failure to start feeding can retard growth and lead to behavioral or developmental problems that reduce survival. In Chinook salmon, alevins may start feeding immediately upon emergence even if they have not yet absorbed all of the egg yolk (Linley, 2001). During freshwater residence, Chinook salmon juveniles feed in the water column and from the water surface. Food items include a variety of small terrestrial and aquatic insects and aquatic crustaceans; the prey species of juveniles depend on availability (habitat and months), prey size distribution, and the size of the fish (Koehler et al., 2006; Rondorf, Gray, & Fairley, 1990). The coarse bottom substrate found in faster flowing riverine habitats supports drift of larger aquatic insects such as caddisflies (*Trichoptera*), mayflies (*Ephemeroptera*), stoneflies (*Plecoptera*), and other benthic organisms when they are present in the water column during high flow events. These taxa, when present, are important food items in terms of biomass for Chinook salmon juveniles. Terrestrial insects and midges (*Diptera*: *Chironmidae*) often dominate the diet in slower moving water with finer bottom substrate such as floodplains, off-channel ponds, sloughs, and in lakes/reservoirs (J. A. Miller & Simenstad, 1997; Rondorf, et al., 1990; Sommer, Nobriga, Harrell, Batham, & Kimmerer, 2001; Tabor, Gearns, McCoy III, & Camacho, 2006). In addition, copepods and daphnia may make up a high proportion of the diet in ponds, reservoirs and lakes, and in the mainstems of large rivers (Koehler, et al., 2006; Rondorf, et al., 1990; Sommer, et al., 2001). At periods, swarming terrestrial insects such as ants can make up a substantial portion of the diet of Chinook salmon rearing in floodplains, ponds and reservoirs (Rondorf, et al., 1990). In estuaries, scuds, mysids, and gammarid amphipods may be major prey (J. A. Miller & Simenstad, 1997).

Studies of stream habitat use show that there are velocity thresholds for rearing fry and juveniles, that fish move to faster and deeper water as they grow, and that fish use substrate and cover as refuge from high velocities (D. W. Chapman & Bjornn, 1969; Everest & Chapman, 1972; S. W. Johnson, Thedinga, & Koski, 1992). In the mainstem of large rivers and in lakes, fry and juveniles rear along the river margins and in nearshore areas that are less than one meter deep and have low lateral bank slopes (Sergeant & Beauchamp, 2006; Tiffan, Clark, Garland, & Rondorf, 2006). Juveniles tend to avoid the elevated water velocities found in the thalweg of river channels. As they grow larger, their habitat preferences change; juveniles move away from stream margins and begin to use deeper water (Everest & Chapman, 1972; Tabor, et al., 2006). When the river channel is greater than 9- to 10-ft in depth, juvenile salmon tend to inhabit the surface waters (M. C. Healey, 1982).

Chinook salmon fry may also move into non-natal tributaries (*i.e.,* streams other than those where they incubated) to rear (Limm & Marchetti, 2009; Teel, Baker, Kuligowski, Friesen, & Shields, 2009). In both the Columbia River and Sacramento River, California, fry and juveniles move into seasonally inundated floodplains and off-channel water bodies to rear as they move downstream (Limm & Marchetti, 2009; Sommer, et al., 2001; Teel, et al., 2009). However, Chinook salmon use of floodplain and off-channel habitat depend on availability of these habitats, the life history of the race, time of year, flow, and temperatures. Up to a certain limit, distribution in floodplain habitat is positively correlated with water temperatures (Limm & Marchetti, 2009; Sommer, et al., 2001; Teel, et al., 2009). Floodplain wetlands and off-channel habitat also often have higher prey densities Several studies have shown that fry rearing on large floodplains experience a higher growth rate, and possibly higher survival, than fry remaining in the main channel (Jeffres, Opperman, & Moyle, 2008; Limm & Marchetti, 2003; Sommer, et al., 2001). The increased growth rate is likely caused by the higher water temperatures as well as the higher prey densities in these habitats. Having sufficient growth during the juvenile stage is critical as some studies indicate that size at smolting influence survival during the first year in the ocean. As flow decreases and water temperature increases in summer, juveniles move out of the inundated floodplain habitat or succumb to lethal temperatures and stranding.

Many Chinook salmon populations use the estuary intensively for rearing, and a downstream movement of large numbers of fry is typical for many populations (Reimers, 1973; Sazaki, 1966;

Thorpe, 1994). Estuaries can provide a productive environment and additional growth, refuge from predators, and a transition to marine waters; availability of unmodified estuaries is correlated with difference between rivers in survival of hatchery reared fish from smolt to maturity (Magnusson & Hilborn, 2003). Ocean-type Chinook salmon migrate downstream as fry immediately after emerging from spawning beds (M.C. Healey, 1991). These smaller fry and sub-yearlings extensively use shallow water habitat and sloughs within the estuary to rear to the smolt stage (K. L. Fresh, Casillas, Johnson, & Bottom, 2005). Yearling juveniles of the river-type life history enter the estuaries at the smolting stage; they usually spend less time in estuaries and use deeper water than fry or sub-yearlings (K. L. Fresh, et al., 2005).

Upon entering the marine environment, immature Chinook salmon maintain close proximity to nearshore areas. The highest ocean mortality of immature Chinook salmon occurs during the first year after entering the ocean. Expected survival during this period depends both on the condition of the fish such as size and the physical conditions of the marine environment. Ocean condition such as coastal upwelling and atmospheric condition such as El Niño have a significant influence on returning run size. Because of the annual variability in ocean and climatic conditions, the stock-recruitment relationship in Chinook salmon is weak.

Immature Chinook salmon of the ocean- and river-type may have different dispersal and migration patterns during their first marine year (M.C. Healey, 1991). The larger stream-type immature fish disappear from the surface waters of the Strait of Georgia in early summer. In contrast, during their first ocean year, ocean-type fish are abundant in the sheltered surface waters and estuaries of the Strait of Georgia and the Puget Sound from July through November and some continue to be present throughout winter. Estuaries provide the only shelter along the open coasts of Washington, Oregon, and California; in these areas, ocean-type fry remain longer in their native estuaries. After ocean entry, immature Chinook salmon may move into large estuaries and bays as they migrate along the coast. Chinook salmon remain at sea for one to six years (more commonly two to four years), with the exception of a small proportion of yearling males (called jack salmon) which mature in fresh water or return after two or three months in salt water.

Status and Trends

Chinook salmon face natural threats from flooding, changes in ocean productivity, and predation. Chinook salmon have declined from overharvests, loss of genetic integrity by mixing with hatchery reared fish, retracted distribution by migration barriers such as dams, mortality and loss of rearing habitat from gravel mining, degradation of riparian habitat, and modified stream function and reduced water quality from land use practices (logging, agriculture, and urbanization).

Climate change also poses significant hazards to the survival and recovery of salmonids. Hazards from climate change include elevated water temperature, earlier spring runoff and lower summer flows, and winter flooding.

Puget Sound Chinook Salmon

The Puget Sound ESU (Figure 4) includes all runs of Chinook salmon in the Puget Sound region from the North Fork Nooksack River to the Elwha River on the Olympic Peninsula. Thirty-six hatchery populations were included as part of the ESU and five were considered essential for recovery and listed (Table 12). They were spring Chinook salmon from Kendall Creek, the North Fork Stillaguamish River, White River, and Dungeness River, and fall run fish from the Elwha River. These artificially propagated populations are no more divergent relative to the local natural populations than would be expected between closely related populations within the ESU.

Table 12. Puget Sound Chinook salmon - preliminary population structure, abundances, and hatchery contributions (Good et al 2005).

Independent Populations	Historical Abundance	Mean Number of Spawners	Hatchery Abundance Contributions
Nooksack-North Fork	26,000	1,538	91%
Nooksack-South Fork	13,000	338	40%
Lower Skagit	22,000	2,527	0.2%
Upper Skagit	35,000	9,489	2%
Upper Cascade	1,700	274	0.3%
Lower Sauk	7,800	601	0%
Upper Sauk	4,200	324	0%
Suiattle	830	365	0%
Stillaguamish-North Fork	24,000	1,154	40%
Stillaguamish-South Fork	20,000	270	Unknown

Independent Populations	Historical Abundance	Mean Number of Spawners	Hatchery Abundance Contributions
Skykomish	51,000	4,262	40%
Snoqualmie	33,000	2,067	16%
Sammamish	Unknown	Unknown	Unknown
Cedar	Unknown	327	Unknown
Duwamish/Green			
Green	Unknown	8,884	83%
White	Unknown	844	Unknown
Puyallup	33,000	1,653	Unknown
Nisqually	18,000	1,195	Unknown
Skokomish	Unknown	1,392	Unknown
Mid Hood Canal Rivers			
Dosewallips	4,700	48	Unknown
Duckabush	Unknown	43	Unknown
Hamma Hamma	Unknown	196	Unknown
Mid Hood Canal	Unknown	311	Unknown
Dungeness	8,100	222	Unknown
Elwha	Unknown	688	Unknown

Life History

Puget Sound Chinook salmon populations exhibit both early-returning (August) and late-returning (mid-September and October) Chinook salmon spawners (M.C. Healey, 1991). Juvenile Chinook salmon within the Puget Sound generally exhibit an “ocean-type” life history. However, substantial variation occurs with regard to juvenile residence time in freshwater and estuarine environments. Hayman (Hayman, Beamer, & McClure, 1996) described three juvenile life histories for Chinook salmon with varying freshwater and estuarine residency times in the Skagit River system in northern Puget Sound. In this system, 20% to 60% of sub-yearling migrants rear for several months in freshwater habitats while the remaining fry migrate to rear in the Skagit River estuary and delta (Beamer, Hayman, & Smith, 2005). Juveniles in tributaries to Lake Washington exhibit both a stream rearing and a lake rearing strategy. Lake rearing fry are found in highest densities in nearshore shallow (<1 m) habitat adjacent to the opening of tributaries or at the mouth of tributaries where they empty into the lake (Tabor, et al., 2006). Puget Sound Chinook salmon also has several estuarine rearing juvenile life history types that are highly dependent on estuarine areas for rearing (Beamer, et al., 2005). In the estuaries, fry use tidal marshes and connected tidal channels including dikes and ditches developed to protect and drain agricultural land. During their first ocean year, immature Chinook salmon use nearshore areas of Puget Sound during all seasons and can be found long distances from their natal river systems (Brennan, Higgins, Cordell, & Stamatiou, 2004).

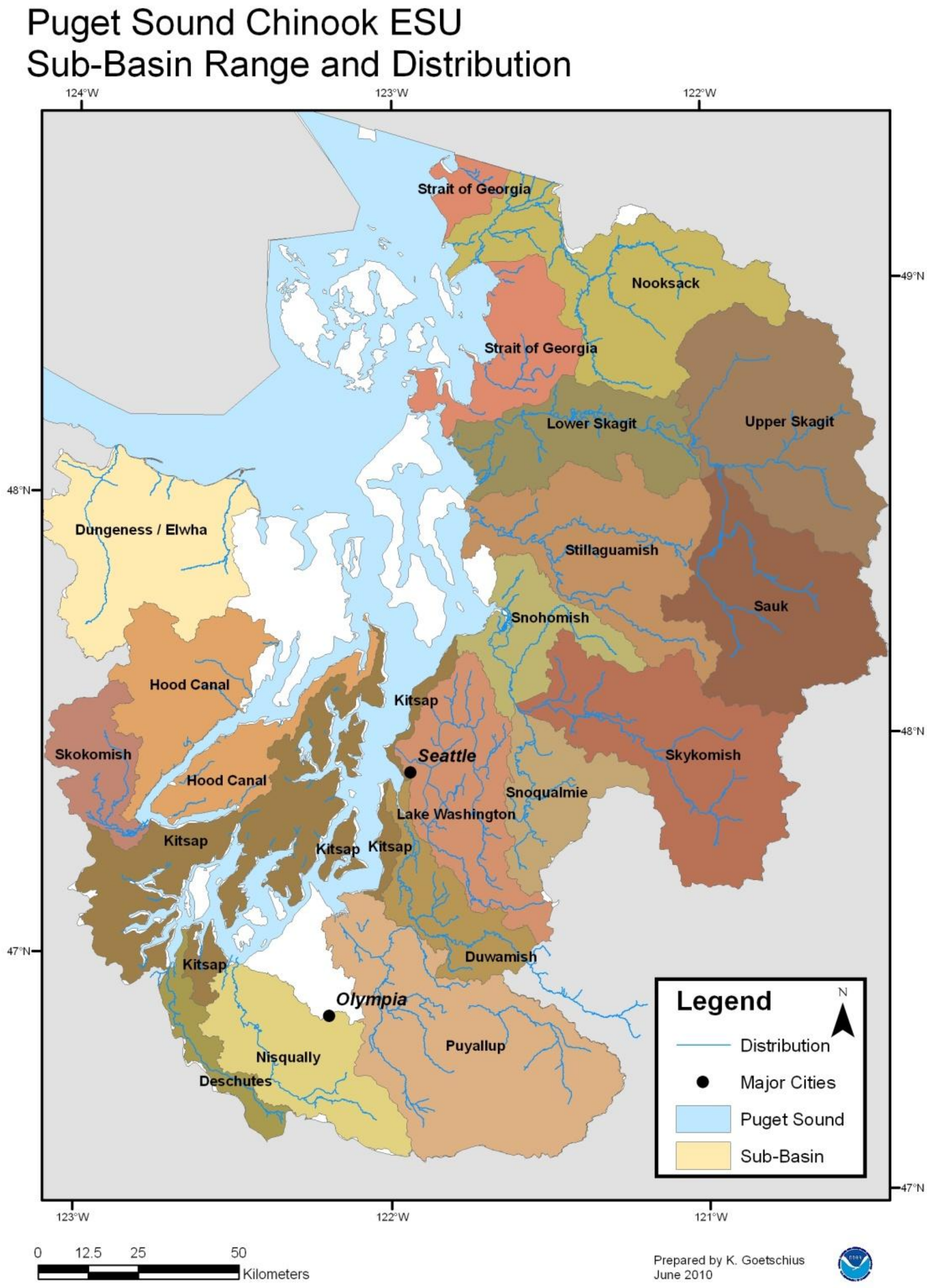


Figure 4. Puget Sound Chinook salmon distribution

Status and Trends

NMFS listed Puget Sound Chinook salmon as threatened in 1999 (64 FR 14308) and reaffirmed its status as threatened on June 28, 2005 (70 FR 37160). Historically, the ESU included 31 rivers or river systems that supported historic independent populations. Of the historic populations, only 22 are extant (Mary H. Ruckelshaus et al., 2006) (Table 12). A disproportionate loss of an early-run life history represents a significant loss of the evolutionary legacy of the ESU (Mary H. Ruckelshaus, et al., 2006).

The spatial structure of the ESU is compromised by extinct and weak populations being disproportionably distributed to the mid- to southern Puget Sound and the Strait of Juan de Fuca. A large portion (at least 11) of the extant runs is sustained, in part, through artificial propagation. Of the populations with greater than 1,000 natural spawners, only two have a low fraction of hatchery fish. Populations known to contain significant natural production are found in the northwest Puget Sound.

Estimates of the historic abundance range from 1,700 to 51,000 potential Puget Sound Chinook salmon spawners per population. During the period from 1996 to 2001, the geometric mean of natural spawners in populations of Puget Sound Chinook salmon ranged from 222 to just over 9,489 fish. Thus, the historical estimates of spawner capacity are several orders of magnitude higher than spawner abundances currently observed throughout the ESU (T. P. Good, et al., 2005). Long-term trends in abundance and median population growth rates for naturally spawning populations indicate that approximately half of the populations are declining and the other half are increasing in abundance over the length of available time series. However, the median overall long-term trend in abundance is close to 1 for most populations that have a lambda exceeding 1, indicating that most of these populations are barely replacing themselves. Eight of 22 populations are declining over the short-term, compared to 11 or 12 populations that have long-term declines (T. P. Good, et al., 2005). Populations with the greatest long-term population growth rates are the North Fork Nooksack and White rivers.

Critical Habitat

Critical habitat was designated for this species on September 2, 2005 (70 FR 52630). It includes 1,683 km of stream channels, 41 square km of lakes, and 3,512 km of nearshore marine habitat. Of 61 watersheds (5th field Hydrological Units or HUC 5) reviewed in NMFS' assessment of critical habitat for the Puget Sound ESU, 9 watersheds were rated as having a medium conservation value, 12 were rated as low, and the remaining watersheds (40), where the bulk of federal lands overlap with this ESU, were rated as having a high conservation value for Puget Sound Chinook salmon (Figure 5). The 19 nearshore marine areas were all given a high conservation value rating. (Table 13).

Table 13. Puget Sound Chinook salmon watersheds with conservation values.

HUC 4 Subbasin	HUC 5 Watershed conservation Value (CV)					
	High CV	PCE(s) [1]	Medium CV	PCE(s) [1]	Low CV	PCE(s) [1]
Strait of Georgia	0		0		3	(3, 1, 2)
Nooksack	4	(1, 3, 2)	1	(3, 1)	0	
Upper Skagit	4	(1, <3)	1	(3)	0	
Sauk	4	(1, 2, 3)	0		0	
Lower Skagit	2	(3, 1, 2)	0		0	
Stillaguamish	3	(1, 3)	0		0	
Skykomish	5	(1, 3)	0		0	
Snoqualmie	2	(1, 3, 2)	0		0	
Snohomish	1	(1,2,3)	1	(1, 2, 3)		
Lake Washington	1	(1)	3	(1, 3, <2)	0	
Duwamish	2	(3, 1, 2)	1	(3)	0	
Puyallup	5	(3, 2, 1)	0		0	
Nisqually	2	(1, <3)	0		0	
Deschutes	0		0		2	(1, 3)
Skokomish	1	(1, 3)	0		0	
Hood Canal	2	(1)	1	(1)	3	(1, <3,<2)
Kitsap	0		0		4	(3, 1)
Dungeness/Elwha	2	(1)	1	(3, 1)	0	
Totals	40		9		12	

1 Numbers in parenthesis refers to the dominant (in river miles) PCE(s) within the HUC 5 watersheds. PCE 1 is spawning and rearing, 2 is rearing and migration, and 3 is migration and presence. PCEs with < means that the number of river miles of the PCE is much less than river miles of the other PCE.

Forestry practices have heavily impacted migration, spawning, and rearing PCEs in the upper watersheds of most rivers systems within critical habitat designated for the Puget Sound Chinook salmon. Degraded PCEs include reduced conditions of substrate supporting spawning, incubation and larval development caused by siltation of gravel; and degraded rearing habitat by removal of cover and reduction in channel complexity. Urbanization and agriculture in the lower alluvial valleys of mid- to southern Puget Sound and the Strait of Juan de Fuca have reduced channel function and connectivity, reduced available floodplain habitat, and affected water quality. Thus, these areas have degraded spawning, rearing, and migration PCEs. Hydroelectric development and flood control also obstruct Puget Sound Chinook salmon migration in several basins. The most functional PCEs are found in northwest Puget Sound: the Skagit River basin, parts of the Stillaguamish River basin, and the Snohomish River basin where federal land overlap with critical habitat designated for the Puget Sound Chinook salmon. However, estuary PCEs are degraded in these areas by reduction in the water quality from contaminants, altered salinity conditions, lack of natural cover, and modification and lack of access to tidal marshes and their channels.

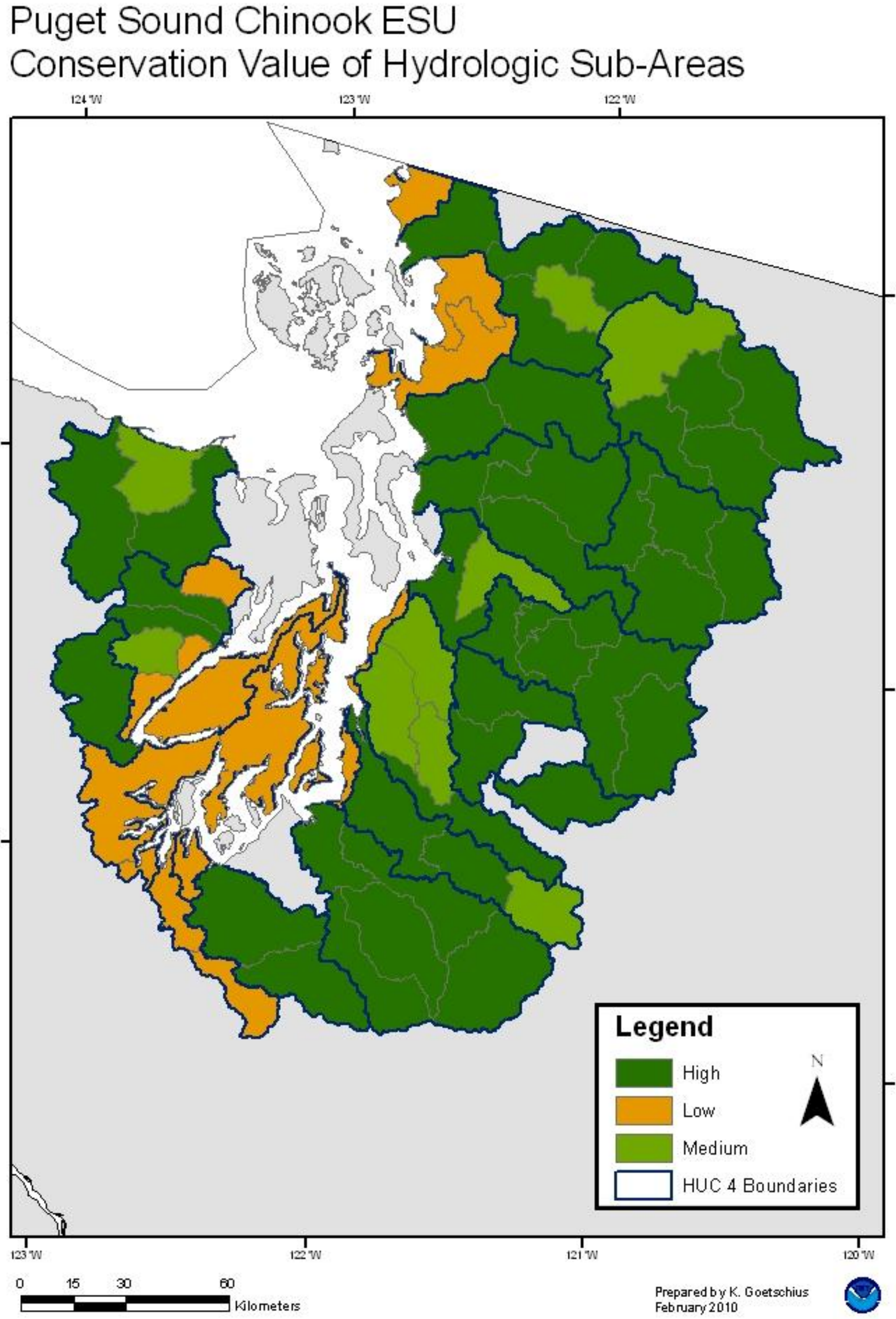


Figure 5. Puget Sound Chinook salmon Conservation Values per Sub-watershed

Lower Columbia River Chinook Salmon

The Lower Columbia River (LCR) Chinook salmon ESU (Figure 6) includes all naturally-spawned populations of fall-run and spring-run Chinook salmon from the Columbia River and its tributaries from its mouth at the Pacific Ocean upstream to a transitional point between Oregon and Washington, east of the Hood River and the White Salmon River. The eastern boundary for this species occurs at Celilo Falls, which corresponds to the edge of the drier Columbia Basin Ecosystem. It also includes the Willamette River to Willamette Falls, Oregon, exclusive of spring-run Chinook salmon in the Clackamas River. Seventeen artificial propagation programs are included in the ESU (70 FR 37160). These artificially propagated populations are no more divergent relative to the local natural populations than would be expected between closely related populations within this ESU.

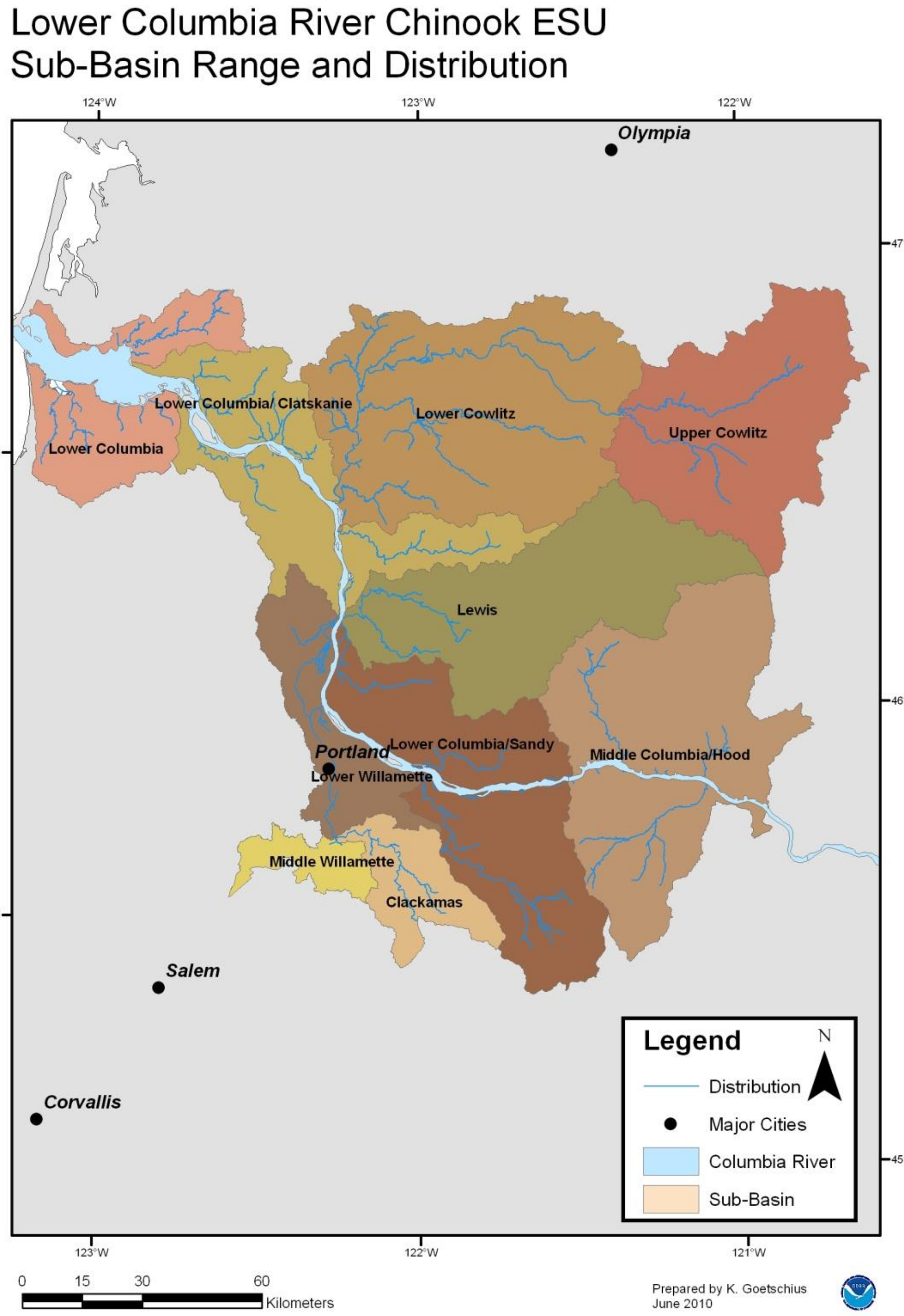


Figure 6. Lower Columbia River Chinook salmon distribution.

Life History

LCR Chinook salmon display three run types including early fall-runs, late fall-runs, and spring-runs. Presently, the fall-run is the predominant life history type. Spring-run Chinook salmon were numerous historically. Fall-run Chinook salmon enter fresh water typically in August through October. Early fall-run spawn within a few weeks in large river mainstems. The late fall-run enters in immature conditions, has a delayed entry to spawning grounds, and resides in the river for a longer time between river entry and spawning. Spring-run Chinook salmon enter fresh water in March through June to spawn in upstream tributaries in August and September.

Offspring of fall-run spawning may migrate as fry to the ocean soon after yolk absorption (*i.e.*, ocean-type), at 30–45 mm in length (M.C. Healey, 1991). In the Lower Columbia River system, however, the majority of fall-run Chinook salmon fry migrate either at 60-150 days post-hatching in the late summer or autumn of their first year. Offspring of fall-run spawning may also include a third group of yearling juveniles that remain in fresh water for their entire first year before emigrating. The spring-run Chinook salmon migrates to the sea as yearlings (stream-type) typically in spring. However, the natural timing of LCR spring-run Chinook salmon emigration is obscured by hatchery releases (J. Myers et al., 2006).

Once at sea, the ocean-type LCR Chinook salmon tend to migrate along the coast, while stream-type LCR Chinook salmon appear to move far off the coast into the central North Pacific Ocean (M.C. Healey, 1991; J. Myers, et al., 2006). Adults return to tributaries in the lower Columbia River predominately as three- and four-year-olds for fall-run fish and four- and five-year-olds for spring-run fish.

Status and Trends

NMFS originally listed LCR Chinook salmon as threatened on March 24, 1999 (64 FR 14308), and reaffirmed their threatened status on June 28, 2005 (70 FR 37160). Thirty-one independent Chinook salmon populations – 22 fall- and late fall-runs and 9 spring- runs – are estimated to have existed historically in the Lower Columbia River (J. Myers, et al., 2006). The Willamette/Lower Columbia River Technical Review Team (W/LCRTRT) has estimated that 8-10 historic populations have been extirpated, most of them spring-run populations. The fall-run

Chinook salmon historically occurred throughout the Lower Columbia River basin, while spring-run Chinook salmon only occurred in the upper portions of Lower Columbia Basins that consist of snowmelt driven flow regimes. The Cowlitz, Kalama, Lewis, White Salmon, and Klickitat Rivers are the major river systems on the Washington side, and the lower Willamette and Sandy Rivers are foremost on the Oregon side.

The basin wide spatial structure has remained generally intact. However, the loss of about 35% of historic habitat has affected distribution within several Columbia River subbasins. Currently, only one population appears self sustaining (T. P. Good, et al., 2005). Table **14** identifies populations within the LCR Chinook salmon ESU, their abundances, and hatchery input.

Table 14. Lower Columbia River Chinook salmon - population structure, abundances, and hatchery contributions (T. P. Good, et al., 2005; J. Myers, et al., 2006).

Run	Population	Historical Abundance	Mean Number of Spawners	Hatchery Abundance Contributions
F-R	Grays River (WA)	2,477	99	38%
	Elochoman River (WA)	Unknown	676	68%
	Mill, Abernathy, and German Creeks (WA)	Unknown	734	47%
	Youngs Bay (OR)	Unknown	Unknown	Unknown
	Big Creek (OR)	Unknown	Unknown	Unknown
	Clatskanie River (OR)	Unknown	50	Unknown
	Scappoose Creek (OR)	Unknown	Unknown	Unknown
F-R	Lower Cowlitz River (WA)	53,956	1,562	62%
	Upper Cowlitz River (WA)	Unknown	5,682	Unknown
	Coweeman River (WA)	4,971	274	0%
	Toutle River (WA)	25,392	Unknown	Unknown
	Salmon Creek and Lewis River (WA)	47,591	256	0%
	Washougal River (WA)	7,518	3,254	58%
	Kalama River (WA)	22,455	2,931	67%
	Clackamas River (OR)	Unknown	40	Unknown
	Sandy River (OR)	Unknown	183	Unknown
LF-R	Lewis R-North Fork (WA)	Unknown	7,841	13%
	Sandy River (OR)	Unknown	504	3%
S-R	Upper Cowlitz River (WA)	Unknown	Unknown	Unknown
	Tilton River (WA)	Unknown	Unknown	Unknown
	Cispus River (WA)	Unknown	1,787*	Unknown
	Toutle River (WA)	2,901	Unknown	Unknown
	Kalama River (WA)	4,178	98	Unknown
	Lewis River (WA)	Unknown	347	Unknown
	Sandy River (OR)	Unknown	3,085	3%
F-R	Upper Columbia Gorge (WA)	2,363	136	13%

Run	Population	Historical Abundance	Mean Number of Spawners	Hatchery Abundance Contributions
	Big White Salmon R (WA)	Unknown	334	21%
	Lower Columbia Gorge (OR)	Unknown	Unknown	Unknown
	Hood River (OR)	Unknown	18	Unknown
S-R	Big White Salmon R (WA)	Unknown	334	21%
	Hood River (OR)	Unknown	18	Unknown

*Arithmetic mean
Recent 5-year spawner abundance (up to 2001) and historic abundance over more than 20 years is given as a geometric mean, and include hatchery origin Chinook salmon.
F-R is fall run, LF-R is late fall run, and S-R is spring run Chinook salmon.

Historical records of Chinook salmon abundance are sparse. However, cannery records suggest a peak run of 4.6 million fish [43 million lbs see (Lichatowich, 1999) in 1883]. Historically, the number of spring-run Chinook salmon returning to the Lower Columbia River may have almost equaled that of fall-run Chinook salmon (J. Myers, et al., 2006). Today, the majority of spring-run LCR Chinook salmon populations are extirpated and total returns are substantially lower than for the fall-run component.

Trend indicators for most populations are negative. The majority of populations for which data are available have a long-term trend of <1; indicating the population is in decline (Bennet, 2005; T. P. Good, et al., 2005). Only the late-fall run population in Lewis River has an abundance and population trend that may be considered viable (McElhany, Chilcote, Myers, & Beamesderfer, 2007). The Sandy River is the only stream system supporting a natural production of spring-run Chinook salmon of any amount. However, the population is at risk from low abundance and negative to low population growth rates (McElhany, et al., 2007).

The genetic diversity of all populations (except the late fall-run Chinook salmon) has been eroded by large hatchery influences and periodically by low effective population sizes. The near loss of the spring-run life history type remains an important concern for maintaining diversity within the ESU.

The ESU is at risk from generally low abundances in all but one population, combined with most populations having a negative or stagnant long-term population growth. However, fish from conservation hatcheries do help to sustain several LCR Chinook salmon runs in the short-term though this is unlikely to result in sustainable wild populations in the long-term. Having only one population that may be viable puts the ESU at considerable risk from environmental stochasticity and random catastrophic events. The loss of life history diversity limits the ESU's ability to maintain its fitness in the face of environmental change.

Critical Habitat

NMFS designated critical habitat for LCR Chinook salmon on September 2, 2005 (70 FR 52630). It includes all Columbia River estuarine areas and river reaches proceeding upstream to the confluence with the Hood Rivers as well as specific stream reaches in a number of tributary subbasins.

As shown in Figure 7, of the watersheds (HUC 5s) reviewed in NMFS' assessment of critical habitat for the LCR Chinook salmon ESU, 13 subbasins were rated as having a medium conservation value, four were rated as low, and the remaining subbasins (31), were rated as having a high conservation value to LCR Chinook salmon (Table 15). Additionally, four watersheds were given a "possibly high" rating, *i.e.*, they may be essential to conservation of the species but are currently unoccupied.

Table 15. LCR Chinook salmon HUC 5 watersheds with conservation values

HUC 4 Subbasin	HUC 5 Watershed conservation Value (CV)					
	High CV	PCE(s)[1]	Medium CV	PCE(s)[1]	Low CV	PCE(s)[1]
Middle-Columbia/Hood	6	(1)	2	(3)	0	
Lower Columbia/Sandy	7	(1, 3)	1	(3, 1)	1	(3)
Lewis	2	(1, 2, 3)	0		0	
Lower Columbia/Clatskanie	2	(3, 1)	3	(3, 2)	1	(2)
Upper Cowlitz River	5	(3)	0		0	
Lower Cowlitz	4	(3, 1)	4	(3, 1)	0	
Lower Columbia	2	(3, 1)	1		0	
Middle Willamette	0		0		1	(2)
Clackamas	1	(1)	0		1	
Lower Willamette	1	(2)	2	(2)	0	
Lower Columbia Corridor	1	(3)	0		0	
Total	31		13		12	

1 Numbers in parenthesis refers to the dominant (in river miles) PCE(s) within the HUC 5 watersheds. PCE 1 is spawning and rearing, 2 is rearing and migration, and 3 is migration and presence. PCEs with < means that the number of river miles of the PCE is much less than river miles of the other PCE.

Timber harvest, agriculture, and urbanization have degraded spawning and rearing PCEs by reducing floodplain connectivity and water quality, and by removing natural cover in several rivers. Hydropower development projects have reduced timing and magnitude of water flows, thereby altering the water quantity needed to form and maintain physical habitat conditions and support juvenile growth and mobility. Adult and juvenile migration PCEs are affected by several dams along the migration route.

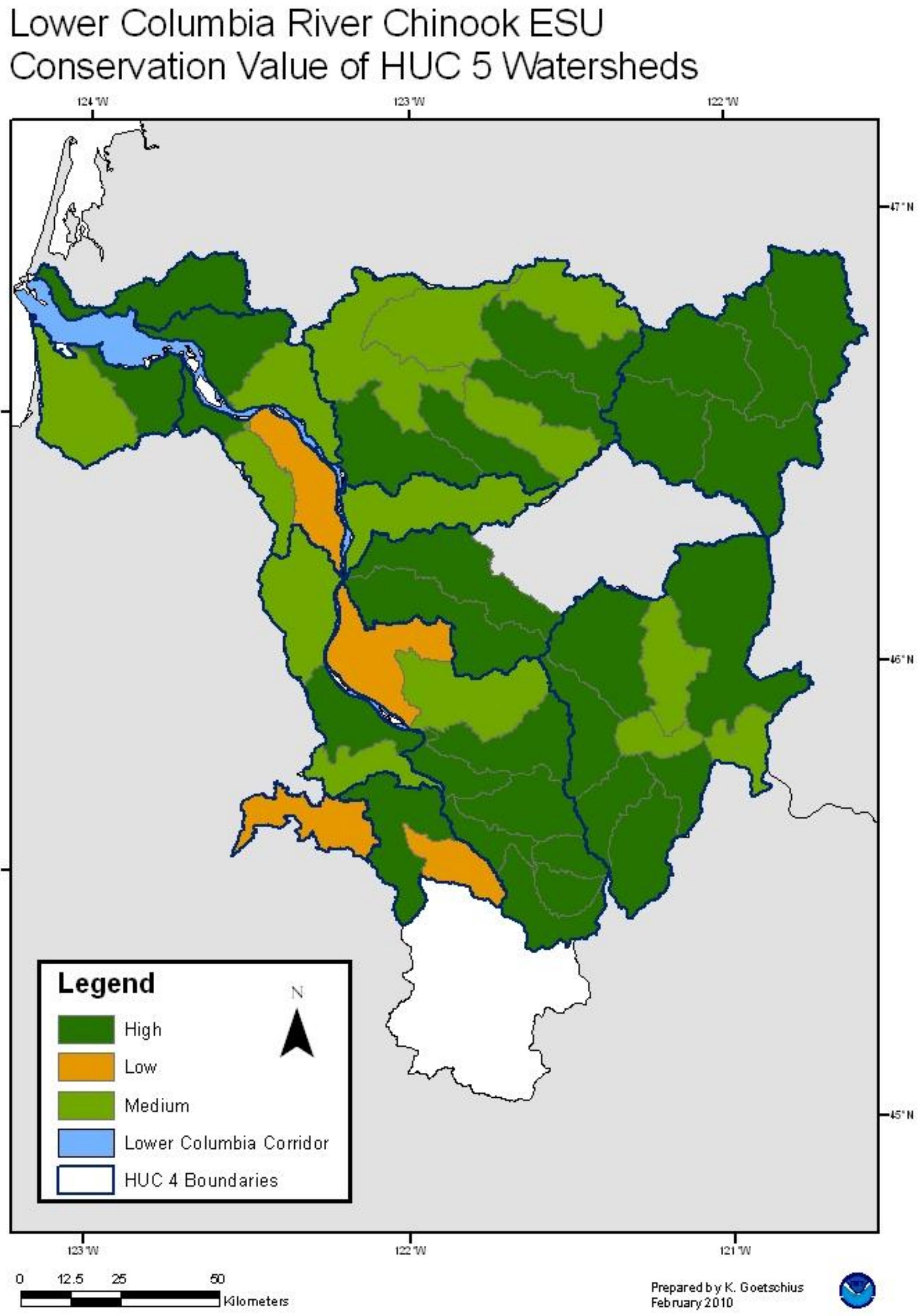


Figure 7. Lower Columbia River Chinook salmon Conservation Values per Sub-Area

Upper Columbia River Spring-run Chinook Salmon

The Upper Columbia River (UCR) Spring-run Chinook salmon ESU includes all naturally spawned populations of spring-run Chinook salmon in all Columbia River tributaries upstream of the Rock Island Dam and downstream of Chief Joseph Dam in Washington State. Major tributary subbasins with existing runs are the Wenatchee, Entiat, and Methow Rivers (Figure 8).

Several hatchery populations are also listed (70 FR 37160). These artificially propagated populations are no more divergent relative to the local natural populations than would be expected between closely related populations within this ESU.

Life History

UCR Spring-run Chinook salmon begin returning from the ocean in the early spring. They enter the upper Columbia tributaries from April through July, with the run peaking in mid-May. After migration, UCR Spring-run Chinook salmon hold in freshwater tributaries until spawning occurs in the late summer, peaking in mid- to late August. Juvenile spring-run Chinook salmon spend a year in fresh water before emigrating to salt water in the spring of their second year.

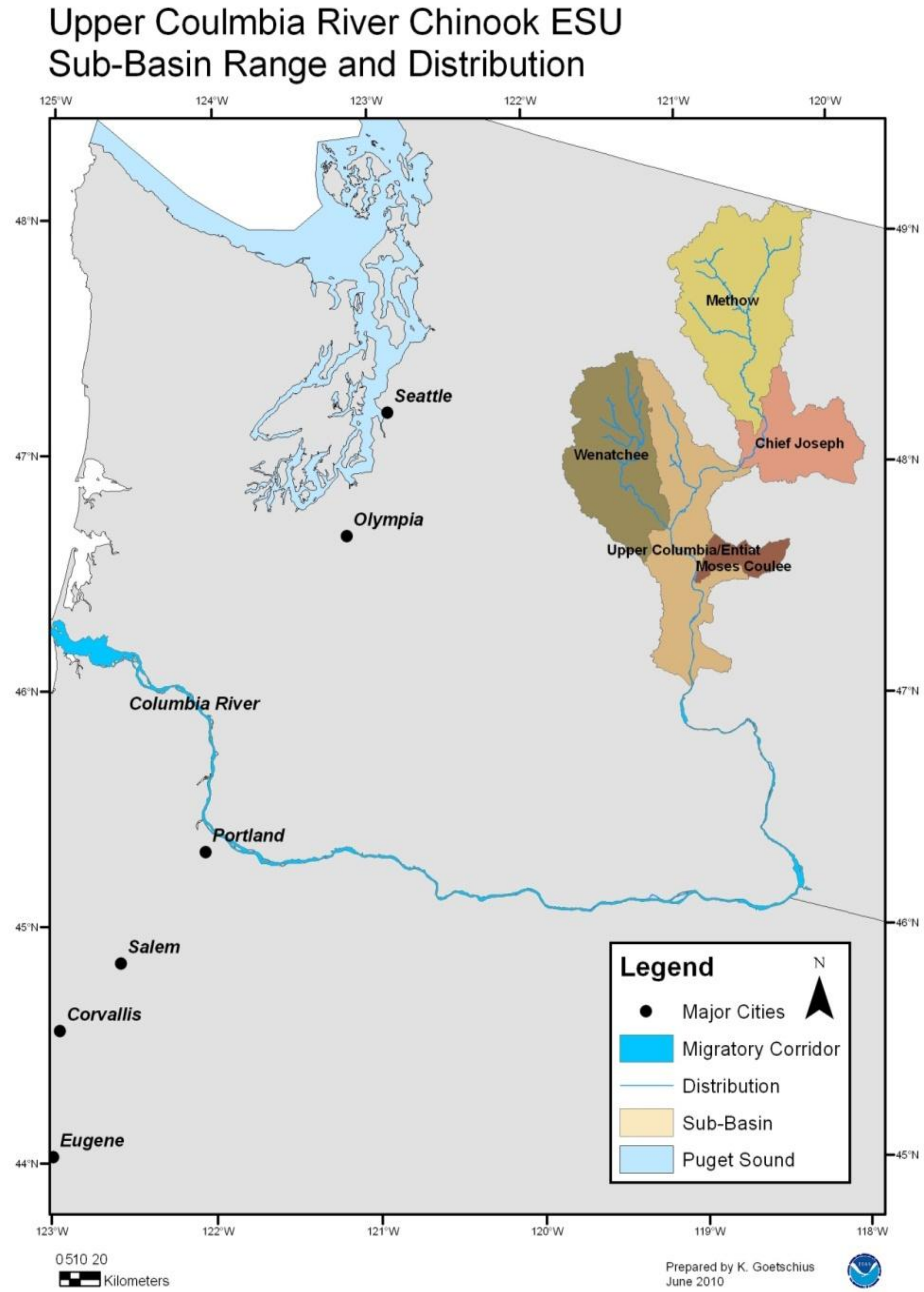


Figure 8. Upper Columbia River Chinook salmon distribution

Status and Trends

NMFS listed UCR Spring-run Chinook salmon as endangered on March 24, 1999 (64 FR 14308), and reaffirmed their endangered status on June 28, 2005 (70 FR 37160). The ESU consisted of four populations. Of these, one is now extinct and three are extant. The Interior Columbia Basin Technical Review Team (ICBTRT) characterizes the spatial structure risk to UCR Spring-run Chinook populations as "low" or "moderate." Table 16 identifies populations within the UCR Spring-run Chinook salmon ESU, their abundances, and hatchery input.

Table 16. Upper Columbia River Spring-run Chinook salmon - preliminary population structure, abundances, and hatchery contributions

Population	Historical Abundance	Mean Number of Spawners (Range)[a]	Hatchery Abundance Contributions
Methow River	~2,100	680 (79-9,9-04)	59%
Twisp River	Unknown	58 redds (10-369)	54%
Chewuch River	Unknown	58 redds (6-1,105)	41%
Lost/Early River	Unknown	12 (3-164)	54%
Entiat River	~380	111 (53-444)	42%
Wenatchee River	~2,400	470 (119 -4,446)	42%
Chiwawa River	Unknown	109 redds (34-1,046)	47%
Nason Creek	Unknown	54 redds (8-374)	39%
Upper Wenatchee River	Unknown	8 redds (0-215)	66%
White River	Unknown	9 redds (1-104)	8%
Little Wenatchee River	Unknown	11 redds (3-74)	21%
Okanogan River	Unknown	Extirpated	NA

[a] 5-year geometric mean number of spawners unless otherwise noted; includes hatchery fish. Range denoted in parenthesis. Means calculated from years 1997 to 2001, except Lost/Early Winter creeks did not include 1998 as no data were available. Data reported in (T. P. Good, et al., 2005).

For all populations, average abundance over the recent 10-year period is below the average abundance thresholds that the ICBTRT identifies as a minimum for low risk (ICTRT, 2008a, 2008b, 2008c). The geometric mean spawning escapements from 1997 to 2001 were 273 for the Wenatchee population, 65 for the Entiat population, and 282 for the Methow population. These numbers represent only 8% to 15% of the minimum abundance thresholds. The five-year geometric mean remained low as of 2003. Recently, the 2007 UCR spring Chinook jack counts, an indicator of future adult returns, have increased to their highest level since 1977.

Based on 1980-2004 returns, the lambda for this ESU is estimated at 0.93 (meaning the population is not replacing itself) (T. Fisher & Hinrichsen, 2006). The long-term trend for abundance and lambda for individual populations indicate a decline for all three populations (T. P. Good, et al., 2005). Short-term lambda values indicate an increasing trend for the Methow population, but not for the Wenatchee and Entiat populations (ICTRT, 2008a, 2008b, 2008c).

Finally, the ICBTRT characterizes the diversity risk to all UCR Spring-run Chinook populations as “high”. The high risk is a result of reduced genetic diversity from homogenization of populations that occurred under the Grand Coulee Fish Maintenance Project in 1939-1943.

Abundance data showed an increase in spawner returns in 2000 and 2001 (T. P. Good, et al., 2005). However, this increase did not manifest itself in subsequent years. Thus, recent available data on population viability suggest that the ESU continues to be at high risk from small population size; all three UCR Spring-run Chinook salmon populations are affected by low abundances and failing recruitment. Should population growth rates continue at the 1980-2004 levels, UCR Spring-run Chinook salmon populations have a high probability of decline within 50 years. The genetic integrity of all populations has been compromised by periods of low effective population size and low proportion of natural-origin fish.

Critical Habitat

NMFS designated critical habitat for UCR Spring-run Chinook salmon on September 2, 2005 (70 FR 52630). It includes all Columbia River estuarine areas and river reaches proceeding upstream to Chief Joseph Dam and several tributary subbasins.

The UCR Spring-run Chinook salmon ESU has 31 watersheds within its range. Five watersheds received a medium rating and 26 received a high rating of conservation value to the ESU (Table 17). The Columbia River rearing/migration corridor downstream of the spawning range was rated as having a high conservation value (Figure 9).

Spawning and rearing PCEs are somewhat degraded in tributary systems by urbanization in lower reaches, grazing in the middle reaches, and irrigation and diversion in the major upper drainages. These activities have resulted in excess erosion of fine sediment and silt that smother spawning gravel; reduction in flow quantity necessary for successful incubation, formation of physical rearing conditions, and juvenile mobility. Moreover siltation further affects critical habitat by reducing water quality through contaminated agricultural runoff; and removing natural cover. Adult and juvenile migration PCEs are heavily degraded by Columbia River Federal dam projects and a number of mid-Columbia River Public Utility District dam projects also obstruct the migration corridor.

Table 17. UCR Spring-run Chinook salmon watersheds with conservation values.

HUC 4 Subbasin	HUC 5 Watershed conservation Value (CV)					
	High CV	PCE(s)[1]	Medium CV	PCE(s)[1]	Low CV	PCE(s)[1]
Chief Joseph	1	(3)	0		0	0
Methow	5	(1, <2, <3)	2	(1, 2)	0	
Upper Columbia/Entiat	3	(3, 2[2], 1[2])	1	(3)	0	
Wenatchee	3	(1, 2, <3)	2	(2, 1)	0	
Moses Coulee	1	(1, =0.8mi)	0		0	
Upper Columbia/Priest Rapids	3	(3)	0		0	
Middle Columbia/Lake Wallula	5	(3)	0		0	
Middle Columbia/Hood	4	(3)	0		0	
Lower Columbia/Sandy	1	(3)	0		0	
Lower Columbia Corridor	all	(3)[3]	0		0	
Total	26		5		0	

1 Numbers in parenthesis refers to the dominant (in river miles) PCE(s) within the HUC 5 watersheds. PCE 1 is spawning and rearing, 2 is rearing and migration, and 3 is migration and presence. PCEs with < means that the number of river miles of the PCE is much less than river miles of the other PCE.

2 Only one of the three watersheds, Entiat River, had PCEs 1 and 2.

3 The Lower Columbia Corridor includes 46.5 miles of estuarine PCEs.

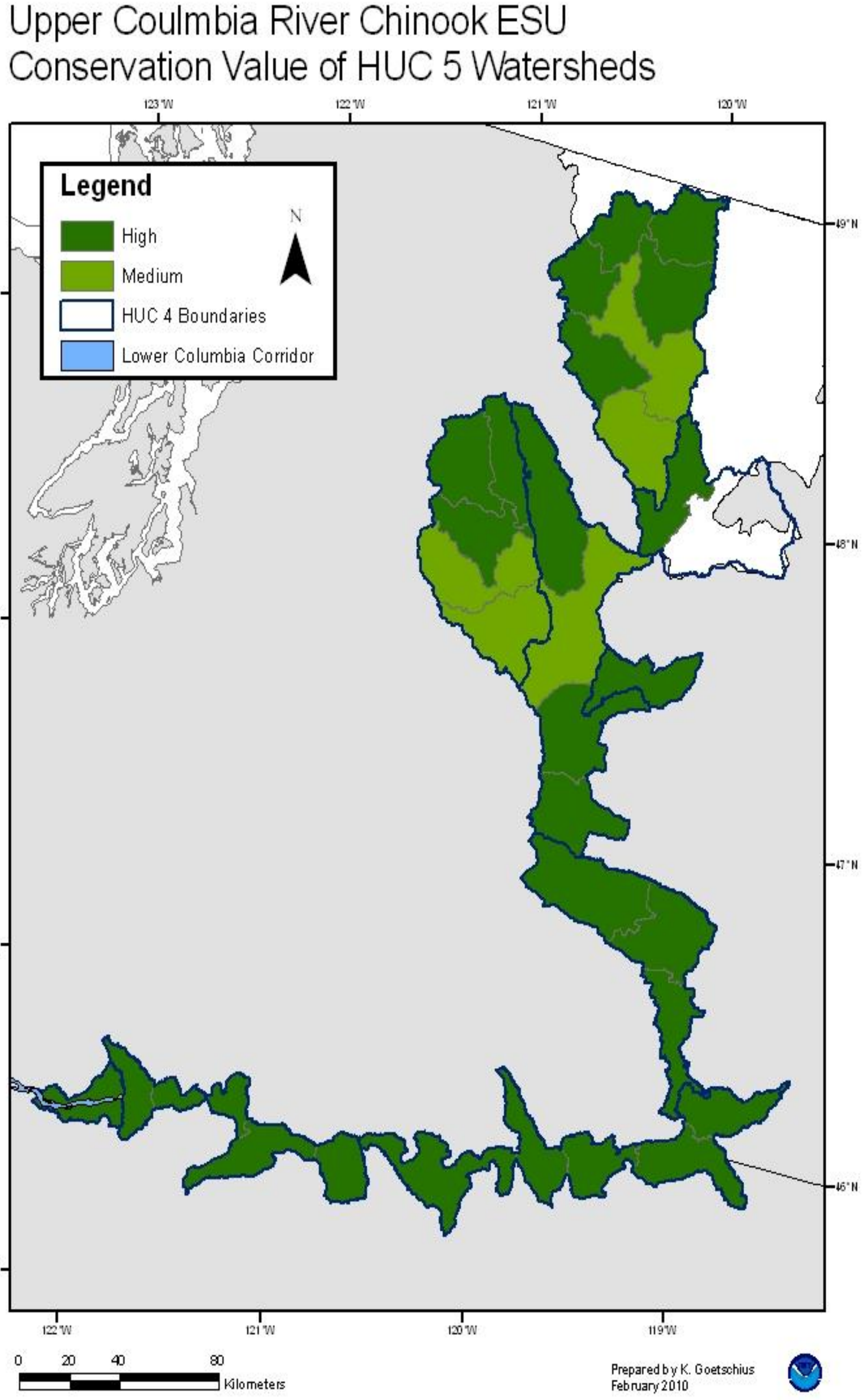


Figure 9. Upper Columbia River Spring-run Chinook salmon Conservation Values per Sub-Area

Snake River Fall-run Chinook Salmon

The Snake River (SR) Fall-run Chinook salmon ESU (Figure 10) includes all naturally spawned populations of fall-run Chinook salmon in the mainstem Snake River below Hells Canyon Dam, and in the Tucannon River, Grande Ronde River, Imnaha River, Salmon River, and Clearwater River subbasins (70 FR 37176,). Four artificial propagation programs are included in the ESU. These artificially propagated populations are no more divergent relative to the local natural populations than would be expected between closely related populations within this ESU.

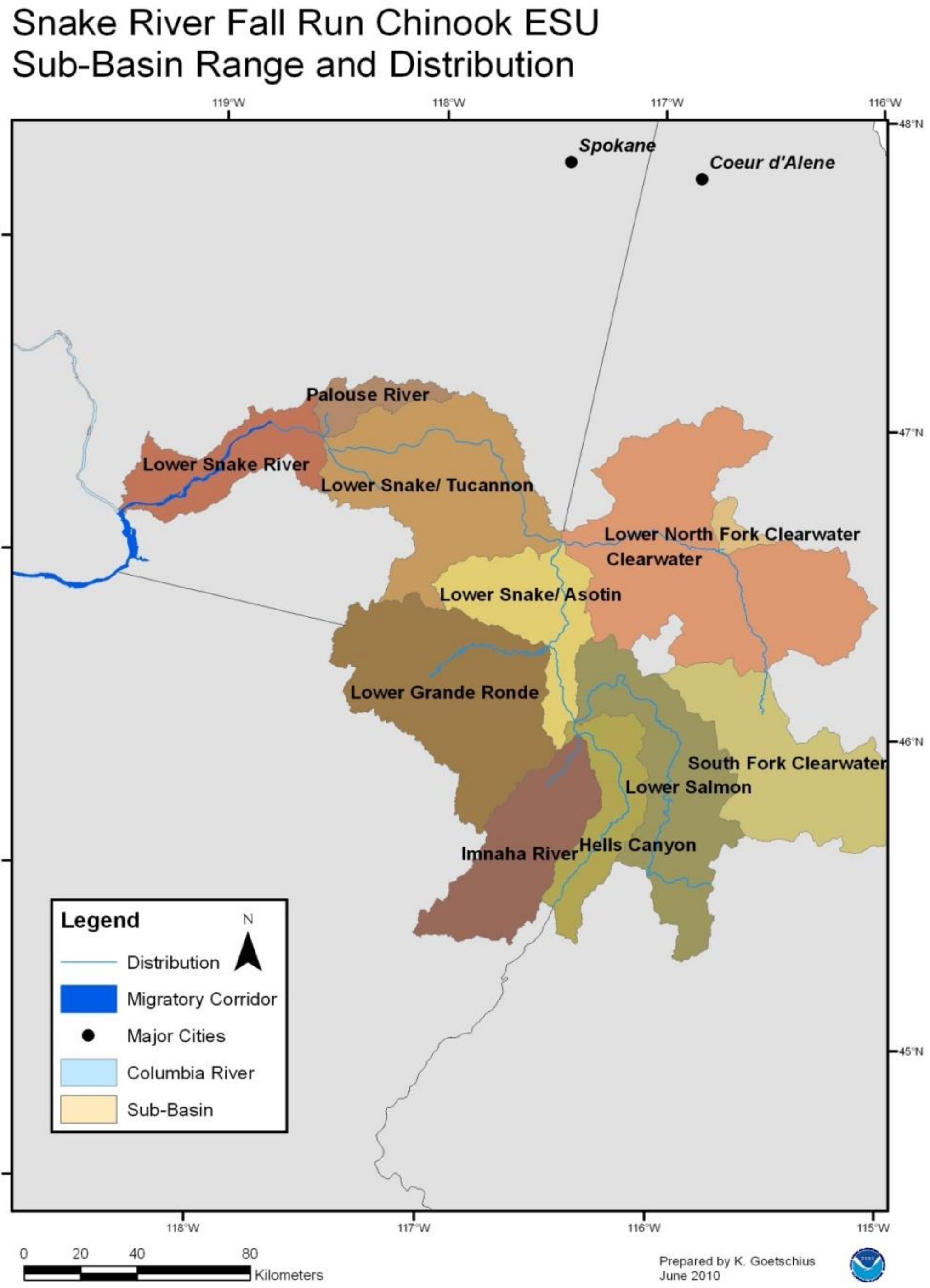


Figure 10. Snake River Fall-run Chinook salmon distribution

Status and Trends

NMFS originally listed SR Fall-run Chinook salmon as endangered in 1992 (57 FR 14653) but reclassified their status as threatened on June 28, 2005 (70 FR 37160). The SR Fall-run Chinook salmon consists of one extant population that is mostly limited to a core spawning area within a 32-km section of the mainstem Snake River (ICTRT, 2003). Two populations have been extirpated.

Estimated annual returns for the period 1938 to 1949 were at 72,000 fish. By the 1950s, numbers had declined to an annual average of 29,000 fish (T. C. Bjornn & Horner, 1980). Numbers of SR Fall-run Chinook salmon continued to decline during the 1960s and 1970s as approximately 80% of their historic habitat were eliminated or severely degraded by the construction of the Hells Canyon complex (1958 to 1967) and the lower Snake River dams (1961 to 1975). The abundance of natural-origin spawners in the SR Fall-run Chinook ESU for 2001 (2,652 adults) exceeded 1,000 fish for the first time since counts began at the Lower Granite Dam in 1975. The recent five-year mean abundance of 871 naturally produced spawners at the time of the last status review generated concern that despite recent improvements, the abundance level is very low for an entire ESU. On the other hand, during the years from 1975 to 2000, the ESU fluctuated between 500 to 1,000 natural spawners. This suggests a higher degree of stability in growth rate at low population levels than is seen in other salmonid populations. Further, numbers of natural-origin SR Fall-run Chinook salmon have increased over the last few years, with estimates at Lower Granite Dam of 2,652 fish in 2001, 2,095 fish in 2002, and 3,895 fish in 2003.

Long- and short-term trends in natural returns are positive. Productivity is likely sustained largely by a system of small artificial rearing facilities in the lower Snake River Basin. Depending upon the assumptions made regarding the reproductive contribution of hatchery fish, long- and short-term trends in productivity are at or above replacement.

Low abundances in the 1990s combined with a large proportion of hatchery derived spawners likely have reduced genetic diversity from historic levels. Nevertheless, the SR Fall-run Chinook salmon remains genetically distinct from similar fish in other basins.

As the ESU's single population spawning activities are limited to a relatively short reach of the free flowing mainstem Snake River, it is at considerable risk from environmental variability and stochastic events. The 1997 to 2001 geometric mean natural-origin count over Lower Granite Dam approximate 35% of the proposed delisting abundance criteria of 2,500 natural spawners averaged over eight years. Current observed abundances indicate that the ESU is at moderate risk from low abundances.

Critical Habitat

NMFS designated critical habitat for SR Fall-run Chinook salmon on December 28, 1993 (58 FR 68543). It includes the Columbia River reaches presently or historically accessible to listed fall-run Chinook salmon (except river reaches above impassable natural falls, and Dworshak and Hells Canyon Dams) from the estuary upstream to the confluence of the Snake River; all Snake River reaches from the confluence of the Columbia River upstream to Hells Canyon Dam. It also includes the Palouse River from its confluence with the Snake River upstream to Palouse Falls; the Clearwater River from its confluence with the Snake River upstream to its confluence with Lolo Creek; and the North Fork Clearwater River from its confluence with the Clearwater River upstream to Dworshak Dam. Designated areas consist of the water, waterway bottom, and the adjacent riparian zone (defined as an area 300 feet from the normal high water line on each side of the river channel) (58 FR 68543).

Individual watersheds within the ESU have not been evaluated for their conservation value. However, the lower Columbia River corridor is among the areas of high conservation value to the ESU because it connects every population with the ocean and is used by rearing/migrating juveniles and migrating adults. The Columbia River estuary is a unique and essential area for juveniles and adults making the physiological transition between life in freshwater and marine habitats.

Salmon habitat has been altered throughout the ESU through loss of important spawning and rearing habitat and the loss or degradation of migration corridors. The major degraded PCEs within critical habitat designated for SR Fall-run Chinook salmon include: (1) safe passage for juvenile migration which is reduced by the presence of the Snake and Columbia River hydropower system within the lower mainstem; (2) rearing habitat water quality altered by influx of contaminants and changing seasonal temperature regimes caused by water flow management; and (3) spawning/rearing habitat PCE attributes (spawning areas with gravel, water quality, cover/shelter, riparian vegetation, and space to support egg incubation and larval growth and development) that are reduced in quantity (80% loss) and quality due to the mainstem lower Snake River hydropower system.

Water quality impairments in the designated critical habitat are common within the range of this ESU. Pollutants such as petroleum products, pesticides, fertilizers, and sediment in the form of turbidity enter the surface waters and riverine sediments from the headwaters of the Snake, Salmon, and Clearwater Rivers to the Columbia River estuary; traveling along with contaminated stormwater runoff, aerial drift and deposition, and via point source discharges. Some contaminants such as mercury and pentachlorophenol enter the aquatic food web after reaching water and may be concentrated or even biomagnified in the salmon tissue. This species also requires migration corridors with adequate passage conditions (water quality and quantity available at specific times) to allow access to the various habitats required to complete their life cycle.

Snake River Spring/Summer-Run Chinook Salmon

This ESU includes production areas that are characterized by spring-timed returns, summer-timed returns, and combinations from the two adult timing patterns. The SR Spring/Summer-run Chinook ESU includes all naturally spawned populations of spring/summer-run Chinook salmon in the mainstem Snake River and the Tucannon River, Grande Ronde River, Imnaha River, and Salmon River subbasins (57 FR 23458, Figure 11). Fifteen artificial propagation programs are included in the ESU (70 FR 37176). These artificially propagated populations are no more divergent relative to the local natural populations than would be expected between closely related populations within this ESU.

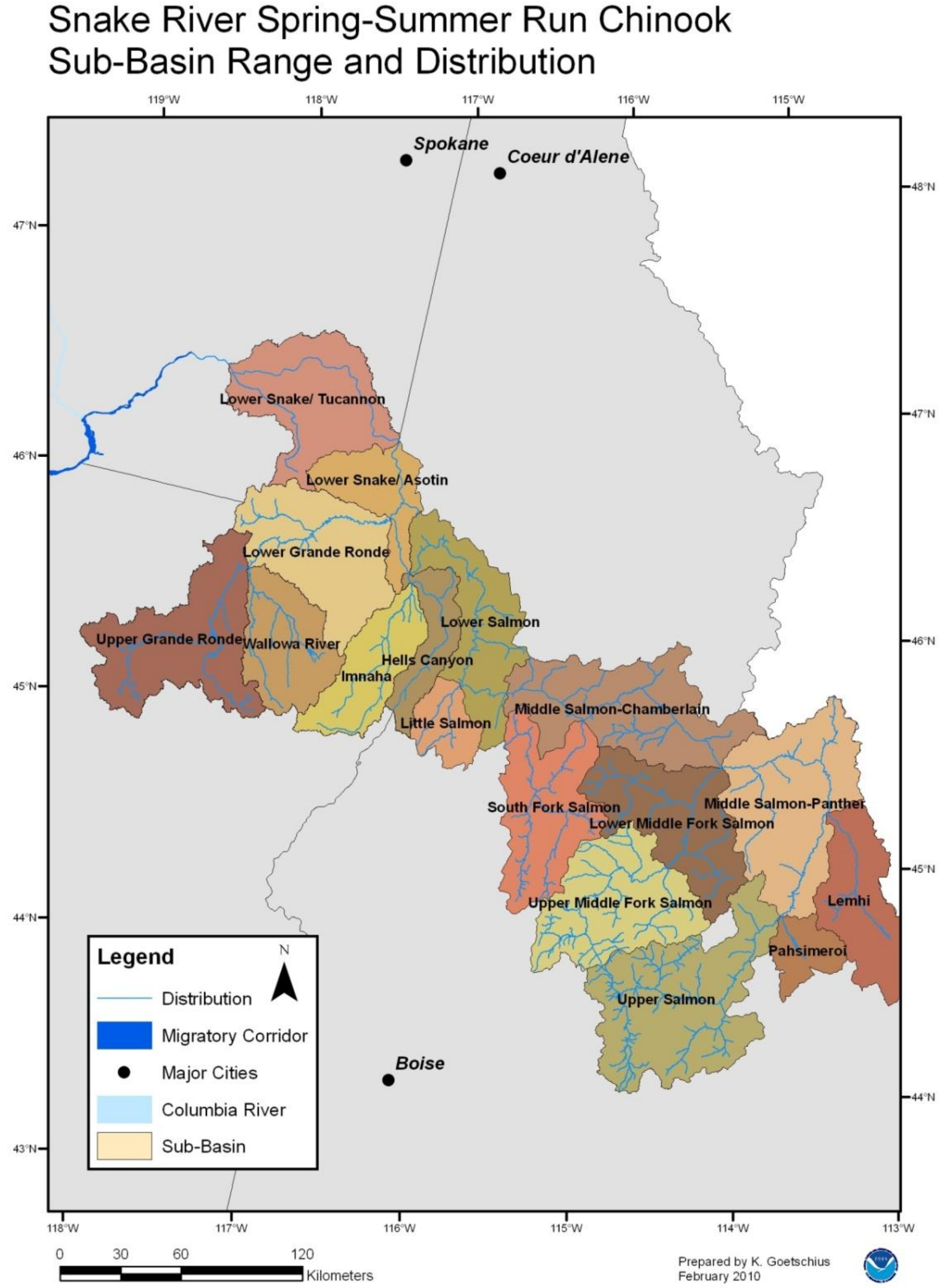


Figure 11. **Snake River Spring/Summer-run Chinook salmon distribution.**

Life History

Runs classified as spring-run Chinook salmon pass Bonneville Dam beginning in early March to mid-June; runs classified as summer-run Chinook salmon return to the Columbia River from June through August. SR Spring/Summer-run Chinook salmon exhibit a stream-type life history. In general, spring-run type Chinook salmon tend to spawn in higher elevation reaches of major Snake River tributaries while summer-run Chinook salmon tend to spawn lower in the Snake River drainages. However, there is an overlap of summer-run Chinook salmon spawning areas and that of spring-run spawners. Spring-run Chinook salmon spawn in mid- through late August, and summer-run Snake River Chinook salmon spawn approximately one month later than spring-run fish. Eggs incubate over the following winter, and hatch in late winter and early spring of the following year. Juvenile fish mature in fresh water for one year before they migrate to the ocean in the spring of their second year of life. Depending on the tributary and the specific habitat conditions, juveniles may migrate extensively from natal reaches into alternative summer-rearing or overwintering areas. Snake River Spring/Summer-run Chinook salmon return from the ocean to spawn primarily as four and five year-old fish, after two to three years in the ocean.

Status and Trends

NMFS originally listed SR Spring/Summer-run Chinook salmon as threatened on April 22, 1992 (57 FR 14653), and reaffirmed their threatened status on June 28, 2005 (70 FR 37160). The ICBTRT has identified 31 historic populations (Table 18). Historic populations above Hells Canyon Dam are considered extinct (ICTRT, 2003). Multiple spawning sites are accessible and natural spawning and rearing are well distributed within the ESU. However, many spawning aggregates have also been extirpated, which has increased the spatial separation of some populations. The South Fork and Middle Fork Salmon Rivers currently support the bulk of natural production in the drainage. Table 18 identifies populations within the Snake River Spring/Summer-run Chinook salmon ESU, their abundances, and hatchery input.

Table 18. Snake River Spring/Summer-run Chinook salmon populations, abundances, and hatchery contributions (T. P. Good, et al., 2005). Note: rpm denotes redds per mile.

Current Populations	Historical Abundance	Mean Number of Spawners (Range)	Hatchery Abundance Contributions
Tucannon River	Unknown	303 (128-1,012)	76%
Wenaha River	Unknown	225 (67-586)	64%
Wallowa River	Unknown	0.57 redds (0-29)	5%
Lostine River	Unknown	34 redds (9-131)	5%
Minam River	Unknown	180 (96-573)	5%
Catherine Creek	Unknown	50 (13-262)	56%
Upper Grande Ronde River	Unknown	46 (3-336)	58%
Imnaha River	Unknown	564 redds (194-3,041)	62%
Big Sheep Creek	Unknown	0.25 redds (0-1)	97%
Little Salmon	Unknown	Unknown	Unknown
South Fork Salmon River	Unknown	496 redds (277-679)	9%
Secesh River	Unknown	144 redds (38-444)	4%
Johnson Creek	Unknown	131 redds (49-444)	0%
Big Creek spring run	Unknown	53 redds (21-296)	0%
Big Creek summer run	Unknown	5 redds (2-58)	Unknown
Loon Creek	Unknown	27 redds (6-255)	0%
Bear Valley/Elk Creek	Unknown	266 (72-712	0%
Marsh Creek	Unknown	53 (0-164)	0%
North Fork Salmon River	Unknown	5.6 redds (2-19)	Unknown
Lemhi River	Unknown	72 redds (35-216)	0%
Pahsimeroi River	Unknown	161 (72-1,097	Unknown
East Fork Salmon spring run	Unknown	0.27 rpm (0.2 – 1.41)	Unknown
East Fork Salmon summer run	Unknown	1.22 rpm (0.35 – 5.32)	0%
Yankee Fork spring run	Unknown	0	Unknown
Yankee Fork summer run	Unknown	2.9 redds (1-18)	0%
Valley Creek spring run	Unknown	7.4 redds (2-28)	0%
Valley Creek summer run	Unknown	2.14 rpm (0.71 – 9.29)	Unknown
Upper Salmon spring run	Unknown	69 redds (25-357)	Unknown
Upper Salmon summer run	Unknown	0.24 rpm (0.07 – 0.58)	Unknown
Alturas Lake Creek	Unknown	2.7 redds (0-18)	Unknown
Lick Creek	Unknown	1.44 redds (0-29)	59%
ESU Estimate	~1.5 million	~9,700	

According to Matthews and Waples (Matthews & Waples, 1991), total annual SR Spring/Summer-run Chinook salmon production may have exceeded 1.5 million adult fish in the late 1800s. Total (natural plus hatchery origin) returns fell to roughly 100,000 spawners by the late 1960s (Fulton, 1968). Between 1981 and 2000, total returns fluctuated between extremes of

1,800 and 44,000 fish. The 2001 and 2002 total returns increased to over 185,000 and 97,184 adults, respectively.

Abundance of summer run Chinook salmon have increased since the low returns in the mid-1990s (lowest run size was 692 fish in 1995). The 1997 to 2008 geometric mean total return for the summer run component at Lower Granite Dam was slightly more than 8,700 fish, compared to the geometric mean of 3,076 fish for the years 1987 to 1996 (Data from the Columbia Basin Fisheries Agencies and Tribes http://www.fpc.org/). However, over 80% of the 2001 return and over 60% of the 2002 return originated from hatcheries (T. P. Good, et al., 2005). Good *et al.* (2005) reported that risks to individual populations within the ESU may be greater than the extinction risk for the entire ESU due to low levels of annual abundance of individual populations. Further, despite the increase in abundance during the last ten years, annual abundance continues to be variable and is most pronounced in natural-origin fish. Thus, although the average abundance in the most recent decade is higher than the previous decade, there is no obvious long-term trend (T. P. Good, et al., 2005) (Data from the Columbia Basin Fisheries Agencies and Tribes http://www.fpc.org/). However, recent trends, buoyed by the last five years, are approaching 1. Additionally, hatchery fish are faring better than wild fish, which comprise roughly 40% of the total returns in the past decade. Overall, most populations are far below their respective interim recovery targets.

There is no evidence of wide-scale genetic introgression by hatchery populations. The high variability in life history traits indicates sufficient genetic variability within the ESU to maintain distinct subpopulations adapted to local environments (T. P. Good, et al., 2005).

Critical Habitat

NMFS designated critical habitat for the Snake River (SR) Spring/Summer-run Chinook salmon on October 25, 1999 (64 FR 57399). This critical habitat encompasses the waters, waterway bottoms, and adjacent riparian zones of river reaches of the Columbia, Snake, and Salmon Rivers, and all tributaries of the Snake and Salmon Rivers, that are or were accessible to listed Snake River salmon (except reaches above impassable natural falls, and Dworshak and Hells Canyon Dams).

NMFS identified spawning, rearing, and migration as PCEs for the SR Spring/Summer-run Chinook salmon. Spawning and juvenile rearing essential features consist of adequate (1) spawning gravel, (2) water quality, (3) water quantity, (4) water temperature, (5) riparian vegetation, (6) food, (7) cover/shelter, and (8) space. Juvenile and adult migration corridor essential features consist of adequate (1) substrate, (2) water quality, (3) water quantity, (4) water temperature, (5) food (juveniles only), (6) riparian vegetation, and (7) access.

Watersheds within the critical habitat designated for the SR Spring/Summer-run Chinook salmon have not been evaluated for their conservation value. However, the lower Columbia River corridor is among the areas of high conservation value to the ESU because it connects every population with the ocean and is used by rearing/migrating juveniles and migrating adults.

Spawning and juvenile rearing PCEs are regionally degraded by changes in flow quantity, water quality, and loss of cover. Juvenile and adult migrations are obstructed by reduced access that has resulted from altered flow regimes from hydroelectric dams. According to the ICBTRT, the Panther Creek population was extirpated because of legacy and modern mining-related pollutants creating a chemical barrier to fish passage (D. J. Chapman & Julius, 2005).

Presence of cool water that is relatively free of contaminants is particularly important for the spring/summer run life history as adults hold over the summer and juveniles may rear for a whole year in the river. Water quality impairments are common in the range of the critical habitat designated for this ESU. Pollutants such as petroleum products, pesticides, fertilizers, and sediment in the form of turbidity enter the surface waters and riverine bottom substrate from the headwaters of the Snake, Salmon, and Clearwater Rivers to the Columbia River estuary as contaminated stormwater runoff, aerial drift and deposition, and via point source discharges. Some contaminants such as mercury and pentachlorophenol enter the aquatic food web after reaching water and may be concentrated or even biomagnified in the salmon tissue. This species also requires migration corridors with adequate passage conditions (water quality and quantity available at specific times) to allow access to the various habitats required to complete their life cycle.

Upper Willamette River Chinook Salmon

The Upper Willamette River (UWR) Chinook salmon ESU includes all naturally spawned populations of spring-run Chinook salmon in the Clackamas River and in the Willamette River, and its tributaries, above Willamette Falls, Oregon (Figure 12). Seven artificial propagation programs are included in the ESU (70 FR 37160, June 28, 2005). These artificially propagated populations are no more divergent relative to the local natural populations than would be expected between closely related populations within the ESU.

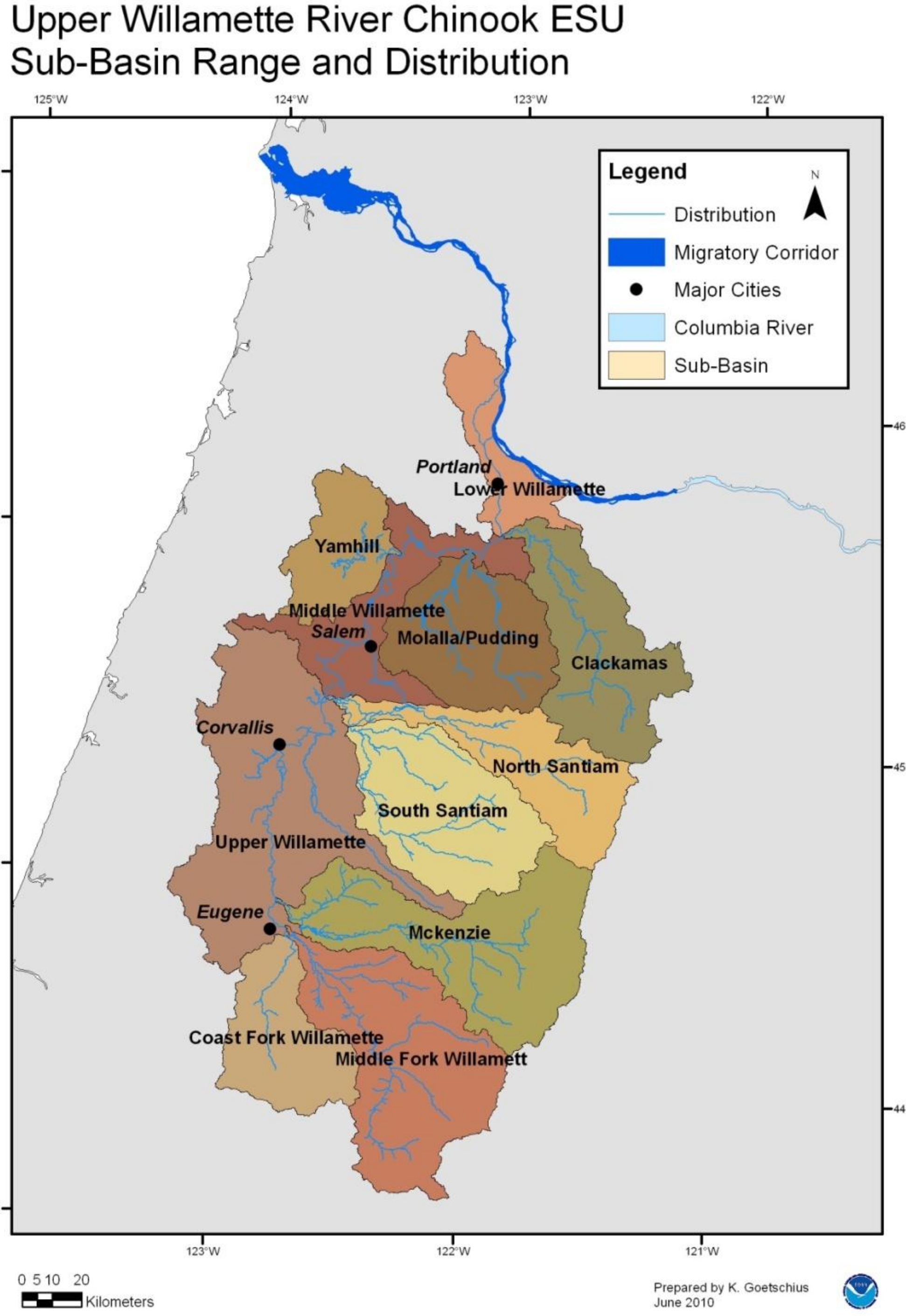


Figure 12. Upper Willamette River Chinook salmon distribution

Life History

UWR Chinook salmon exhibit an earlier time of entry into the Columbia River than other spring-run Chinook salmon ESUs (J. M. Myers et al., 1998). Adults appear in the lower Willamette River in February, but the majority of the run ascends Willamette Falls in April and May, with a peak in mid- to late May. However, present-day salmon ascend the Willamette Falls via a fish ladder. Consequently, the migration of spring Chinook salmon over Willamette Falls extends into July and August (overlapping with the beginning of the introduced fall-run of Chinook salmon).

The adults hold in deep pools over summer and spawn in late fall or early winter when winter storms augments river flows. Fry may emerge from February to March and sometimes as late as June (J. Myers, et al., 2006). Juvenile migration varies with three distinct juvenile emigration "runs": fry migration in late winter and early spring; sub-yearling (0 yr +) migration in fall to early winter; and yearlings (1 yr +) migrating in late winter to spring. Sub-yearlings and yearlings rear in the mainstem Willamette River where they also use floodplain wetlands in the lower Willamette River during the winter-spring floodplain inundation period.

Status and Trends

NMFS originally listed UWR Chinook salmon as threatened on March 24, 1999 (64 FR 14308), and reaffirmed their threatened status on June 28, 2005 (70 FR 37160). Historically, this ESU included sizable numbers of spawning salmon in the Santiam River, the middle fork of the Willamette River, and the McKenzie River, as well as smaller numbers in the Molalla River, Calapooia River, and Albiqua Creek. Table 19 identifies populations within the UWR Chinook salmon ESU, their abundances, and hatchery input.

The W/LCRTRT identified seven historical independent populations (J. Myers, et al., 2006) (Table 19). Most natural spring Chinook salmon populations of this ESU are likely extirpated or nearly so. The spring Chinook salmon in the McKenzie River is the only remaining naturally reproducing population in this ESU. Current spatial distribution is reduced by the loss of 30 to 40% of the total historic habitat which has restricted spawning to a few areas below dams.

Table 19. Upper Willamette River Chinook salmon independent populations core (C) and genetic legacy (G) populations, and hatchery contributions (T. P. Good, et al., 2005).

Functionally Independent Populations	Historical Abundance	Most Recent Spawner Abundance	Hatchery Abundance Contributions
Clackamas River	Unknown	2,910	64%
Molalla River	Unknown	52 redds	>93%
North Santiam River	Unknown	~ 7.1 rpm	>95%
South Santiam River	Unknown	982 redds	>84%
Calapooia River	Unknown	16 redds	100%
McKenzie River	Unknown	~2,470	26%
Middle Fork Willamette River	Unknown	235 redds	>39%
Total	>70,000	~9,700	Mostly hatchery

Note: rpm denotes redds per mile

The total abundance of adult spring-run Chinook salmon (hatchery-origin + natural-origin fish) passing Willamette Falls has remained relatively steady over the past 50 years (ranging from approximately 20,000 to 70,000 fish). However, the current abundance is an order of magnitude below the peak abundance levels observed in the 1920s (approximately 300,000 adults). Total number of fish increased during the period from 1996 to 2004 when it peaked at more than 96,000 adult spring-run Chinook salmon passing Willamette Falls. Since then, the run has steadily decreased with only about 14,000 fish counted in 2008, the lowest number since 1960. ESU abundance increased again to about 25,000 adult spring-run Chinook salmon in 2009. Runs consist of a high but uncertain fraction of hatchery-produced fish.

The spring Chinook salmon in the McKenzie River is the only remaining self sustaining naturally reproducing independent population. The other natural-origin populations in this ESU have very low current abundances, and long- and short-term population trends are negative.

Access of fall-run Chinook salmon to the upper Willamette River and the mixing of hatchery stocks within the ESU have threatened the genetic integrity and diversity of the species. Much of the genetic diversity that existed between populations has been homogenized (J. Myers, et al., 2006).

Critical Habitat

NMFS designated critical habitat for this species on September 2, 2005 (70 FR 52630).

Designated critical habitat includes all Columbia River estuarine areas and river reaches proceeding upstream to the confluence with the Willamette River as well as specific stream reaches in a number of subbasins.

NMFS assessed the conservation value of 59 watersheds within the range of the UWR Chinook salmon (Table 20). Nineteen watersheds received a low rating, 18 received a medium rating, and 22 received a high rating of conservation value to the ESU (NMFS, 2005b). The lower Willamette/Columbia River rearing/migration corridor downstream of the spawning range is also considered to have a high conservation value and is the only habitat designated in four of the high value watersheds.

The current condition of PCEs of the UWR Chinook salmon critical habitat indicates that migration and rearing PCEs are not currently functioning or are degraded. These conditions impact their ability to serve their intended role for species conservation. The migration PCE is degraded by dams altering migration timing and water management altering the water quantity necessary for mobility and survival. Migration, rearing, and estuary PCEs are also degraded by loss of riparian vegetation and instream cover. Pollutants such as petroleum products, fertilizers, pesticides, and fine sediment enter the stream through runoff, point source discharge, drift during application, and non-point discharge where agricultural and urban development occurs. Degraded water quality in the lower Willamette River where important floodplain rearing habitat is present affects the ability of this habitat to sustain its role to conserve the species.

Table 20. UWR Chinook salmon watersheds with conservation values

HUC 4 Subbasin	HUC 5 Watershed conservation Value (CV)					
	High CV	PCE(s)[1]	Medium CV	PCE(s)[1]	Low CV	PCE(s)[1]
Middle Fork Willamette	4	(1)	6	(2, 1)	0	
Coastal Fork Willamette	0		0		4	(2, 1)
Upper Willamette	0		3	(2, 1)	3	(2)
McKenzie	5	(1, 2)	2	(2, 1)	0	
North Santiam	2	(1)	1	(2, 1)	0	
South Santiam	3	(1, 2)	3	(2, 1)	0	
Middle Willamette	0		0		4	(2)
Yamhill	0		0		4	(2)
Molalla/Pudding	0		3	(1, 2)	3	(2)
Clackamas	5	(1)[2]	0		1	(1)
Lower Willamette	3	(2)	0		0	
Columbia River Corridor	all	(3)	0		0	
Total	22		18		19	

1 Numbers in parenthesis refers to the dominant (in river miles) PCE(s) within the HUC 5 watersheds. PCE 1 is spawning and rearing, 2 is rearing and migration, and 3 is migration and presence. PCEs with < means that the number of river miles of the PCE is much less than river miles of the other PCE.

2 .Lower Clackamas River provides for 13.4 miles of PCE 2

California Coastal Chinook Salmon

California Coastal (CC) Chinook salmon includes all naturally-spawned coastal Chinook salmon spawning north from Redwood Creek to, and including, the Russian River to the south as shown in Figure 13. Seven artificial propagation programs are part of this ESU. These artificially propagated populations are no more divergent relative to the local natural populations than would be expected between closely related populations within this ESU.

Life History

CC Chinook salmon are a fall-run, ocean-type fish. Although a spring-run (river-type) component existed historically, it is now considered extinct (Bjorkstedt, et al., 2005). The different populations vary in run timing depending on latitude and hydrological differences between watersheds. Entry of CC Chinook salmon into the Russian River depends on increased flow from fall storms, usually in November to January. Juveniles of this ESU migrate downstream from April through June and may reside in the estuary for an extended period before entering the ocean.

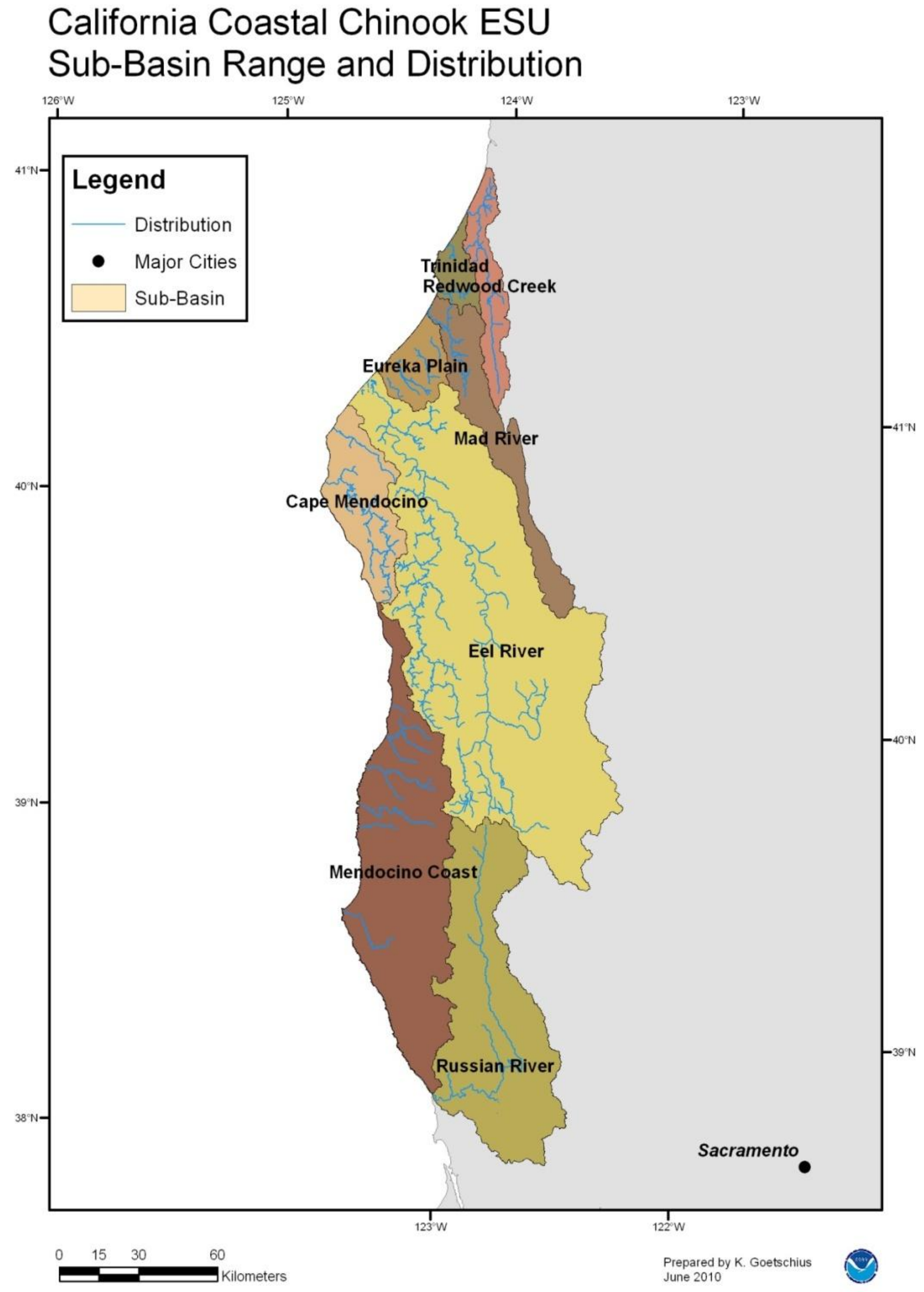


Figure 13. California Coastal Chinook salmon distribution

Table 21. California Coastal Chinook salmon fall-run populations-preliminary population structure, abundances, and hatchery contributions (T. P. Good, et al., 2005)

Population	Historic Spawner Abundance	Mean Number of Spawners	Hatchery Abundance Contributions
Eel River (includes * tributaries below) – 2 populations		156-2,730	~30%
Mainstem Eel River*	13,000	Inc. in Eel River	Unknown
Van Duzen River*	2,500	Inc. in Eel River	Unknown
Middle Fork Eel River*	13,000	Inc. in Eel River	Unknown
South Fork Eel River*	27,000	Inc. in Eel River	Unknown
North Fork Eel River*	Unknown	Inc. in Eel River	Unknown
Upper Eel River*	Unknown	Inc. in Eel River	Unknown
Redwood Creek	1,000-5,000	Unknown	0
Mad River	1,000-5,000	19-103	Unknown
Bear River	100	Unknown	0
Mattole River	1,000-5,000	Unknown	17%
Small Humboldt County rivers	1,500	Unknown	0
Rivers north of Mattole River	600	Unknown	0
Humboldt Bay tributaries	40	120	40 (33%)
Noyo River	50	Unknown	0
Russian River	50-500	>1,383 – >6,103	~0%
Tenmile to Gualala coastal effluents	Unknown	Unknown	0
Total	20,750-72,550	Unknown	

Status and Trends

NMFS listed CC Chinook salmon as threatened on September 16, 1999 (64 FR 50393), and reaffirmed their threatened status on June 28, 2005 (70 FR 37160). The CC Chinook ESU historically consisted of 10 functionally independent populations and 5 potentially independent populations (Bjorkstedt, et al., 2005). Seventeen basins may have had Chinook salmon runs that relied on immigration from the larger basins. ESU connectivity is substantially reduced by the near extirpation of all historically independent populations between the Russian River in Sonoma County and Mattole River in Humboldt County (NMFS, 2008a; Brian C. Spence, et al., 2008). The number of extant populations is uncertain.

Historical estimates of escapement suggest abundance was roughly 73,000 in the early 1960s, with the majority of fish spawning in the Eel River, and about 21,000 in the 1980s (T. P. Good, et al., 2005). Table 21 identifies populations within the CC Chinook salmon ESU, their abundances, and hatchery input.

Comparison of historical and current abundance information indicates that independent populations of Chinook salmon are depressed in many basins (Bennet, 2005; T. P. Good, et al., 2005; NMFS, 2008a). All spring-run populations once occupying the North Mountain Interior are considered extinct or nearly so. Redd counts in Mattole River in the northern portion of the ESU indicate a small but consistent population; the cooler northern climate likely provides for favorable conditions for these populations (Brian C. Spence, et al., 2008). The Eel River interior fall-run populations are severely depressed (Brian C. Spence, et al., 2008). Two functionally independent populations are believed to have existed along the southern coastal portion of the ESU; of these two, only the Russian River currently has a run of any significance (Bjorkstedt, et al., 2005). This is also the only population with abundance time series. The 2000 to 2007 median observed (at Mirabel Dam) Russian River Chinook salmon run size is 2,991 with a maximum of 6,103 (2003) and a minimum of 1,125 (2008) adults (D. Cook, 2008; Sonoma County Water Agency (SCWA), 2008). The number of spawners has steadily decreased since its high returns in 2003 with 1,963 fish observed in 2007 and 1,125 observed by December 22, 2008. The time series is too short to estimate lambda.

The CC Chinook ESU is at considerable risk from population fragmentation and reduced spatial diversity. There is little connectivity between the southern and northern portions of their range. At the southern portion of the ESU, only the Russian River population has had a constant run that exceeded 1,000 adult spawning fish over the last 10 years. This places the ESU at risk from random catastrophic events, chronic stressors, and long-term environmental change. Life history diversity has been significantly reduced by loss of the spring-run race and reduction in coastal populations.

Critical Habitat

NMFS designated critical habitat for the CC Chinook salmon on September 2, 2005 (70 FR 52488). It includes multiple CALWATER hydrological units north from Redwood Creek and south to Russian River (Table 22). The total area of critical habitat includes 1,500 miles of stream habitat and about 25 square miles of estuarine habitat, mostly within Humboldt Bay. A list and maps of watersheds and streams designated as critical habitat for CC Chinook salmon can be found in the Federal Register (70 FR 52488, Sept. 2, 2005).

There are 45 occupied CALWATER Hydrologic Subarea (HSA) watersheds within the freshwater and estuarine range of this ESU. Eight watersheds received a low rating, 10 received a medium rating, and 27 received a high rating of conservation value to the ESU (70 FR 52488). Two estuarine habitat areas used for rearing and migration (Humboldt Bay and the Eel River Estuary) also received a high conservation value rating (Figure 14).

Table 22. CC Chinook salmon CALWATER HSA watersheds with conservation values

HUC 4 Subbasin	HUC 5 Watershed conservation Value (CV)					
	High CV	PCE(s)[1]	Medium CV	PCE(s)[1]	Low CV	PCE(s)[1]
Redwood Creek	2	(1, 2, 3)	1	(1, 2, 3)	0	
Trindad	1	(1, 2, 3)	0		1	(1, 2, 3)
Mad River	3	(1, 2, 3)	0		0	
Eureka Plain	1	(1, 2, 3)	0		0	
Eel River	12	(1, 2, 3)	4	(1, 2, 3)	3	(1, 2, 3)
Cape Mendocino	2	(1, 2, 3)	0		0	
Mendocino Coast	2	(1, 2, 3)	3	(1, 2, 3)	2	(1, 2, 3)
Russian River	4	(1, 2, 3)	2	(1, 2, 3)	2	(1, 2, 3)
Total	**27**		**10**		**8**	

1 Numbers in parenthesis refers to the dominant (in river miles) PCE(s) within the HUC 5 watersheds. PCE 1 is spawning and rearing, 2 is rearing and migration, and 3 is migration and presence. PCEs with < means that the number of river miles of the PCE is much less than river miles of the other PCE.

Critical habitat in this ESU consists of limited quantity and quality summer and winter rearing habitat, as well as marginal spawning habitat. Compared to historical conditions, there are fewer pools, limited cover, and reduced habitat complexity. The current condition of PCEs of the CC Chinook salmon critical habitat indicates that PCEs are not currently functioning or are degraded; their conditions are likely to maintain a low population abundance across the ESU. CC Chinook salmon spawning PCE in coastal streams is degraded by years of timber harvest that has produced large amounts of sand and silt in spawning gravel and reduced water quality by increased turbidity. Agriculture and urban areas has impacted rearing and migration PCEs in the Russian River by degrading water quality and by disconnecting the river from it floodplains by the construction of levees. Water management from dams within the Russian and Eel River watersheds maintain high flows and warm water during summer which benefits the introduced predatory Sacramento pikeminnow. This has resulted in excessive predation along migration corridors. Breaches of the sandbar at the mouth of the Russian River result in periodic mixing of salt water. This condition degrades the estuary PCE by altering water quality and salinity conditions that support juvenile physiological transitions between fresh- and salt water.

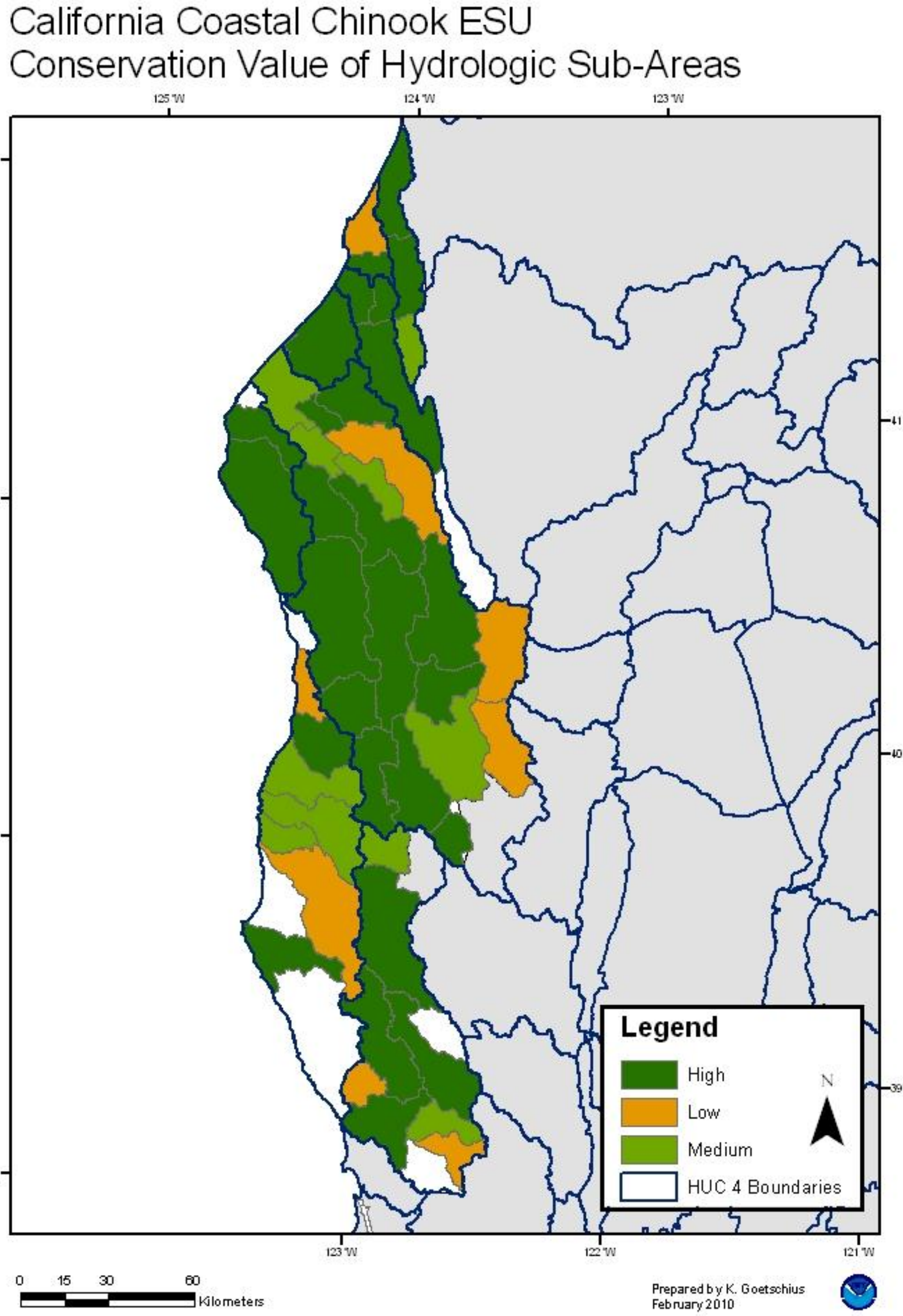


Figure 14. California Coastal Chinook salmon Conservation Values per Sub-Area

Central Valley Spring-run Chinook Salmon

The Central Valley (CV) Spring-run Chinook salmon includes all naturally spawned populations of spring-run Chinook salmon in the Sacramento River, California, and its tributaries (Figure 15). The Feather River Hatchery spring-run Chinook salmon is included in this ESU. This artificially propagated population is no more divergent relative to the local natural populations than would be expected between closely related populations within this ESU. Table 23 identifies populations within the CV Spring-run Chinook salmon ESU, their abundances, and hatchery input.

Life History

CV Spring-run Chinook salmon enter the Sacramento River from March to September and spawn from late August through early October, with a peak in September. Chinook salmon require cool fresh water while they mature over the summer. Adult upstream migration may be blocked by temperatures above 21ºC (McCullough, 1999). Fry emerge from the gravel November to March. Juvenile spring-run emigration in the Sacramento River is highly variable and they may migrate either as soon as they emerge from the gravel or as yearlings. The majority of spring-run fry emerging in the tributaries migrate downstream from December through February during high flows. Juvenile CV Spring-run Chinook salmon have been observed rearing in the lower reaches of non-natal tributaries and intermittent streams in the Sacramento Valley during the winter months. Peak fry/sub-yearling movements are observed farther downstream in lower Sacramento River (Knights Landing) and the Delta during March and April. Up to 25% of juveniles may remain in the tributaries to rear and outmigrate as yearlings the next fall, normally starting in December.

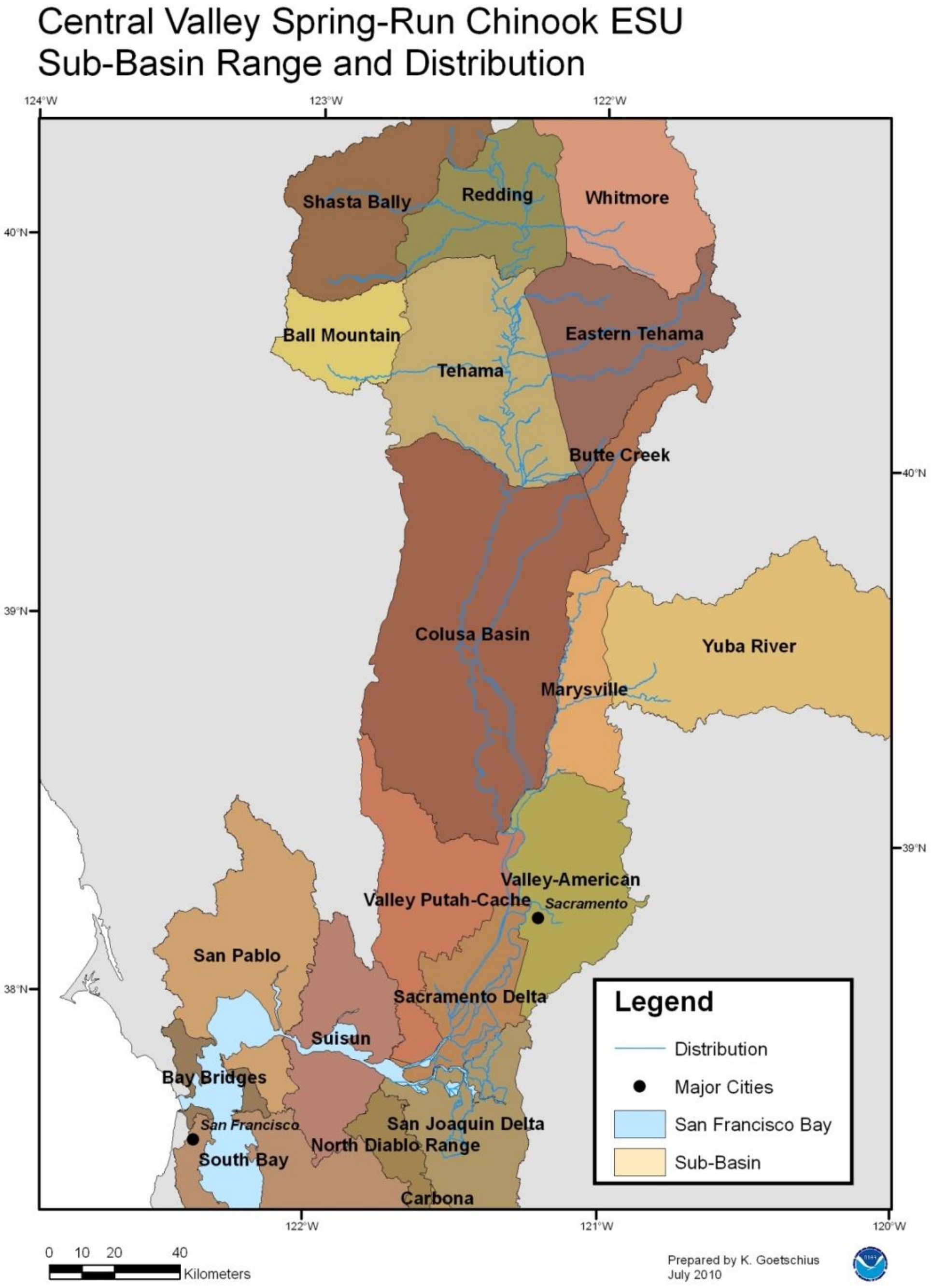


Figure 15. Central Valley Spring-run Chinook salmon distribution

Status and Trends

NMFS originally listed CV Spring-run Chinook salmon as threatened on September 16, 1999 (64 FR 50393), and reaffirmed their threatened status on June 28, 2005 (70 FR 37160). Historically, spring-run Chinook salmon were predominant throughout the Sacramento and San Joaquin River drainages. All runs within the San Joaquin River basin are now extirpated. Naturally spawning populations of CV Spring-run Chinook salmon currently are restricted to accessible reaches of the upper mainstem Sacramento River and its tributaries Butte, Deer, and Mill Creeks. Limited spawning occurs in the basins of smaller tributaries (CDFG, 1998).

Table 23. Central Valley Spring-run Chinook salmon--preliminary population structure, historic and most recent natural production, spawner abundance, and hatchery contributions (T. P. Good, et al., 2005; USFWS & Reclamation, 2007)

Population	Historic Natural Production (1967 – 1991)	Most Recent Natural Production[1] (2000 – 2006)	Most Recent Spawner Abundance[2] (2000- 2006)	Hatchery Abundance Contributions
Butte Creek	1,000	6,516 – 19,809	4,118 – 10,625	Unknown
Deer Creek	3,300	1,387 – 3,461	637 – 2,759	Unknown
Mill Creek	2,200	1,184 – 26,190	544 – 1594	Unknown
Sacramento River	29,000	0 – 1,134	0 – 394	Unknown
Total	Estimated historic abundance: ~700,000 for all populations	11,403 – 26,190	5,370 – 14,044	Unknown

1. Includes catches
2. *i.e.*, escapement

The Central Valley drainage supported spring-run Chinook salmon runs as large as 700,000 fish between the late 1880s and the 1940s (L. R. Brown, Moyle, & Yoshiyama, 1994). Before construction of Friant Dam, nearly 50,000 adults were counted in the San Joaquin River alone (Fry, 1961).

Median natural production of spring-run Chinook salmon from 1970 to 1989 was 30,220 fish. In the 1990s, the population experienced a substantial production failure with an estimated natural production ranging between 3,863 and 7,806 fish (with the exception of 1995 which had a natural production of an estimated 35,640 adults) during the years between 1991 and 1997 (USFWS & Reclamation, 2007). Numbers of naturally produced fish increased significantly in

1998 to an estimated 48,755 adults and estimated natural production has remained above 10,000 fish since then (USFWS & Reclamation, 2007).

The Sacramento River trends and lambda show a long- and short- term negative trend and negative population growth (T. P. Good, et al., 2005). Meanwhile, the median production of Sacramento River tributary populations increased from a low of 4,248 with only one year exceeding 10,000 fish before 1998 to a combined natural production of more than 10,000 spring-run Chinook in all years after 1998 (data from (USFWS & Reclamation, 2007)). Time series data for Mill, Deer, Butte, and Big Chico Creeks spring-run Chinook salmon (updated through 2006) show that all three tributary spring-run Chinook populations have long-and short-term lambdas >1; indicating population growth (T. P. Good, et al., 2005). Although the populations are small, CV spring-run Chinook salmon have some of the highest population growth rates in the Central Valley.

Critical Habitat

NMFS designated critical habitat for this species on September 2, 2005 (70 FR 52488).
The critical habitat boundary includes the Sacramento River and several tributaries from the Big Chico tributary with Sacramento River upstream to Shasta Dam (Table 24).

There are 38 occupied HSA watersheds within the freshwater and estuarine range of this ESU. As shown in Figure 16, seven watersheds received a low rating, 3 received a medium rating, and 27 received a high rating of conservation value to the ESU (NMFS, 2005c). Four of these HSA watersheds comprise portions of the San Francisco-San Pablo-Suisun Bay estuarine complex which provides rearing and migratory habitat for this ESU.

The current condition of PCEs of the CV Spring-run Chinook salmon critical habitat indicates that PCEs are not currently functioning or are degraded; their conditions are likely to maintain a low population abundance across the ESU. Spawning and rearing PCEs are degraded by high water temperature caused by the loss of access to historic spawning areas in the upper watersheds which maintained cool and clean water throughout the summer. The rearing PCE is degraded by floodplain habitat being disconnected from the mainstem of larger rivers throughout the Sacramento River watershed, thereby reducing effective foraging. Migration PCE is degraded by lack of natural cover along the migration corridors. Juvenile migration is obstructed by water diversions along Sacramento River and by two large state and federal water-export facilities in the Sacramento-San Joaquin Delta.

Table 24. CV Spring-run Chinook salmon CALWATER HSA watersheds with conservation values

HUC 4 Subbasin	HUC 5 Watershed conservation Value (CV)					
	High CV	PCE(s) ^{1}	Medium CV	PCE(s) ^{1}	Low CV	PCE(s) ^{1}
San Francisco Bay	San Francisco Bay	Estuary PCEs	0	0	1	Estuary PCEs
Suisun Bay	Suisun Bay	1	0	0	0	
Tehama	1	(1, 2, 3)	1	(1, 2, 3)	0	
Whitmore	1	(1, 2, 3)	0		2	(1, 2, 3)
Redding	2	(1, 2, 3)	0		0	
Eastern Tehama	4	(1, 2, 3)	0		0	
Sacramento Delta	1	(2, 3, 1)	0		0	
Valley Putah-Cache	1	(1, 2, 3)	0		0	
Marysville	3	(1, 2, 3)	0		0	
Yuba River	2	(1, 2, 3)	1	(1, 2, 3)	1	(1, 2, 3)
Valley-American	2	(1, 2, 3)	0		0	
Colusa Basin	4	(1, 2, 3)	0		0	
Butte Creek	1	(1, 2, 3)	0		0	
Ball Mountain	0		0		1	(1, 2, 3)
Shasta Bally	3	(1, 2, 3)	0		1	(1, 2, 3)
North Diablo Range	0		1	(1, 2, 3)	0	
San Joaquin Delta	0		0		1	(1, 2, 3)
Total	28		3		7	

1 Numbers in parenthesis refers to the dominant (in river miles) PCE(s) within the HUC 5 watersheds. PCE 1 is spawning and rearing, 2 is rearing and migration, and 3 is migration and presence. PCEs with < means that the number of river miles of the PCE is much less than river miles of the other PCE.

Contaminants from agriculture and urban areas have degraded rearing and migration PCEs to the extent that they have lost their functions necessary to serve their intended role to conserve the species. Water quality impairments in the designated critical habitat of this ESU include inputs from fertilizers, insecticides, fungicides, herbicides, surfactants, heavy metals, petroleum products, animal and human sewage, sediment in the form of turbidity, and other anthropogenic pollutants. Pollutants enter the surface waters and riverine sediments as contaminated stormwater runoff, aerial drift and deposition, and via point source discharges. Some contaminants such as mercury and pentachlorophenol enter the aquatic food web after reaching water and may be concentrated or even biomagnified in salmon tissue.

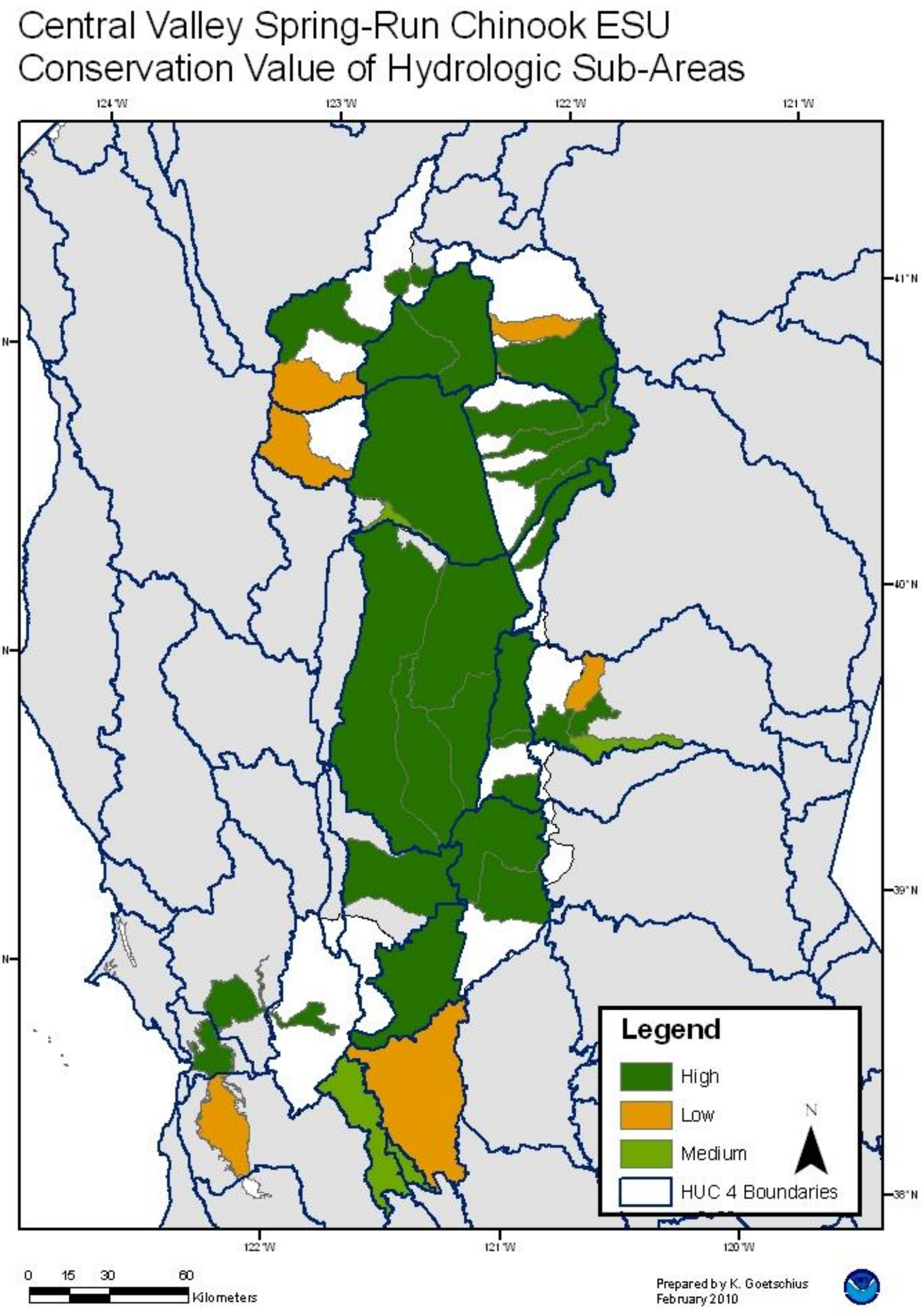


Figure 16. Central Valley Spring-run Chinook salmon Conservation Values per Sub-Area

Sacramento River Winter-run Chinook Salmon

The ESU includes all winter-run Chinook salmon entering and using the Sacramento River system in the Central Valley, California. The ESU boundary extends from the Carquinez Strait by the City of Vallejo and Benicia upstream the Sacramento River, including all its tributaries, to below Keswick Dam (Figure 17). The ESU now consists of a single spawning population.

Life History

The winter-run Chinook salmon have characteristics of both stream- and ocean-type races (M.C. Healey, 1991). Adults enter fresh water in winter or early spring but delays spawning until May and June. Fry emerge from the gravel in late June to early July and continue through October (F. W. Fisher, 1994). Young winter-run Chinook salmon start migrating to sea as early as mid July with a peak movement over the Red Bluff Diversion Dam (RBDD) in September. Some offspring move downstream as fry while other rear in the upper Sacramento River and move down as smolt. Normally fry have passed the RBDD by October while smolts may pass over the RBDD until March. Juvenile winter-runs occur in the Delta primarily from November through early May. Winter-run juveniles remain in the Delta until they are from 5 to 10 months of age, and then begin emigrating to the ocean as early as November and continue through May (F. W. Fisher, 1994; J. M. Myers, et al., 1998). The winter-run race matures between two and six years of age with the majority returning as three-year olds.

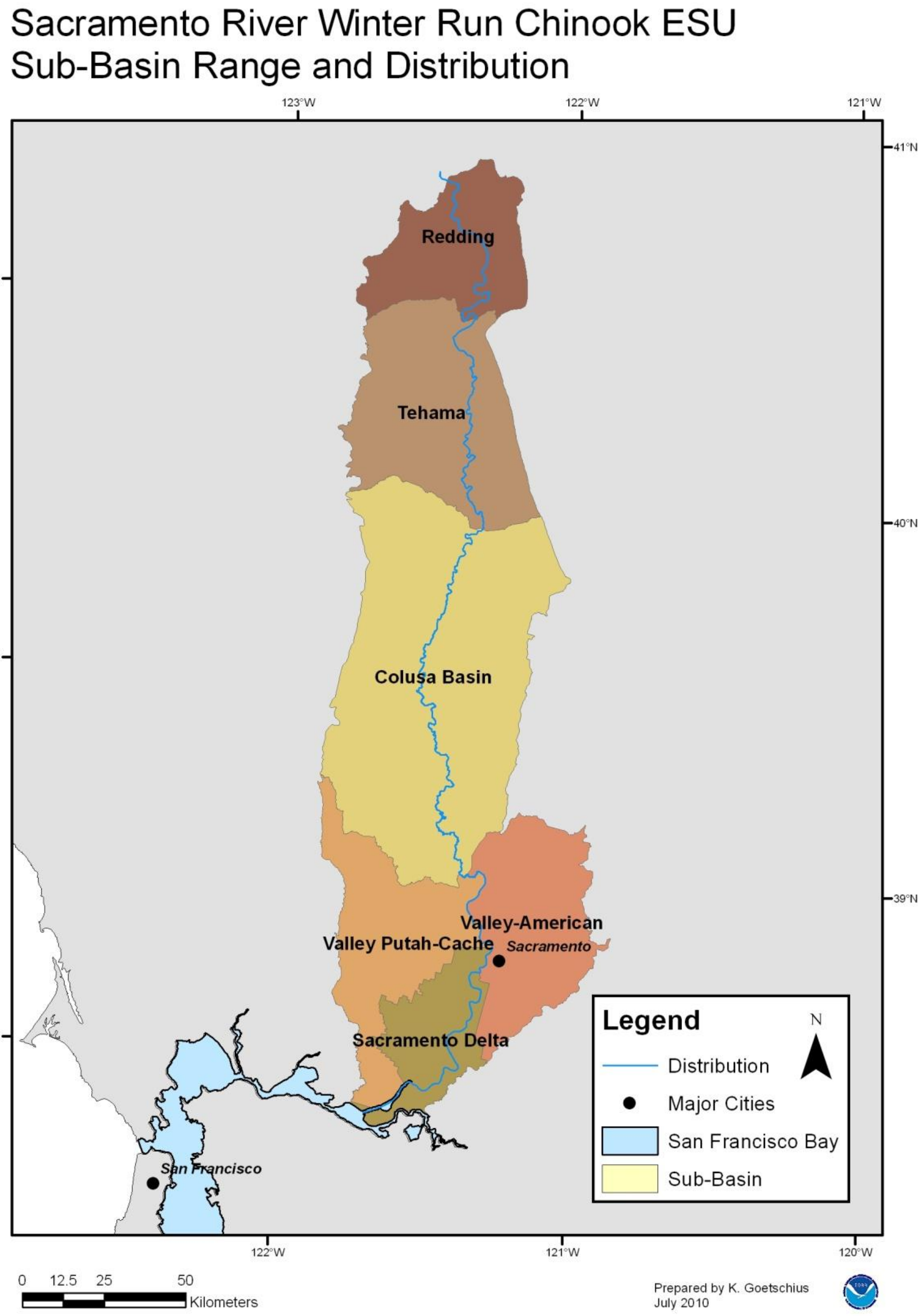


Figure 17. **Sacramento River Winter-run Chinook salmon distribution**

Status and Trends

NMFS listed Sacramento River Winter-run Chinook salmon as endangered on January 4, 1994 (59 FR 440), and reaffirmed their endangered status on June 28, 2005 (70 FR 37160). The winter-run Chinook salmon spawned and reared in the upper Sacramento River and its tributaries (Slater, 1963; Yoshiyama, Gerstung, Fisher, & Moyle, 1998). Today the Shasta Dam eliminates access to the historic spawning habitat. Cold water releases from the dam have also created conditions suitable for winter-run spawning and rearing in a 60- to 100-mile long portion of the Sacramento River downstream of the dam. As a result, the Sacramento River Winter-run Chinook salmon has been reduced to a single spawning population confined to a portion of the mainstem Sacramento River.

Winter-runs may have been as large as 200,000 fish based upon commercial fishery records from the 1870s (F. W. Fisher, 1994). During the first three years of operation of the counting facility at the RBDD (From 1967 to 1969), an average of 86,500 winter-run Chinook salmon were counted (CDFG, 2008). Critically low levels were reached during the drought of 1987 to 1992 with an absolute bottom of 191 fish counted. The three-year average run size for the period of 1989 to 1991 was 388 fish.

The population grew rapidly from the early 1990s to mid-2005. Mean run size increased from 1,363 before 2000 with all runs estimated to less than 10,000 fish to an average run of 8,470 adults between 2000 and 2006 with two runs estimated to more than 10,000 fish (USFWS & Reclamation, 2007). However, the natural produced winter-run Chinook salmon plunged in 2007 and 2008, with 4,461 adults estimated for 2007 and a preliminary estimate between of 2,600-2,950 adults for 2008 (USFWS, 2008).

The Sacramento River Winter-run Chinook salmon is expected to have lost some genetic diversity through bottleneck effects in the late 1980s and early 1990s. Hatchery releases may also have affected population genetics. The loss of natural spawning habitat and hydrological conditions has further removed the natural evolutionary processes that maintained the unique winter-run life history.

Critical Habitat

NMFS designated critical habitat for this species on June 16, 1993 (58 FR 33212). It includes: the Sacramento River from Keswick Dam, Shasta County (river mile 302) to Chipps Island (river mile 0) at the westward margin of the Sacramento-San Joaquin Delta, and other specified estuarine waters.

NMFS identified specific water temperature criteria, minimum instream flow criteria, and water quality standards as essential physical features (PCEs) of the ESU's habitat for species conservation. In addition, biological features vital for the Sacramento River winter-run Chinook salmon include unimpeded adult upstream migration routes, spawning habitat, egg incubation and fry emergence areas, rearing areas for juveniles, and unimpeded downstream migration routes for juveniles.

This ESU has not been evaluated for the conservation value of individual subbasins or river sections. However, since spawning, rearing, and migration of the winter-run race is restricted to the mainstem of the Sacramento River, the entire Sacramento River is considered of high conservation value. The Delta is similarly considered of high conservation value for rearing and migration.

As there is overlap in designated critical habitat for both the Sacramento River Winter-run Chinook salmon and the spring-run Chinook salmon, the conditions of PCEs for both ESUs are similar. The current condition of PCEs for the Sacramento River Winter-run Chinook salmon indicates that they are not currently functioning or are degraded. Their conditions are likely to maintain low population abundances across the ESU. Spawning and rearing PCEs are especially degraded by high water temperature caused by the loss of access to historic spawning areas in the upper watersheds where water maintain lower temperatures. The rearing PCE is further degraded by floodplain habitat disconnected from the mainstems of larger rivers throughout the Sacramento River watershed. The migration PCE is also degraded by the lack of natural cover along the migration corridors. Rearing and migration PCEs are further affected by pollutants entering the surface waters and riverine sediments as contaminated stormwater runoff, aerial drift and deposition, and via point source discharges. Juvenile migration is obstructed by water diversions along Sacramento River and by two large state and federal water-export facilities in the Sacramento-San Joaquin Delta.

Chum Salmon

Description of the Species

Chum salmon have the widest natural geographic and spawning distribution of any Pacific salmonid as their range extend farther along the shores of the Arctic Ocean than other salmonids. Chum salmon have been documented to spawn from Korea and the Japanese island of Honshu, east around the rim of the North Pacific Ocean to Monterey Bay, California. Historically, chum salmon were distributed throughout the coastal regions of western Canada and the U.S. Presently, major spawning populations occur as far south as Tillamook Bay on the northern Oregon coast. We discuss the distribution, life history diversity, status, and critical habitat of the two species of threatened chum salmon separately.

Chum salmon are semelparous, spawn primarily in fresh water, and exhibit obligatory anadromy (there are no recorded landlocked or naturalized freshwater populations). Chum salmon spend two to five years in feeding areas in the northeast Pacific Ocean, which is a greater proportion of their life history than other Pacific salmonids. Chum salmon are distributed throughout the North Pacific Ocean and Bering Sea.

North American chum salmon migrate north along the coast in a narrow coastal band that broadens in southeastern Alaska. However, some data suggest that Puget Sound chum, including Hood Canal Summer-run chum, may not migrate into northern British Columbian and Alaskan waters. Instead, Puget Sound chum salmon travel directly offshore into the North Pacific Ocean.

Chum salmon usually spawn in the lower reaches of rivers. Redds are dug in the mainstem or in side channels of rivers from just above tidal influence to nearly 100 km from the sea. The time to hatching and emergence from the gravel redds are influenced by DO, gravel size, salinity, nutritional conditions, behavior of alevins in the gravel, and incubation temperature (reviewed (Bakkala, 1970; Salo, 1991; Schroder, 1977; Schroder et al., 1974)). For example, fertilized eggs hatch in about 100-150 days at 4°C, but hatch in only 26-40 days at 15°C. Juveniles outmigrate to sea water almost immediately after emerging from the gravel that covers their redds (Salo, 1991). The immature salmon distribute themselves widely over the North Pacific Ocean. The maturing adults return to the home streams at various ages, usually at two through five years, and in some cases up to seven years (Bigler, 1985). This ocean-type migratory behavior contrasts with the stream-type behavior of some other species in the genus *Oncorhynchus* (*e.g.*, steelhead, coho, and most types of Chinook and sockeye salmon). Stream-type salmonids usually migrate to sea at a larger size, after months or years of freshwater rearing. Thus, survival and growth for juvenile chum salmon depend less on freshwater conditions than on favorable estuarine conditions. Another behavioral difference between chum salmon and other salmonid species is that chum salmon form schools. Presumably, this behavior reduces predation (Pitcher, 1986) especially if fish movements are synchronized to swamp predators (R. J. Miller & Brannon, 1982).

The duration of estuarine residence for chum salmon juveniles are known for only a few estuaries. Observed residence time ranged from 4 to 32 days, with about 24 days as the most common (O. W. Johnson et al., 1997). Chum salmon juveniles use shallow, low flow habitats for rearing that include inundated mudflats, tidal wetlands and their channels, and sloughs.

Status and Trends

Chum salmon, like the other salmon NMFS has listed, have declined from overharvests, hatcheries, native and non-native exotic species, dams, gravel mining, water diversions, destruction or degradation of riparian habitats, and land use practices (logging, agriculture, and urbanization). Climate change also poses significant hazards to the survival and recovery of salmonids. Hazards from climate change include elevated water temperature, earlier spring runoff and lower summer flows, and winter flooding.

Hood Canal Summer-run Chum Salmon

The Hood Canal (HC) Summer-run chum salmon ESU (Figure 18) includes all naturally spawned populations in Hood Canal and its tributaries as well as populations in Olympic Peninsula rivers between Hood Canal and Dungeness Bay, Washington (64 FR 14508). Eight artificial propagation programs are included in the ESU: the Quilcene National Fish Hatchery, Hamma Hamma Fish Hatchery, Lilliwaup Creek Fish Hatchery, Union River/Tahuya, Big Beef Creek Fish Hatchery, Salmon Creek Fish Hatchery, Chimacum Creek Fish Hatchery, and the Jimmycomelately Creek Fish Hatchery summer-run chum hatchery programs. These artificially propagated populations are no more divergent relative to the local natural populations(s) than what would be expected between closely related natural populations within the species. Table 25 identifies populations within the HC Summer-run chum salmon ESU, their abundances, and hatchery input.

Table 25. Hood Canal Summer-run Chum salmon populations, abundances, and hatchery contributions (T. P. Good, et al., 2005).

Historically Independent Populations	Stocks (Streams)	Historical Abundance	Most Recent Spawner Abundance	Hatchery Abundance Contributions
Strait of Juan de Fuca	Chimacum Creek	Unknown	Extinct	N/A
	Dungeness Creek	Unknown	Unknown	Unknown
	Jimmycomelately Creek	Unknown	~60	Unknown
	Salmon/Snow creeks	Unknown	~2,200	0-69%
Hood Canal	Big/Little Quilcene rivers	Unknown	~4,240	5-51%
	Dosewallips River	Unknown	~900	Unknown
	Duckabush River	Unknown	Unknown	Unknown
	Hamma Hamma River	Unknown	~758	Unknown
	Lilliwaup Creek	Unknown	~164	Unknown
	Skokomish River	Unknown	Extinct	N/A
	Big Beef Creek*	Unknown	Extinct	100
	Dewetto Creek*	Unknown	Extinct	Unknown
	Anderson Creek*	Unknown	Extinct	N/A
	Mission Creek*	Unknown	Extinct	N/A
	Tahuya River*	Unknown	Extinct	N/A
	Union River*	Unknown	~690	Unknown

* Streams on the east side of Hood Canal.

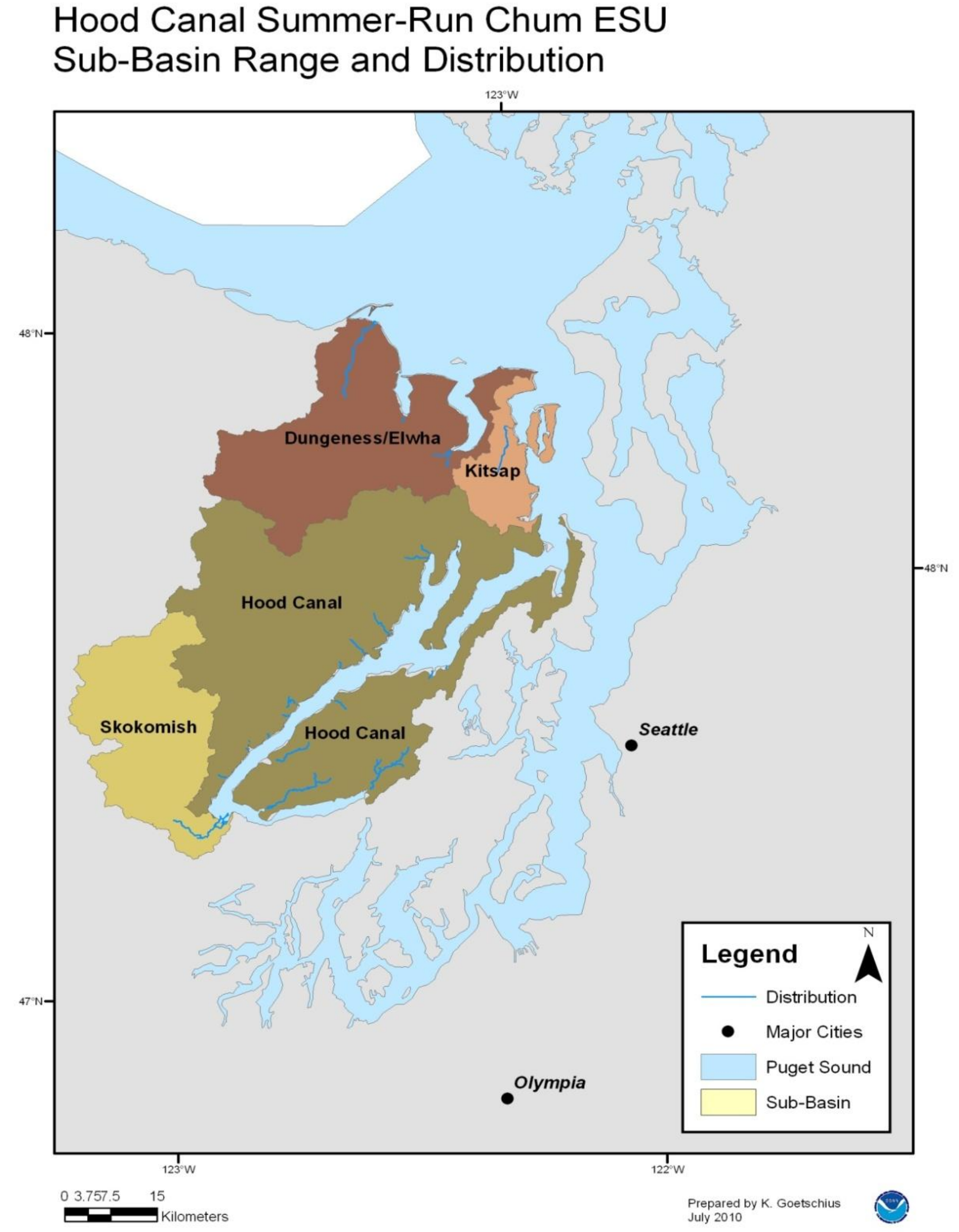


Figure 18. Hood Canal Summer-run Chum salmon distribution

Life History

Run-timing data from as early as 1913 indicated temporal separation between summer- and fall-run chum salmon in Hood Canal (O. W. Johnson, et al., 1997). The HC Summer-run chum salmon enter natal rivers by late August until October (Washington Department of Fish and Wildlife (WDFW), 1993). Spawning occurs from mid-September through mid-October. Adults generally spawn in low gradient, lower mainstem reaches of natal streams, typically in center channel areas due to the low flows encountered in the late summer and early fall. Eggs incubate in redds for five to six months and fry emerge between January and May. After hatching, fry move rapidly downstream to subestuarine habitats. HC Summer-run chum salmon seem to have a longer incubation time than fall-run chum salmon in the same streams. Consequently, offspring of summer-run chum salmon have lower average weight and less lipid content than offspring of fall-run chum salmon. Thus, prey availability during their early life history is important for fry survival.

HC Summer-run chum salmon juveniles quickly migrate up the Hood Canal and into the main body of Puget Sound starting in February/March (O. W. Johnson, et al., 1997). The juveniles rear for an average of 23 days in the subestuary deltas which support a diverse array of habitats (tidal channels, mudflats, marshes, and eelgrass meadows). These habitats provide essential rearing and transition environments for this ESU and juveniles rear in these habitats before entering the ocean. Fry in Hood Canal have not been observed to display daily tidal migrations (Bax, 1983). Fry movement is associated with prey availability. Juveniles feed primarily on plankton and epibenthic organisms, while subadults feed on similar items as well as larger prey (including fishes and squid).

Fish may emerge from streams over an extended period; some juveniles may remain in Quilcene Bay for several weeks. Most adults return as spawners as three- and four-year old fish.

Status and Trends

NMFS listed HC Summer-run chum salmon as threatened on March 25, 1999 (64 FR 14508), and reaffirmed their threatened status on June 28, 2005 (70 FR 37160). The HC extant summer-run chum ESU consists of two historic independent populations (the Strait of Juan de Fuca and

Hood Canal populations) that together were constituted of an estimated 16 historic stocks (Sands et al., 2007). Of the 16 historic stocks, seven are considered extirpated. With the extirpation of many local stocks, much of the historical spatial structure has been lost on both the population and the ESU level. Most of the extirpated stocks occurred on the eastern side of Hood Canal, which affects the current spatial structure of the ESU. The widespread loss of estuary and lower floodplain habitat continue to impact the ESU's spatial structure and connectivity.

The Strait of Juan de Fuca population includes three extant stocks that spawn in rivers and streams entering the eastern Strait of Juan de Fuca and Admiralty Inlet. The Hood Canal population consists of six extant stocks within the Hood Canal watershed. HC Summer-run chum salmon are part of an extensive rebuilding program developed and implemented in beginning in 1992 by the state and tribal co-managers. The largest supplemental program occurs at the Big Quilcene River fish hatchery. Reintroduction programs occur in Big Beef (Hood Canal population) and Chimacum (Strait of Juan de Fuca population) creeks. All hatchery fish are marked and can be distinguished from naturally produced fish. There is concern that the Quilcene hatchery stock has high rates of straying, and may represent a risk to historical population structure and diversity.

Adult returns for some of the HC Summer-run chum salmon stocks showed modest improvements in 2000, with upward trends continuing in 2001 and 2002. The recent five-year mean abundance is variable among stocks, ranging from one fish to nearly 4,500 fish. Two stocks (Quilcene and Union River) are above the conservation thresholds established by the rebuilding plan. However, most stocks remain depressed. Estimates of the fraction of naturally spawning hatchery fish exceed 60% for some stocks. This indicates that reintroduction programs are supplementing the numbers of total fish spawning naturally in streams. Both the Strait of Juan de Fuca and the Hood Canal populations have long-term trends above replacement; long-term lambda values range from 0.85 to 1.39 (T. P. Good, et al., 2005). Long-term trends in productivity are above replacement only for the Quilcene and Union River stocks.

Critical Habitat

Critical habitat for this species was designated on September 2, 2005 (70 FR 52630). Of 11 watersheds reviewed in NMFS' assessment of critical habitat for the Hood Canal Summer-run chum salmon ESU (Figure 19), nine watersheds were rated as having a high conservation value while three were rated as having a medium value for conservation (Table 26). Five nearshore marine areas were also given a high conservation value rating. None of the watersheds was considered to be of a low conservation value, primarily because approximately half of the historical populations in this ESU have been extirpated, and the remaining populations are limited to only about 60 stream miles. Many of the watersheds have less than four miles of spawning habitat and none of them have more than 8.5 miles.

Table 26. Hood Canal Summer-run chum salmon watersheds with conservation values

HUC 4 Subbasin	HUC 5 Watershed conservation Value (CV)					
	High CV	PCE(s) [1]	Medium CV	PCE(s) [1]	Low CV	PCE(s) [1]
Skokomish	0		1	(1, 3)	0	
Hood Canal	6	(1, 3)	1	(1)[2]	0	
Kitsap	1	(1)	0		0	
Dungeness/Elwha	2	(1)	1	(3, 1)	0	
Total	9		3		0	

1 Numbers in parenthesis refers to the dominant (in river miles) PCE(s) within the HUC 5 watersheds. PCE 1 is spawning and rearing, 2 is rearing and migration, and 3 is migration and presence. PCEs with < means that the number of river miles of the PCE is much less than river miles of the other PCE.

Spawning PCE is degraded by excessive fine sediment in the gravel. Rearing PCE is degraded by loss of access to sloughs in the estuary and nearshore areas and excessive predation. Low river flows in several rivers also adversely affect most PCEs. In the estuarine areas, both migration and rearing PCEs of juveniles are impaired by loss of functional floodplain areas necessary for growth and development of juvenile chum salmon. These degraded conditions likely maintain low population abundances across the ESU.

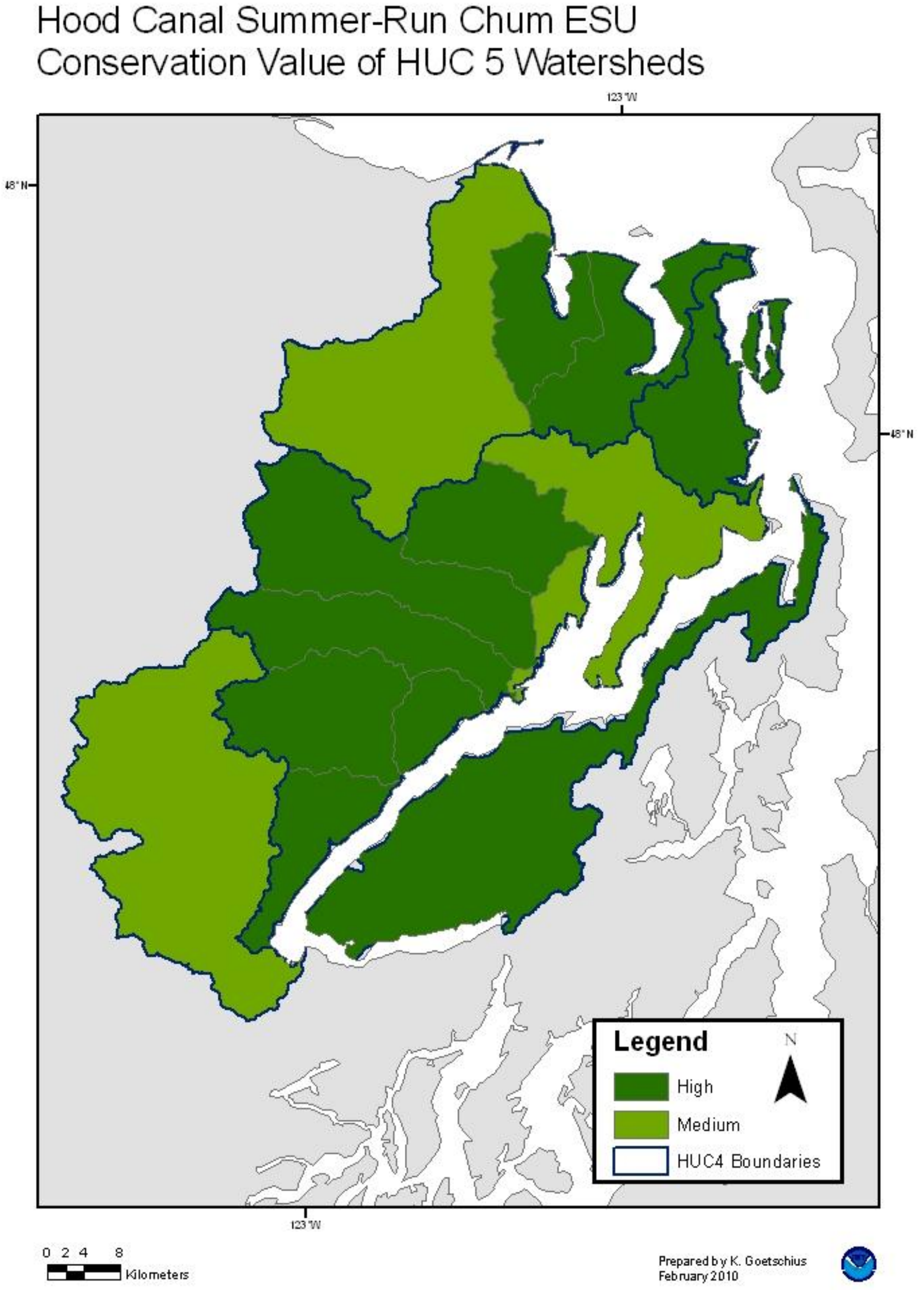


Figure 19. Hood Canal Summer-run Conservation Values per Sub-area

Columbia River Chum Salmon

Columbia River (CR) chum salmon includes all natural-origin chum salmon in the Columbia River and its tributaries in Oregon and Washington. The species consists of two populations: Grays River and Lower Gorge in Washington State (Figure **20**). This ESU also includes three artificial hatchery programs. These artificially propagated populations are no more divergent relative to the local natural populations than would be expected between closely related populations within this ESU.

Table 27. Populations within the Columbia River chum salmon ESU, their abundances, and hatchery input (T. P. Good, et al., 2005).

Current Populations	Historical Abundance	Most Recent Spawner Abundance	Hatchery Abundance Contributions
Youngs Bay	Unknown	Not reported	0
Grays River	7,511	3,832 and 2,720*	Unknown
Big Creek	Unknown	Not reported	0
Elochoman River	Unknown	Not reported	0
Clatskanie River	Unknown	Not reported	0
Mill, Abernathy, and German Creeks	Unknown	Not reported	0
Scappoose Creek	Unknown	Not reported	0
Cowlitz River	141,582	Not reported	0
Kalama River	9,953	Not reported	0
Lewis River	89,671	Not reported	0
Salmon Creek	Unknown	Not reported	0
Clackamas River	Unknown	Not reported	0
Sandy River	Unknown	Not reported	0
Washougal River	15,140	Not reported	0
Lower gorge tributaries	>3,141	425	0
Upper gorge tributaries	>8,912	137 and 223*	0

* Salmon Scape Statistics Query 2009: Estimated total number of natural spawners for the years 2007 and 2008.

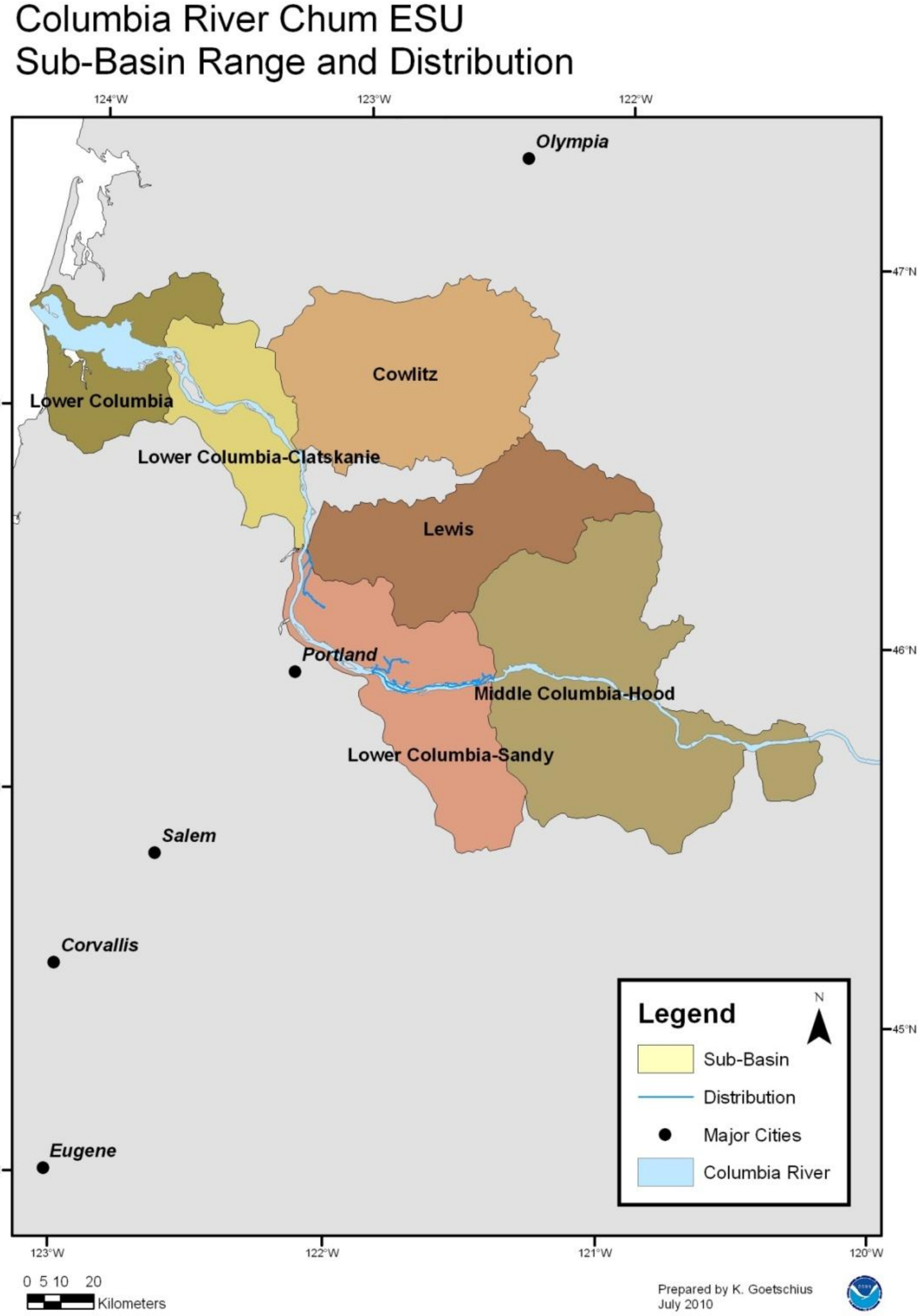


Figure 20. Columbia River Chum salmon distribution

Life History

Chum salmon return to the Columbia River in late fall (mid-October to December). They primarily spawn in the lower reaches of rivers, digging redds along the edges of the mainstem and in tributaries or side channels. Some spawning sites are located in areas where geothermally-warmed groundwater or mainstem flow upwells through the gravel.

Chum salmon fry emigrate from March through May shortly after emergence. Juvenile chum salmon reside and feed in estuaries before beginning their long distance oceanic migration. Chum salmon may choose either the upper or lower estuaries depending on the relative productivity of each. The timing of entry of juvenile chum salmon into sea water is correlated with the warming of the nearshore waters and the accompanying plankton blooms (Burgner, 1991). The movement offshore generally coincides with the decline of inshore prey resources and when fish have grown to a size that allows them to feed upon neritic organisms and avoid predators (Burgner, 1991). The period of estuarine residence is a critical life history phase and plays a major role in determining the size of the subsequent adult run back to fresh water.

Status and Trends

NMFS listed CR chum salmon as threatened on March 25, 1999, and reaffirmed their threatened status on June 28, 2005 (71 FR 37160). Regarding spatial structure, historically this ESU was highly prolific; CR chum salmon were reported in almost every river in the Lower Columbia River basin. However, few CR chum salmon have been observed in tributaries between the Dalles and Bonneville dams in recent years. Chum salmon were not observed in any of the upper gorge tributaries, including the White Salmon River, during the 2003 and 2004 spawning ground surveys. Surveys of the White Salmon River in 2002 found only one male and one female carcass; the female had not spawned (Ehlke & Keller, 2003). However, in the Cascades, chum salmon sampled from each tributary recently appeared as remnants of genetically distinct populations (Greco, Capri, & Rustad, 2007).

Historically, the ESU was composed of 17 populations in Oregon and Washington between the mouth of the Columbia River and the Cascade crest (J. Myers, et al., 2006)

(Table 27). Only two populations with any significant spawning remain today, both on the Washington side (T. P. Good, et al., 2005). They are the Grays River and the Lower Gorge (which include Hardy and Hamilton Creeks) populations (T. P. Good, et al., 2005). In addition, during the first years after 2000, new (or newly discovered) spawning was observed in the Washougal River mainstem and in the Washington side of the Columbia River mainstem below the mouth of Washougal River (T. P. Good, et al., 2005). It is unclear whether this spawning has been maintained. An extensive 2000 survey in Oregon streams supports that chum salmon are extirpated from the Oregon portion of this ESU (T. P. Good, et al., 2005).

The CR chum salmon runs have declined substantially from historic levels concurrently with the drastic reduction of spawning populations. In the early 1900s, the ESU numbered in the hundreds of thousands to a million returning adults that supported a large commercial fishery in the first half of this century. However, by the 1950s, most runs had disappeared and fisheries landings in later years rarely exceeded 2,000 chum salmon per year (Fulton, 1970; Marr, 1943; Rich, 1942). During the 1980s and 1990s, the estimated combined abundance of natural spawners for the Lower Gorge, Washougal, and Grays River populations was below 4,000 adults. However, in 2002, the abundance of natural spawners increased to an estimate of total natural spawners exceeding 20,000 adults. The cause of this dramatic increase in abundance is unknown and was not maintained in the following years.

Current ESU abundance is mostly driven by the Lower Gorge and Grays River populations. The estimated size of the Lower Gorge population is at 400-500 individuals, down from a historical level of greater than 8,900 (T. P. Good, et al., 2005). A significant increase in spawner abundance occurred in 2001 and 2002 to around 10,000 adults (T. P. Good, et al., 2005). However, spawner surveys indicate that the abundance again decreased to low levels during 2003 through 2008 though the spawner surveys may underestimate abundance since the proportion of tributary and mainstem spawning differ between years and the surveys do not include spawners in the Columbia River mainstem (T. P. Good, et al., 2005; Washington Department of Fish and Wildlife (WDFW), 2009). In the 1980s, estimates of the Grays River population ranged from 331 to 812 individuals. However, the population increased in 2002 to as many as 10,000 individuals (T. P. Good, et al., 2005). Based on data for number of spawners per river mile, this increase continued through 2003 and 2004. However, fish abundance fell again to less than 5,000 fish during the years 2005 through 2008 (Washington Department of Fish and Wildlife (WDFW), 2009).

Estimates of abundance and trends are available only for the Grays River and Lower Gorge populations. The lambda values indicate a long-term downward trend at 0.954 and 0.984, respectively (T. P. Good, et al., 2005). The 10-year trend (up to 2001) was negative for the Grays River population and just over 1.0 for the Lower Gorge. Long- and short-term productivity trends for populations are at or below replacement.

Critical Habitat

Critical habitat was originally designated for the CR chum salmon on February 16, 2000 (65 FR 7764) and was re-designated on September 2, 2005 (70 FR 52630). Sixteen of the 19 subbasins reviewed in NMFS' assessment of critical habitat for the CR chum salmon ESU were rated as having a high conservation value (

Table 28). The remaining three subbasins were given a medium conservation value (Figure 21). Washington's federal lands were rated as having high conservation value to the species.

Limited information exists on the quality of essential habitat characteristics for CR chum salmon. However, migration PCE has been significantly impacted by dams obstructing adult migration and access to historic spawning locations. Water quality and cover for estuary and rearing PCEs have decreased in quality to the extent that the PCEs are not likely to maintain their intended function to conserve the species.

Table 28. CR chum salmon watersheds with conservation values.

HUC 4 Subbasin	HUC 5 Watershed conservation Value (CV)					
	High CV	PCE(s) [1]	Medium CV	PCE(s) [1]	Low CV	PCE(s) [1]
Middle Columbia/Hood	3	(3)	0		0	
Lower Columbia/Sandy	3	(3, 1)	0		0	
Lewis	2	(3)	0		0	
Lower Columbia/Clatskanie	3	(3, 2, 1)	0		0	
Cowlitz	3	(3)	3	(3)	0	
Lower Columbia	2	(3, 2, 1)	0		0	
Lower Columbia Corridor	all	(3, 1)	0		0	
Total	16		3		0	

1 Numbers in parenthesis refers to the dominant (in river miles) PCE(s) within the HUC 5 watersheds. PCE 1 is spawning and rearing, 2 is rearing and migration, and 3 is migration and presence. PCEs with < means that the number of river miles of the PCE is much less than river miles of the other PCE.

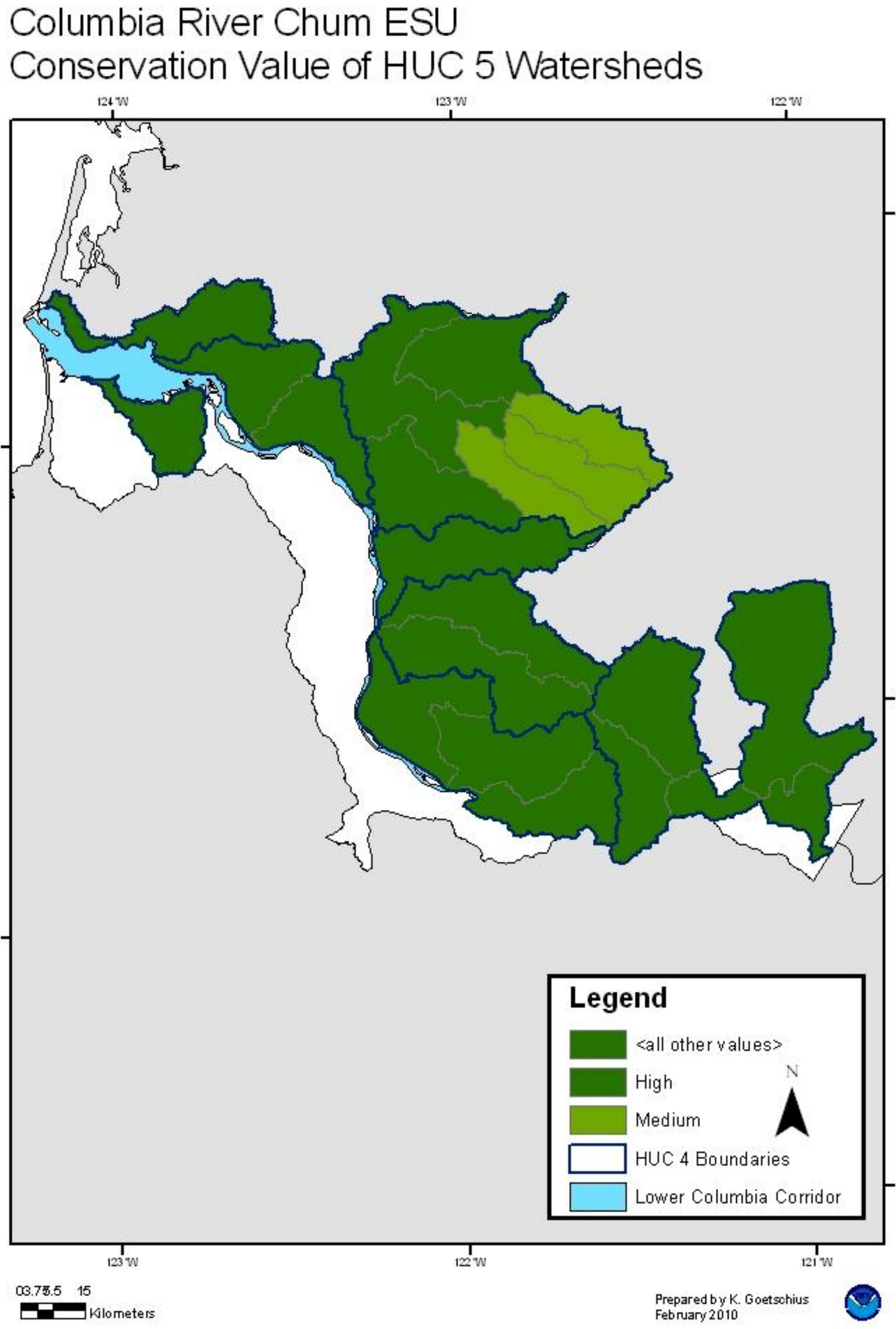


Figure 21. Columbia River Chum salmon Conservation Values per Sub-area

Coho Salmon

Description of the Species

Coho salmon occur naturally in most major river basins around the North Pacific Ocean from central California to northern Japan (Laufle, Pauley, & Shepard, 1986). In this section, we discuss the distribution, life history diversity, status, and critical habitat of the four endangered and threatened coho species separately.

As with other salmon, the coho salmon life cycle consists of a juvenile freshwater phase and a growth phase in the ocean before fish return to rivers to spawn. Along the Oregon/California coast, coho salmon primarily return to rivers to spawn as three-year olds, having spent approximately 18 months rearing in fresh water and 18 months in salt water. In some streams, a smaller proportion of males may return as two-year olds. The presence of two-year old males can allow for substantial genetic exchange between brood years. The relatively fixed three-year life cycle exhibited by female coho salmon limits demographic interactions between brood years. This makes coho salmon more vulnerable to environmental perturbations than other salmonids that exhibit overlapping generations, *i.e.*, the loss of a coho salmon brood year in a stream is less likely than for other Pacific salmon to be reestablished by females from other brood years.

Most coho salmon enter rivers between September and February. In many systems, coho salmon will have to wait to enter until fall rainstorms have provided the river with sufficiently strong flows and depth. Coho salmon spawn from November to January, and occasionally into February and March. Spawning occurs in a few third-order streams. Most spawning activity occurs in fourth- and fifth-order streams. Spawning generally occurs in tributaries with gradients of 3% or less.

Depending on temperature, egg incubation ranges from 35 to 50 days (Sandercock, 1991). Hatchlings remain in the gravel as alevins for several weeks while absorbing the yolk sac before emerging from the gravel. In Oregon coastal streams, total average time from egg deposition to emergence is 110 days (Sandercock, 1991). Following emergence, fry move to areas with weak water currents such as backwaters and shallow areas near the stream banks. As the fry grow, they disperse upstream and downstream to establish and defend territories. Territorial behavior limits summer density in streams and subordinate individuals may congregate in pools (Sandercock, 1991).

Juvenile coho salmon commonly rear in small streams less than five ft. wide and occasionally in larger ponds and lakes (Pollock, Pess, & Beechie, 2004). Juvenile rearing rarely occurs in tributaries exceeding gradients of 3% although they may move to streams with gradients of 4 to 5%. Preferred water quality consists of water with low turbidity, DO levels of 4 to 9 mg/l, and water temperatures ranging from 10° to 15°C (Bell, 1973; McMahon, 1983). Growth is slowed down considerably at 18°C and ceases at 20°C (Bell, 1973; Stein, Reimers, & Hall, 1972). The likelihood of juvenile coho salmon occupying habitat that exceed 16.3°C maximum weekly average temperature declines significantly (Welsh, Hodgson, Roche, & Harvey, 2001).

During spring and summer, the emphasis is on growth and sustained invertebrate forage production and renewal are necessary. During the growth period, coho salmon fry show low risk averseness and position themselves in open water when sufficient food is available (Bugert, Bjornn, & Meehan, 1991; Giannico, 2000; Reinhardt, 1999). The main prey are primarily drifting aquatic invertebrates produced in interstices of the gravel substrate and in the leaf litter within pools, and drifting terrestrial insects produced in the riparian canopy (Sandercock, 1991). Important food organisms include aquatic insects such as chironomid larvae, mayfly, caddisflies, and stonefly. Coho salmon juveniles also feed opportunistically on non-insects, such as small fish and salmon eggs, and terrestrial insects.

Studies of stream habitat use show that there are a velocity threshold for rearing fry and juveniles. Juveniles prefer focal positions that have water velocity less than 20 cm/s (with a preference of 3 – 6 cm/s) with faster flowing adjacent areas with high food renewal through drift (Beecher, Caldwell, & DeMond, 2002; Fausch, 1984, 1993; J. Rosenfeld, Porter, & Parkinson, 2000; Shirvell, 1990). High food abundance (*i.e.,* drift) may increase the potential for net energy gain at higher velocities, allowing fish to move into faster waters where fish experience higher growth rate despite the greater swimming costs (Giannico & Healey, 1999; J. S. Rosenfeld, Leiter, Lindner, & Rothman, 2005). High prey availability also reduces territory size and may increase a stream’s rearing capacity (Dill & Fraser, 1984; Dill, Ydenberg, & Fraser, 1981; Mason, 1976). Reduction in food availability reduces growth by subdominants and less for dominant fish (J. S. Rosenfeld, et al., 2005).

Coho salmon juveniles seek river margins, backwater, and pools during fall and winter; they are rarely found in mid-stream locations of the stream channel during November and February (Robert E. Bilby & Bisson, 1987; R. E. Bilby & Bisson, 2001; Fausch & Northcote, 1992; Tschaplinski & Hartman, 1983). High densities of juvenile coho salmon also occur in log jams (G. T. Brown, 1985; Tschaplinski & Hartman, 1983). In early fall with the onset of the first seasonal freshets, a large portion of the juvenile population may also migrate to overwinter in off-channel habitat such as larger pools, beaver ponds, off-stream side channels and alcoves, ephemeral swamps, and inundated floodplains (G. T. Brown, 1985; Bustard & Narver, 1975a; Thomas E. Nickelson, Rodgers, Johnson, & Solazzi, 1992; Peterson, 1982; Tschaplinski & Hartman, 1983).

During the winter period, juveniles typically reduce feeding activity and growth rates slow down or stop. In spring, juvenile activity increases. By March of their second spring, the juveniles feed heavily on insects and crustaceans and grow rapidly before smoltification and outmigration (Olegario, 2006). Juveniles that overwinter in off-channel habitat, ephemeral streams, and floodplains often experience higher survival and growth than juveniles that overwinter in mainstream channels (G. T. Brown, 1985; Olegario, 2006; Quinn & Peterson, 1996; Swales, Caron, Irvine, & Levings, 1988).

Availability of suitable overwintering habitat has been suggested to determine smolt production in streams (Bustard & Narver, 1975b; Thomas E. Nickelson, et al., 1992). Adult return or smolt production is related to the area of wetlands, lakes, and ponds within watersheds (Timothy J. Beechie, Beamer, & Wasserman, 1994; Pess et al., 2002; Sharma & Hilborn, 2001).

Coho salmon juveniles usually migrate to the ocean as smolts in their second spring. Relative to species such as chum salmon, Chinook salmon, and steelhead, coho salmon smolts usually spend a short time in the estuary with little feeding (Magnusson & Hilborn, 2003; Thorpe, 1994).

Estuarine residence times can average one to three days (B. A. Miller & Sadro, 2003). However, some coho salmon fry may migrate to and rear in the tidally influenced portions of the stream. In one Oregon stream, a portion of the coho salmon fry were observed remaining in the upper estuary to rear after moving into the estuary during their first spring (B. A. Miller & Sadro, 2003).

After entering the ocean, immature coho salmon initially remain in nearshore waters close to the parent stream. North American coho salmon will migrate north along the coast in a narrow coastal band that broadens in southeastern Alaska. During this migration, juvenile coho salmon tend to occur in both coastal and offshore waters.

Status and Trends

Coho salmon depend on the quantity and quality of the freshwater aquatic systems for spawning, rearing, and on the ocean conditions where they grow to maturity. Coho salmon have declined from overharvests, hatchery supplementation, native and non-native species, dams, gravel mining, water diversions, the destruction or degradation of riparian habitat, and land use practices (logging, agriculture, and urbanization). Climate change also poses significant hazards to the survival and recovery of salmonids. Hazards from climate change include elevated water temperature, earlier spring runoff and lower summer flows, and winter flooding.

Lower Columbia River (LCR) Coho Salmon

The LCR coho salmon include all naturally spawned populations of coho salmon in the Columbia River and its tributaries in Oregon and Washington, from the mouth of the Columbia up to and including the Big White Salmon and Hood Rivers, Washington, and the Willamette River to Willamette Falls, Oregon (Figure **22**). This ESU also includes 25 artificial propagation programs (70FR 37160, June 28, 2005).

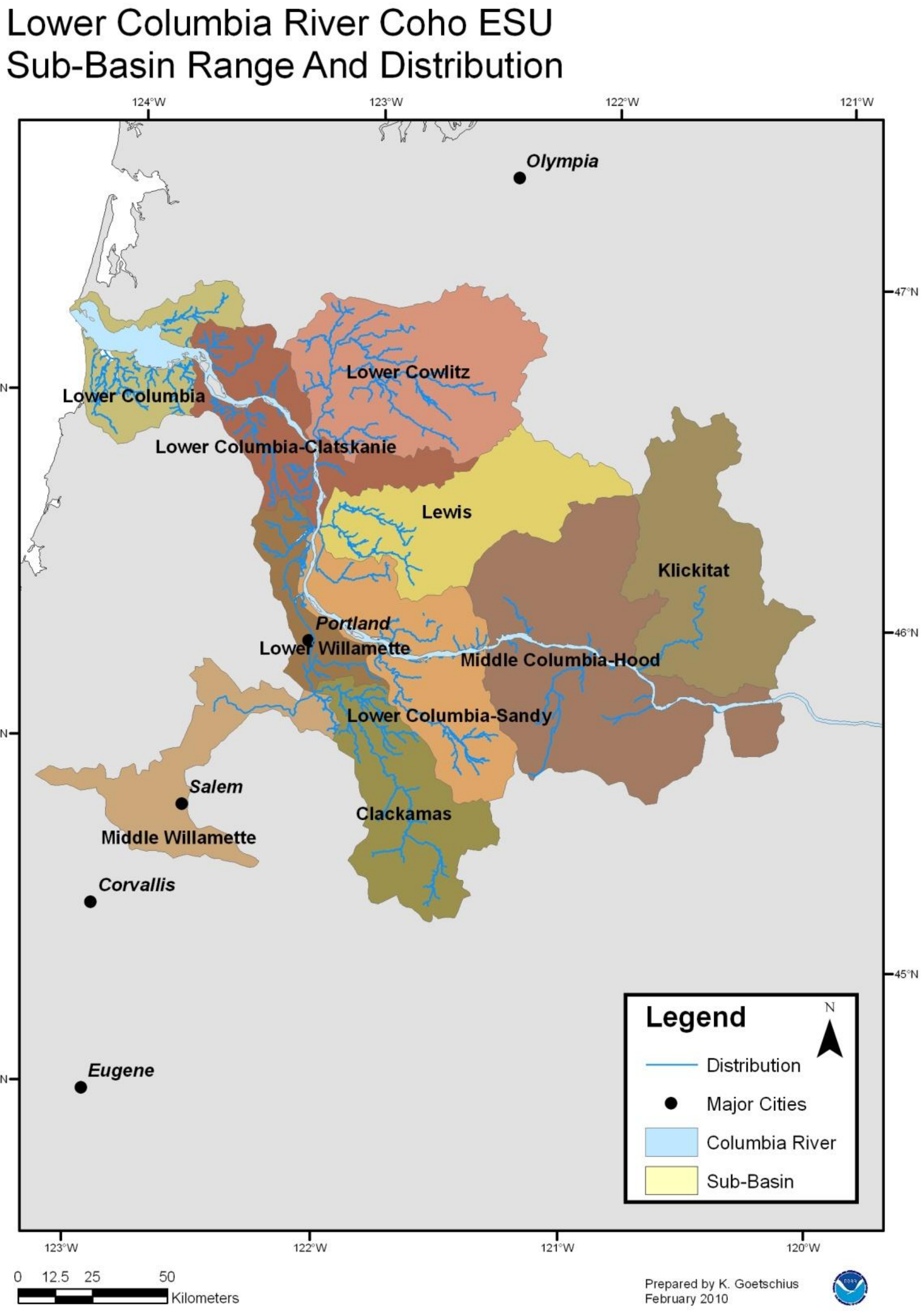


Figure 22. **LCR coho salmon distribution**

Life History

The majority of the LCR coho salmon are of hatchery origin. Hatchery runs are currently managed for two distinct runs: early returning (Type S) and late returning (Type N) (O. W. Johnson, Flagg, Maynard, Milner, & Waknitz, 1991). Type S coho salmon return to fresh water in mid-August and to the spawning tributaries in early September. Spawning peaks from mid-October to early November. Type N coho salmon return to the Columbia River from late September through December and enter the tributaries from October through January. Most Type N spawning occurs from November through January.

Analysis of run timing of coho salmon suggests that the Clackamas River population is composed of one later returning population and one early returning population. The late returning population is believed to be descended from the native Clackamas River population. The early returning population is believed to descend from hatchery fish introduced from Columbia River populations outside the Clackamas River basin (T. P. Good, et al., 2005). The naturally produced coho salmon return to spawn between December and March (O. W. Johnson, et al., 1991).

Fry emerge from the redds during a three-week period between early March and late July. The juveniles rear in fresh water for a year and smolt outmigration occurs from April through June with a peak in May. Smolts migrate through the Columbia River estuary during dusk and dawn. During movement they are found in mid-river areas of the estuary. However, during mid-morning to late afternoon they reside near the shores of the estuary (O. W. Johnson, et al., 1991).

Status and Trends

NMFS listed the LCR coho salmon as threatened on June 28, 2005 (70 FR 37160). The LCR coho salmon ESU historically consisted of 25 independent populations. The vast majority (over 90%) of these are either extirpated or nearly so (Table 29). Today, only 2 of the 25 populations have any significant natural production in the Sandy and Clackamas Rivers. In addition, wild coho salmon have re-appeared in two additional basins (Scappoose and Clatskanie) after a 10-year period during the 1980s and 1990s when they were largely absent (McElhany, et al., 2007).

Table 29. Lower Columbia River coho salmon populations, estimated natural spawner abundances, and hatchery contributions (T. P. Good, et al., 2005; McElhany, et al., 2007).

River/Region	Historical Abundance	2002-2004 Spawner Abundance[1]: Max/Geometric mean	Hatchery Abundance Contributions
Youngs Bay and Big Creek	Unknown	~4,470/200	91%
Grays River	Unknown	Unknown	Unknown
Elochoman River	Unknown	Unknown	Unknown
Clatskanie River	Unknown	~550/286	0-80%
Mill, Germany, and Abernathy creeks	Unknown	Unknown	Unknown
Scappoose Rivers	Unknown	~850/470	0%
Cispus River	Unknown	Unknown	Unknown
Tilton River	Unknown	Unknown	Unknown
Upper Cowlitz River	Unknown	Unknown	Unknown
Lower Cowlitz River	Unknown	Unknown	Unknown
North Fork Toutle River	Unknown	Unknown	Unknown
South Fork Toutle River	Unknown	Unknown	Unknown
Coweeman River	Unknown	Unknown	Unknown
Kalama River	Unknown	Unknown	Unknown
North Fork Lewis River	Unknown	Unknown	Unknown
East Fork Lewis River	Unknown	Unknown	Unknown
Upper Clackamas River	Unknown	~1,770/1,264	12%
Lower Clackamas River	Unknown	~1,180/843	78%
Salmon Creek	Unknown	Unknown	Unknown
Upper Sandy River	Unknown	~1,170/720	0%
Lower Sandy River	Unknown	271/?	97%
Washougal River	Unknown	Unknown	Unknown
Lower Columbia River gorge tributaries	Unknown	Unknown	Unknown
Big White Salmon river	Unknown	Unknown	Unknown
Upper Columbia River gorge tributaries	Unknown	1,317/?	>65%
Hood River	Unknown	~600/~230	Unknown

Prior to 1900, the Columbia River had an estimated annual run of more than 600,000 adults with about 400,000 spawning in the lower Columbia River (O. W. Johnson, et al., 1991). By the 1950s, the estimated number of coho salmon returning to the Columbia River had decreased to 25,000 adults or about 5% of historic levels. Massive hatchery releases since 1960 have increased the Columbia River run size. Between 1980 and 1989, the run varied from 138,000 adults to a historic high of 1,553,000 adults. However, only a small portion of these spawned naturally, and available information indicates that the naturally produced portion has continuously declined since the 1950s. The current number of naturally spawning fish during October and late November ranges from 3,000 to 5,500 fish. The majority of these are of hatchery origin. The 1996 to 1999 geometric mean for the late run in the Clackamas River, the only-run which is considered consisting mainly of native coho salmon, was 35 fish.

Both the long- and short-term trend, and lambda for the natural origin (late-run) portion of the Clackamas River coho salmon are negative but with large confidence intervals (T. P. Good, et al., 2005). The short-term trend for the Sandy River population is close to 1, indicating a relatively stable population during the years 1990 to 2002 (T. P. Good, et al., 2005). The long-term trend (1977 to 2002) for this same population shows that the population has been decreasing (trend=0.54); there is a 43% probability that the median population growth rate (lambda) was less than one.

Hatchery-origin spawners dominate the majority of populations. However, both the upper Clackamas River and the upper Sandy River spawner populations range from zero to very few hatchery origin spawneres. Recent reviews by the W/LCRTRT placed most populations in the high to moderate risk category from eroded diversity (McElhany et al., 2004; McElhany et al., 2006).

Critical Habitat

NMFS has not designated critical habitat for Lower Columbia River coho salmon.

Oregon Coast Coho Salmon

The Oregon Coast (OC) coho salmon ESU includes all naturally spawned populations of coho salmon in Oregon coastal streams south of the Columbia River and north of Cape Blanco (63 FR 42587, August 10, 1998; Figure 23). One hatchery stock, the Cow Creek (ODFW stock # 37) hatchery coho, is included in the ESU. This artificially propagated population is no more divergent relative to the local natural populations than would be expected between closely related populations within this ESU.

Life History

The OC coho salmon exhibit the general three year life cycle as described above. Two- year old males commonly occur in some streams and on average make up 20% of spawning males. However, the proportion of two-year old males is highly variable between years and river systems.

There is some variation in run timing between Oregon watersheds but adults generally start to migrate into rivers at the first fall freshet, usually in late October or early November. A delay in rain can delay river entry considerably. Once in the stream, some coho may spend up to two months in fresh water before spawning. Spawning usually occurs from November through January and may continue into February. Juveniles emerge from the gravel in spring and typically spend a summer and winter in fresh water before migrating to the ocean as smolts, usually in April or May, in their second spring. However, the timing varies between years, among river systems, and based on small-scale habitat variability (Lawson et al., 2007). Coastal coho salmon spend little time in estuarine environments during outmigration. Once in coastal waters, the OC coho salmon eventually move northward. By late summer, juveniles are observed distributed off the mouth of Columbia River and the Washington Coast. In fall and winter juvenile coho salmon continue to move northward and have been caught off the coast of Alaska (Lawson, et al., 2007). Southward movement starts in winter or early spring with adults starting to home to natal streams by August.

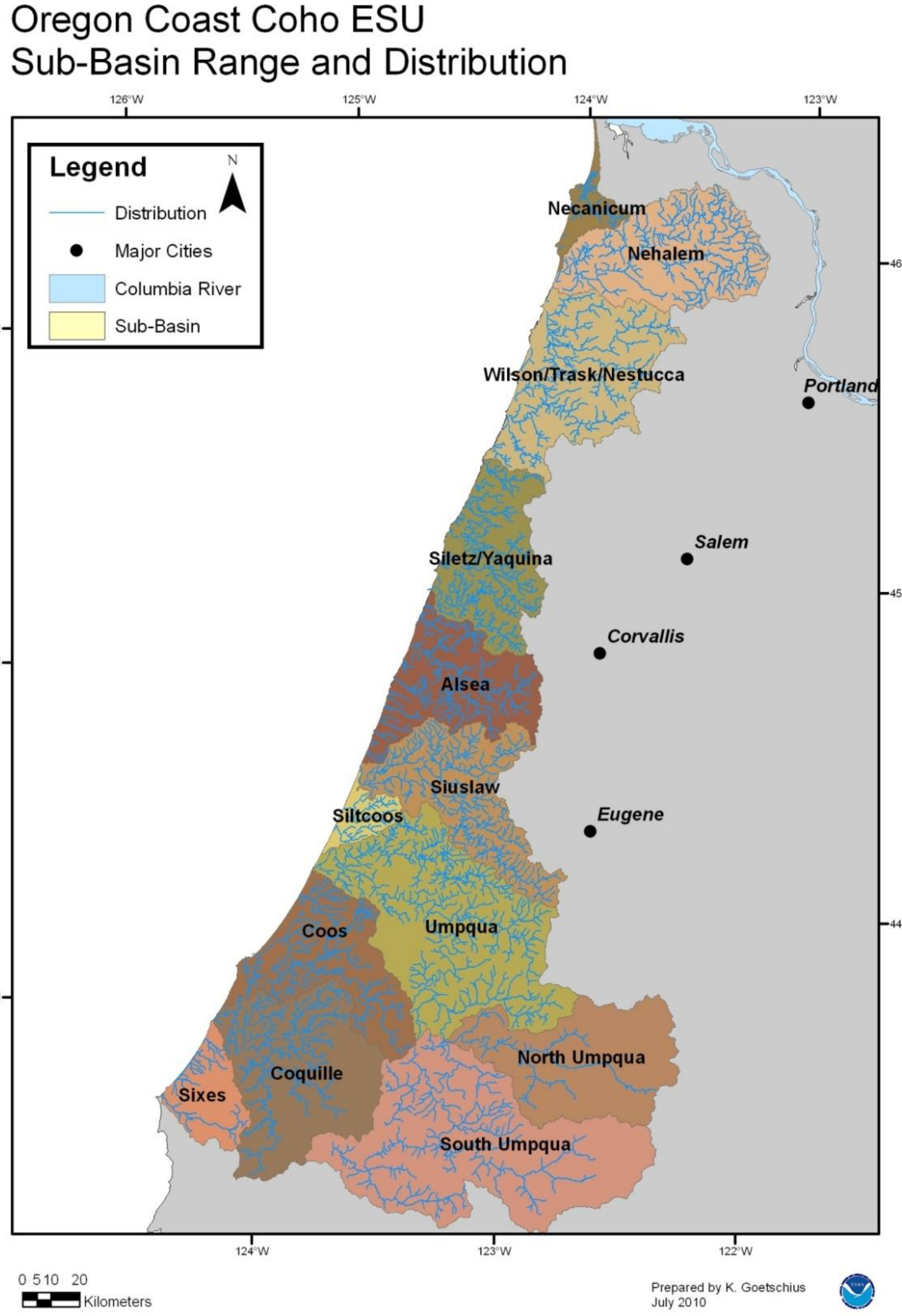


Figure 23**. Oregon Coast Coho salmon distribution**

Status and Trends

NMFS listed the OC coho salmon as a threatened species on February 11, 2008 (73 FR 7816). Lawson *et al.* (Lawson, et al., 2007) considered the ESU to have historically consisted of 13 functionally independent populations and 8 potentially dependent populations. Current coho salmon coastal distribution has not changed markedly compared to historical distribution (Lawson, et al., 2007). However, river alterations and habitat destruction have significantly modified use and distribution within several river basins.

The OC coho salmon historical escapement in the 10 larger basins has been estimated to about 2.4 to 2.9 million spawners (from Table C-1 in (Lawson, et al., 2007)). Recent ESU abundances have decreased drastically since then. The estimated median spawning population during the years 1990 to 1999 was 43,183 (min. 21,279, max. 74,021) coho salmon spawners in the ESU (ODFW, 2009). After 1999, total ESU abundance increased. A median of 165,324 native OC coho salmon spawners was estimated for the

Table 30. Oregon Coast Coho salmon potential historic and estimated recent spawner abundances, and hatchery contributions (T. P. Good, et al., 2005; Lawson, et al., 2007)

Basin	Population historic status	Historic Abundance	Recent Spawner Abundance	Hatchery Abundance Contributions
Necanicum	P-I	68,500	1,889	35-40%
Nehalem	F-I	333,000	18,741	40-75%
Tillamook	F-I	329,000	3,949	30-35%
Nestucca	F-I	104,000	3,846	~5%
Siletz	F-I	122,000	2,295	~50%
Yaquina	F-I	122,000	3,665	~25%
Alsea	F-I	163,000	3,621	~40%
Siuslaw	F-I	267,000	16,213	~40%
Umpqua	F-I*	820,000	24,351	<10%
Siltcoos and Tahhenitch	P-I	100,000	15,967**	0%
Tenmile	P-I	53,000	3,251**	0%
Coos	F-I	206,000	20,136	<5%
Coquille	F-I	417,000	8,847	<5%
Total		924,000	107,553	

*The Umpqua Rive basin is believed to have supported four functionally independent populations.
** Abundance in 2002, ODFW data http://oregonstate.edu/dept/ODFW/spawn/data.htm
F-I = Functionally Independent, P-I = Potentially Independent.

period 2000 through 2008 with a range from a low of 66,169 to a high of 260,000 naturally produced spawners. Table 30 identifies independent populations within the OC coho salmon ESU, historic and recent abundances, and hatchery input.

The abundance and productivity of OC coho salmon since the 1997 status review represented some of the best and worst years on record (T. P. Good, et al., 2005). Yearly adult returns for this ESU were in excess of 160,000 natural spawners in 2001 and 2002. However, these encouraging increases in spawner abundance in 2000–2002 were preceded by three consecutive brood years (the 1994–1996 brood years returning in 1997–1999, respectively) exhibiting recruitment failure. Recruitment failure is when a given year class of natural spawners fails to replace itself when its offspring return to the spawning grounds three years later. At the time of the 2005 status report, these three years of recruitment failure were the only such instances observed thus far in the entire 55-year abundance time series for OC coho salmon (T. P. Good, et al., 2005). The encouraging 2000–2002 increases in natural spawner abundance were primarily observed in populations in the northern portion of the ESU (T. P. Good, et al., 2005). Although encouraged by the increase in spawner abundance in 2000–2002, the long-term trends in ESU productivity remained negative due to the low abundances observed during the 1990s (T. P. Good, et al., 2005).

Recent data indicate that the total abundance of natural spawners in the OC coho salmon ESU again steadily decreased until 2007 with an estimated spawner abundance of 66,169 fish or approximately 25% of the 2002 peak abundance (260,555 spawners) (ODFW, 2009). Thus, recruitment failed during the five years from 2002 through 2007 but abundance increased again in 2008 to 165,324 spawners. There is no apparent weak brood year for the ESU (ODFW, 2009).

Critical Habitat

NMFS designated critical habitat for Oregon Coast coho salmon on February 11, 2008 (73 FR 7816). The designation includes 72 of 80 watersheds and total about 6,600 stream miles including all or portions of the Nehalem, Nestucca/Trask, Yaquina, Alsea, Umpqua, and Coquille basins.

There are 80 watersheds within the range of this ESU. Eight watersheds received a low conservation value rating, 27 received a medium rating, and 45 received a high rating to the ESU (Table 31, and Figure 24).

Table 31. OC coho salmon watersheds with conservation values

HUC 4 Subbasin	HUC 5 Watershed conservation Value (CV)					
	High CV	PCE(s)[1]	Medium CV	PCE(s)[1]	Low CV	PCE(s)[1]
Necanicum	0		1	(1, 2)	0	
Nehalem	5	(1, 2)	0		1	(2, 1)
Wilson/Trask/Nestucca	7	(1, 2)	2	(1, 2)	0	
Siletz/Yaquina	3	(1, 2)	5	(1, 2)	0	
Alsea	4	(1, 2)	3	(1, 2)	1	(1, 2=1.5mi)
Siuslaw	6	(1, 2, <3)	2	(1, 2)	0	
Siltcoos	1	(2, 1)	0		0	
North Umpqua	1	(1, <2)	3	(1, 3, <2)	3	(1)
South Umpqua	3	(1, <2, <<3)	8	(1, 2, 3)	1	(1)
Umpqua	6	(1, 3, 2)	1	(1, 3)	1	(1, 2, 3)
Coos	4	(1, 2, <3)	0		0	
Coquille	4	(1, 2, 3))	1	(1, 2)	1	(1, 2)
Sixes	1	(1, 20	1	(1, 2)		
Total	45		27		8	

[1] Numbers in parenthesis refers to the dominant (in river miles) PCE(s) within the HUC 5 watersheds. PCE 1 is spawning and rearing, 2 is rearing and migration, and 3 is migration and presence. PCEs with < means that the number of river miles of the PCE is much less than river miles of the other PCE.

The spawning PCE has been impacted in many watersheds from the inclusion of fine sediment into spawning gravel from timber harvest and forestry related activities, agriculture, and grazing. These activities have also diminished the channels’ rearing and overwintering capacity by reducing the amount of large woody debris in stream channels, removing riparian vegetation, disconnecting floodplains from stream channels, and changing the quantity and dynamics of stream flows. The rearing PCE has been degraded by elevated water temperatures in 29 of the 80 HUC 5 watersheds; rearing PCE within the Nehalem, North Umpqua, and the inland watersheds of the Umpqua subbasins have elevated stream temperatures. Water quality is impacted by contaminants from agriculture and urban areas in low lying areas in the Umpqua subbasins, and in coastal watersheds within the Siletz/Yaquina, Siltcoos, and Coos subbasins.

Reductions in water quality have been observed in 12 watersheds due to contaminants and excessive nutrition. The migration PCE has been impacted throughout the ESU by culverts and road crossings that restrict passage. As described above the PCEs vary widely throughout the critical habitat area designated for OC coho salmon, with many watersheds heavily impacted with low quality PCEs while habitat in other coho salmon bearing watersheds having sufficient quality for supporting the conservation purpose of designated critical habitat.

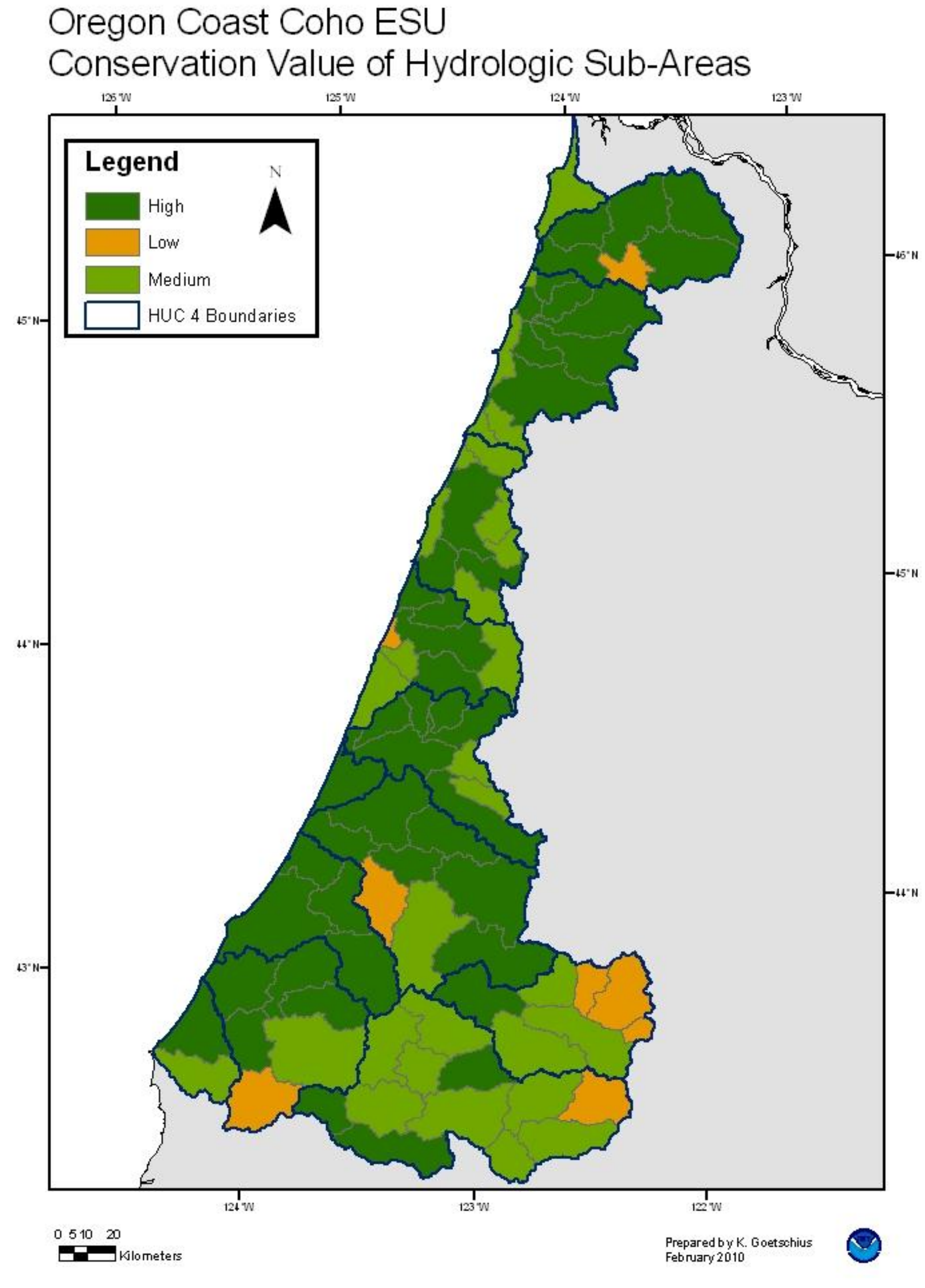


Figure 24. Oregon Coast Coho salmon conservation values per sub-area

Southern Oregon/Northern California Coast Coho Salmon

The Southern Oregon/Northern California Coast (SONCC) coho salmon ESU consists of all naturally spawning populations of coho salmon that reside below long-term, naturally impassible barriers in streams between Punta Gorda, California and Cape Blanco, Oregon (Figure 25). This ESU also includes three artificial propagation programs. These artificially propagated populations are no more divergent relative to the local natural populations than would be expected between closely related populations within this ESU.

Life History

In Oregon, the SONCC coho salmon enter rivers in September or October. River entry is later south of the Klamath River Basin, occurring in November and December, in basins south of the Klamath River to the Mattole River, California. River entry occurs from mid-December to mid-February in rivers farther south. Because coho salmon enter rivers late and spawn late south of the Mattole River, they spend much less time in the river prior to spawning compared to populations farther north. Juveniles emerge from the gravel in spring, and typically spend a summer and winter in fresh water before migrating to the ocean as smolts in their second spring. Coho salmon adults spawn at age three, spending about a year and a half in the ocean.

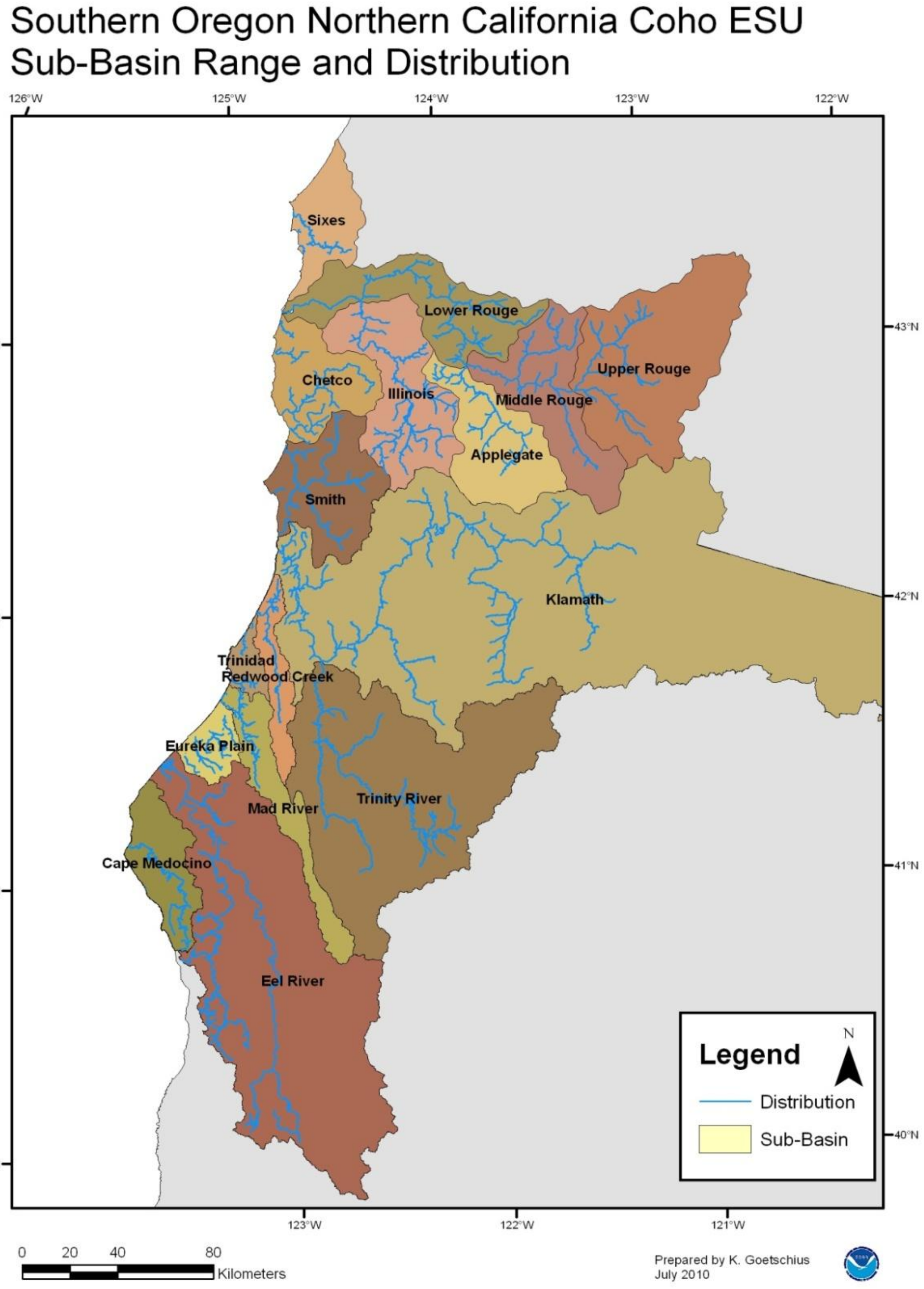


Figure 25. SONCC coho salmon distribution

Status and Trends

NMFS listed SONCC coho salmon as threatened on May 7, 1997 (62 FR 24588), and reaffirmed their threatened status on June 28, 2005 (70 FR 37160). The ESU consists of three major basins: the Rough (OR), Klamath (OR/CA), and the Eel (CA) Rivers. Three historically independent interior populations have been identified for the Rough River basin, eight for the Klamath River basin, and six in the Eel River basin (Williams et al., 2006). In addition, eight coastal basins within the ESU likely supported functionally independent populations under historical conditions, six basins likely supported potentially independent populations, and 13 supported dependent populations. Presence-absence data indicate a disproportionate loss of southern populations compared to the northern portion of the ESU.

Data on population abundance and trends are limited for this ESU. Historical point estimates of coho salmon abundance for the early 1960s and mid-1980s suggest that California statewide coho spawning escapement in the 1940s ranged between 200,000 and 500,000 fish. Numbers declined to about 100,000 fish by the mid-1960s with about 43% originating from this ESU. Brown *et al.* (L. R. Brown, et al., 1994), estimated that about 7,000 wild and naturalized coho salmon were produced in the California portion of this ESU. Further, presence-absence surveys indicate that the SONCC coho salmon have declined in California compared to past abundances (T. P. Good, et al., 2005). Data from surveys in Oregon contrast the California portion of the ESU in that fish presence has been steadily increasing from 1998 through 2007 (Bennet, 2005; T. P. Good, et al., 2005; Jepsen & Leader, 2008).

There is no consistent monitoring of any SONCC coho salmon populations. Trend and median population growth for single populations have therefore not been calculated. Information on abundance and production from California streams is limited. However, presence-absence data show that distributions within watersheds have remained suppressed compared to the historic distribution. Some hatchery releases has occurred but there is not enough information to evaluate the impacts of hatchery on fish diversity.

Critical Habitat

NMFS designated critical habitat for the SONCC coho salmon on May 5, 1999 (64 FR 24049). Species critical habitat encompasses all accessible river reaches between Cape Blanco, Oregon, and Punta Gorda, California and consists of the water, substrate, and river reaches (including off-channel habitats) in specified areas. Accessible reaches are those within the historical range of the ESU that can still be occupied by any life stage of coho salmon. Watersheds within the ESU have not been evaluated for their conservation value.

Critical habitat designated for the SONCC coho salmon is generally of good quality in northern coastal streams. Spawning PCE has been degraded throughout the ESU by logging activities that has increased fines in spawning gravel. Rearing PCE has been considerably degraded in many inland watersheds from the loss of riparian vegetation resulting in unsuitably high water temperatures. Rearing and juvenile migration PCEs have been reduced from the disconnection of floodplains and off-channel habitat in low gradient reaches of streams, consequently reducing winter rearing capacity.

Central California Coast Coho Salmon

The Central California Coast (CCC) coho salmon ESU includes all naturally spawned populations of coho salmon from Punta Gorda in northern California south to and including the San Lorenzo River in central California, as well as populations in tributaries to San Francisco Bay, excluding the Sacramento-San Joaquin River system (Figure 26)
The ESU also includes four artificial propagation programs. These artificially propagated populations are no more divergent relative to the local natural populations than would be expected between closely related populations within this ESU.

Life History

In general, coho salmon within California exhibit a three-year life cycle. However, two-year old males commonly occur in some streams. Both run and spawn timing of coho salmon in this region are late (both peaking in January) relative to northern populations, with little time spent in fresh water between river entry and spawning. Spawning runs coincide with the brief peaks of river flow during the fall and winter. Most CCC coho salmon juveniles undergo smoltification and start their seaward migration one year after emergence from the redd. Juveniles spending two winters in fresh water have, however, been observed in at least one coastal stream within the range of the ESU (Bjorkstedt, et al., 2005). Smolt outmigration generally peaks in April and May (Shapovalov & Taft, 1954; Weitkamp et al., 1995).

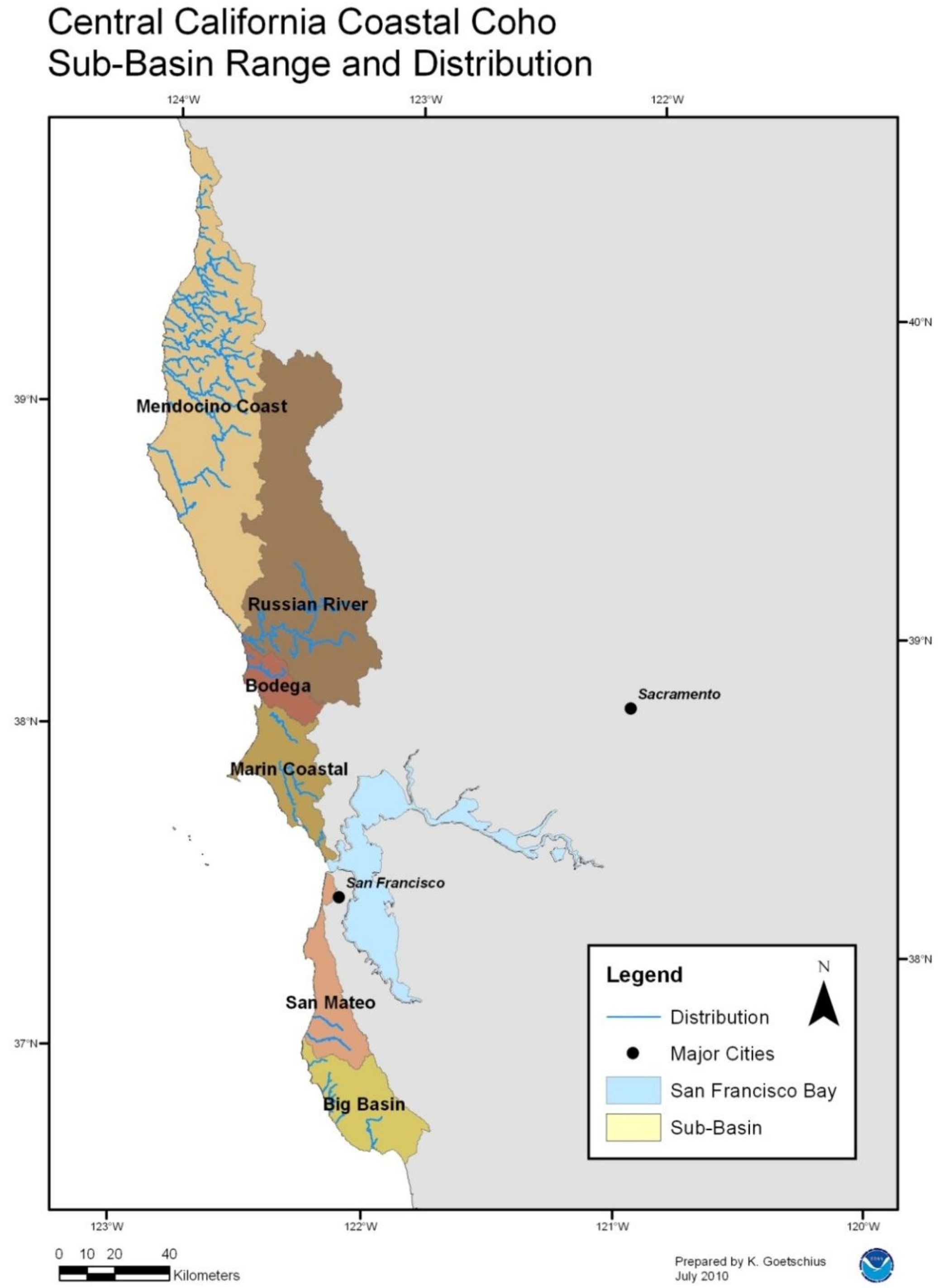


Figure 26. CCC Coho salmon distribution

Status and Trends

NMFS originally listed the CCC coho salmon as threatened on October 31, 1996 (61 FR 56138), and reclassified their status to endangered on June 28, 2005 (70 FR 37160). The ESU consisted historically of 11 functionally independent populations and a larger number of dependent populations (Brian C. Spence, et al., 2008). ESU spatial structure has been substantially modified due to lack of viable source populations and loss of dependent populations. One of the two historically independent populations in the Santa Cruz mountains (*i.e.,* South of the Golden Gate Bridge) is extirpated (T. P. Good, et al., 2005; Brian C. Spence, et al., 2008). Coho salmon are considered effectively extirpated from the San Francisco Bay (NMFS, 2001; Brian C. Spence, et al., 2008). The Russian River population, once the largest and most dominant source population in the ESU, is now at high risk of extinction because of low abundance and failed productivity (Brian C. Spence, et al., 2008). The Lost Coast to Navarro Point to the north contains the majority of coho salmon remaining in the ESU.

Limited information exists on abundance of coho salmon within the CCC coho salmon ESU. About 200,000 to 500,000 coho salmon were produced statewide in the 1940s (T. P. Good, et al., 2005). This escapement declined to about 99,000 by the 1960s with approximately 56,000 (56%) originating from streams within the CCC coho salmon ESU. The estimated number of coho salmon produced within the ESU in the late 1980s had further declined to 6,160 (46% of the estimated statewide production) (T. P. Good, et al., 2005).

Information on the abundance and productivity trends for the naturally spawning component in individual rivers of the CCC coho salmon ESU is extremely limited (T. P. Good, et al., 2005; Brian C. Spence, et al., 2008). There are no long-term time series of spawner abundance for individual river systems. Returns increased in 2001 in streams within the northern portion of the ESU (T. P. Good, et al., 2005). However, recent CCC coho salmon returns (2006/07 and 2007/08) have been discouragingly low (McFarlane, Hayes, & Wells, 2008). About 500 fish have returned in 2010 across the entire range. This is the third straight year of abysmal returns for CCC coho salmon. This year’s low return suggests that all three year classes are faring poorly across the species’ range.

Table 32. Central California Coast Coho salmon populations, abundances, and releases of hatchery raised smolt (Bjorkstedt, et al., 2005; T. P. Good, et al., 2005)

River/Region	Historical Escapement (1963)	1987-1991 Escapement Abundance	Hatchery Abundance Contributions*
Ten Mile River	6,000	160	892 – 796,561
Noyo River	6,000	3,740	940,970 – 242,808
Big River	6,000	280	9,988 – 191,310
Navarro River	7,000	300	20,020 – 143,812
Garcia River	2,000	500 (1984-1985)	183,153
Other Mendacino County rivers	10,000	470	Unknown
Gualala River	4,000	200	10,005 – 135,050
Russian River	5,000	255	7,998 – 415,730
Other Sonoma County rivers	1,000	180	Unknown
Marin County	5,000	435	5,760 – 305,421**
San Mateo County	1,000	Unknown	Unknown
San Francisco Bay	Unknown	Extirpated	NA
Santa Cruz County	1,500	50 (1984-1985)	Unknown
San Lorenzo River	1,600	Unknown	17,160 – 145,960
Total	200,000-500,000	6,570 (min)	

*Most coho salmon hatchery contributions have been infrequent and the numbers indicate the range of documented releases. All hatchery data are from Bjorkstedt *et al.* (2005).
**Lagunitas and Walker Creeks

The best data available for the CCC coho salmon are presence-absence surveys and they are used as a proxy for abundance changes (Table 32). At the time of the 1996 listing, coho salmon occurred in about 47% of the streams (62) and were considered extirpated from 53% (71) of the streams that historically harbored coho salmon within the ESU (L. R. Brown, et al., 1994). Later reviews have concluded that the number of occupied streams relative to historic has not changed and may actually have declined (T. P. Good, et al., 2005; NMFS, 2001).

Hatchery raised smolt have been released infrequently but occasionally in large numbers in rivers throughout the ESU (Bjorkstedt, et al., 2005). Releases have included transfer of stocks within California and between California and other Pacific states as well as smolt raised from eggs collected from native stocks. However, genetic studies show little homogenization of populations, *i.e.,* transfer of stocks between basins have had little effect on the geographic genetic structure of CCC coho salmon (Sonoma County Water Agency (SCWA), 2002). The CCC coho salmon likely has considerable diversity in local adaptations given that the ESU spans a large latitudinal diversity in geology and ecoregions, and include both coastal and inland river basins.

Critical Habitat

Critical habitat for the CCC coho salmon ESU was designated on May 5, 1999 (64 FR 24049). It encompasses accessible reaches of all rivers (including estuarine areas and tributaries) between Punta Gorda and the San Lorenzo River (inclusive) in California. Critical habitat for this species also includes two streams entering San Francisco Bay: Arroyo Corte Madera Del Presidio and Corte Madera Creek. Individual watersheds within the ESU have not been evaluated for their conservation value.

NMFS (2008a) evaluated the condition of each habitat attribute in terms of its current condition relative to its role and function in the conservation of the species. The assessment of habitat for this species showed a distinct trend of increasing degradation in quality and quantity of all PCEs as the habitat progresses south through the species range, with the area from the Lost Coast to the Navarro Point supporting most of the more favorable habitats and the Santa Cruz Mountains supporting the least. However, all populations are generally degraded regarding spawning and incubation substrate, and juvenile rearing habitat. Elevated water temperatures occur in many streams across the entire ESU.

Sockeye Salmon

Description of the Species

Sockeye salmon occur in the North Pacific and Arctic oceans and associated freshwater systems. This species ranges south as far as the Klamath River in California and northern Hokkaido in Japan, to as far north as Bathurst Inlet in the Canadian Arctic and the Anadyr River in Siberia. We discuss the distribution, life history diversity, status, and critical habitat of the two endangered and threatened sockeye species separately.

Spawning generally occurs in late summer and autumn, but the precise time can vary greatly among populations. Males often arrive earlier than females on the spawning grounds, and will persist longer during the spawning period. Average fecundity ranges from about 2,000 eggs per female to 5,000 eggs, depending upon the population and age of the female.

The vast majority of sockeye salmon spawn in outlet streams of lakes or in the lakes themselves. In lakes, the species commonly spawn along “beaches” where underground seepage creates upwelling that provides eggs and alevins with fresh oxygenated water. Incubation is a function of water temperature, but generally lasts between 100 and roughly 200 days (Burgner, 1991). Sockeye salmon fry primarily use lakes as rearing areas with river emerged fry migrating into lakes to rear. Fry emerging in streams emptying into lakes usually move rapidly with the water flow downstream into lakes. Fry emerging from lake-outlet spawning areas migrate upstream into lakes. In these cases, fry hold for a period in the stream and may feed actively before moving upstream into the lake. During upstream migration, they move along the low velocity stream margin. Fry emerging from lakeshore or island spawning grounds distribute along the shoreline of the lake or move offshore into deep water (Burgner, 1991). The juvenile sockeye salmon rear in lakes from one to three years after emergence.

Some sockeye spawn in rivers without lake habitat for juvenile rearing. Offspring of these riverine spawners use the lower velocity sections of rivers as juvenile rearing environment for one to two years. Alternatively, juveniles may also migrate to sea in their first year.

Certain populations of *O. nerka* become resident in the lake environment and are called kokanee or little redfish (Burgner, 1991). Kokanee and sockeye often co-occur in many interior lakes, where access to the sea is possible but energetically costly. On the other hand, coastal lakes, where the migration to sea is relatively short and energetic costs are minimal, rarely support kokanee populations.

During freshwater rearing, sockeye salmon feeding behavior change as the juvenile transit through stages from emergence to the time of smoltification. As the alevins emerge from gravel, they feed little and depend mostly on the yolk sack, if it is still present, for growth (Burgner, 1991). It is therefore critical for the small fry to start feeding as the yolk sack reserves are being depleted; a high mortality is observed when fishes are starved for more than two weeks after yolk absorption (Bilton & Robins, 1973). In the earlier fry stage from spring to early summer, juveniles forage exclusively in the warmer littoral (*i.e.*, shoreline) zone where they depend mostly on dipteran insects (mostly chironomidae larvae and pupae) and on cyclopoid copepods and cladocerans. In summer, underyearling sockeye salmon transit from the littoral habitat to a pelagic existence where they feed on larger zooplankton. However, diptera, especially chironomids, can contribute substantially in caloric value. Older and larger fish may also prey on fish larvae. Distribution in lakes and prey preference is, however, a dynamic process that changes diurnally and annually, with water temperature, with the presence and abundance of particular prey species, presence of predators and competitors, and the size of the sockeye salmon juveniles.

Upon smoltification, anadromous sockeye migrate to the ocean. Peak emigration to the ocean occurs in mid-April to early May in southern sockeye populations (<52ºN latitude) and as late as early July in northern populations (62ºN latitude) (Burgner, 1991). River-type sockeye populations make little use of estuaries during their emigration to the marine environment. Upon entering marine waters, sockeye may reside in the nearshore or coastal environment for several months but are typically distributed offshore by fall (Burgner, 1991). Adult sockeye salmon return to their natal lakes to spawn after spending one to four years at sea.

Status and Trends

Sockeye salmon depend on the quantity and quality of aquatic systems. Sockeye salmon, like the other salmon NMFS has listed, have declined from overharvests, hatcheries, native and non-native exotic species; dams, gravel mining, water diversions, destruction or degradation of riparian habitat, and land use practices (logging, agriculture, and urbanization). Climate change also poses significant hazards to the survival and recovery of salmonids. Hazards from climate change include elevated water temperature, earlier spring runoff and lower summer flows, and winter flooding.

Ozette Lake Sockeye Salmon

Distribution

This ESU includes sockeye salmon that migrate into and rear in the Ozette Lake near the northwest tip of the Olympic Peninsula in Olympic National Park, Washington (Figure **27**). The Ozette Lake sockeye salmon ESU includes all naturally spawned anadromous populations of sockeye salmon in Ozette Lake, Ozette River, Coal Creek, and other tributaries flowing into Ozette Lake. Composed of only one population, the Ozette Lake sockeye salmon ESU consists of five spawning aggregations or subpopulations which are grouped according to their spawning locations. The five spawning locations are Umbrella and Crooked creeks, Big Rive, and Olsen's and Allen's beaches (Rawson et al., 2009). Two artificial populations are also considered part of this ESU. These artificially propagated populations are no more divergent relative to the local natural population than would be expected between closely related natural populations (70 FR 37160, June 28, 2005).

Sockeye salmon stock reared at the Makah Tribe's Umbrella Creek Hatchery were included in the ESU, but were not considered essential for recovery of the ESU. However, once the hatchery fish return and spawn in the wild, their progeny are considered as listed under the ESA.

Life History

Adult Ozette Lake sockeye salmon enter Ozette Lake through the Ozette River from April to early August. Of these, about 99% are four-year old adults. Adults remain in the lake for an extended period before spawning from late October through February. Sockeye salmon spawn primarily in lakeshore upwelling areas in Ozette Lake. Minor spawning may occur below Ozette Lake in the Ozette River or in Coal Creek, a tributary of the Ozette River. Native sockeye salmon do not presently spawn in tributary streams to Ozette Lake but they may have spawned there historically. However, a hatchery program has initiated tributary-spawning by hatchery fish in Umbrella Creek and Big River (T. P. Good, et al., 2005).

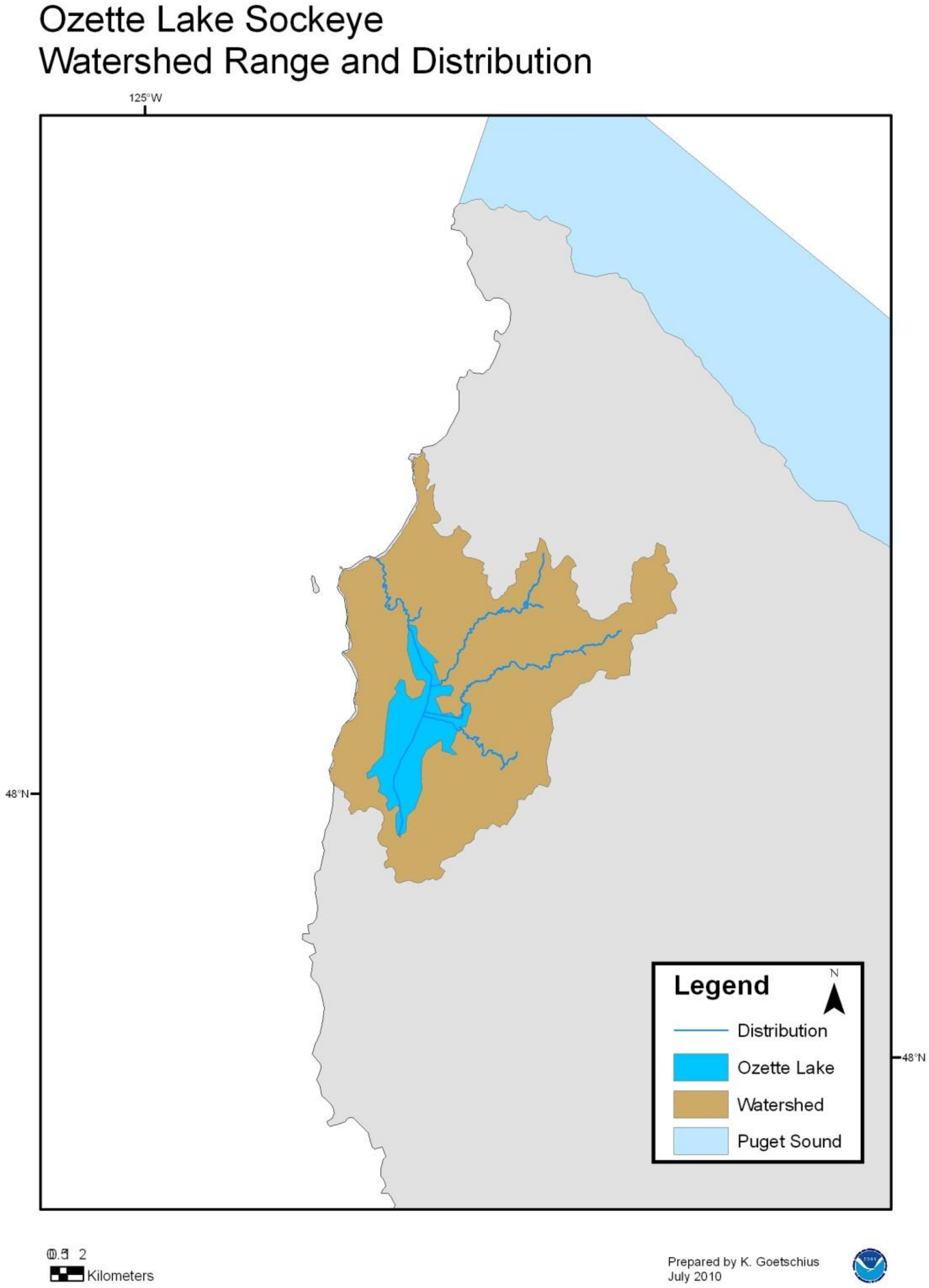


Figure 27. **Ozette Lake Sockeye salmon distribution**

Egg incubation occurs from October through May. Emergence and dispersal in the lake occurs from late-February through May. Fry disperse to the limnetic zone in Ozette Lake, where the fish rear. Tributary fry also migrate to the lake soon after emergence. In their second spring after one year of rearing, Ozette Lake sockeye salmon emigrate seaward as age 1+ smolts. The lake is highly productive and water fleas dominate the diet. Sockeye salmon smolts produced in Ozette Lake are documented as the third largest, averaging 4 ½ to 5 inches in length, among west coast sockeye populations examined for average smolt size. The majority of Ozette Lake sockeye salmon return to spawn after two years in the ocean (NMFS, 2008f). Ozette Lake also supports a population of kokanee which is not listed under the ESA. There is a large genetic difference between the anadromous and the resident *O. nerka* populations (Crewson et al., 2001).

Status and Trends

NMFS originally listed the Ozette Lake sockeye salmon as a threatened species in 1999 (64 FR 14528), and reaffirmed their threatened status on June 28, 2005 (70 FR 37160).

The Ozette Lake sockeye salmon ESU is composed of one historical population, with substantial substructuring of individuals into multiple spawning aggregations. Historically at least four beaches in the lake were used for spawning but only two beach spawning locations – Allen's and Olsen's beaches – remain today.

The historical abundance of Ozette Lake sockeye salmon is poorly documented, but may have been as high as 50,000 individuals (Blum, 1988). Kemmerich (Kemmerich, 1945), reported a decline in the run size since the 1920s weir counts and Makah Fisheries Management (Makah Fisheries Management, 2000) concluded a substantial decline in the Tribal catch of Ozette Lake sockeye salmon occurred at the beginning of the 1950s. Whether decrease in abundance compared to historic estimates is a result of fewer spawning aggregations, lower abundances at each aggregation, or both, is unknown (T. P. Good, et al., 2005).

The most recent (1996-2006) escapement estimates (run size minus broodstock take) range from a low of 1,404 in 1997 to a high of 6,461 in 2004, with a median of approximately 3,800 sockeye per year (geometric mean: 3,353) (Rawson, et al., 2009). No statistical estimation of trends is reported. However, comparing four year averages (to include four brood years in the average since the species primarily spawn as four-year olds) shows an increase during the period 2000 to 2006: For return years 1996 to 1999 the run size averaged 2,460 sockeye salmon, for the years 2000 to 2003 the run size averaged just over 4,420 fish, and for the years 2004 to 2006, the three-year average abundance estimate was 4,167 sockeye (Data from appendix A in (Rawson, et al., 2009)). It is estimated that between 35,500 and 121,000 spawners could be normally carried after full recovery (Hard, Jones, Delarm, & Waples, 1992).

The supplemental hatchery program began with out-of-basin stocks and make up an average of 10% of the run. The proportion of beach spawners originating from the hatchery is unknown but it is likely that straying is low. Hatchery originated fish is therefore not believed to have had a major effect on the genetics of the naturally spawned population. However, Ozette Lake sockeye has a relatively low allelic diversity at microsatellite DNA loci compared to other *O. nerka* populations examined in Washington State (Crewson, et al., 2001). Genetic differences occur between age cohorts. As different age groups do not spawn with each other, the population may be more vulnerable to significant reductions in population structure due to catastrophic events or unfavorable conditions affecting one year class. Based on this, the Puget Sound TRT's diversity viability criterion is one or more persistent spawning aggregation(s) with each major genetic and life history group being present within the aggregation (Rawson, et al., 2009). Currently this is not the case; both spawning aggregations are at risk from losing year classes.

Critical Habitat

NMFS designated critical habitat for Ozette Lake sockeye salmon on September 2, 2005 (70 FR 52630). It encompasses areas within the Hoh/Quillayute subbasin, Ozette Lake, and the Ozette Lake watershed. The entire occupied habitat for this ESU is within the single watershed for Ozette Lake. This watershed was given a high conservation value rating. Spawning and rearing PCEs are found in the lake and in portions of three lake tributaries. Ozette River also provides rearing and migration PCEs. The river mouth provides estuarine habitat.

Spawning habitat has been affected by loss of tributary spawning areas and exposure of much of the available beach spawning habitat due to low water levels in summer. Further, native and non-native vegetation as well as sediment have reduced the quantity and suitability of beaches for spawning. The rearing PCE is degraded by excessive predation and competition with introduced non-native species, and by loss of tributary rearing habitat. Migration habitat may be adversely affected by high water temperatures and low water flows in summer which causes a thermal block to migration (La Riviere, 1991).

Snake River Sockeye Salmon

The Snake River (SR) sockeye salmon ESU includes all anadromous and residual sockeye from the Snake River basin, Idaho, as well as artificially propagated sockeye salmon from the Redfish Lake Captive Broodstock Program (70 FR 37160, June 28, 2005). The Redfish Lake is located in the Salmon River basin, a subbasin within the larger Snake River basin (Figure 28).

Life History

SR sockeye salmon are unique compared to other sockeye salmon populations. Sockeye salmon returning to Redfish Lake in Idaho's Stanley Basin travel a greater distance from the sea (approximately 900 miles) to a higher elevation (6,500 ft) than any other sockeye salmon population and are the southern-most population of sockeye salmon in the world (Bjornn et al 1968). Stanley Basin sockeye salmon are separated by 700 or more river miles from two other extant upper Columbia River populations in the Wenatchee River and Okanogan River drainages. These latter populations return to lakes at substantially lower elevations (Wenatchee at 1,870 ft, Okanagon at 912 ft) and occupy different ecoregions.

A resident form of *O. nerka* (kokanee), also occur in the Redfish Lake. The residuals are non-anadromous; they complete their entire life cycle in fresh water. However, studies have shown that some ocean migrating juveniles are progeny of resident females (Rieman, Myers, & Nielsen, 1994). The residents also spawn at the same time and in the same location as anadromous sockeye salmon.

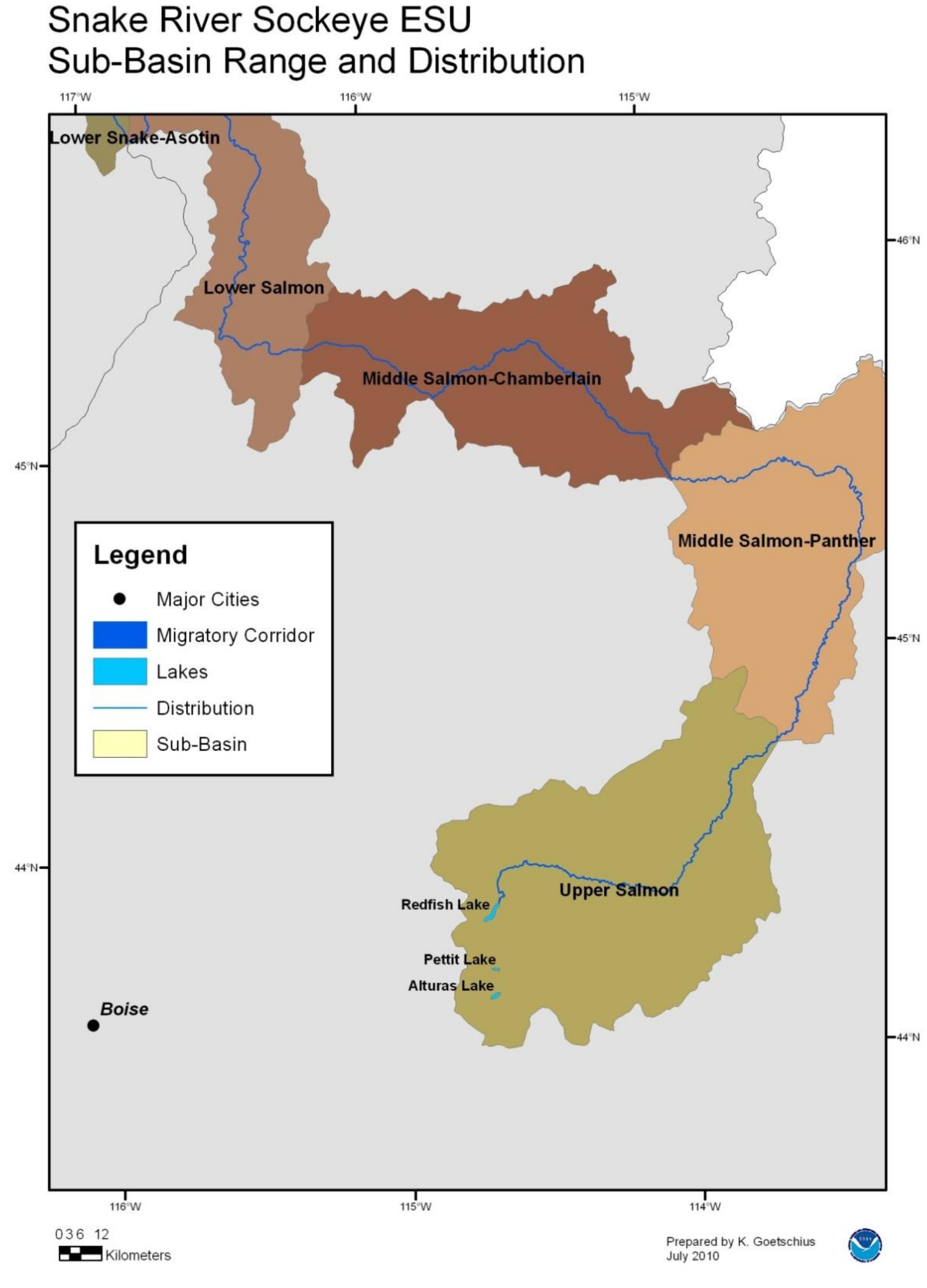


Figure 28. **SR Sockeye Salmon distribution**

Historically, sockeye salmon entered the Columbia River system in June and July, and arrived at Redfish Lake between August and September (NMFS, 2008d). Spawning occurred in lakeshore gravel and generally peaked in October. Fry emerged in the spring (generally April and May) then migrated to open waters of the lake to feed. Juvenile sockeye remained in the lake for one to three years before migrating through the Snake and Columbia Rivers to the ocean. While pre-dam reports indicate that sockeye salmon smolts migrate in May and June, PIT tagged sockeye smolts from Redfish Lake pass Lower Granite Dam from mid-May to mid-July. Adult anadromous sockeye spent two or three years in the open ocean before returning to Redfish Lake to spawn.

Status and Trends

NMFS originally listed SR sockeye salmon as endangered in 1991, and reaffirmed their endangered status on June 28, 2005 (70 FR 37160). Subsequent to the 1991 listing, the residual form of sockeye residing in Redfish Lake was identified. In 1993, NMFS determined that residual sockeye salmon in Redfish Lake was part of the SR sockeye salmon ESU.

The only extant sockeye salmon population in the Snake River basin at the time of listing occurred in Redfish Lake, in the Stanley Basin (upper Salmon River drainage) of Idaho. Other lakes in the Salmon River basin that historically supported sockeye salmon include Alturas Lake above Redfish Lake which was extirpated in the early 1900s as a result of irrigation diversions, although residual sockeye may still exist in the lake (D. Chapman & Witty, 1993). From 1955 to 1965, the Idaho Department of Fish and Game eradicated sockeye salmon from Pettit, Stanley, and Yellowbelly lakes, and built permanent structures on each of the lake outlets that prevented re-entry of anadromous sockeye salmon (D. Chapman & Witty, 1993). Other historic sockeye salmon populations within the Snake River basin include Wallowa Lake (Grande Ronde River drainage, Oregon), Payette Lake (Payette River drainage, Idaho), and Warm Lake (South Fork Salmon River drainage, Idaho) (Gustafson et al., 1997). These populations are now considered extinct.

Recent annual abundances of natural origin sockeye salmon in the Stanley Basin have been extremely low. No natural origin anadromous adults have returned since 1998 and the abundance of residual sockeye salmon in Redfish Lake is unknown. This species is currently entirely supported by adults produced through the captive propagation program.

Adult returns to Redfish Lake during the period 1954 through 1966 ranged from 11 to 4,361 fish (T. Bjornn, Craddock, & Corley, 1968). In 1985, 1986, and 1987, 11, 29, and 16 sockeye, respectively, were counted at the Redfish Lake weir (T. P. Good, et al., 2005). Only 18 natural origin sockeye salmon have returned to the Stanley Basin since 1987. The first adult returns from the captive brood stock program returned to the Stanley Basin in 1999. From 1999 through 2005, a total of 345 captive brood adults that had migrated to the ocean returned to the Stanley Basin. Recent years have seen an increase in returns to over 600 in 2008 and more than 700 returning adults in 2009. Current smolt-to-adult survival of sockeye originating from the Stanley Basin lakes is rarely greater than 0.3% (Hebdon, Kline, Taki, & Flagg, 2004).

Critical Habitat

NMFS designated critical habitat for SR sockeye salmon on December 28, 1993 (58 FR 68543). Designated habitat encompass the waters, waterway bottoms, and adjacent riparian zones of specified lakes and river reaches in the Columbia River that are or were accessible to listed Snake River salmon (except reaches above impassable natural falls, and Dworshak and Hells Canyon Dams). SR sockeye critical habitat areas include the Columbia River from a straight line connecting the west end of the Clatsop jetty (Oregon side) and the west end of the Peacock jetty (Washington side), all river reaches from the estuary upstream to the confluence of the Snake River, and all Snake River reaches upstream to the confluence of the Salmon River; all Salmon River reaches to Alturas Lake Creek; Stanley, Redfish, Yellow Belly, Pettit, and Alturas Lakes (including their inlet and outlet creeks); Alturas Lake Creek and that portion of Valley Creek between Stanley Lake Creek; and the Salmon River.

Conservation values of individual watersheds have not been reported (58 FR 68543). However, all areas occupied and used for migration by the SR sockeye salmon should be considered of high conservation value as the species' distribution is limited to a single lake within the Snake River basin.

The quality and quantity of rearing and juvenile migration PCEs have been reduced from activities such as tilling, water withdrawals, timber harvest, grazing, mining, and alteration of floodplains and riparian vegetation. These activities disrupt access to foraging areas, increase the amount of fines in the steam substrate that support production of aquatic insects, and reduce instream cover. Adult and juvenile migration PCE is affected by four dams in the Snake River basin that obstructs migration and increases mortality of downstream migrating juveniles.

Water quality impairments in the designated critical habitat of the SR sockeye salmon include inputs from fertilizers, insecticides, fungicides, herbicides, surfactants, heavy metals, acids, petroleum products, animal and human sewage, dust suppressants (*e.g.*, magnesium chloride), radionuclides, sediment in the form of turbidity, and other anthropogenic pollutants. Pollutants enter the surface waters and riverine sediments from the headwaters of the Salmon River to the Columbia River estuary as contaminated stormwater runoff, aerial drift and deposition, and via point source discharges. Some contaminants such as mercury and pentachlorophenol enter the aquatic food web after reaching water and may be concentrated or even biomagnified in the salmon tissue. Sockeye salmon require migration corridors with adequate passage conditions (water quality and quantity available at specific times) to allow access to the various habitats required to complete their life cycle. Multiple exposures to contaminants occur to all life stages throughout the entire range of the SR sockeye salmon.

Steelhead

Description of the Species

Steelhead are native to Pacific Coast streams extending from Alaska south to northwestern Mexico. We discuss the distribution, life history, status, and critical habitat of the 11 endangered and threatened steelhead species separately.

Steelhead have a protracted run time relative to Pacific salmon and do not tend to travel in large schools. Nevertheless, steelhead can be divided into two basic run-types: the stream-maturing type, or summer steelhead, and the ocean-maturing type, or winter steelhead. The summer steelhead enters fresh water in a sexually immature condition between May and October (Busby et al., 1996; T.E. Nickelson et al., 1992). They then hold in cool, deep holding pools during summer and fall before moving to spawning sites as mature adults in January and February (Barnhart, 1986; T.E. Nickelson, et al., 1992). Summer steelhead most commonly occur in streams where snowmelt contributes substantially to the annual hydrograph. The winter steelhead enters fresh water between November and April with well-developed gonads and spawns shortly after river entry (Busby, et al., 1996; T.E. Nickelson, et al., 1992). Variations in migration timing exist between populations. Some adults enter coastal streams in the spring, just before spawning (Meehan & Bjornn, 1991).

Steelhead typically spawn in small tributaries rather than large, mainstem rivers; spawning distribution often overlap with coho salmon. However, steelhead tend to prefer higher gradients (generally 2-7%, sometimes up to 12% or more) and their distribution tend to extend farther upstream than for coho salmon. Summer steelhead commonly spawn higher in a watershed than do winter steelhead, sometimes even using ephemeral streams from which juveniles are forced to emigrate as flows diminish.

Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more than once before death (Busby, et al., 1996). Mostly females spawn more than once but rarely more than twice before dying (T.E. Nickelson, et al., 1992). Iteroparity is more common among southern steelhead populations than northern populations (Busby, et al., 1996).

Juveniles rear in fresh water from one to four years, then smolt and migrate to the ocean in March and April (Barnhart, 1986). After two to three weeks, in late spring, and following yolk sac absorption, alevins emerge from the gravel and begin actively feeding. The fry usually inhabit shallow water along banks and stream margins of streams (T.E. Nickelson, et al., 1992). As they grow, steelhead juveniles commonly occupy faster flowing water such as riffles. Older and larger juveniles are more risk averse; they stay in deeper water and keep close to cover (Peter A. Bisson, Nielsen, Palmson, & Grove, 1982; Peter A. Bisson, Sullivan, & Nielsen, 1988). Some older juveniles move downstream to rear in larger tributaries and mainstem rivers (T.E. Nickelson, et al., 1992).

Steelhead juveniles are highly territorial, dominance is based on initial size, and high densities result in increased migration. Juvenile steelhead that have established territories migrate little during their first summer (Peter A. Bisson, et al., 1988). Steelhead fry and parr hold close to the substratum where flows are lower and sometimes counter to the main stream. Here, steelhead foray up into surface currents for drifting food or prey at invertebrates on the stream bottom (Peter A. Bisson, et al., 1988; Kalleberg, 1958). Older steelhead commonly uses deeper pools (Peter A. Bisson, et al., 1982; Peter A. Bisson, et al., 1988).

Juvenile steelhead are opportunistic and feed on a wide variety of aquatic and terrestrial insects (D. W. Chapman & Bjornn, 1969). Prey species varies with season and availability; they utilize higher prey diversity than sympatric coho salmon (Pert, 1987). Prey includes common aquatic stream insects such as caddisflies, mayflies, and stoneflies but also other insects (especially chironomid pupae), zooplankton, and benthic organisms (Merz, 2002; Pert, 1987). Older juveniles sometimes prey on emerging fry, other fish larvae, crayfish, and even small mammals but these are not a major food source (Merz, 2002).

All listed salmonids use shallow, low flow habitats at some point in their life cycle. However, steelhead juveniles use such habitat less than coho salmon and prefer faster flowing stream sections. During winter and spring, juveniles often seek protection under rocks and boulders to escape high flows. Contrary to coho salmon, steelhead seem to avoid overwintering in channels that have organic matter or “muck” as bottom substrate. They may move into inundated floodplains to forage during the high flow season.

In Oregon and California, steelhead may enter estuaries where sand bars close off the estuary, thereby creating low salinity lagoons. The migration of juvenile steelhead to lagoons occurs throughout the year, but is concentrated in the late spring/early summer and in the late fall/early winter period (Shapovalov & Taft, 1954; Zedonis, 1992). In southern California, two discrete groups of juvenile steelhead use different habitat provided by lagoons: steelhead juveniles that use the upper and fresher areas of coastal lagoons for freshwater rearing throughout the year, and smolts that drop down from the watershed and use the lagoon primarily in the spring prior to seawater entry (Cannata, 1998; Zedonis, 1992).

Immature steelhead migrate directly offshore during their first summer from whatever point they enter the ocean rather than along the coastal belt as salmon do. During the fall and winter, juveniles move southward and eastward (Hartt & Dell, 1986; T.E. Nickelson, et al., 1992). Steelhead typically reside in marine waters for two or three years prior to returning to their natal stream to spawn as four or five-year olds.

Status and Trends

Steelhead survival depends on the quantity and quality of those aquatic systems they occupy. Steelhead have declined from overharvests, hatcheries, native and non-native exotic species, dams, gravel mining, water diversions, destruction or degradation of riparian habitat, and land use practices (logging, agriculture, and urbanization). Climate change also poses significant hazards to the survival and recovery of salmonids. Hazards from climate change include elevated water temperature, earlier spring runoff and lower summer flows, and winter flooding.

Puget Sound Steelhead DPS

This DPS includes all naturally spawned anadromous winter-run and summer-run steelhead in streams in the river basins of the Strait of Juan de Fuca, Puget Sound, and Hood Canal, Washington, bounded to the west by the Elwha River (inclusive) and to the north by the Nooksack River and Dakota Creek (inclusive), as well as the Green River natural and Hamma Hamma winter-run steelhead hatchery stocks (Figure 29). The remaining hatchery programs are not considered part of the DPS because they are more than moderately diverged from the local native populations.

Life History

The Puget Sound steelhead DPS contains both winter-run and summer-run steelhead. Adult winter-run steelhead generally return to Puget Sound tributaries from December to April (NMFS, 2005d). Spawning occurs from January to mid-June, with peak spawning occurring from mid-April through May. Prior to spawning, maturing adults hold in pools or in side channels to avoid high winter flows. Less information exists for summer-run steelhead as their smaller run size and higher altitude headwater holding areas have not been conducive for monitoring. Based on information from four streams, adult run time occur from mid-April to October with a higher concentration from July through September (NMFS, 2005d).

The majority of juveniles reside in the river system for two years with a minority migrating to the ocean as one or three-year olds. Smoltification and seaward migration occur from April to mid-May. The ocean growth period for Puget Sound steelhead ranges from one to three years in the ocean (Busby, et al., 1996). Juveniles or adults may spend considerable time in the protected marine environment of the fjord-like Puget Sound during migration to the high seas.

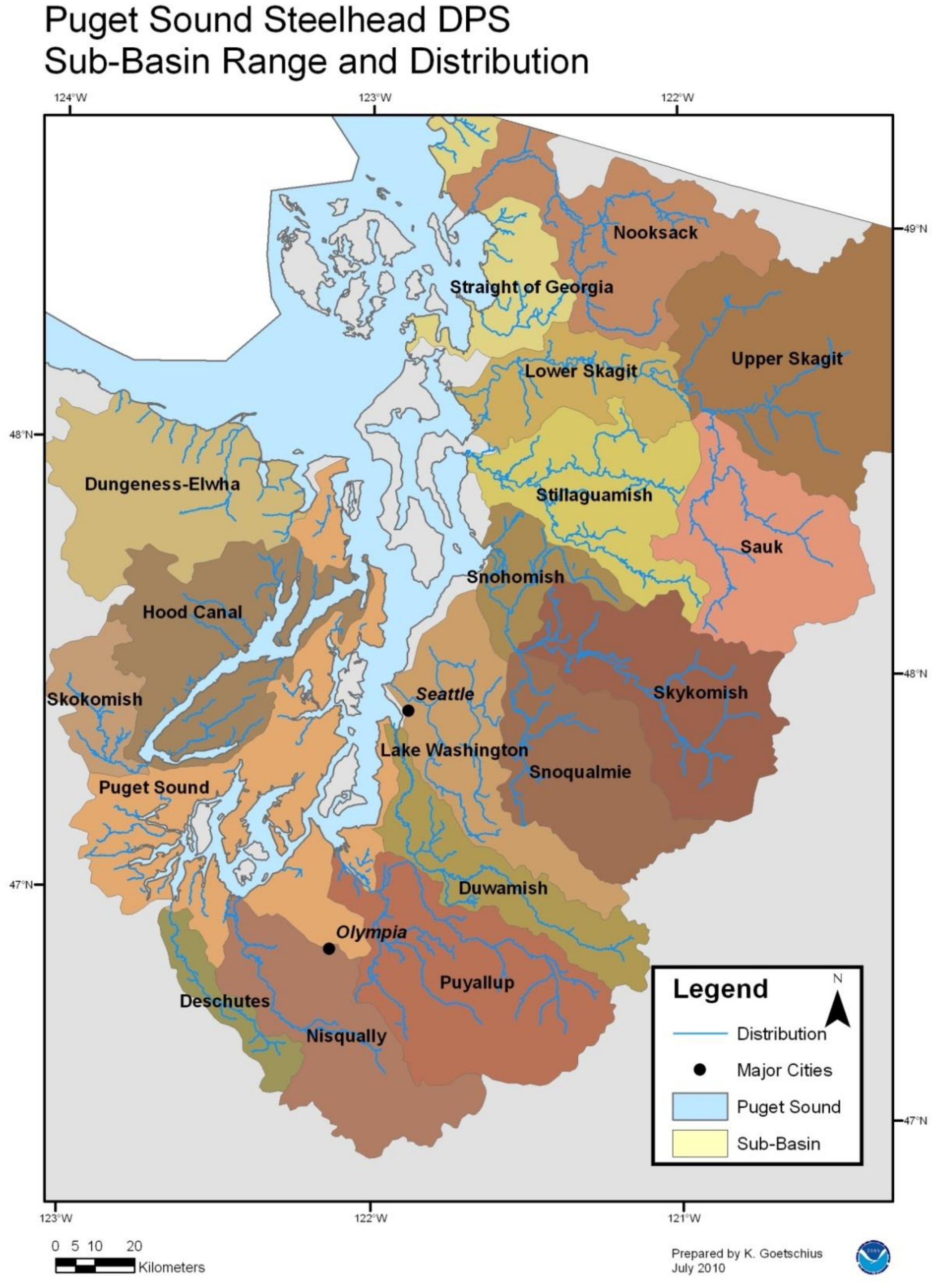


Figure 29. Puget Sound steelhead distribution

Status and Trends

NMFS listed Puget Sound steelhead as threatened on May 11, 2007 (72 FR 26722). Fifty-three populations of steelhead have been identified in this DPS, of which 37 are winter-run. Summer-run populations are distributed throughout the DPS but are concentrated in northern Puget Sound and Hood Canal; only the Elwha River and Canyon Creek support summer-run steelhead in the rest of the DPS. The Elwha River run, however, is descended from introduced Skamania Hatchery summer-run steelhead. Historical summer-run steelhead in the Green River and Elwha River were likely extirpated in the early 1900s. Table 33 provides the geometric mean estimates of escapement of natural spawners for Puget Sound steelhead.

In the early 1980s, run size for this DPS was calculated at about 100,000 winter-run fish and 20,000 summer-run fish. By the 1990s, the total run size for four major stocks exceeded 45,000, roughly half of which were natural escapement. The Washington Department of Fish and Wildlife (WDFW) concluded that DPS escapement (excluding the Hamma Hamma population, see below) further declined by 23% during the years from 1999 through 2004 relative to the period from 1994 through 1998 (Washington Department of Fish and Wildlife (WDFW), 2008). Of the 53 known stocks of Puget Sound steelhead, the WDFW 2002 stock assessment categorized five stocks as healthy, 19 as depressed, one as critical, and 27 of unknown status. The WDFW (2008) data show escapement of natural spawners for the period 1980 to 2004 and the period 2000 to 2004 (Washington Department of Fish and Wildlife (WDFW), 2008).

In the 1996 and 2005 status reviews, the Skagit and Snohomish Rivers (North Puget Sound) winter-run steelhead were found to produce the largest escapements ((Busby, et al., 1996), (NMFS, 2005d)). The two rivers still produce the largest wild escapement with a recent (2005 to 2008) four-year geometric mean of 5,468 for the Skagit River and an average 2,944 steelhead in Snohomish River for the two years 2005 and 2006 (Washington Department of Fish and Wildlife (WDFW), 2009). Lake Washington has the lowest abundances of winter-run steelhead with an escapement of less than 50 fish in each year from 2000 through 2004 (Washington Department of Fish and Wildlife (WDFW), 2008). The stock is now virtually extirpated with only eight and four returning fish in 2007 and 2008, respectively (Washington Department of Fish and Wildlife

(WDFW), 2009). No abundance estimates exist for most of the summer-run populations; all appear to be small, most averaging less than 200 spawners annually.

Table 33. Geometric mean estimates of escapement of natural spawners for Puget Sound steelhead

Population	Run type	Long Term	5-Year
Canyon	SSH	N/A	N/A
Skagit	SSH	N/A	N/A
Snohomish	SSH	N/A	N/A
Stillaguamish	SSH	N/A	N/A
Canyon	WSH	N/A	N/A
Dakota	WSH	N/A	N/A
Nooksack	WSH	N/A	N/A
Samish	WSH	501	852
Skagit	WSH	6,994	5,419
Snohomish	WSH	5,283	3,230
Stillaguamish	WSH	1,028	550
Tolt	SSH	129	119
Green	SSH	N/A	N/A
Cedar	WSH	138	37
Green	WSH	1,802	1,620
Lk. Washington	WSH	308	37
Nisqually	WSH	1,116	392
Puyallup	WSH	1,714	907
Dewatto	WSH	24	25
Dosewallips	WSH	71	77
Duckabush	WSH	17	18
Hamma Hamma	WSH	30	52
Quilcene	WSH	17	18
Skokomish	WSH	439	203
Tahuya	WSH	114	117
Union	WSH	55	55
Elwha	SSH	N/A	N/A
Dungeness	WSH	311	174
Elwha	WSH	N/A	N/A
McDonald	WSH	150	96
Morse	WSH	106	103

For each population, estimates are provided for both long term (all yr, ca. 1980-2004 for most populations) and for a recent five year period (5 yr, 2000-2004). SSH, summer steelhead; WSH, winter steelhead. (NMFS (2005e) status review updated for Puget Sound steelhead, http://www.nwr.noaa.gov/ESA-Salmon-Listings/Salmon-Populations/Steelhead/STPUG.cfm)

Long-term trends (1980 to 2004) for the Puget Sound steelhead natural escapement have declined significantly for most populations, especially in southern Puget Sound, and in some populations in northern Puget Sound (Stillaguamish winter-run), Canal (Skokomish winter-run), and along the Strait of Juan de Fuca (Dungeness winter-run) (NMFS, 2005d). Positive trends were observed in the Samish winter-run (northern Puget Sound) and the Hamma Hamma winter-run (Hood Canal) populations. The increasing trend on the Hamma Hamma River may be due to a captive rearing program rather than to natural escapement (NMFS, 2005d).

The negative trends in escapement of naturally produced fish resulted from peaks in natural escapement in the early 1980s. Still, the period 1995 through 2004 (short-term) showed strong negative trends for several populations. This is especially evident in southern Puget Sound (Green, Lake Washington, Nisqually, and Puyallup winter-run), Hood Canal (Skokomish winter-run), and the Strait of Juan de Fuca (Dungeness winter-run) (NMFS, 2005d). As with the long-term trends, positive trends were evident in short-term natural escapement for the Samish and Hamma Hamma winter-run populations, and also in the Snohomish winter-run populations.

Median population growth rates (λ) using 4-year running sums is less than 1, indicating declining population growth, for nearly all populations in the DPS (NMFS, 2005d). However, some of the populations with declining recent population growth show only slight declines, (*e.g.*, Samish and Skagit winter-run in northern Puget Sound, and Quilcene and Tahuya winter-run in Hood Canal).

Only two hatchery stocks genetically represent native local populations (Hamma Hamma and Green River natural winter-run). The remaining programs, which account for the vast preponderance of production, are either out-of-DPS derived stocks or were within-DPS stocks that have diverged substantially from local populations. The WDFW estimated that 31 of the 53 stocks were of native origin and predominantly natural production (Washington Department of Fish and Wildlife (WDFW), 1993).

Intentional and inadvertent hatchery selection on life history in Chambers Creek winter-run steelhead has resulted in a domesticated strain with a highly modified average run and spawn timing. If interbreeding occurs, such changes can have a detrimental effect on fitness in the wild. However, genetic analyses by Phelps *et al*. (Phelps, Leider, Hulett, Baker, & Johnson, 1997), indicated reproductive isolation of and/or poor spawning success by hatchery-origin fish. This was shown in a later study on the Clackamas River in Oregon (kostow, Marshall, & Phelps, 3003). There is, however, some evidence for introgression by hatchery releases into winter-run steelhead populations in tributaries to the Strait of Juan de Fuca. However, this may have been due to the small size of the naturally-spawning populations relative to the hatchery introductions.

Critical Habitat

NMFS has not designated critical habitat for the Puget Sound steelhead.

Lower Columbia River Steelhead

The LCR steelhead DPS includes all naturally spawned steelhead populations below natural and manmade impassable barriers in streams and tributaries to the Columbia River between the Cowlitz and Wind Rivers, Washington (inclusive), and the Willamette and Hood Rivers, Oregon (inclusive) (Figure 30). Two hatchery populations are included in this species, the Cowlitz Trout Hatchery winter-run population and the Clackamas River population but neither was listed as threatened.

Life History

The LCR steelhead DPS includes both summer- and winter-run stocks (Table 34). Summer-run steelhead return sexually immature to the Columbia River from May to November, and spend several months in fresh water prior to spawning. Winter-run steelhead enter fresh water from November to April, are close to sexual maturation during freshwater entry, and spawn shortly after arrival in their natal streams. Where both races spawn in the same stream, summer-run steelhead tend to spawn at higher elevations than the winter-run.

The majority of juvenile LCR steelhead remain for two years in freshwater environments before ocean entry in spring. Both winter- and summer-run adults normally return after two years in the marine environment.

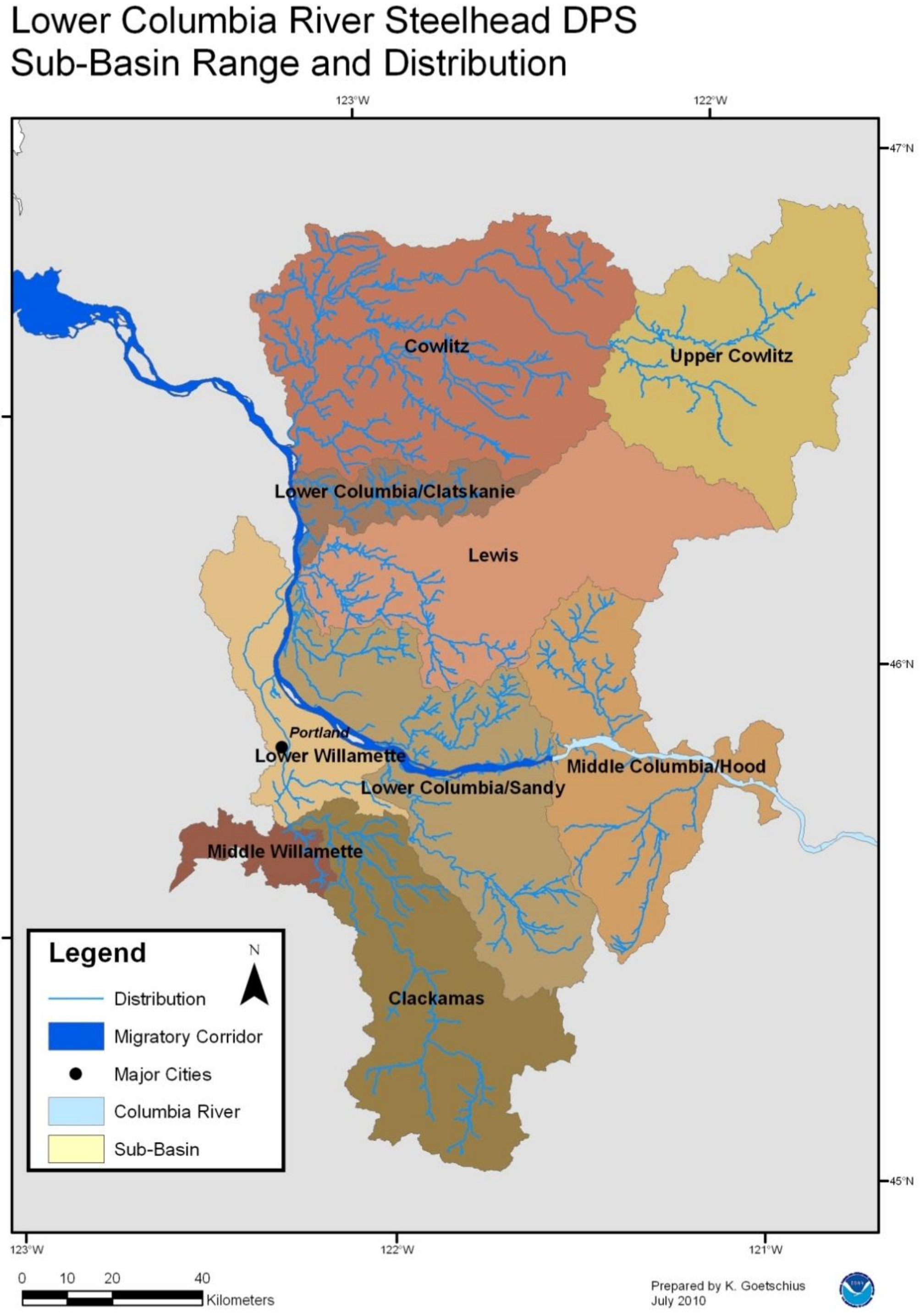


Figure 30 **Lower Columbia River steelhead distribution**

Status and Trends

NMFS listed LCR steelhead as threatened on March 19, 1998 (63 FR 13347), and reaffirmed their threatened status on January 5, 2006 (71 FR 834). The LCR steelhead had 17 historically independent winter steelhead populations and 6 independent summer steelhead populations (McElhany et al., 2003; J. Myers, et al., 2006). All historic LCR steelhead populations are considered extant. However, spatial structure within the historically independent populations, especially on the Washington side, has been substantially reduced by the loss of access to the upper portions of some basins due to tributary hydropower development.

All LCR steelhead populations declined from 1980 to 2000, with sharp declines beginning in 1995. Historical counts in some of the larger tributaries (Cowlitz, Kalama, and Sandy Rivers) suggest the population probably exceeded 20,000 fish. During the 1990s, fish abundance dropped to 1,000 to 2,000 fish. Recent abundance estimates of natural-origin spawners range from completely extirpated for some populations above impassable barriers to over 700 fishes for the Kalama and Sandy winter-run populations.

A number of the populations have a substantial fraction of hatchery-origin spawners in spawning areas. Many of the long-and short-term trends in abundance of individual populations are negative.

There is a difference in population stability between winter- and summer-run LCR steelhead. The winter-run steelhead in the Cascade region has the highest likelihood of being sustained as it includes a few populations with moderate abundance and positive short-term population growth rates (T. P. Good, et al., 2005; McElhany, et al., 2007). The Gorge summer-run steelhead is at the highest risk over the long-term as the Hood River population is at high risk of being lost (McElhany, et al., 2007)

Table 34. LCR Steelhead salmon populations, historic abundances (T. P. Good, et al., 2005), 1998 – 2002 and 2004 to 2005 geometric mean abundance (T. P. Good, et al., 2005)(Salmon Scape Query 2009), and hatchery contributions (T. P. Good, et al., 2005; McElhany, et al., 2003).

Population	Run	Historical Abundance	Recent Geometric Mean Total Abundances	Hatchery Abundance Contributions
Cispus River	Winter	Unknown	Unknown	Unknown
Tilton River		Unknown	2,787/--	~73%
Upper Cowlitz River		Unknown	Unknown	Unknown
Lower Cowlitz River		1,672	Unknown	Unknown
Coweeman River		2,243	466/488	~50%
SF Toutle River		2,627	504/616	~2%
NF Toutle River		3,770	196/169	0%
Kalama River		3,165	726/1440	0%
NF Lewis River		713	Unknown	Unknown
EF Lewis River		3,131	Unknown/514	Unknown
Salmon Creek		Unknown	Unknown	Unknown
Washougal River		2,497	323/528	0%
Clackamas River		Unknown	560/--	41%
Sandy River		Unknown	977/--	42%
Lower tributaries		793	Unknown	Unknown
Upper tributaries		243	Unknown	Unknown
Hood River		Unknown	756/--	~52%
Kalama River	Summer	Unknown	--/384	
NF Lewis River		Unknown	Unknown	Unknown
EF Lewis River		Unknown	--/474	
Washougal River		Unknown	--/668	
Hood River		Unknown	931/--	~83%
Wind River		2,288	--/627	~5%

Critical habitat

Critical habitat was designated for the LCR steelhead on September 2, 2005 (70 FR 52488). Of 41 subbasins listed as critical habitat for the LCR steelhead, 28 subbasins were rated as having a high conservation value. Eleven subbasins were rated as having a medium value and two were rated as having a low value to the conservation of the DPS (
Table 35).

Table 35. LCR steelhead watersheds with conservation values.

HUC 4 Subbasin	HUC 5 Watershed conservation Value (CV)					
	High CV	PCE(s)[1]	Medium CV	PCE(s)[1]	Low CV	PCE(s)[1]
Middle-Columbia/Hood	4	(1, 3, <2)	1	(3, 1)	1	(3, 1)
Lower Columbia/Sandy	4	(1, 3)	5	(3, 1)	0	
Lewis	2	(3, 1, 2)	0		0	
Lower Columbia/Clatskanie	1	(3, 1)	0		0	
Upper Cowlitz River	5	(3)	0		0	
Cowlitz	3	(3, 1)	5	(3, 1, 2)	0	
Middle Willamette	0		0		1	(1, 2)
Clackamas	6	(1, <2)	0		0	
Lower Willamette	3	(2, 1, 3)	0		0	
Lower Columbia Corridor	all	(3, 2)	0		0	
Total	28		11		2	

[1] Numbers in parenthesis refers to the dominant (in river miles) PCE(s) within the HUC 5 watersheds. PCE 1 is spawning and rearing, 2 is rearing and migration, and 3 is migration and presence. PCEs with < means that the number of river miles of the PCE is much less than river miles of the other PCE

Critical habitat is affected by reduced quality of rearing and juvenile migration PCEs within the lower portion and alluvial valleys of many watersheds; contaminants from agriculture affect both water quality and food production in these reaches of tributaries and in the mainstem Columbia River. Several dams affect adult migration PCE by obstructing the migration corridor. Watersheds which consist of a large proportion of federal lands such as is the case with the Sandy River watershed, have relatively healthy riparian corridors that support attributes of the rearing PCE such as cover, forage, and suitable water quality (Figure 31).

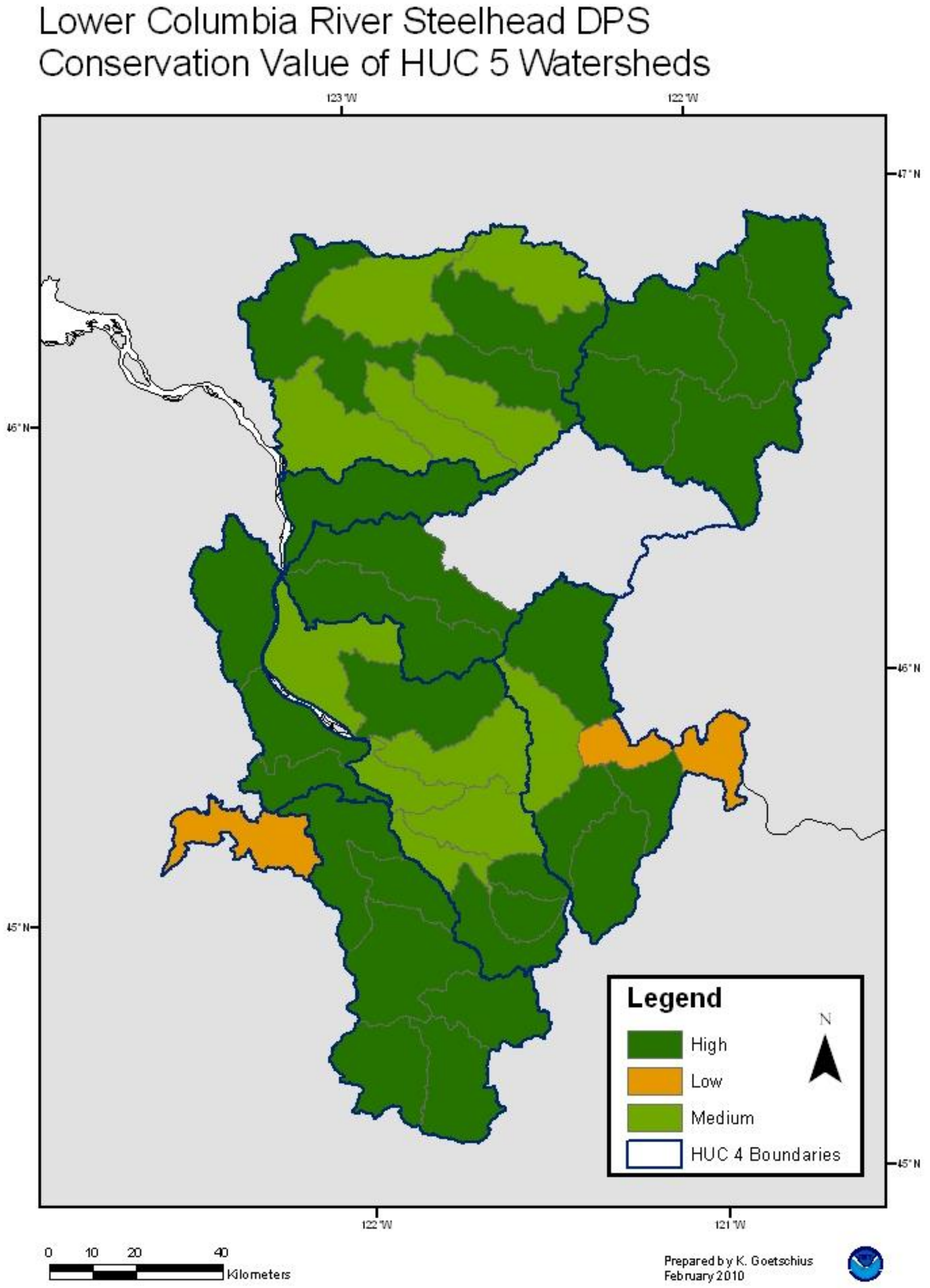


Figure 31 Lower Columbia River Steelhead conservation values per sub-area

Upper Willamette River Steelhead

The UWR steelhead DPS includes all naturally spawned winter-run steelhead populations below natural and manmade impassable barriers in the Willamette River, Oregon, and its tributaries upstream from Willamette Falls to the Calapooia River (inclusive) (Figure 32). No artificially propagated populations that reside within the historical geographic range of this DPS are included in this listing. Hatchery summer-run steelhead occur in the Willamette Basin but are an out-of-basin population that is not included in this DPS.

Life History

Native steelhead in the Upper Willamette are a late-migrating winter group that enters fresh water in January and February (Howell et al., 1985). UWR steelhead do not ascend to their spawning areas until late March or April, which is late compared to other West Coast winter steelhead. Spawning occurs from April to June 1. The unusual run timing may be an adaptation for ascending the Willamette Falls, which may have facilitated reproductive isolation of the stock. The smolt migration past Willamette Falls also begins in early April and proceeds into early June, peaking in early- to mid-May (Howell, et al., 1985). Smolts generally migrate through the Columbia via Multnomah Channel rather than the mouth of the Willamette River. As with other coastal steelhead, the majority of juveniles smolt and outmigrate after two years; adults return to their natal rivers to spawn after spending two years in the ocean. Repeat spawners are predominantly female and generally account for less than 10% of the total run size (Busby, et al., 1996).

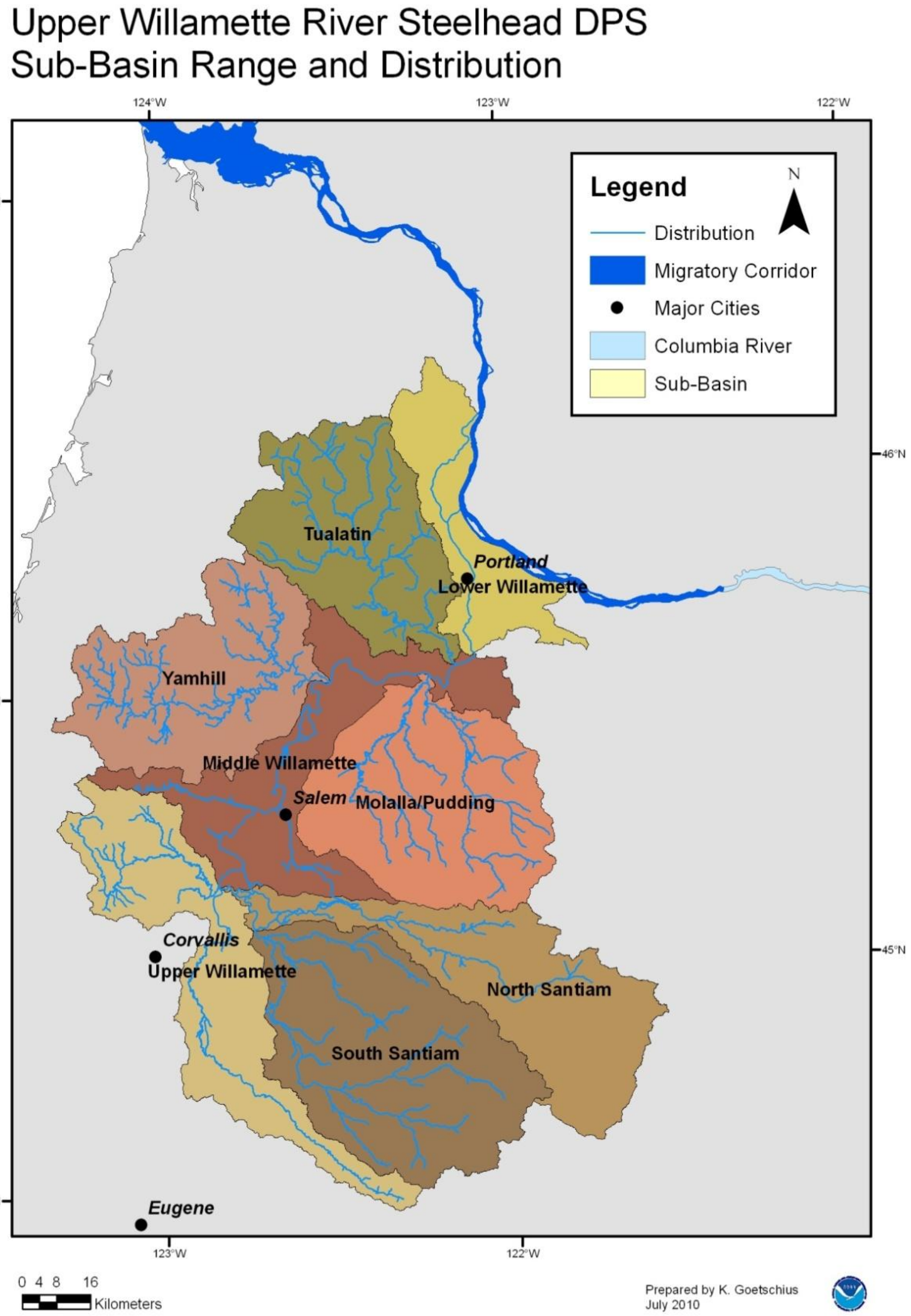


Figure 32. UWR Steelhead distribution

Status and Trends

NMFS originally listed UWR steelhead as threatened on March 25, 1999 (64 FR 14517), and reaffirmed their threatened status on January 5, 2006 (71 FR 834). Four basins on the east side of the Willamette River historically supported independent populations for the UWR steelhead, all of which remain extant. Data reported in McElhaney et al. (2007) indicate that currently the two largest populations within the DPS are the Santiam River populations. Mean spawner abundance in both the North and South Santiam River is about 2,100 native winter-run steelhead. However, about 30% of all habitat has been lost due to human activities (McElhany, et al., 2007). The North Santiam population has been substantially affected by the loss of access to the upper North Santiam basin. The South Santiam subbasin has lost habitat behind non-passable dams in the Quartzville Creek watershed. Notwithstanding the lost spawning habitat, the DPS continues to be spatially well distributed, occupying each of the four major subbasins.

Table 36. Upper Willamette River steelhead salmon populations, core (C) and genetic legacy (G) populations, abundances, and hatchery contributions (T. P. Good, et al., 2005; McElhany, et al., 2003).

Historic Independent Populations	Historical Abundance	Most Recent Spawner Abundance	Hatchery Abundance Contributions
Mollala Rivers	Unknown	0.972 rpm	Unknown
North Santiam River	Unknown	0.963 rpm	Unknown
South Santiam River	Unknown	0.917 rpm	Unknown
Calapooia River	Unknown	1.053 rpm	Unknown
Total	Unknown	5,819	

Note: rpm denotes redds per mile.

UWR steelhead are moderately depressed from historical levels (McElhany, et al., 2007). Average number of late-fall steelhead passing Willamette Falls decreased during the 1990s to less than 5,000 fish. The number again increased to over 10,000 fish in 2001 and 2002. The geometric and arithmetic mean number of late-run steelhead passing Willamette Falls for the period 1998 to 2001 were 5,819 and 6,795, respectively.

Population information for individual basins exist as redds per (river) mile. These redd counts show a declining long-term trend for all populations (T. P. Good, et al., 2005). One population, the Calapooia, had a positive short-term trend during the years from 1990 to 2001. McElhany *et al.* (2007) however, found that the populations had a low risk of extinction. Two of the populations were considered at moderate risk from failed abundances and recruitment levels and two (North and South Santiam Rivers) were considered at low risk given current abundances and recruitment (McElhany, et al., 2007).

Hatchery raised winter-run steelhead were released in the Upper Willamette River up to 1999. These fish were out of basin stocks and had an earlier return timing than the native steelhead. The impact of these releases on the genetic diversity and life history of the native population is unknown (Table 36). Nevertheless, remains of the early run still exist and the release of hatchery fish has been discontinued.

Critical Habitat

NMFS designated critical habitat for this species on September 2, 2005 (70 FR 52488). It includes all Columbia River estuarine areas and river reaches proceeding upstream to the confluence with the Willamette River and specific stream reaches in the following subbasins: Upper Willamette, North Santiam, South Santiam, Middle Willamette, Molalla/Pudding, Yamhill, Tualatin, and Lower Willamette (NMFS, 2005c).

Table 37. UWR steelhead watersheds with conservation values

HUC 4 Subbasin	HUC 5 Watershed conservation Value (CV)					
	High CV	PCE(s) [1]	Medium CV	PCE(s) [1]	Low CV	PCE(s) [1]
Upper Willamette	1	(1, 2)	2	(2, 1)	0	
North Santiam	3	(1, 2)	0		0	
South Santiam	6	(1, 2)	0		0	
Middle Willamette	0		0		4	(2, 1)
Yamhill	0		1	(1, 2)	6	(2, 1)
Molalla/Pudding	1	(1)	2	(2, 1)	3	(2, 1)
Tualatin	0		1	(1, 2)	4	(1, 2, 3)
Lower Willamette	3	(2)	0		0	
Columbia River Corridor	all	(3)	0		0	
Total	14		6		17	

1 Numbers in parenthesis refers to the dominant (in river miles) PCE(s) within the HUC 5 watersheds. PCE 1 is spawning and rearing, 2 is rearing and migration, and 3 is migration and presence. PCEs with < means that the number of river miles of the PCE is much less than river miles of the other PCE.

Of the subbasins reviewed in NMFS' assessment of critical habitat for the UWR steelhead, 14 subbasins were rated as having a high conservation value, six were rated as having a medium value, and 17 were rated as having a low conservation value (Table 37).

The current condition of critical habitat designated for the UWR steelhead is degraded (Figure 33), and provides a reduced the conservation value necessary for species recovery. Critical habitat is affected by reduced quality of juvenile rearing and migration PCEs within many watersheds; contaminants from agriculture affect both water quality and food production in several watersheds and in the mainstem Columbia River. Several dams affect adult migration PCE by obstructing the migration corridor.

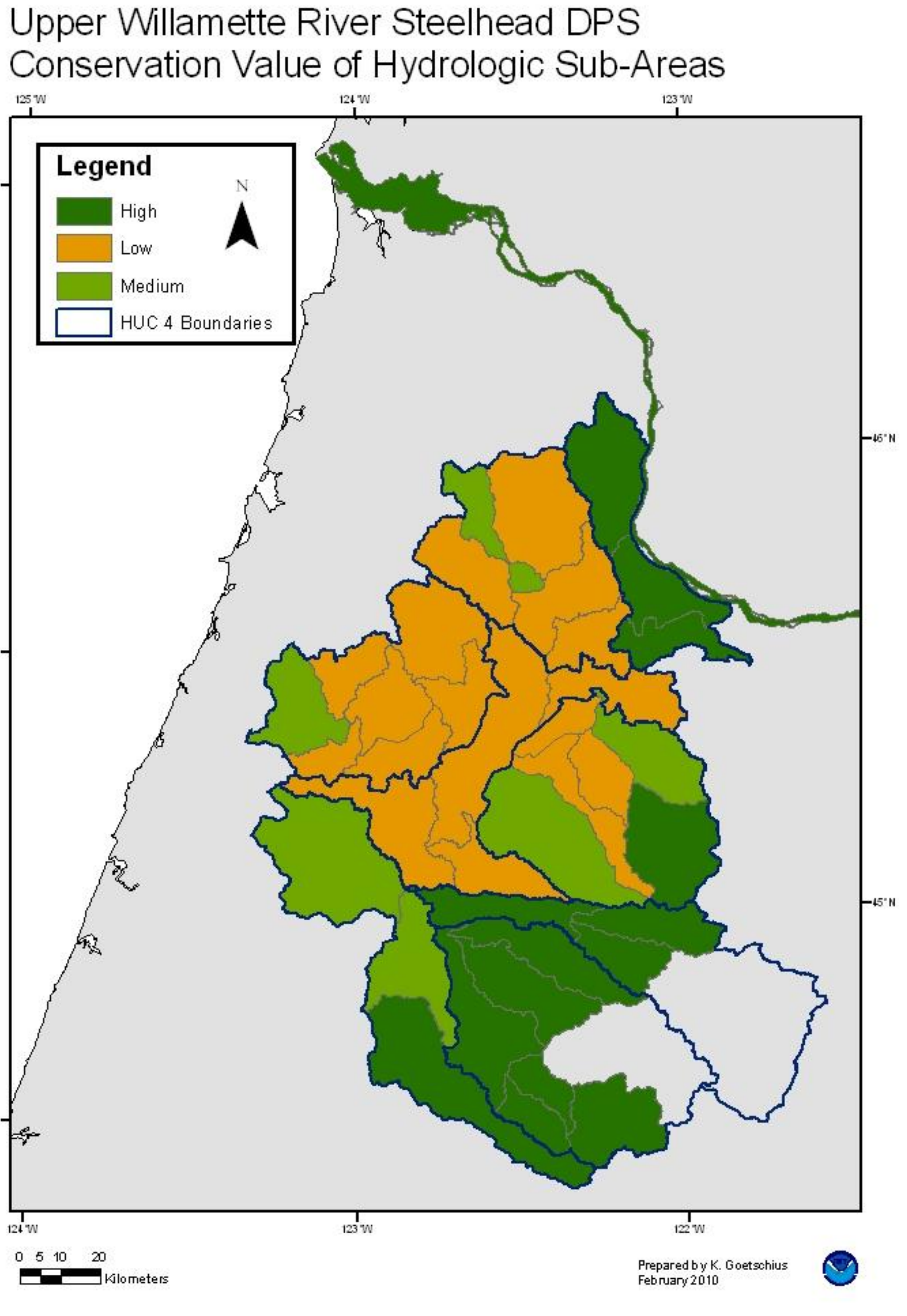


Figure 33. Upper Willamette River Steelhead conservation values per sub-area

Middle Columbia River Steelhead

The MCR steelhead DPS includes all naturally spawned steelhead populations below natural and manmade impassable barriers in streams from above the Wind River, Washington, and the Hood River, Oregon (exclusive), upstream to, and including, the Yakima River, Washington, excluding *O. mykiss* from the Snake River Basin. Steelhead from the Snake River basin (described later in this section) are excluded from this DPS. Seven artificial propagation programs are part of this DPS. They include: the Touchet River Endemic, Yakima River Kelt Reconditioning Program (in Satus Creek, Toppenish Creek, Naches River, and Upper Yakima River), Umatilla River, and the Deschutes River steelhead hatchery programs (Figure 34). These artificially propagated populations are considered no more divergent relative to the local natural populations than would be expected between closely related natural populations within the DPS.

According to the ICBTRT (ICTRT, 2003), this DPS is composed of 16 populations in four major population groups (Cascade Eastern Slopes Tributaries, John Day River, Walla Walla and Umatilla Rivers, and Yakima River), and one unaffiliated population (Rock Creek).

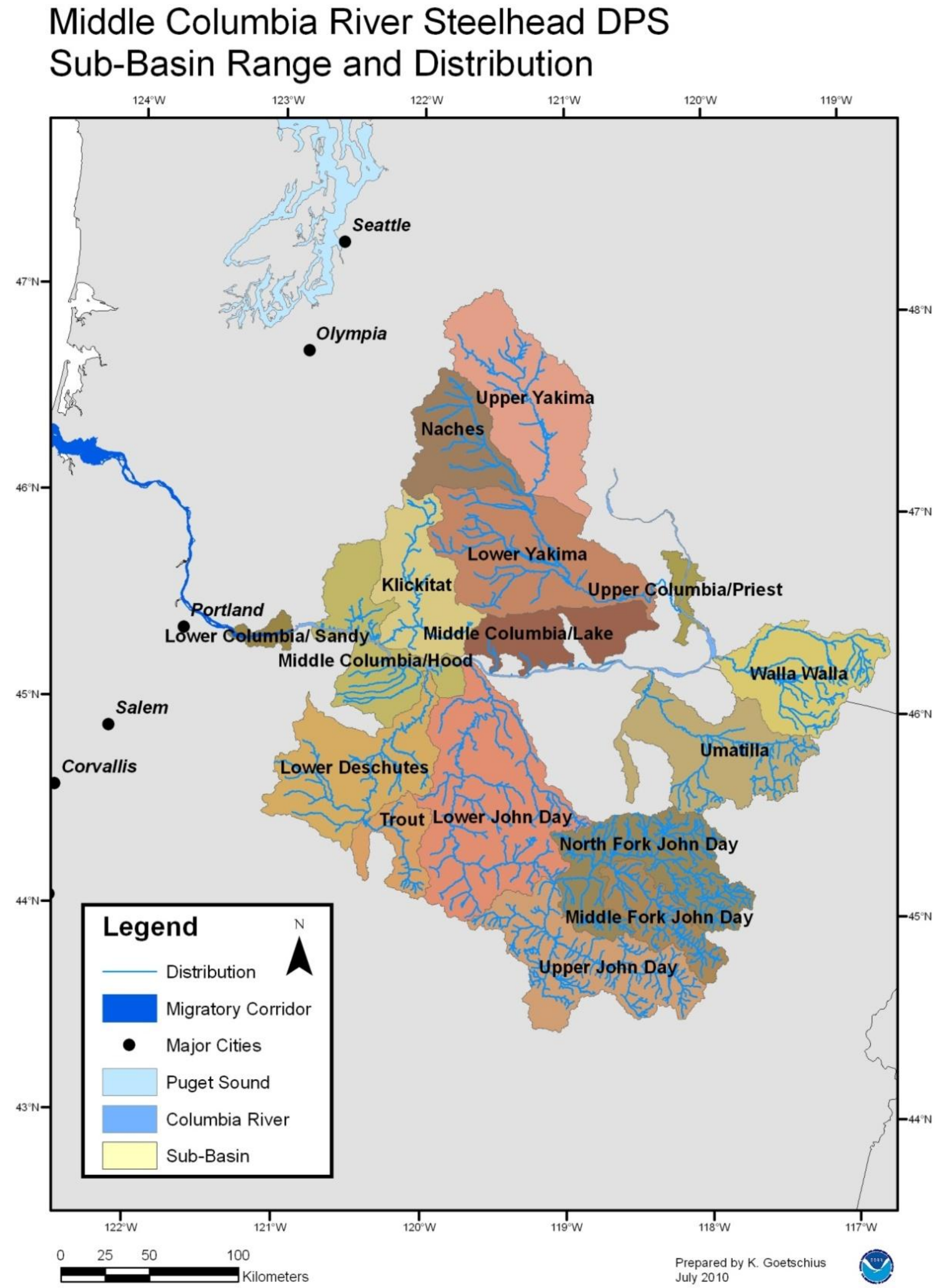


Figure 34. MCR Steelhead distribution

Life History

MCR steelhead populations are mostly of the summer-run type. Adult steelhead enter fresh water from June through August. The only exceptions are populations of inland winter-run steelhead which occur in the Klickitat River and Fifteenmile Creek (Busby, et al., 1996).

The majority of juveniles smolt and outmigrate as two-year olds. Most of the rivers in this region produce about equal or higher numbers of adults having spent one year in the ocean as adults having spent two years. However, summer-run steelhead in Klickitat River have a life cycle more like LCR steelhead whereby the majority of returning adults have spent two years in the ocean (Busby, et al., 1996). Adults may hold in the river up to a year before spawning.

Status and Trends

NMFS listed MCR steelhead as threatened on March 25, 1999 (64 FR 14517), and reaffirmed their threatened status on January 5, 2006 (71 FR 834). The ICTRT identified 16 extant populations in four major population groups (Cascades Eastern Slopes Tributaries, John Day River, Walla Walla and Umatilla Rivers, and Yakima River) and one unaffiliated independent population (Rock Creek) (ICTRT, 2003). There are two extinct populations in the Cascades Eastern Slope major population group: the White Salmon River and the Deschutes Crooked River above the Pelton/Round Butte Dam complex. Present population structure is delineated largely on geographical proximity, topography, distance, ecological similarities or differences.

Historic run estimates for the Yakima River imply that annual species abundance may have exceeded 300,000 returning adults (Busby, et al., 1996). The five-year average (geometric mean) return of natural MCR steelhead for 1997 to 2001 was up from previous years' basin estimates. Returns to the Yakima River, the Deschutes River, and sections of the John Day River system were substantially higher compared to 1992 to 1997 (T. P. Good, et al., 2005). The five-year average for these basins is 298 and 1,492 fish, respectively (T. P. Good, et al., 2005).

Table 38. Middle Columbia River steelhead independent populations, abundances, and hatchery contributions (T. P. Good, et al., 2005; ICTRT, 2003)

Major Basins	Population	Historical Abundance	Most Recent Spawner Abundance	Hatchery Abundance Contributions
Cascade Eastern Slope Tributaries	Klickitat River	Unknown	97-261 reds	Unknown
	White Salmon River	*Unknown*	*Extirpated*	*N/A*
	Fifteenmile Creek	Unknown	2.87 rpm	100%
	East and West Deschutes River*	Unknown	10,026-21,457	38%
	Crooked River	*Unknown*	*Extirpated*	N/A
John Day	John Day upper main	Unknown	926-4,168	96%
	John Day lower main	Unknown	1.4 rpm	0%
	John Day NF			
	upper NF	Unknown	2.57 rpm	0%
	lower NF	Unknown	.52 rpm	0%
	John Day MF	Unknown	3.7 rpm	0%
	John Day SF	Unknown	2.52 rpm	0%
Walla Walla and Umatilla	Umatilla River	Unknown	1,480-5,157	60%
	Walla Walla River	Unknown	Unknown	Unknown
	Touchet River	Unknown	273-527	Unknown
	Willow Creek	*Unknown*	*Extirpated*	*N/A*
Yakima	Yakima River Basin	Unknown	1,058-4,061	97%
	Satus Creek	Unknown	Unknown	Unknown
	Toppenish Creek	Unknown	Unknown	Unknown
	Naches River	Unknown	Unknown	Unknown
	Upper Yakima	Unknown	Unknown	Unknown

*Deschutes River is divided into two historically independent populations: the Eastside and Westside Tributaries

Good *et al.* (2005) calculated that the median estimate of long-term trend over 12 indicator data sets was –2.1% per year (–6.9 to 2.9), with 11 of the 12 being negative. Long-term annual population growth rates (λ) were also negative (T. P. Good, et al., 2005). The median long-term λ was 0.98, assuming that hatchery spawners do not contribute to production, and 0.97 assuming that both hatchery- and natural-origin spawners contribute equally.

The median short-term (1990–2001) annual population growth rate assuming no hatchery contribution is estimated to 1.045 (T. P. Good, et al., 2005). Of the 12 datasets, 8 indicator trends have a positive growth rate. Assuming that potential hatchery spawners contributed at the same rate as natural-origin spawners resulted in lower estimates of population growth rates. The median short-term λ under the assumption of equal hatchery- and natural-origin spawner effectiveness was 0.967, with 6 of the 12 indicator trends exhibiting positive growth rates.

The Yakima River populations are at a risk from overall depressed abundances and the majority of spawning occurring in only one tributary (T. P. Good, et al., 2005). The Cascade populations are at risk by the only population with large runs being dominated by out-of-basin strays (T. P. Good, et al., 2005). Returns to sections of the John Day River system increased in the late 1990s and these populations are the only ones with returns consisting mainly of natural spawners (T. P. Good, et al., 2005). However, degraded habitat conditions in the John Day River basin (NMFS, 1999) may affect the populations' ability to maintain a positive recruitment during less productive ocean conditions (T. P. Good, et al., 2005).

Table 38 summarizes MCR steelhead independent populations, abundances and hatchery contributions(T. P. Good, et al., 2005; ICTRT, 2003). Status reviews in the 1990s noted considerable reduction in abundances in several basins, loss and degraded freshwater habitat, and stray steelhead in Deschutes River. The population experienced a substantial increase in abundance in some basins since these reviews (T. P. Good, et al., 2005).

Critical Habitat

Critical habitat was designated for this species on September 2, 2005 (70 FR 52630).

The CHART assessment for this DPS addressed 15 (HUC4) subbasins containing 106 occupied watersheds (HUC5), as well as the Columbia River rearing/migration corridor (NMFS, 2005a). Of all the watersheds, 73 were rated as having a high conservation value, 24 as medium value, and 9 as low value (

Table 39). The lower Columbia River rearing/migration corridor downstream of the spawning range is also considered to have a high conservation value.

Table 39. MCR steelhead watersheds with conservation values

HUC 4 Subbasin	HUC 5 Watershed conservation Value (CV)					
	High CV	PCE(s) [1]	Medium CV	PCE(s) [1]	Low CV	PCE(s) [1]
Upper Yakima	3	(1, 3, 2)	1	(2, 1)	0	
Naches	3	(1, 3)	0		0	
Lower Yakima	3	(1, 3)	3	(3[1], 2)	0	
Middle Columbia/Lake Wallula	2	(3, <1)	3	(3)	0	
Walla Walla	5	(1, 3, 2)	3	(3, 1, 2)	1	(3)
Umatilla	6	(1, 2)	1	(1, 2)	3	(1, 2)
Middle Columbia/Hood	3	(1, 3)	4	(3, <2)	1	(1)
Klickitat	4	(3, 1)	0		0	
Upper John Day	12	(1, 2, 3)	1	(1, 2)	0	
North Fork John Day	9	(1, 2, 3)	1	(1, 2)	0	
Middle Fork John Day	4	(1, 3)	0		1	(2, 1)
Lower John Day	7	(1, 3)	6	(1, 3, 2)	1	(3, <2)
Lower Deschutes	8[3]	(1, 2)	0		1	(1, =1.9mi)
Trout	2	(1)	1	(1)	1	(1,=1.5mi)
Lower Columbia/Sandy	1	(3)	0		0	
Upper Columbia/Priest Rapids	1	(3)	0		0	
Lower Columbia Corridor	all	(3)[2]				
Total	73		24		9	

1 Numbers in parenthesis refers to the dominant (in river miles) PCE(s) within the HUC 5 watersheds. PCE 1 is spawning and rearing, 2 is rearing and migration, and 3 is migration and presence. PCEs with < means that the number of river miles of the PCE is much less than river miles of the other PCE.

The current condition of critical habitat designated for the MCR steelhead is moderately degraded (Figure 35). Critical habitat is affected by reduced quality of juvenile rearing and migration PCEs within many watersheds; contaminants from agriculture affect both water quality and food production in several watersheds and in the mainstem Columbia River. Loss of riparian vegetation to grazing has resulted in high water temperatures in the John Day basin. Reduced quality of the rearing PCEs has diminished its contribution to the conservation value necessary for the recovery of the species. Several dams affect adult migration PCE by obstructing the migration corridor.

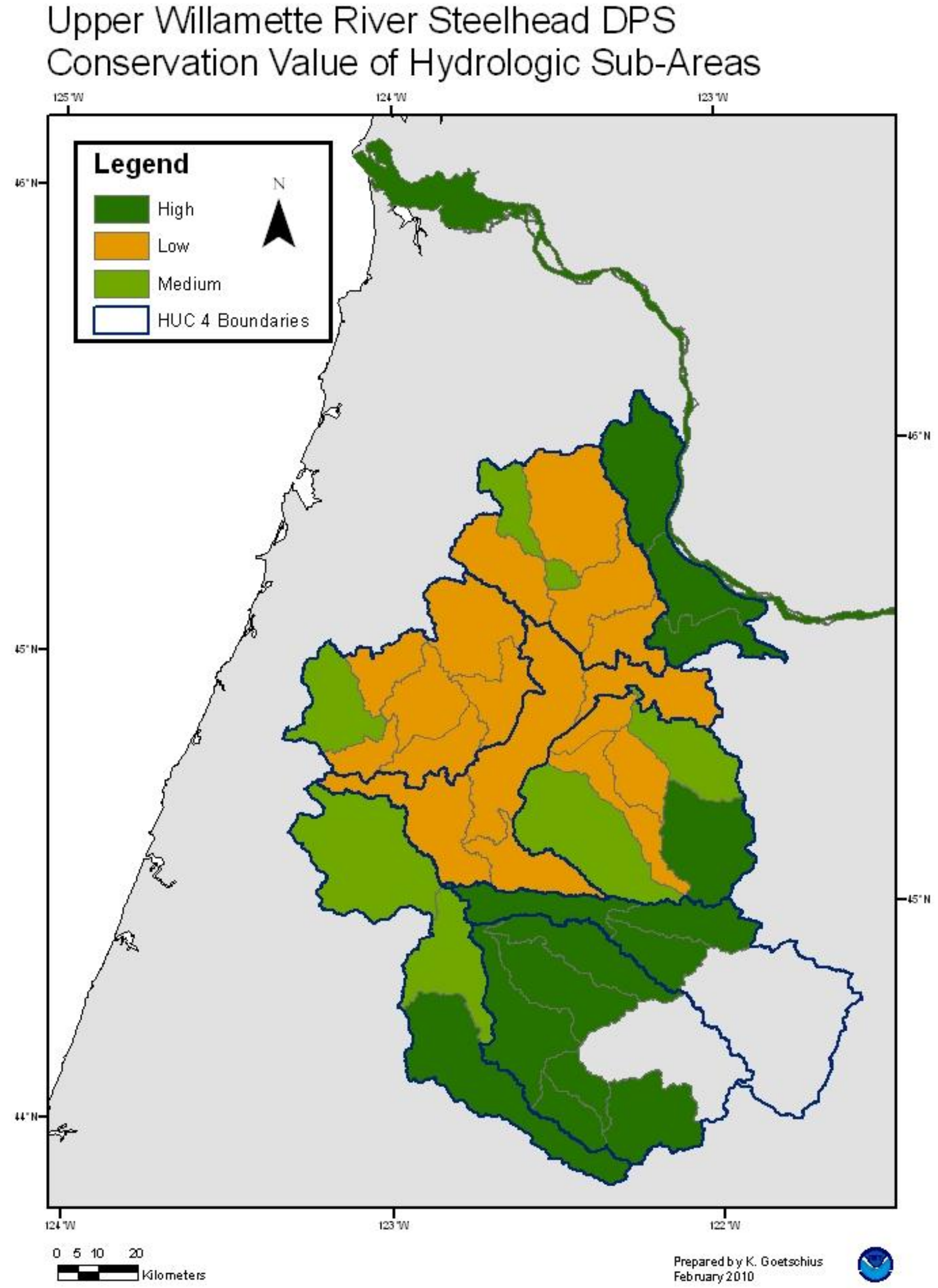


Figure 35. Upper Willamette River Steelhead conservation values per sub-area

Upper Columbia River Steelhead

The UCR steelhead DPS includes all naturally spawned steelhead populations below natural and man-made impassable barriers in streams in the Columbia River basin upstream from the Yakima River, Washington, to the U.S. - Canada border (Figure 36). The UCR steelhead DPS also includes six artificial propagation programs: the Wenatchee River, Wells Hatchery (in the Methow and Okanogan Rivers), Winthrop NFH, Omak Creek, and the Ringold steelhead hatchery programs. These artificially propagated populations are no more divergent relative to the local natural populations than would be expected between closely related populations within this DPS.

Life History

All UCR steelhead are summer-run steelhead. Adults return in the late summer and early fall, with most migrating relatively quickly to their natal tributaries. A portion of the returning adult steelhead overwinters in mainstem reservoirs, passing over upper-mid-Columbia dams in April and May of the following year. Spawning occurs in the late spring of the year following river entry. Juvenile steelhead spend one to seven years rearing in fresh water before migrating to sea. Smolt outmigrations are predominantly year class two and three (juveniles), although some of the oldest smolts are reported from this DPS at seven years. Most adult steelhead return to fresh water after one or two years at sea.

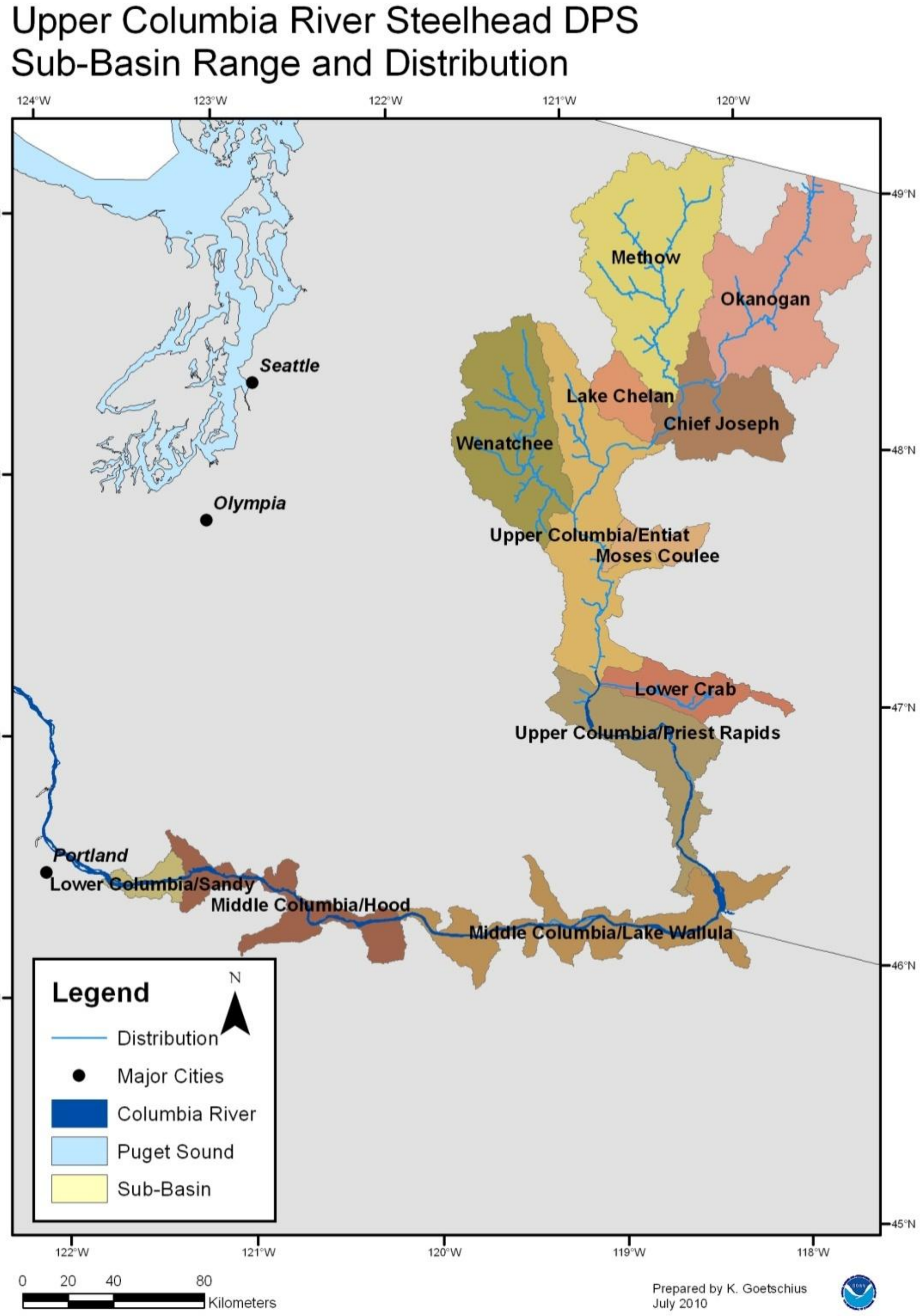


Figure 36. UCR Steelhead distribution

Status and Trends

NMFS originally listed UCR steelhead as endangered on August 19, 1997 (62 FR 43937). NMFS changed the listing to threatened on January 5, 2006 (71 FR 834). After litigation resulting in a change in the DPS' status to endangered and then again as threatened, on August 24, 2009, NMFS reaffirmed the species' status as threatened (74 FR 42605). The UCR steelhead consisted of four historical independent populations: the Wenatchee, Entiat, Methow, and Okanogan. All populations are extant. The UCR steelhead must navigate over several dams to access spawning areas. The construction of Grand Coulee Dam in 1939 blocked access to over 50% of the river miles formerly available to UCR steelhead (ICTRT, 2003).

Returns of both hatchery and naturally produced steelhead to the upper Columbia River have increased in recent years. The average 1997 to 2001 return counted through the Priest Rapids fish ladder was approximately 12,900 fish. The average for the previous five years (1992 to 1996) was 7,800 fish. Abundance estimates of returning naturally produced UCR steelhead were based on extrapolations from mainstem dam counts and associated sampling information (T. P. Good, et al., 2005). The natural component of the annual steelhead run over Priest Rapids Dam increased from an average of 1,040 (1992-1996), representing about 10% of the total adult count, to 2,200 (1997-2001), representing about 17% of the adult count during this period of time (ICTRT, 2003).

Table 40. Upper Columbia River Steelhead salmon populations, abundances, and hatchery contributions (T. P. Good, et al., 2005).

Population	Historical Abundance	Most Recent Spawner Abundance	Hatchery Abundance Contributions
Wenatchee/Entiat rivers	Unknown	1,899-8,036	71%
Methow/Okanogan rivers	Unknown	1,879-12,801	91%
Total	Unknown	3,778-20,837	

Recent population abundances for the Wenatchee and Entiat aggregate population and the Methow population remain well below the minimum abundance thresholds developed for these populations (ICTRT, 2003). A five-year geometric mean (1997 to 2001) of approximately 900 naturally produced steelhead returned to the Wenatchee and Entiat rivers (combined). The abundance is well below the minimum abundance thresholds but it represents an improvement over the past (an increasing trend of 3.4% per year).

Regarding the population growth rate of natural production, on average, over the last 20 full brood year returns (1980/81 through 1999/2000 brood years), including adult returns through 2004-2005, UCR steelhead populations have not replaced themselves. Overall adult returns are dominated by hatchery fish (Table 40), and detailed information is lacking on the productivity of the natural population.

All UCR steelhead populations have reduced genetic diversity from homogenization of populations that occurred during the Grand Coulee Fish Maintenance project from 1939-1943, from 1960, and 1981 (D. Chapman et al., 1994).

Critical Habitat

Critical habitat was designated for this species on September 2, 2005 (70 FR 52630).
The CHART assessment for this ESU addressed 10 (HUC4) subbasins containing 41 occupied watersheds (HUC5), as well as the Columbia River rearing/migration corridor. Thirty-one of the watersheds were rated as having a high conservation value, seven as medium value, and three as low value (

Table 41). The lower Columbia River rearing/migration corridor downstream of the spawning range is of high conservation value.

The current condition of critical habitat designated for the UCR steelhead is moderately degraded. Habitat quality in tributary streams varies from excellent in wilderness and roadless areas to poor in areas subject to heavy agricultural and urban development (Figure 37). Critical habitat is affected by reduced quality of juvenile rearing and migration PCEs within many watersheds; contaminants from agriculture affect both water quality and food production in several watersheds and in the mainstem Columbia River. Several dams affect adult migration PCE by obstructing the migration corridor.

Table 41. UCR Steelhead watersheds with conservation values

HUC 4 Subbasin	HUC 5 Watershed conservation Value (CV)					
	High CV	PCE(s) [1]	Medium CV	PCE(s) [1]	Low CV	PCE(s) [1]
Chief Joseph	1	(3, 2)	0		2	(2)
Okanogan	2	(3, 1)	3	(3)	0	
Similkameen	1	(3)	0		0	
Methow	7	(1, 3)	0		0	
Lake Chelan	0		1	(1, 3)	0	
Upper Columbia/Entiat	3	(3, 1)	1	(3)	0	
Wenatchee	4	(1, 2, 3)	1	(3, 1)	0	
Moses Coulee	0		0		1	(2)
Lower Crab	0		1	(3)	0	
Upper Columbia/Priest Rapids	3	(3)	0		0	
Middle Columbia/Lake Wallula	5	(3)	0		0	
Middle Columbia/Hood	4	(3)	0		0	
Lower Columbia/Sandy	1	(3)	0		0	
Lower Columbia Corridor	all	(3)	0		0	
Total	31		7		3	

1 Numbers in parenthesis refers to the dominant (in river miles) PCE(s) within the HUC 5 watersheds. PCE 1 is spawning and rearing, 2 is rearing and migration, and 3 is migration and presence. PCEs with < means that the number of river miles of the PCE is much less than river miles of the other PCE.

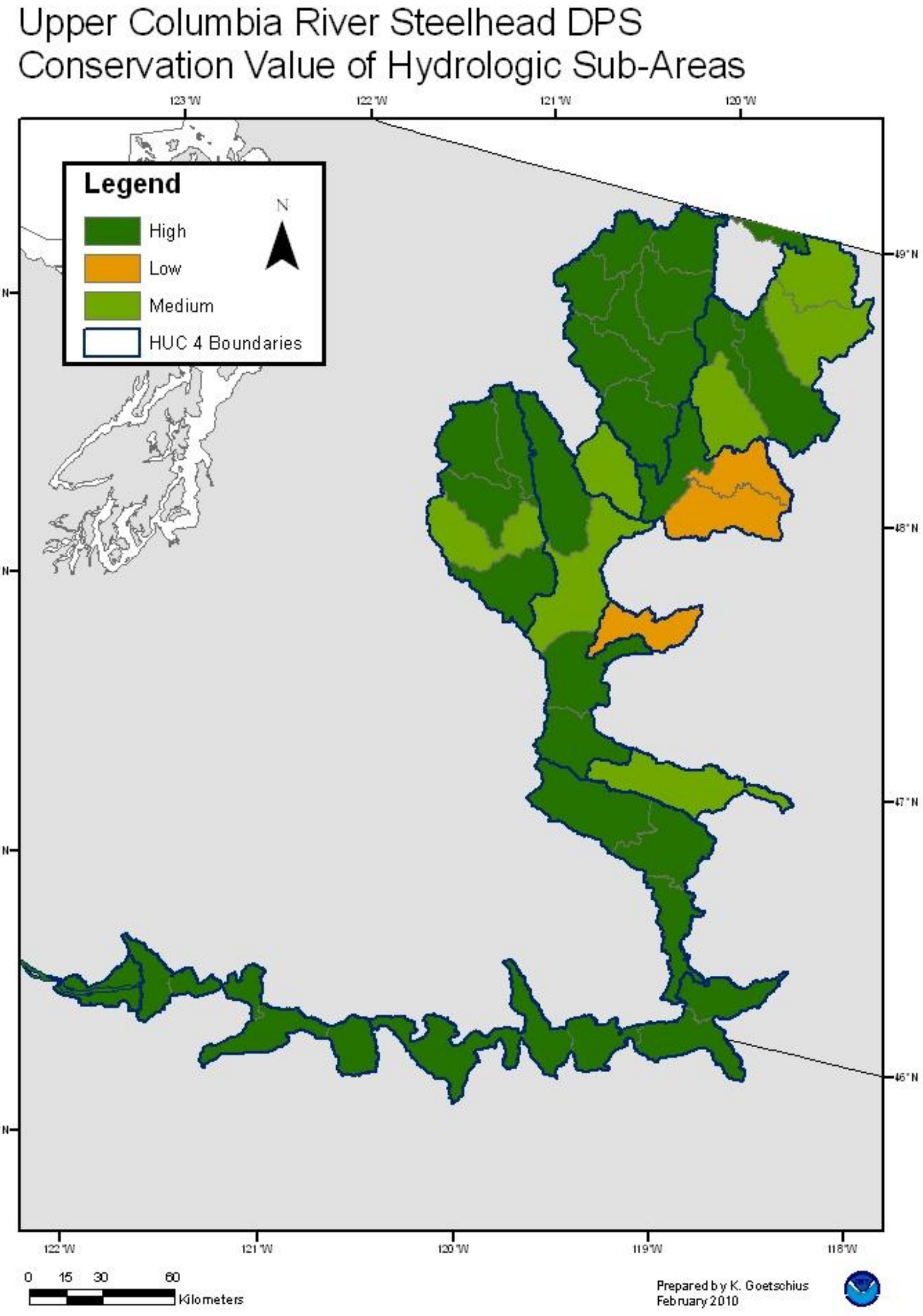


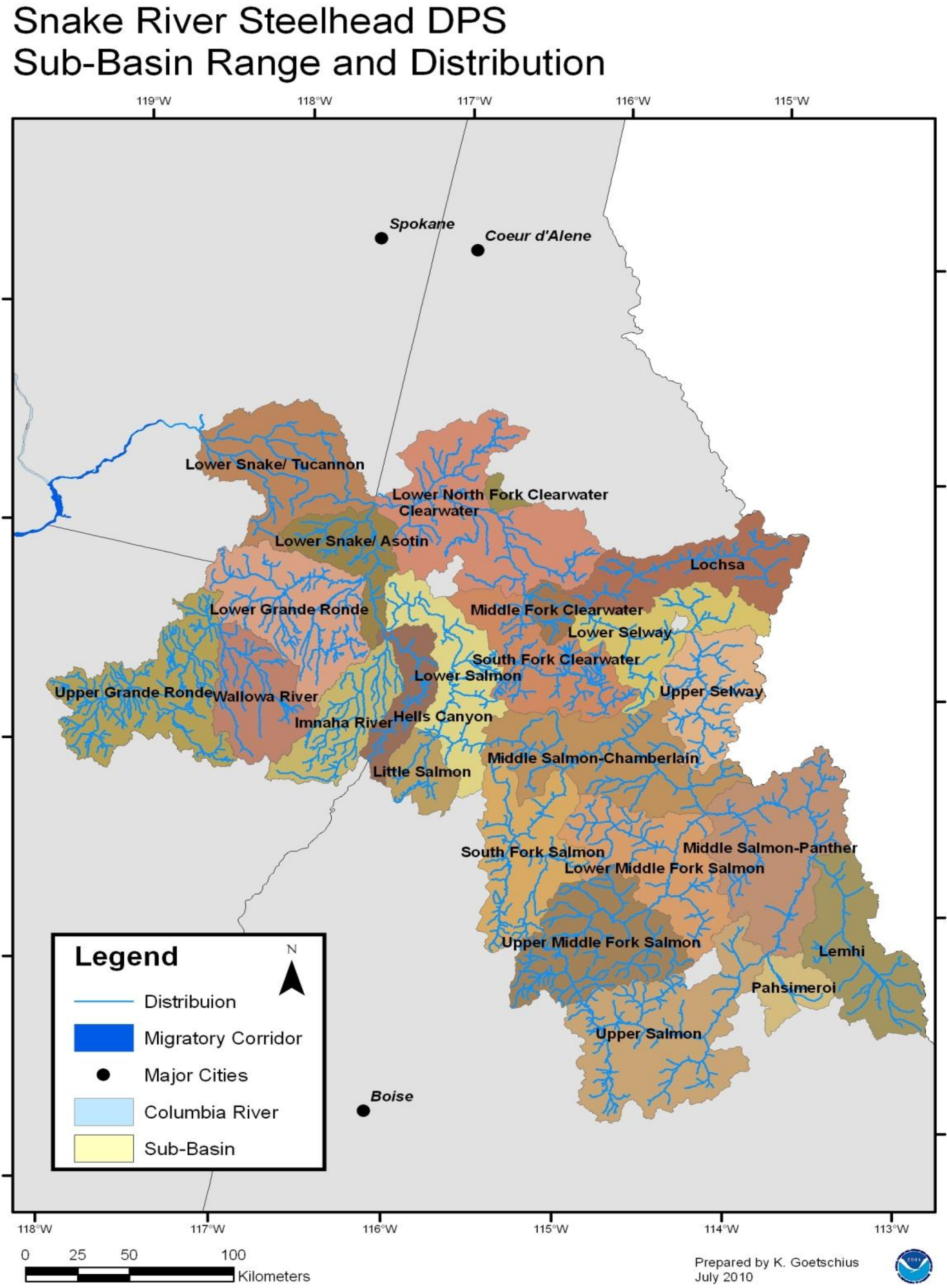
Figure 37. Upper Columbia River Steelhead conservation values per sub-area.

Snake River Steelhead

The Snake River (SR) basin steelhead DPS includes all naturally spawned steelhead populations below natural and man-made impassable barriers in streams in the Columbia River Basin upstream from the Yakima River, Washington, to the U.S. - Canada border (Figure **38**). Six artificial propagation programs are also included in the DPS: the Tucannon River, Dworshak National Fish Hatchery, Lolo Creek, North Fork Clearwater, East Fork Salmon River, and the Little Sheep Creek/Imnaha river hatchery programs. These artificially propagated populations are no more divergent relative to the local natural populations than what would be expected between closely related natural populations within the DPS.

Life History

SR basin steelhead are generally classified as summer-run fish. They enter the Columbia River from late June to October. After remaining in the river through the winter, SR basin steelhead spawn the following spring (March to May). Managers recognize two life history patterns within this DPS primarily based on ocean age and adult size upon return: A-run or B-run. A-run steelhead are typically smaller, have a shorter freshwater and ocean residence (generally one year in the ocean), and begin their up-river migration earlier in the year. B-run steelhead are larger, spend more time in fresh water and the ocean (generally two years in ocean), and appear to start their upstream migration later in the year. SR basin steelhead usually smolt after two or three years.



Snake River Steelhead DPS
Sub-Basin Range and Distribution

Prepared by K. Goetschius
July 2010

Figure 38 **SR Basin Steelhead distribution**

Status and Trends

NMFS listed SR basin steelhead as threatened on August 18, 1997 (62 FR 43937), and reaffirmed their threatened status on January 5, 2006 (71 FR 834). The ICTRT (ICTRT, 2003) identified 23 populations. SR basin steelhead remain spatially well distributed in each of the six major geographic areas in the Snake River basin (T. P. Good, et al., 2005). The SR basin steelhead B- run populations remain particularly depressed.

Table 42 SR Basin Steelhead salmon populations, abundances, and hatchery contributions (T. P. Good, et al., 2005)

River	Historical Abundance	Most Recent Spawner Abundance	Hatchery Abundance Contributions
Tucannon River	3,000	257-628	26%
Lower Granite run	Unknown	70,721-259,145	86%
Snake A-run	Unknown	50,974-25,950	85%
Snake B-run	Unknown	9,736-33,195	89%
Asotin Creek	Unknown	0-543 redds	Unknown
Upper Grande Ronde River	15,000	1.54 rpm	23%
Joseph Creek	Unknown	1,077-2,385	0%
Imnaha River	4,000	3.7 rpm	20%
Camp Creek	Unknown	55-307	0%
Total	22,000 (min)	?	

Note: rpm denotes redds per mile.

A quantitative assessment for viability of SR steelhead is difficult given limited data on adult spawning escapement for specific tributary production areas. Annual return estimates are limited to counts of the aggregate return over Lower Granite Dam, and spawner estimates for the Tucannon, Asotin, Grande Ronde, and Imnaha Rivers (Table 42). The 2001 return over Lower Granite Dam was substantially higher relative to the low levels seen in the 1990s; the recent geometric five-year mean abundance (14,768 natural returns) was approximately 28% of the interim recovery target level (52,00 natural spawners). The 10-year average for natural-origin steelhead passing Lower Granite Dam between 1996 and 2005 is 28,303 adults. Parr densities in natural production areas, which are another indicator of population status, have been substantially below estimated capacity for several decades. The Snake River supports approximately 63% of the total natural-origin production of steelhead in the Columbia River Basin. The current condition of Snake River Basin steelhead (T. P. Good, et al., 2005) is summarized below.

There is uncertainty for wild populations given limited data for adult spawners in individual populations. Regarding population growth rate, there are mixed long- and short-term trends in abundance and productivity. Regarding spatial structure, the SR basin steelhead are well distributed with populations remaining in six major areas. However, the core area for B-run steelhead, once located in the North Fork of the Clearwater River, is now inaccessible to steelhead. Finally, genetic diversity is affected by the displacement of natural fish by hatchery fish (declining proportion of natural-origin spawners).

Overall, the abundances remain well below interim recovery criteria. The high proportion of hatchery produced fish in the runs remains a major concern.

Critical Habitat

Critical habitat was designated for this species on September 2, 2005 (70 FR 52630). Figure 39 shows the conservation rankings per sub-area. Of the watersheds assessed, 229 were rated as having a high conservation value, 42 as medium value, and 12 as low value (Table 43). The Columbia River migration corridor was also given a high conservation value rating (NMFS 2005a).

The current condition of critical habitat designated for SR basin steelhead is moderately degraded. Critical habitat is affected by reduced quality of juvenile rearing and migration PCEs within many watersheds; contaminants from agriculture affect both water quality and food production in several watersheds and in the mainstem Columbia River. Loss of riparian vegetation to grazing has resulted in high water temperatures in the John Day basin. These factors have substantially reduced the rearing PCEs contribution to the conservation value necessary for species recovery. Several dams affect adult migration PCE by obstructing the migration corridor.

Table 43 SR steelhead watersheds with conservation values

HUC 4 Subbasin	HUC 5 Watershed conservation Value (CV)					
	High CV	PCE(s) [1]	Medium CV	PCE(s) [1]	Low CV	PCE(s) [1]
Hells Canyon	3	(1, 2, 3)	0		0	
Imnaha River	5	(1)	0		0	
Lower Snake/Asotin	3	(1, 2, 3)	0		0	
Upper Grande Ronde	9	(1, 2)	2	(2, 1)	0	
Wallowa River	5	(1)	1	(1)	0	
Lower Grande Ronde	7	(1)	0		0	
Lower Snake/Tucannon	2	(1, 3)	2	(3, 1)	4	(1, 3)
Palouse River	0		1	(3, 1)	0	
Upper Salmon	20	(1)	6	(1)	1	(1)
Pahsimeroi	1	(1)	2	(1)	0	
Middle Salmon-Panther	16	(1, <3)	6	(1)	1	(1)
Lemhi	11	(1)[4]	1	(1)	0	
Upper Middle Fork Salmon	13	(1)	0		0	
Lower Middle Fork Salmon	17	(1, <2)	0		0	
Middle Salmon-Chamberlain	14	(1, <3)	3	(3, 1)	1	(1)
South Fork Salmon	15	(1)	0		0	
Lower Salmon	12	(1, 3)	5	(1, 3)	0	
Upper Selway	9	(1, 3)	0		0	
Lower Selway	13	(1, 2)	0		0	
Lochsa	14	(1)	0		0	
Middle Fork Clearwater	2	(1)	0		0	
South Fork Clearwater	8	(1, 3)	3	(1)	2	(1, <3)
Clearwater	16	(1)	10	(1, 2, 3)	3	(1)
Lower Snake River	3	(3)	0		0	
Upper Columbia/Priest Rapids	1	(2)	0		0	
Middle Columbia/Lake Wallula	5	(2)	0		0	
Middle Columbia/Hood	4	(2)	0		0	
Lower Columbia/Sandy	1	(2)	0		0	
Lower Columbia Corridor	all	(3)	0		0	
Total	229		42		12	

1 Numbers in parenthesis refers to the dominant (in river miles) PCE(s) within the HUC 5 watersheds. PCE 1 is spawning and rearing, 2 is rearing and migration, and 3 is migration and presence. PCEs with < means that the number of river miles of the PCE is much less than river miles of the other PCE.

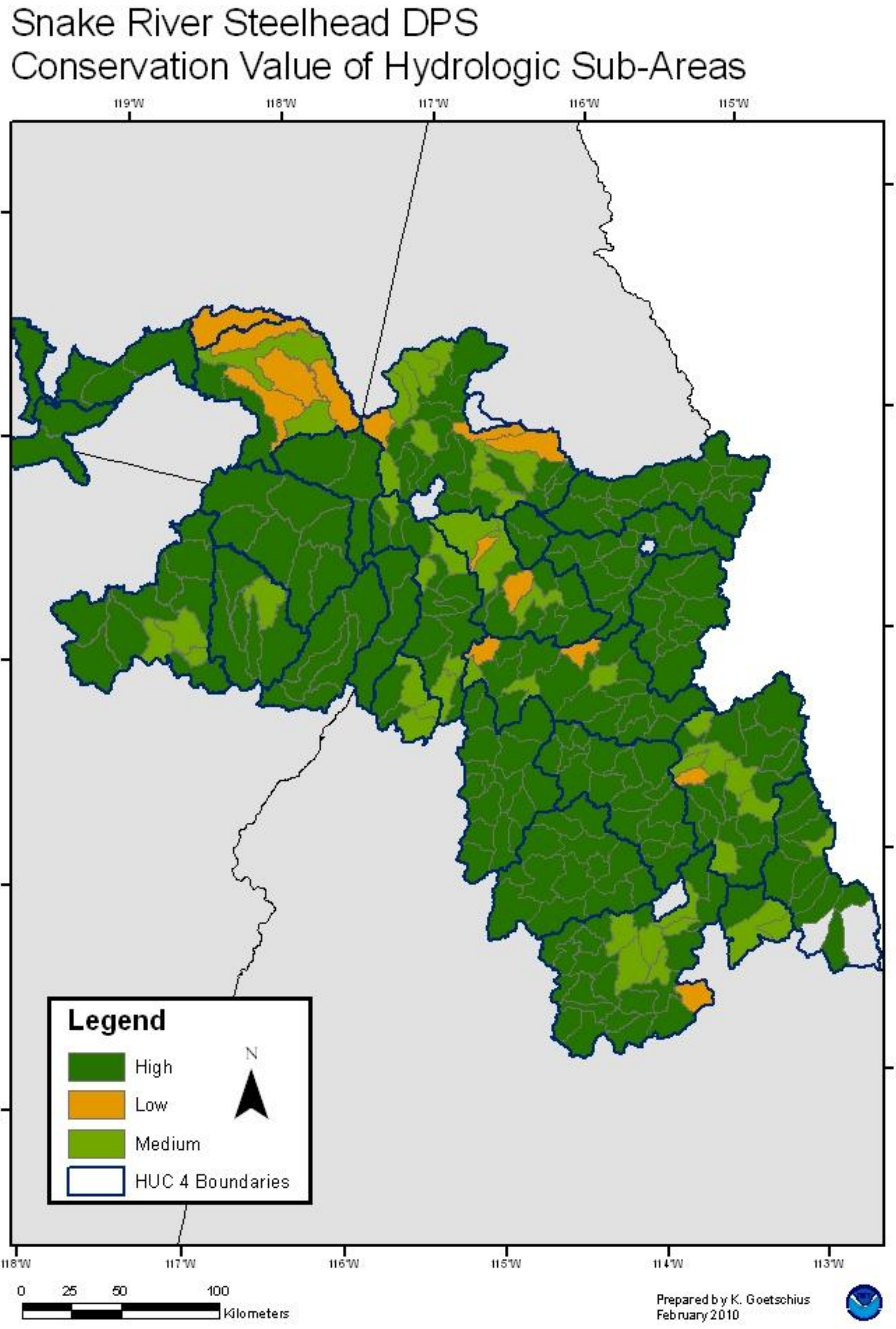


Figure 39. Snake River Steelhead conservation values per sub-area

Northern California Steelhead

The NC steelhead DPS includes all naturally spawned steelhead populations below natural and manmade impassable barriers in California coastal river basins from Redwood Creek southward to, but not including, the Russian River, as well as two artificial propagation programs: the Yeager Creek Hatchery, and North Fork Gualala River Hatchery (Gualala River Steelhead Project) steelhead hatchery programs (Figure 40).

Life History

This DPS includes both winter- and summer –run steelhead. In the Mad and Eel Rivers, immature steelhead may return to fresh water as "half-pounders" after spending only two to four months in the ocean. Generally, a half-pounder will overwinter in fresh water and return to the ocean in the following spring.

Juvenile out-migration appears more closely associated with size than age but generally, throughout their range in California, juveniles spend two years in fresh water (Busby et al 1996). Smolts range from 14-21 cm in length. Juvenile steelhead may migrate to rear in lagoons throughout the year with a peak in the late spring/early summer and in the late fall/early winter period (Shapovalov & Taft, 1954; Zedonis, 1992).

Steelhead spend anywhere from one to five years in salt water, however, two to three years are most common (Busby, et al., 1996). Ocean distribution is not well known but coded wire tag recoveries indicate that most NC steelhead migrate north and south along the continental shelf (Barnhart, 1986).

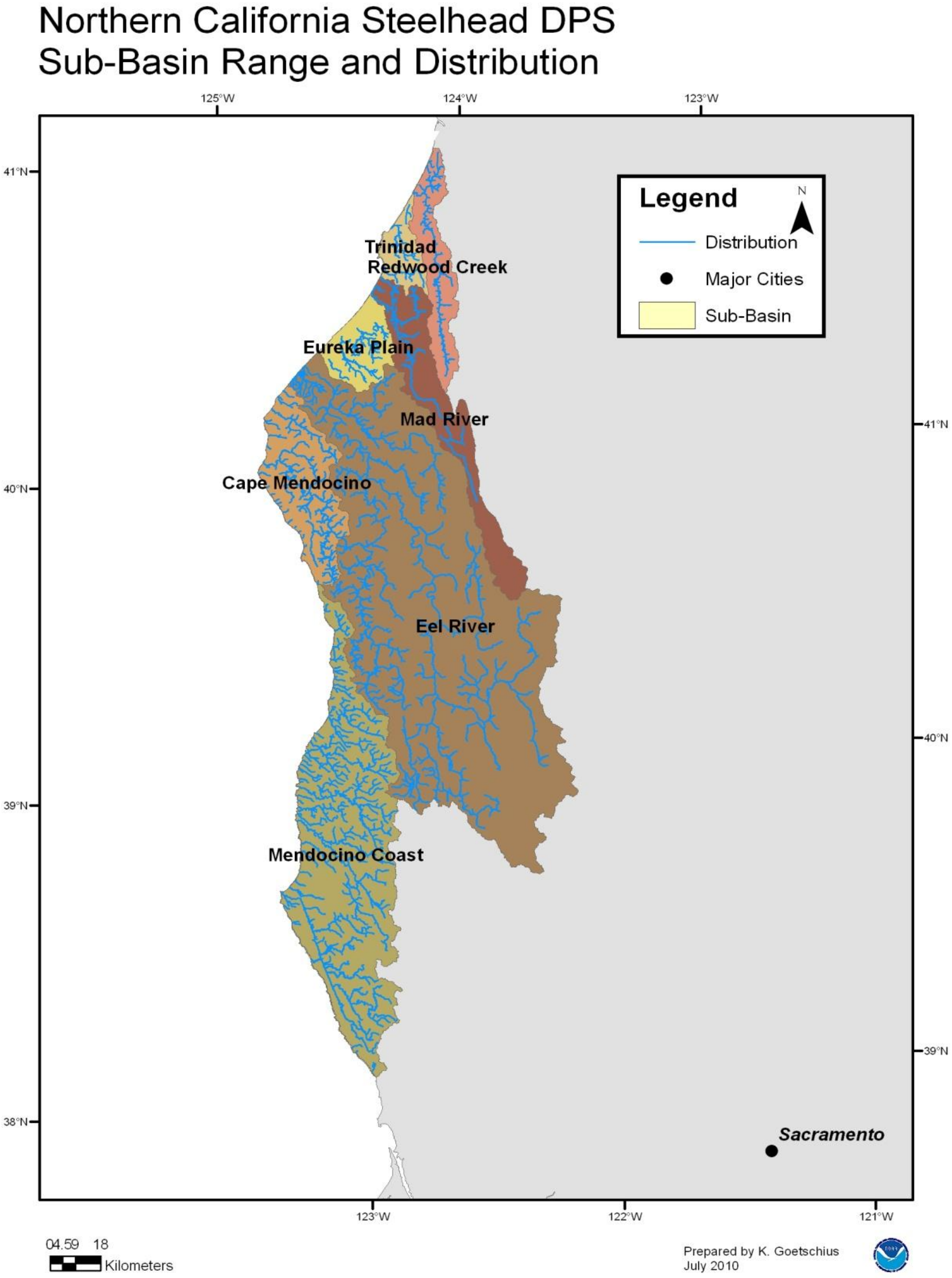


Figure 40. Northern California Steelhead distribution

Status and Trends

NMFS listed NC steelhead as threatened on June 7, 2000 (65 FR 36074), and reaffirmed their threatened status on January 5, 2006 (71 FR 834). The DPS encompass 15 historic functionally independent populations (and 22 potentially independent populations) of winter steelhead and 10 historic independent populations of summer steelhead (Bjorkstedt, et al., 2005). Although the DPS spatial structure is relatively intact, the spatial structure and distribution within most watersheds have been adversely affected by barriers and high water temperatures. One of the basins, the Upper Mainstem Eel, has lost too much of its habitat to sustain an independent population today (Brian C. Spence, et al., 2008). Production in the Mad River has been substantially reduced by the loss of 36% of its potential steelhead habitat. Large portions of the interior Russian River have been lost to the Coyote Valley Dam on the Russian River and the Warm Springs Hydroelectric Facility on Dry Creek, a major tributary to the Russian River. Spatial distribution in several smaller coastal watersheds has been impacted by constructed barriers blocking access to tributaries and headwaters.

Long-term data sets are limited for the NC steelhead. Before 1960, estimates of abundance specific to this DPS were available from dam counts in the upper Eel River (Cape Horn Dam–annual avg. no. adults was 4,400 in the 1930s), the South Fork Eel River (Benbow Dam–annual avg. no. adults was 19,000 in the 1940s), and the Mad River (Sweasey Dam– annual avg. no. adults was 3,800 in the 1940s). Estimates of steelhead spawning populations for many rivers in this DPS totaled 198,000 by the mid-1960s (

Table 44).

During the first status review on this DPS, adult escapement trends were computed from seven populations. Five of the seven populations exhibited declines while two exhibited increases with a range of almost a 6% annual decline to a 3.5% increase. At that time, little information existed for the actual contribution of hatchery fish to natural spawning, and on present total run sizes for the DPS (Busby, et al., 1996).

Table 44. NC Steelhead salmon historic functionally independent populations and their abundances and hatchery contributions (T. P. Good, et al., 2005)

Population	Historical Abundance	Recent Spawner Abundance	Hatchery Abundance Contributions
Mad River (S)	6,000	162-384	2%
MF Eel River (S)	Unknown	384-1,246	0%
NF Eel River (S)	Uknown	Extirpated	N/A
Mattole River (S)	Unknown	9-30*	Unknown
Redwood Creek (S)	Unknown	6*	Unknown
Van Duzen (W)	10,000	Unknown	Unknown
Mad River (W)	6,000	Unknown	Unknown
SF Eel River (W)	34,000	2743-20,657	Unknown
Mattole River (W)	12,000	Unknown	Unknown
Redwood Creek (W)	10,000	Unknown	Unknown
Humboldt Bay (W)	3,000	Unknown	Unknown
Freshwater Creek (W)		25-32	
Ten Mile River (W)	9,000	Unknown	Unknown
Noyo River (W)	8,000	186-364*	Unknown
Big River (W)	12,000	Unknown	Unknown
Navarro River (W)	16,000	Unknown	Unknown
Garcia River (W)	4,000	Unknown	Unknown
Gualala River (W)	16,000	Unknown	Unknown
Total	198,000	Unknown	

*From Spence et al. (2008). Redwood Creek abundance is mean count over four generations. Mattole River abundances from surveys conducted between 1996 and 2005. Noyo River abundances from surveys conducted since 2000.
Summer –run steelhead is noted with a (S) and winter-run steelhead with a (W)

More recent time series data are from snorkel counts conducted on adult summer-run steelhead in the Middle Fork Eel River. Good *et al.* (2005) estimated lambda at 0.98 with a 95% confidence interval of 0.93 and 1.04. The result is an overall downward trend in both the long- and short- term. Juvenile data were also recently examined. Both upward and downward trends were apparent (T. P. Good, et al., 2005).

Reduction of summer-run steelhead populations has significantly reduced current DPS diversity compared to historic conditions. Of the 10 summer-run steelhead populations, only four are extant. Of these, only the Middle Fork Eel River population is at moderate risk of extinction, the remaining three are at high risk (Brian C. Spence, et al., 2008). Hatchery influence has likely been limited.

Critical Habitat

NMFS designated critical habitat for NC steelhead on September 2, 2005 (70 FR 52488). Specific geographic areas designated include the following CALWATER hydrological units: Redwood Creek, Trinidad, Mad River, Eureka Plain, Eel River, Cape Mendocino, and the Mendocino Coast. The total area of critical habitat includes about 3,000 miles of stream habitat and about 25 square miles of estuarine habitat, mostly within Humboldt Bay.

There are 50 occupied CALWATER Hydologic Subareas (HSA) watersheds within the freshwater and estuarine range of this ESU. Nine watersheds received a low rating, 14 received a medium rating, and 27 received a high rating of conservation value to the ESU (NMFS, 2005a) (Table 45, and Figure 41). Two estuarine habitat areas used for rearing and migration (Humboldt Bay and the Eel River Estuary) also received a high conservation value rating.

Table 45. NC steelhead CALWATER HSA watersheds with conservation values

HUC 4 Subbasin	HUC 5 Watershed conservation Value (CV)					
	High CV	PCE(s)[1]	Medium CV	PCE(s)[1]	Low CV	PCE(s)[1]
Redwood Creek	2	(1, 2, 3)	1	(1, 2, 3)	0	
Trindad	1	(1, 2, 3)	0		1	(1, 2, 3)
Mad River	3	(1, 2, 3)	0		1	(1, 2, 3)
Eureka Plain	1	(1, 2, 3)	0		0	
Eel River	10	(1, 2, 3)	9	(1, 2, 3)	0	
Cape Mendocino	1	(1, 2, 3)	0		2	(1, 2, 3)
Mendocino Coast	9	(1, 2, 3)	4	(1, 2, 3)	5	(1, 2, 3)
Total	27		14		9	

[1] Numbers in parenthesis refers to the dominant (in river miles) PCE(s) within the HUC 5 watersheds. PCE 1 is spawning and rearing, 2 is rearing and migration, and 3 is migration and presence. PCEs with < means that the number of river miles of the PCE is much less than river miles of the other PCE.

The current condition of critical habitat designated for the NC steelhead is moderately degraded. Nevertheless, it does provide some conservation value necessary for species recovery. Within portions of its range, especially the interior Eel River, rearing PCE quality is affected by elevated temperatures by removal of riparian vegetation. Spawning PCE attributes such as the quality of substrate supporting spawning, incubation, and larval development have been generally degraded throughout designated critical habitat by silt and sediment fines in the spawning gravel. Bridges and culverts further restrict access to tributaries in many watersheds, especially in watersheds with forest road construction, thereby reducing the function of adult migration PCE.

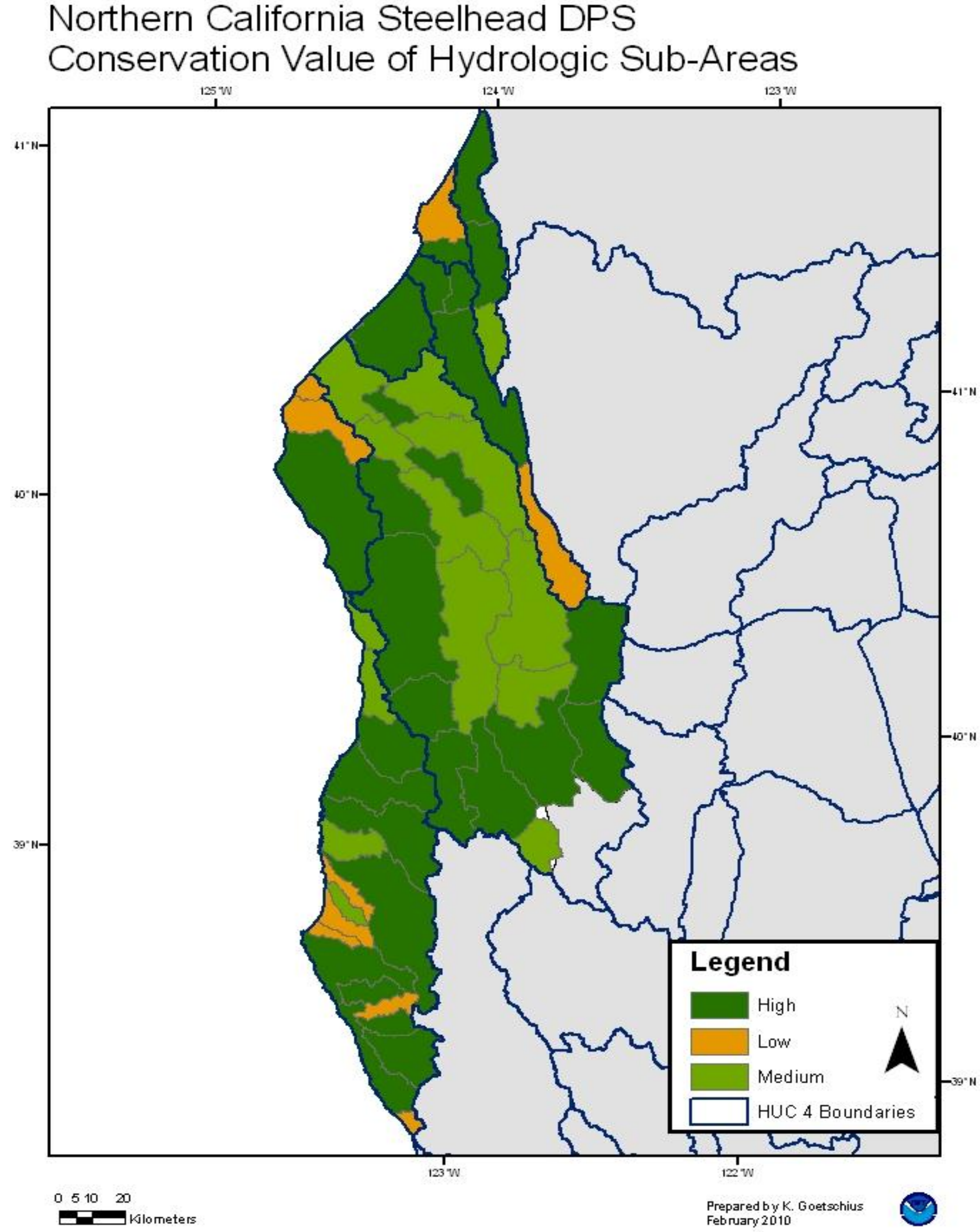


Figure 41. Northern California Steelhead conservation values per sub-area

Central California Coast Steelhead

The CCC steelhead DPS includes all naturally spawned steelhead populations below natural and manmade impassable barriers in California streams from the Russian River (inclusive) to Aptos Creek (inclusive), and the drainages of San Francisco, San Pablo, and Suisun Bays eastward to Chipps Island at the confluence of the Sacramento and San Joaquin Rivers (Figure 42).

Life History

The DPS is entirely composed of winter-run fish, as are those DPSs to the south. Adults return to the Russian River and migrate upstream from December – April, and smolts emigrate between March – May) (Hayes, Bond, Hanson, & MacFarlane, 2004; Shapovalov & Taft, 1954). Most spawning takes place from January through April. While age at smoltification typically ranges for one to four years, recent studies indicate that growth rates in Soquel Creek likely prevent juveniles from undergoing smoltification until age two (Sogard, Williams, & Fish, 2009). Survival in fresh water reaches tends to be higher in summer and lower from winter through spring for year classes 0 and 1 (Sogard, et al., 2009). Larger individuals also survive more readily than do smaller fish within year classes (Sogard, et al., 2009). Greater movement of juveniles in fresh water has been observed in winter and spring versus summer and fall time periods. Smaller individuals are more likely to be observed to exceed 0.3 mm per day, and are highest in winter through spring, potentially due to higher water flow rates and greater food availability (Boughton et al., 2007; Sogard, et al., 2009).

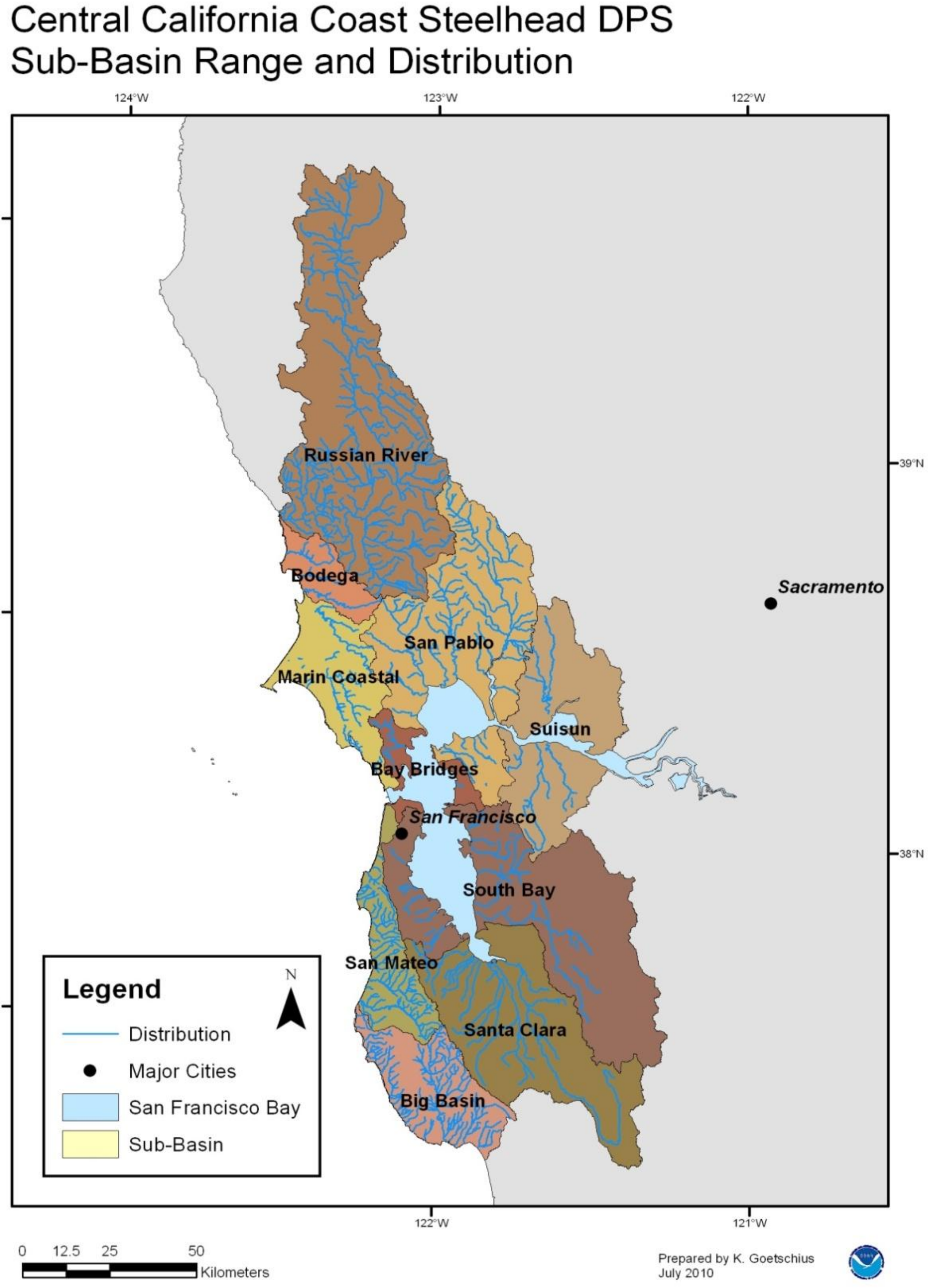


Figure 42. CCC steelhead distribution

Status and Trends

NMFS listed CCC steelhead as threatened on August 18, 1997 (62 FR 43937), and reaffirmed their threatened status on January 5, 2006 (71 FR 834). The CCC steelhead consisted of nine historic functionally independent populations and 23 potentially independent populations (Bjorkstedt, et al., 2005). Of the historic functionally independent populations, at least two are extirpated while most of the remaining are nearly extirpated. Current runs in the basins that originally contained the two largest steelhead populations for CCC steelhead, the San Lorenzo and the Russian Rivers (Table 46), both have been estimated at less than 15% of their abundances just 30 years earlier (T. P. Good, et al., 2005). Steelhead access to significant portions of the upper Russian River has also been blocked (Busby, et al., 1996; NMFS, 2008a).

Table 46. CCC Steelhead populations, historic population type, abundances, and hatchery contributions (T. P. Good, et al., 2005; NMFS, 2008a) .

Basin	Pop. Type	Historical Abundance	Most Recent Spawner Abundance	Hatchery Abundance Contributions
Upper Russian River	FI	65,000 (1970)	1,750-7,000 (1994)	Unknown
Lagunitas Creek	PI	Unknown	400-500 (1990s)	Unknown
Stemple Creek	PI	Unknown	Extirpated	N/A
Americano Creek	PI	Unknown	Extirpated	N/A
San Gregorio	FI	1,000 (1973)	Unknown	Unknown
Waddell Creek	PI	481	150 (1994)	Unknown
Scott Creek	D	Unknown	<100 (1991)	Unknown
San Vicente Creek	D	150 (1982)	50 (1994)	Unknown
San Lorenzo River	FI	20,000	<150 (1994)	Unknown
Soquel Creek	PI	500-800 (1982)	<100 (1991)	Unknown
Aptos Creek	PI	200 (1982)	50-75 (1994)	Unknown
Guadalupe River	FI	Unknown	Unknown	Unknown
Napa River	FI	Unknown	Unknown	Unknown
San Leandro River	FI	Unknown	Extirpated*	N/A
San Lorenzo River	FI	20,000 pre-1965	<150 (1994)	N/A
Alameda Creek	FI	Unknown	Extirpated	N/A
Total		94,000	2,400-8,125	

*A remnant stray run may still exist (Robert A. Leidy, Becker, & Harvey, 2005)
Population type: FI, historic functionally independent; PI, historic potentially independent.

Historically, the entire CCC steelhead DPS may have consisted of an average runs size of 94,000 adults in the early 1960s (T. P. Good, et al., 2005). Information on current CCC steelhead populations consists of anecdotal, sporadic surveys that are limited to only smaller portions of watersheds. Presence-absence data indicated that most (82%) sampled streams (a subset of all historical steelhead streams) had extant populations of juvenile *O. mykiss* (Adams, 2000; T. P. Good, et al., 2005). Table YY identifies populations within the CCC steelhead salmon ESU, their abundances, and hatchery input.

Though the information for individual populations is limited, available information strongly suggests that no population is viable. Long-term population sustainability is extremely low for the southern populations in the Santa Cruz mountains and in the San Francisco Bay (NMFS, 2008a). Declines in juvenile southern populations are consistent with the more general estimates of declining abundance in the region (T. P. Good, et al., 2005). The interior Russian River winter-run steelhead has the largest runs with an estimate of an average of over 1,000 spawners; it may be able to be sustained over the long-term but hatchery management has eroded the population's genetic diversity (Bjorkstedt, et al., 2005; NMFS, 2008a).

Data on abundance trends do not exist for the DPS as a whole or for individual watersheds. Thus, it is not possible to calculate long-term trends or lambda.

Critical Habitat

Critical habitat was designated for this species on September 2, 2005 (70 FR 52630). It includes the Russian River watershed, coastal watersheds in Marin County, streams within the San Francisco Bay, and coastal watersheds in the Santa Cruz Mountains down to Apos Creek.

There are 47 occupied HSA watersheds within the freshwater and estuarine range of this ESU. As shown in Figure 43, fourteen watersheds are considered of low conservation value, 13 as having a medium conservation value, and 19 as having a high conservation value to the ESU (NMFS, 2005c) (

Table 47). Five of these HSA watersheds comprise portions of the San Francisco-San Pablo- Suisun Bay estuarine complex which provides rearing and migratory habitat for this ESU.

Table 47. CCC steelhead CALWATER HSA watersheds with conservation values.

HUC 4 Subbasin	HUC 5 Watershed conservation Value (CV)					
	High CV	PCE(s)[1]	Medium CV	PCE(s)[1]	Low CV	PCE(s)[1]
Russian River	7	(1, 2, 3)	2	(1, 2, 3)	1	(1, 2, 3)
Bodega Bay	0		1	(1, 2, 3)	1	(1, 2, 3)
Coastal Marin County	1	(1, 2, 3)	1	(1, 2, 3)	2	(1, 2, 3)
San Mateo	2	(1, 2, 3)	2	(1, 2, 3)	1	(1, 2, 3)
Bay Bridges	1	(estuarine PCEs)	1	(1, 2, 3)	1	(1, 2, 3)
South Bay	1	(estuarine PCEs)	1	(1, 2, 3)	1	(1 mi of 2 and 3)
Santa Clara	1	(estuarine PCEs)	2	(1, 2, 3)	2	(1, 2, 3)
San Pablo	3	(1, 2, 3)	1	(1, 2, 3)	2	(1, 2, 3)
Suisun	0		1	(1, 2, 3)	4	(1, 2, 3)
Big Basin	3	(1, 2, 3)	1	(1, 2, 3)	0	
Total	19		13		15	

[1] Numbers in parenthesis refers to the dominant (in river miles) PCE(s) within the HUC 5 watersheds. PCE 1 is spawning and rearing, 2 is rearing and migration, and 3 is migration and presence. PCEs with < means that the number of river miles of the PCE is much less than river miles of the other PCE.

Streams throughout the critical habitat have reduced quality of spawning PCEs; sediment fines in spawning gravel have reduced the ability of the substrate attribute to provide well oxygenated and clean water to eggs and alevins. High proportions of fines in bottom substrate also reduce forage by limiting the production of aquatic stream insects adapted to running water. Elevated water temperatures and impaired water quality have further reduced the quality, quantity and function of the rearing PCE within most streams. These impacts have diminished the ability of designated critical habitat to conserve the CCC steelhead.

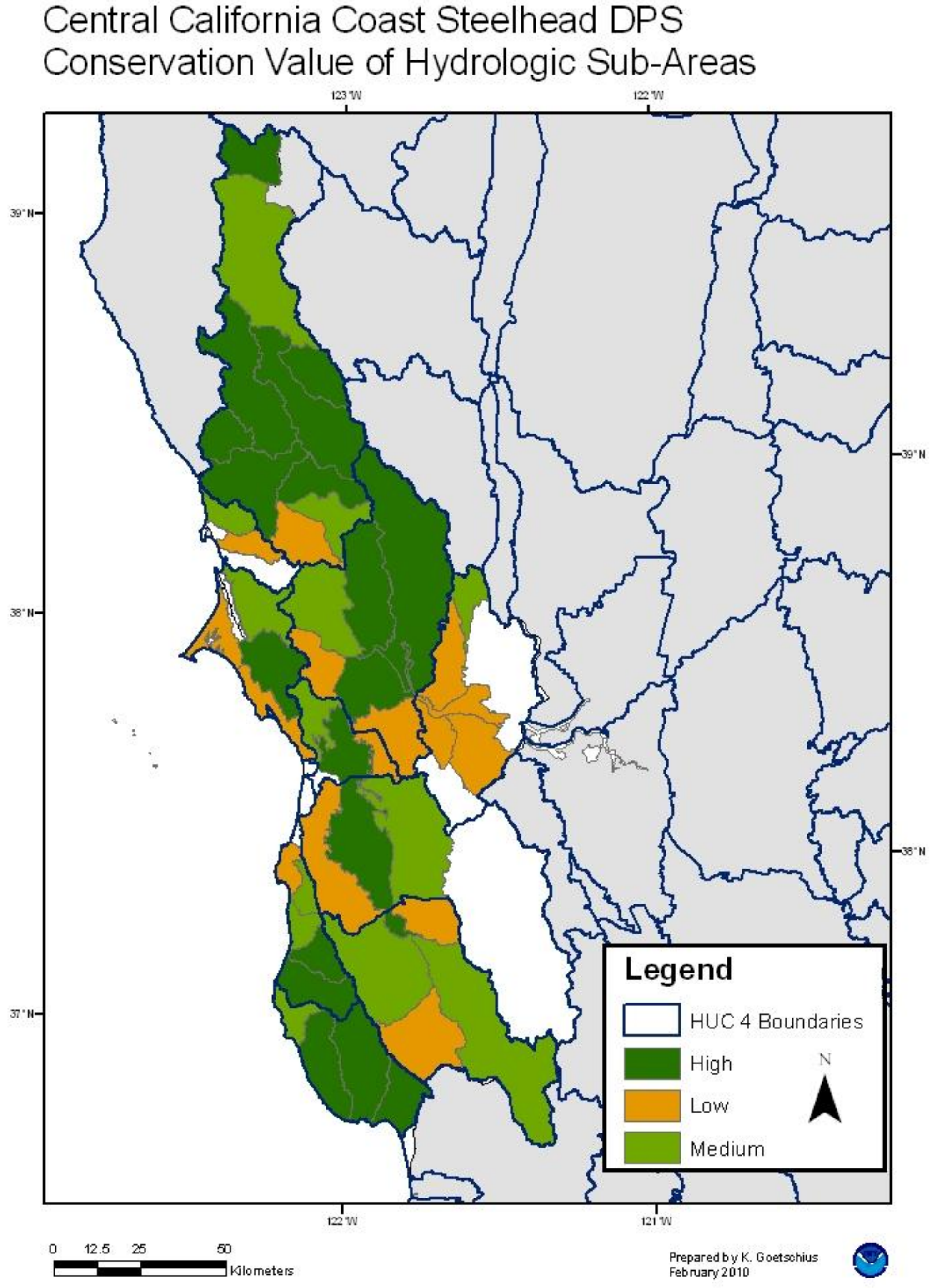


Figure 43. Central California Coast Steelhead conservation values per sub-area.

California Central Valley Steelhead

The California Central Valley (CCV) steelhead DPS includes all naturally spawned steelhead populations below natural and manmade impassable barriers in the Sacramento and San Joaquin Rivers and their tributaries, excluding steelhead from San Francisco and San Pablo Bays and their tributaries, as well as two artificial propagation programs: the Coleman NFH, and Feather River Hatchery steelhead hatchery programs **(**Figure 44**).**

Life History

CCV steelhead are considered winter steelhead and have the longest freshwater migration of any population of winter steelhead. CCV steelhead generally leave the ocean from August through April (Busby, et al., 1996), and spawn from December through April, with peaks from January though March, in small streams and tributaries where cool, well oxygenated water is available year-round (Hallock, Van Woert, & Shapovalov, 1961; D. McEwan & Jackson, 1996). Most spawning habitat for steelhead in the Central Valley is located in areas directly downstream of dams containing suitable environmental conditions for spawning and incubation.

Newly emerged fry move to the shallow, protected areas associated with the stream margin (D. McEwan & Jackson, 1996). Steelhead rearing during the summer occurs primarily in higher velocity areas in pools, although young of the year also are abundant in glides and riffles. Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their outmigration. Non-natal, intermittent tributaries also may be used for juvenile rearing. Migratory corridors are downstream of the spawning areas and include the lower mainstems of the Sacramento and San Joaquin rivers and the Delta.

Hallock *et al*. (1961) found that juvenile steelhead in the Sacramento River basin migrate downstream during most months of the year, but the peak period of emigration occurred in the spring, with a much smaller peak in the fall. Emigrating CCV steelhead use the lower reaches of the Sacramento River and the Delta for rearing and as a migration corridor to the ocean. Some juvenile steelhead may use tidal marsh areas, non-tidal freshwater marshes, and other shallow water areas in the Delta as rearing areas for short periods prior to their final emigration to the sea (Hallock, et al., 1961).

Status and Trends

NMFS originally listed CCV steelhead as threatened on March 19, 1998, and reaffirmed their threatened status on January 5, 2006 (71 FR 834). The CCV steelhead DPS may have consisted of 81 historical and independent populations (Lindley et al., 2006). Spatial structure and patchiness strongly influenced suitable habitats being isolated due largely to high summer temperatures on the valley floor.

The species' present distribution has been greatly reduced with about 80% of historic habitat lost behind dams and about 38% of habitat patches that supported independent populations are no longer accessible to steelhead (Lindley, et al., 2006). Existing wild steelhead stocks in the Central Valley are mostly confined to the upper Sacramento River and its tributaries, including Antelope, Deer, and Mill Creeks and the Yuba River. Populations may exist in Big Chico and Butte Creeks. A few wild steelhead are produced in the American and Feather Rivers (T. P. Good, et al., 2005). Steelhead have also been observed in Clear Creek and Stanislaus River (Demko & Cramer, 2000; T. P. Good, et al., 2005). Until recently, steelhead were considered extirpated from the San Joaquin River system. Recent monitoring has detected small self-sustaining populations of steelhead in the Stanislaus, Mokelumne, Calaveras, and other streams previously thought to be void of steelhead (T. P. Good, et al., 2005). In 2004, a total of 12 steelhead smolts were collected in monitoring trawls at the Mossdale station in the lower San Joaquin River (CDFG unpublished data).

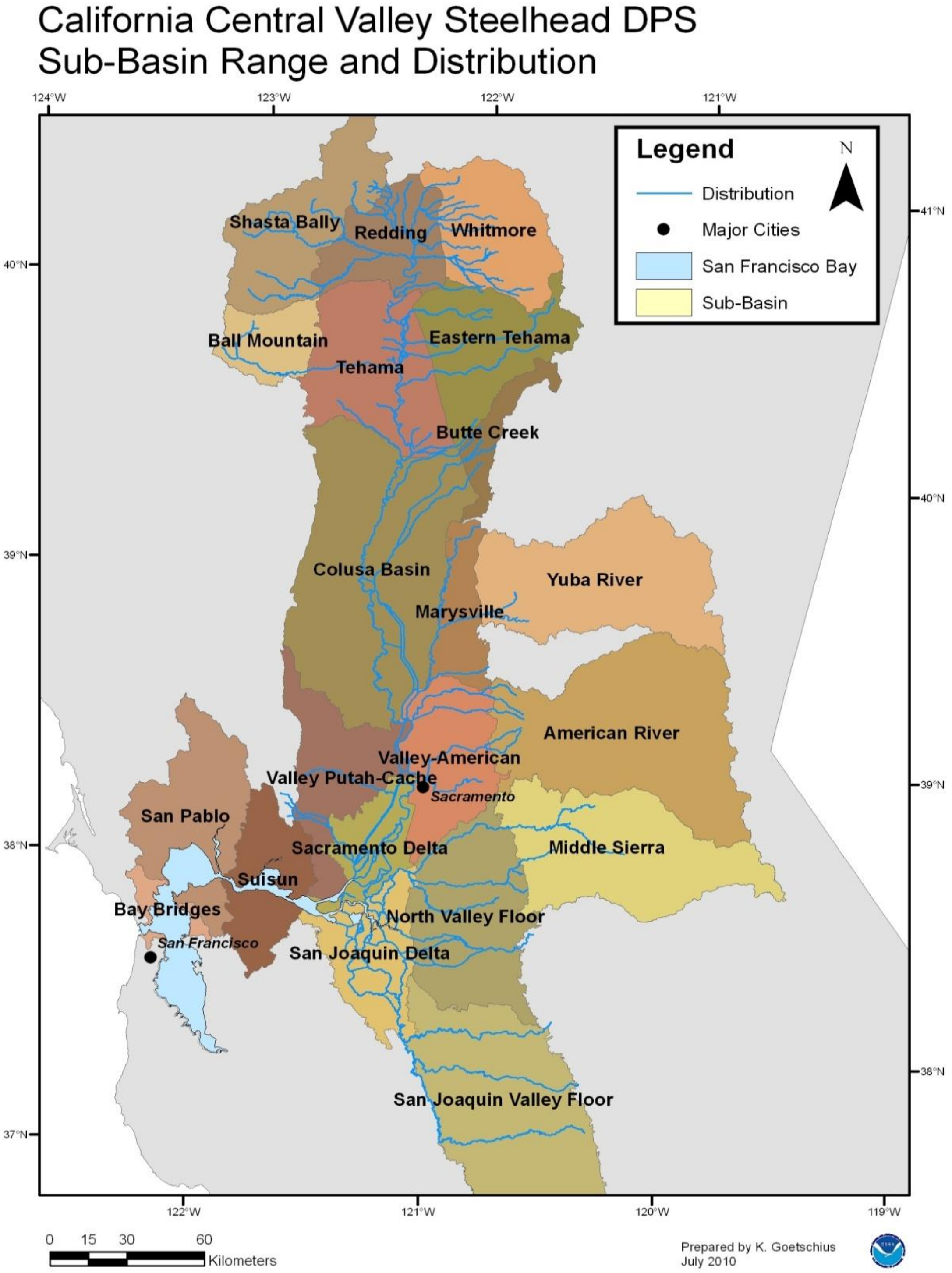


Figure 44. CCV steelhead distribution

Historic CCV steelhead run size may have approached one to two million adults annually (D. R. McEwan, 2001). By the early 1960s, the steelhead run size had declined to about 40,000 adults (D. R. McEwan, 2001). Over the past 30 years, the naturally spawned steelhead populations in the upper Sacramento River have declined substantially. Hallock *et al.* (1961) estimated an average of 20,540 adult steelhead in the Sacramento River, upstream of the Feather River, through the 1960s. Steelhead were counted at the Red Bluff Diversion Dam (RBDD) up until 1993. Counts at the dam declined from an average of 11,187 for the period of 1967 to 1977, to an average of approximately 2,000 through the early 1990s. An estimated total annual run size for the entire Sacramento-San Joaquin system was no more than 10,000 adults during the early 1990s (D. McEwan & Jackson, 1996; D. R. McEwan, 2001). Based on catch ratios at Chipps Island in the Delta and using some generous assumptions regarding survival, the average number of CV steelhead females spawning naturally in the entire Central Valley during the years 1980 to 2000 was estimated at about 3,600 (T. P. Good, et al., 2005).

CCV steelhead lack annual monitoring data for calculating trends and lambda. However, the RBDD counts and redd counts up to 1993 and later sporadic data show that the DPS has had a significant long-term downward trend in abundance (NMFS, 2009a).

The CCV steelhead distribution ranged over a wide variety of environmental conditions and likely contained biologically significant amounts of spatially structured genetic diversity (Lindley, et al., 2006). Thus, the loss of populations and reduction in abundances have reduced the large diversity that existed within the DPS. The genetic diversity of the majority of CCV steelhead spawning runs is also compromised by hatchery-origin fish.

Critical Habitat

NMFS designated critical habitat for CCV steelhead on September 2, 2005 (70 FR 52488). Critical habitat includes stream reaches such as those of the Sacramento, Feather, and Yuba Rivers, and Deer, Mill, Battle, and Antelope creeks in the Sacramento River basin; the lower San Joaquin River to the confluence with the Merced River, including its tributaries, and the waterways of the Delta (Figure 45). The total area of critical habitat includes about 2,300 miles of stream habitat and about 250 square miles of estuarine habitat in the San Francisco-San Pablo-Suisan Bay estuarine complex.

There are 67 occupied HAS watersheds within the freshwater and estuarine range of this DPS. Twelve watersheds received a low rating, 18 received a medium rating, and 37 received a high rating of conservation value to the ESU (NMFS, 2005c). Four of these HSA watersheds comprise portions of the San Francisco-San Pablo-Suisun Bay estuarine complex which provides rearing and migratory habitat for this ESU.

Table 48. CCV spring-run Chinook salmon CALWATER HSA watersheds with conservation values

HUC 4 Subbasin	HUC 5 Watershed conservation Value (CV)					
	High CV	PCE(s) [1]	Medium CV	PCE(s) [1]	Low CV	PCE(s) [1]
San Francisco Bay	1	2	0		0	
South Bay	0		0		1	2
San Pablo	1	2	0		0	
Suisun Bay	1	2	0		0	
Tehama	1	1, 2, 3	1	1, 2, 3	0	
Whitmore	3	1, 2, 3	2	1, 2, 3	2	1, 2, 3
Redding	2	1, 2, 3	0		0	
Eastern Tehama	4	1, 2, 3	1	1, 2, 3	1	1, 2, 3
Sacramento Delta	1	1, 2, 3	0		0	
Valley Putah-Cache	0		2	1, 2, 3	0	
American River	0		1	1, 2, 3	0	
Marysville	2	1, 2, 3	1	1, 2, 3	0	
Yuba River	2	1, 2, 3	0		2	1, 2, 3
Valley-American	2	1, 2, 3	0		0	
Colusa Basin	4	1, 2, 3	0		0	
Butte Creek	1	1, 2, 3	1	1, 2, 3	1	1, 2, 3
Ball Mountain	1	1, 2, 3	0		0	
Shasta Bally	2	1, 2, 3	3	1, 2, 3	0	
North Valley Floor	1	1, 2, 3	1	1, 2, 3	1	1, 2, 3
Middle Sierra	0		0		4	1, 2, 3
Upper Calaveras	1	1, 2, 3	0		0	
Stanislaus River	1	1, 2, 3	0		0	
San Joaquin Valley Floor	4	1, 2, 3	3	1, 2, 3	0	
Delta-Mendota Canal	1	1, 2, 3	1	1, 2, 3	0	
North Diablo Range	0		1		0	
San Joaquin Delta	1	1, 2, 3	0		0	
Total	37		18		12	

1 Numbers in parenthesis refers to the dominant (in river miles) PCE(s) within the HUC 5 watersheds. PCE 1 is spawning and rearing, 2 is rearing and migration, and 3 is migration and presence. PCEs with < means that the number of river miles of the PCE is much less than river miles of the other PCE.

The current condition of CCV steelhead critical habitat is degraded, and does not provide the conservation value necessary for species recovery (Table 48). In addition, the Sacramento-San Joaquin River Delta, as part of CCV steelhead designated critical habitat, provides very little function necessary for juvenile CCV steelhead rearing and physiological transition to salt water.

The spawning PCE is subject to variations in flows and temperatures, particularly over the summer months. Some complex, productive habitats with floodplains remain in the system and flood bypasses (*i.e.*, Yolo and Sutter bypasses). However, the rearing PCE is degraded by the channelized, leveed, and riprapped river reaches and sloughs that are common in the Sacramento-San Joaquin system and which typically have low habitat complexity, low abundance of food organisms, and offer little protection from either fish or avian predators. Stream channels commonly have elevated temperatures.

The current conditions of migration corridors are substantially degraded. Both migration and rearing PCEs are affected by dense urbanization and agriculture along the mainstems and in the Delta which contribute to reduced water quality by introducing several contaminants. In the Sacramento River, the migration corridor for both juveniles and adults is obstructed by the RBDD gates which are down from May 15 through September 15. The migration PCE is also obstructed by complex channel configuration making it more difficult for CCV steelhead to migrate successfully to the western Delta and the ocean. In addition, the state and federal government pumps and associated fish facilities change flows in the Delta which impede and obstruct for a functioning migration corridor that enhance migration. The estuarine PCE, which is present in the Delta, is affected by contaminants from agricultural and urban runoff and release of wastewater treatment plants effluent.

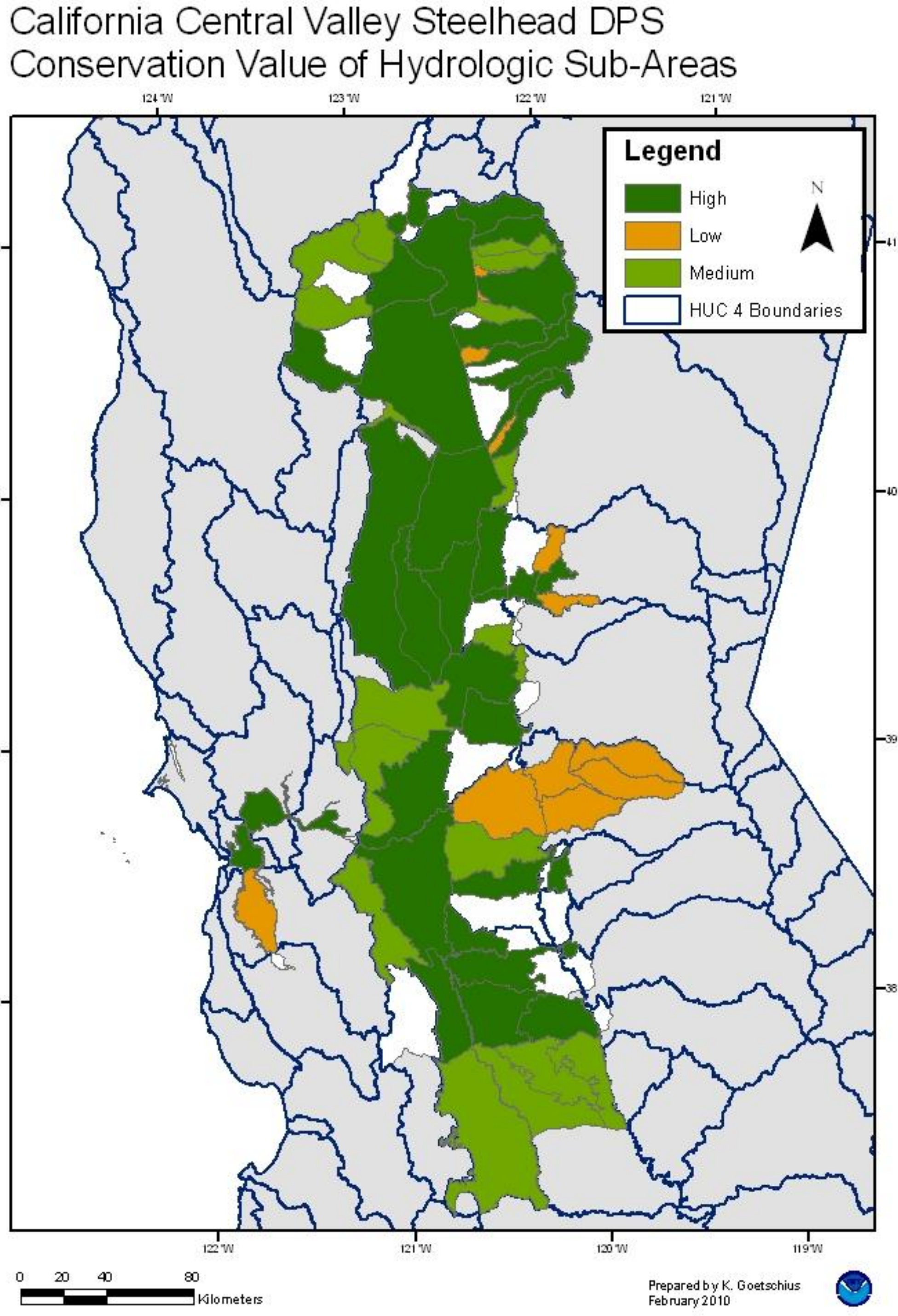


Figure 45. California Central Valley Steelhead conservation value per sub-area

South-Central California Coast Steelhead

South-Central California Coast (S-CCC) steelhead include all naturally spawned steelhead populations below natural and manmade impassable barriers in streams from the Pajaro River (inclusive) to, but not including the Santa Maria River, California. No artificially propagated steelhead populations that reside within the historical geographic range of this DPS are included in this designation. The two largest basins overlapping within the range of this DPS include the inland basins of the Pajaro River and the Salinas River (Figure **47**).

Life History

Only winter steelhead are found in this DPS. Migration and spawn timing are similar to adjacent steelhead populations. There is limited life history information for steelhead in this DPS.

Critical Habitat

Critical habitat was designated for this species on September 2, 2005 (70 FR 52488). There are 29 occupied HSA watersheds within the freshwater and estuarine range of this ESU. Figure 46 depicts the conservation values for this DPS. The conservation value of 6 watersheds is low, 11 are of medium conservation value, and 12 are of a high conservation value to the ESU (

Table 49)(NMFS, 2005c). One of these occupied watershed units is Morro Bay, which is used as rearing and migratory habitat for steelhead populations that spawn and rear in tributaries to the Bay.

Migration and rearing PCEs are degraded throughout critical habitat by elevated stream temperatures and contaminants from urban and agricultural areas. Estuarine PCE is impacted by most estuaries being breached, removal of structures, and contaminants.

Table 49. Number of South-Central California Coast steelhead CALWATER HSA watersheds with conservation values.

HUC 4 Subbasin	HUC 5 Watershed conservation Value (CV)					
	High CV	PCE(s) [1]	Medium CV	PCE(s) [1]	Low CV	PCE(s) [1]
Pajaro River	2	(2, 3, 1)	3	(2, 3, 1)	0	
Carmel River	1	(1, 2, 3)	0		0	
Santa Lucia	1	(1, 2, 3)	0		0	
Salinas	2	(2, 3, 1)	1	(1, 2)	4	(2, 3, <1)
Estero Bay	6	(2, 1, 3)	7	(1, 2, 3)	2	(1, 2, 3)
Total	12		11		6	

1 Numbers in parenthesis refers to the dominant (in river miles) PCE(s) within the HUC 5 watersheds. PCE 1 is spawning and rearing, 2 is rearing and migration, and 3 is migration and presence. PCEs with < means that the number of river miles of the PCE is much less than river miles of the other PCE.

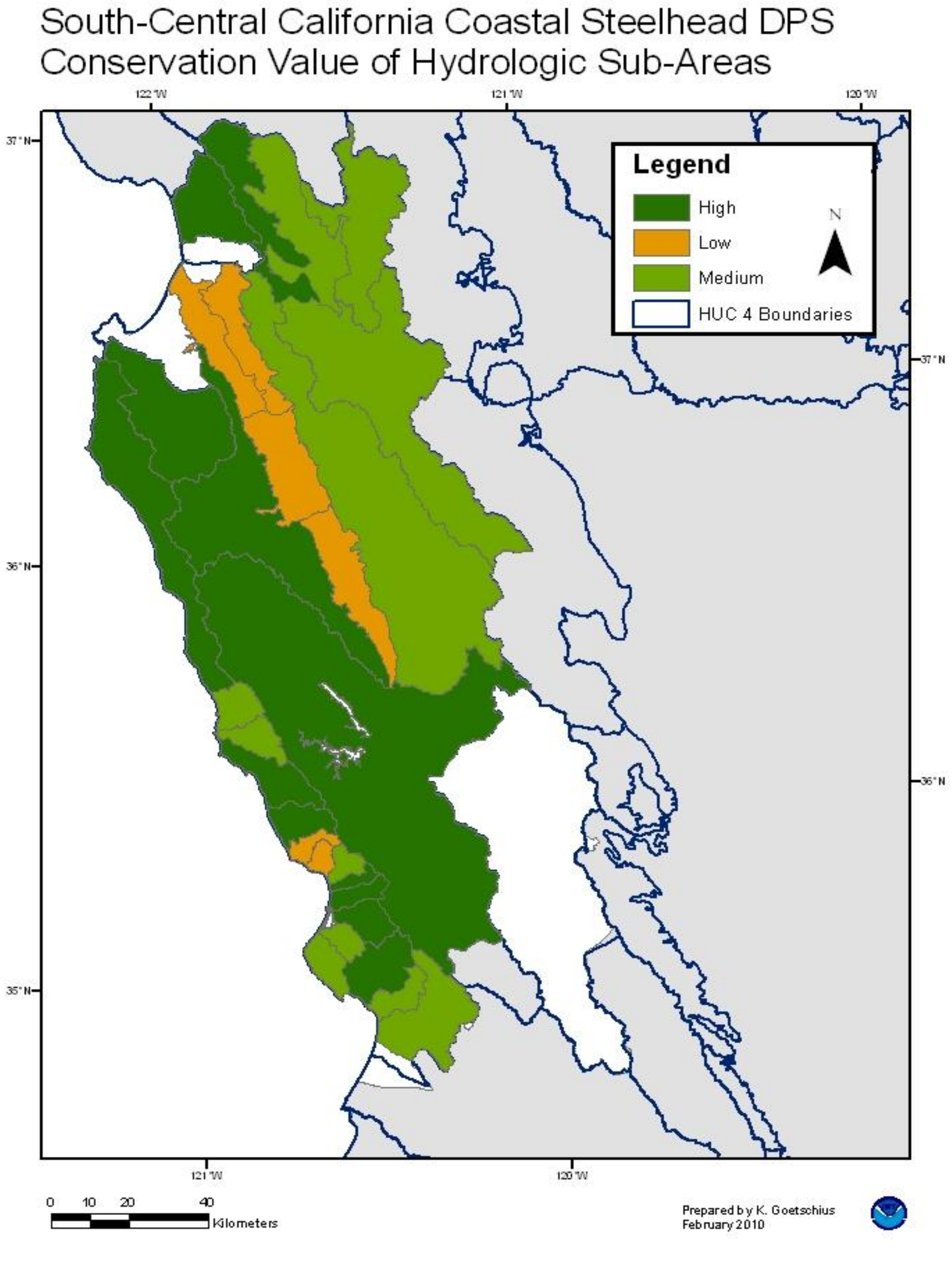


Figure 46. South-Central California Coast Steelhead conservation values per sub-area

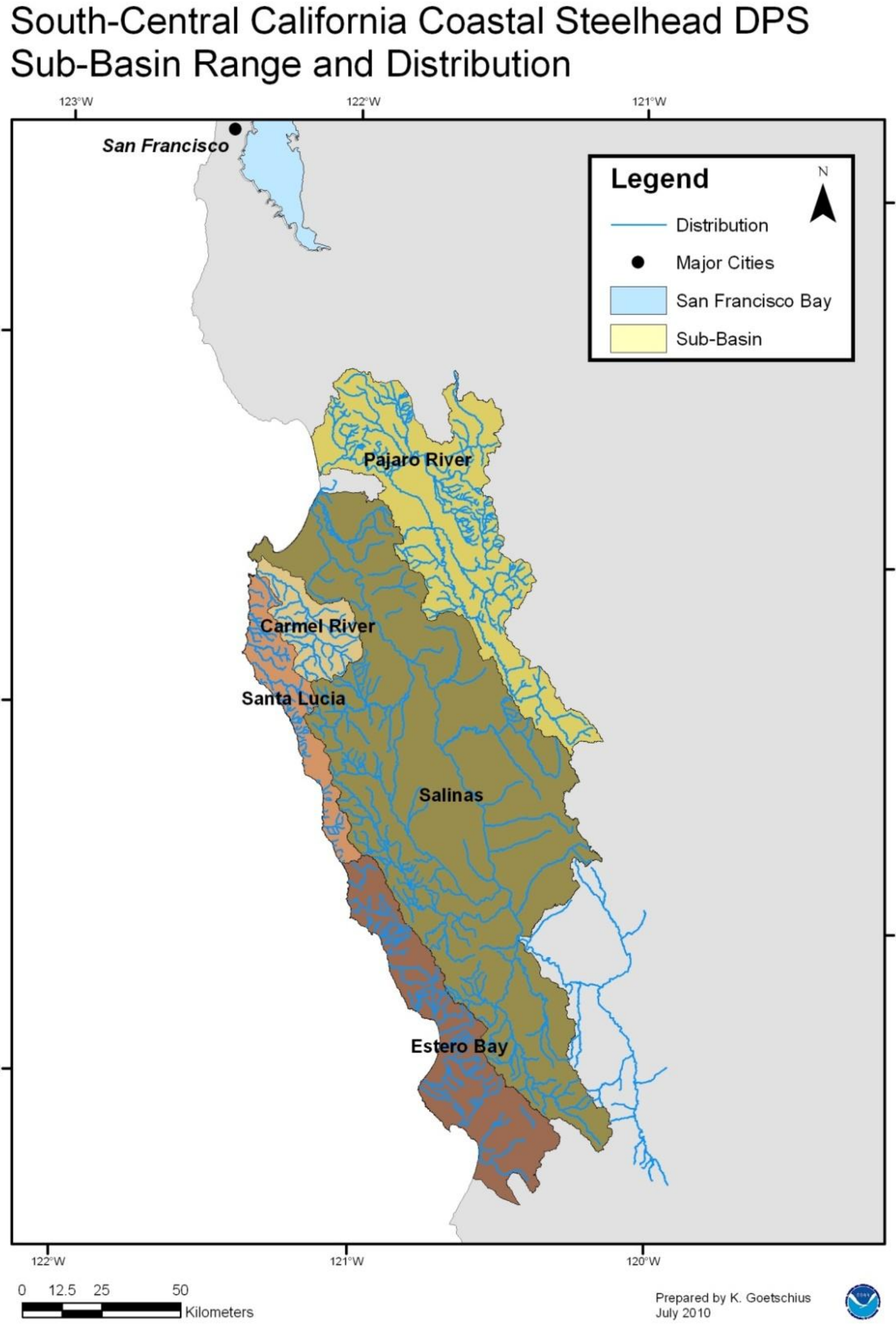


Figure 47**. S-CCC steelhead distribution**

Southern California Steelhead

The Southern California (SC) steelhead DPS includes all naturally spawned steelhead populations below natural and manmade impassable barriers in streams from the Santa Maria River, San Luis Obispo County, California, (inclusive) to the U.S. - Mexico Border (Figure **48**). Artificially propagated steelhead that reside within the historical geographic range of this DPS are not included in the listing.

Life History

There is limited life history information for SC steelhead. In general, migration and life history patterns of SC steelhead populations are dependent on rainfall and stream flow (Moore, 1980). Steelhead within this DPS can withstand higher temperatures compared to populations to the north. The relatively warm and productive waters of the Ventura River have resulted in more rapid growth of juvenile steelhead compared to the more northerly populations (Moore, 1980).

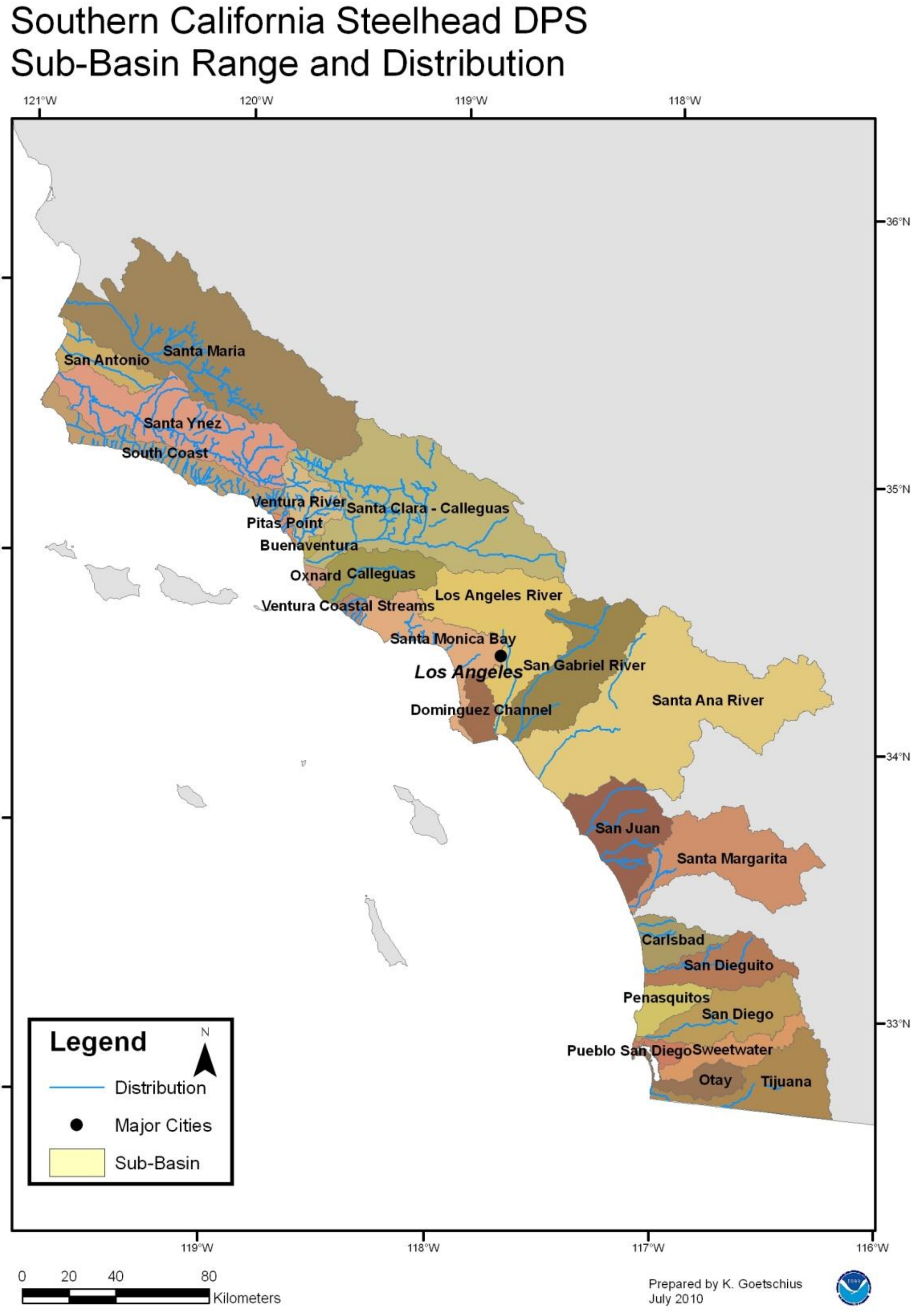


Figure 48 **Southern California steelhead distribution**

Status and Trends

NMFS listed the SC steelhead as endangered on August 18, 1997 (62 FR 43937), and reaffirmed their endangered status on January 5, 2006 (71 FR 834). Historic population structure and evaluation of potential stratification of the DPS have not been conducted for this DPS (Table 50).

Table 50. Southern California Steelhead salmon populations, abundances, and hatchery contributions (T. P. Good, et al., 2005).

River	Historical Abundance	Most Recent Spawner Abundance	Hatchery Abundance Contributions
Santa Ynez River	12,995-30,000	Unknown	Unknown
Ventura River	4,000-6,000	Unknown	Unknown
Matilija River	2,000-2,500	Unknown	Unknown
Creek River	Unknown	Unknown	Unknown
Santa Clara River	7,000-9,000	Unknown	Unknown
Total	32,000-46,000	<500	

Construction of dams and corresponding increase in water temperatures have excluded steelhead distribution in many watersheds throughout southern California. Streams in southern California with steelhead present have declined over the last decade with a southward increase in the proportional loss of populations. Consequently, the SC steelhead have experienced a contraction of its southern range limit (Boughton et al., 2005). This contraction affects the SC steelhead's ability to maintain genetic and life history diversity for adaptation to environmental change

Limited information exists on SC steelhead runs. Based on combined estimates for the Santa Ynez, Ventura, and Santa Clara rivers, and Malibu Creek, an estimated 32,000 to 46,000 adult steelhead occupied this DPS historically. In contrast, less than 500 adults are estimated to occupy the same four waterways presently. The last estimated run size for steelhead in the Ventura River, which has its headwaters in Los Padres National Forest, is 200 adults (Busby, et al., 1996). Table 50 identifies populations within the SC Steelhead salmon ESU, their abundances, and hatchery input.

Critical Habitat

Critical habitat was designated for this species on September 2, 2005 (70 FR 52630). There are 29 HSA watersheds within the freshwater and estuarine range of this ESU designated as critical habitat (Table 51). Figure 49 provides conservation values for this DPS per sub-area. Three watersheds received a low, five received a medium, and 21 received a high conservation value rating for the ESU (NMFS, 2005c).

Table 51. Southern California steelhead CALWATER HSA watersheds with conservation values

HUC 4 Subbasin	HUC 5 Watershed conservation Value (CV)					
	High CV	PCE(s)[1]	Medium CV	PCE(s)[1]	Low CV	PCE(s)[1]
Santa Maria	1	(1, 2, 3)	0		1	(1, 2, 3)
Santa Ynez	2	(2, 3, 1)	2	(1, 2, 3)	1	(2, 3, 1)
South Coast	5	(2, 3, 1)	0		0	
Ventura River	2	(2, 3, 1)	2	(1, 2, 3)	0	
Santa Clara-Calleguas	5	(2, 3, 1)	1	(2, 3)	0	
Santa Monica Bay	3	(2, 1, 3)	0		0	
Calleguas	0		0		1	(2, 3)
San Juan	3	(2, 3, 1)	0		0	
Total	21		5		3	

[1] Numbers in parenthesis refers to the dominant (in river miles) PCE(s) within the HUC 5 watersheds. PCE 1 is spawning and rearing, 2 is rearing and migration, and 3 is migration and presence. PCEs with < means that the number of river miles of the PCE is much less than river miles of the other PCE.

All PCEs have been affected by degraded water quality by pollutants from densely populated areas and agriculture within the DPS. Elevated water temperatures impact rearing and juvenile migration PCEs in all river basins and estuaries. Rearing and spawning PCEs have also been affected throughout the DPS by management or reduction in water quantity. The spawning PCE has also been affected by the combination of erosive geology and land management activities that have resulted in an excessive amount of fines in the spawning gravel of most rivers.

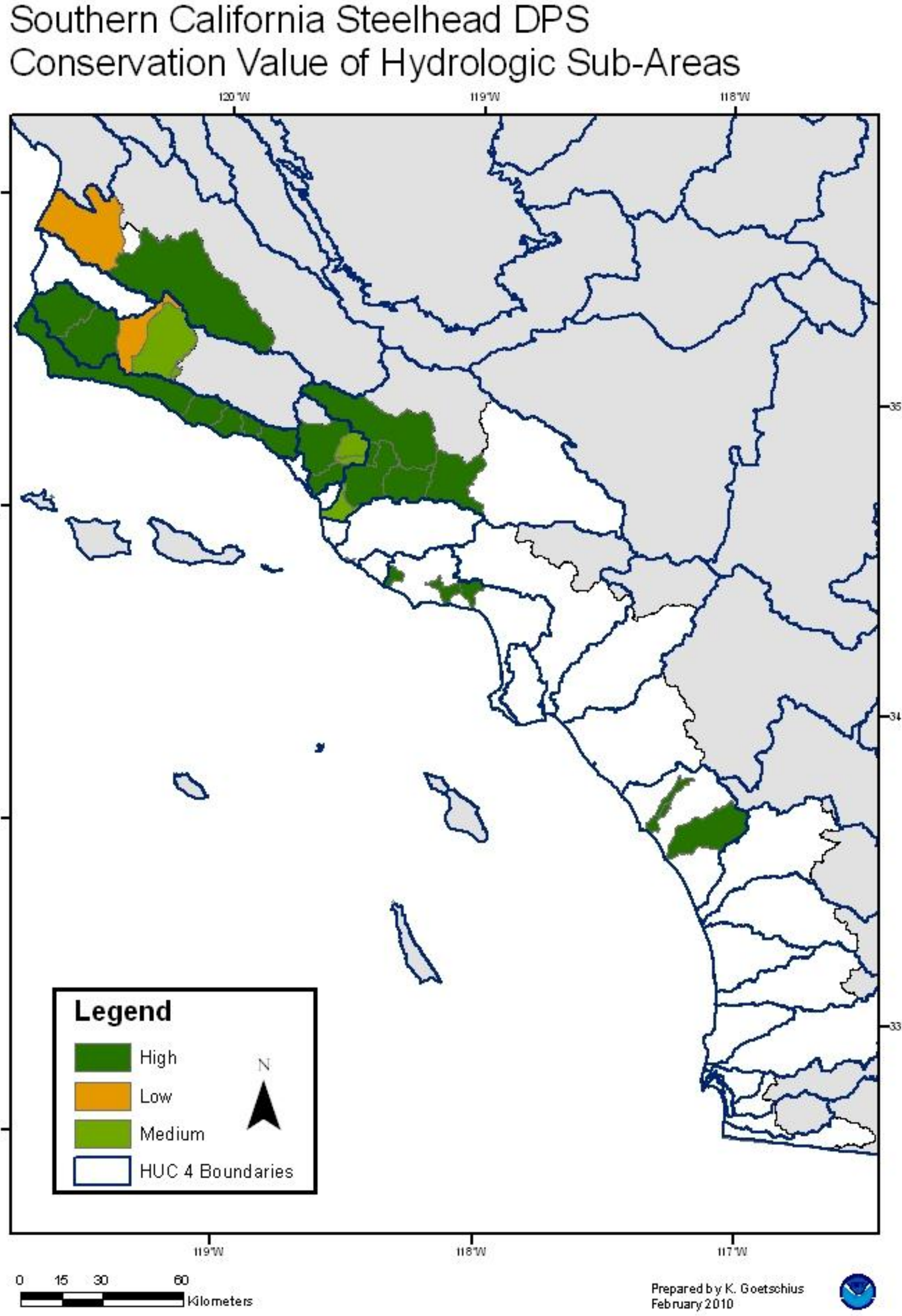


Figure 49. Southern California Steelhead Conservation Values per Sub-area

Environmental Baseline

By regulation, environmental baselines for Opinions include the past and present impacts of all state, federal or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR §402.02). The environmental baseline for this Opinion includes a general description of the natural and anthropogenic factors influencing the current status of listed Pacific salmonids and the environment within the action area.

Our summary of the environmental baseline complements the information provided in the *Status of Listed Resources* section of this Opinion, and provides the background necessary to understand information presented in the *Effects of the Proposed Action*, and *Cumulative Effects* sections of this Opinion. We then evaluate the consequences of EPA's actions in combination with the status of the species, environmental baseline and the cumulative effects to determine the likelihood of jeopardy or adverse modification of designated critical habitat.

The proposed action under consultation is focused geographically on the aquatic ecosystems in the states of California, Idaho, Oregon, and Washington. Accordingly, the environmental baseline for this consultation focuses on the general status and trends of the aquatic ecosystems in these four states and the consequences of that status for listed resources under NMFS' jurisdiction. We describe the principal natural phenomena affecting all listed Pacific salmonids under NMFS jurisdiction in the action area.

We further describe anthropogenic factors through the predominant land and water uses within a region, as land use patterns vary by region. Background information on pesticides in the aquatic environment is also provided. This context illustrates how the physical and chemical health of regional waters and the impact of human activities have contributed to the current status of listed resources in the action area.

Natural Mortality Factors

Available data indicate high natural mortality rates for salmonids, especially in the open ocean/marine environment. According to Bradford (1997), salmonid mortality rates range from 90 to 99%, depending on the species, the size at ocean entry, and the length of time spent in the ocean. Predation, inter- and intraspecific competition, food availability, smolt quality and health, and physical ocean conditions likely influence the survival of salmon in the marine environment (Bradford, et al., 1997; Brodeur et al., 2004). In freshwater rearing habitats, the natural mortality rate averages about 70% for all salmonid species (Bradford, et al., 1997). Past studies in the Pacific Northwest suggest that the average freshwater survival rate (from egg to smolt) is 2 to 3% throughout the region (Bradford, et al., 1997; D. E. Marshall & Britton, 1990). A number of suspected causes contributing to natural mortality include parasites and/or disease, predation, water temperature, low water flow, wildland fire, and oceanographic features and climatic variability.

Parasites and/or Disease

Most young fish are highly susceptible to disease during the first two months of life. The cumulative mortality in young animals can reach 90 to 95%. Although fish disease organisms occur naturally in the water, native fish have co-evolved with them. Fish can carry these diseases at less than lethal levels (Foott, Harmon, & Stone, 2003; Kier Associates, 1991; Walker & Foott, 1993). However, disease outbreaks may occur when water quality is diminished and fish are stressed from crowding and diminished flows (Guillen, 2003; B.C. Spence, Lomnicky, Hughs, & Novitzki, 1996). Young coho salmon or other salmonid species may become stressed and lose their resistance in higher temperatures (B.C. Spence, et al., 1996). Consequently, diseased fish become more susceptible to predation and are less able to perform essential functions, such as feeding, swimming, and defending territories (McCullough, 1999). Examples of parasites and disease for salmonids include whirling disease, infectious hematopoietic necrosis (IHN), sea-lice (*Lepeophtheirus salmonis*), *Henneguya salminicola*, *Ichthyopthirius multifiliis* or Ich, and Columnaris *(Flavobacterium columnare*).

Whirling disease is a parasitic infection caused by the microscopic parasite *Myxobolus cerebrali*. Infected fish continually swim in circular motions and eventually expire from exhaustion. The disease occurs in the wild and in hatcheries and results in losses to fry and fingerling salmonids, especially rainbow trout. The disease is transmitted by infected fish and fish parts and birds.

IHN is a viral disease in many wild and farmed salmonid stocks in the Pacific Northwest. This disease affects rainbow/steelhead trout, cutthroat trout (*Salmo clarki*), brown trout (*Salmo trutta*), Atlantic salmon (*Salmo salar*), and Pacific salmon including Chinook, sockeye, chum, and coho salmon. The virus is triggered by low water temperatures and is shed in the feces, urine, sexual fluids, and external mucus of salmonids. Transmission is mainly from fish to fish, primarily by direct contact and through the water.

Sea lice also cause deadly infestations of wild and farm-grown salmon. *Henneguya salminicola*, a protozoan parasite, is commonly found in the flesh of salmonids. The fish responds by walling off the parasitic infection into a number of cysts that contain milky fluid. This fluid is an accumulation of a large number of parasites. Fish with the longest freshwater residence time as juveniles have the most noticeable infection. The order of prevalence for infection is coho followed by sockeye, Chinook, chum, and pink salmon.

Additionally, ich (a protozoan) and Columnaris (a bacterium) are two common fish diseases that were implicated in the massive kill of adult salmon in the Lower Klamath River in September 2002 (CDFG, 2003; Guillen, 2003).

Predation

Salmonids are exposed to high rates of natural predation, during freshwater rearing and migration stages, as well as during ocean migration. Salmon along the U.S. west coast are prey for marine mammals, birds, sharks, and other fishes. Concentrations of juvenile salmon in the coastal zone experience high rates of predation. In the Pacific Northwest, the increasing size of tern, seal, and sea lion populations may have reduced the survival of some salmon ESUs/DPSs.

Marine Mammal Predation

Marine mammals are known to attack and eat salmonids. Harbor seals (*Phoca vitulina*), California sea lions (*Zalophus californianus*), and killer whales (*Orcinus orca*) prey on juvenile or adult salmon. Killer whales have a strong preference for Chinook salmon (up to 78% of identified prey) during late spring to fall (Ford & Ellis, 2006; B. Hanson, Baird, & Schorr, 2005; Hard, et al., 1992). Generally, harbor seals do not feed on salmonids as frequently as California sea lions (Pearcy, 1997). California sea lions from the Ballard Locks in Seattle, Washington have been estimated to consume about 40% of the steelhead runs since 1985/1986 (Gustafson, et al., 1997). In the Columbia River, salmonids may contribute substantially to sea lion diet at specific times and locations (Pearcy, 1997). Spring Chinook salmon and steelhead are subject to pinniped predation when they return to the estuary as adults (NMFS, 2006). Adult Chinook salmon in the Columbia River immediately downstream of Bonneville Dam have also experienced increased predation by California sea lions. In recent years, sea lion predation of adult Lower Columbia River winter steelhead in the Bonneville tailrace has increased. This prompted ongoing actions to reduce predation effects. They include the exclusion, hazing, and in some cases, lethal take of marine mammals near Bonneville Dam (NMFS, 2008d).

Avian Predation

Large numbers of fry and juveniles are eaten by birds such as mergansers (*Mergus* spp.), common murre (*Uria aalage*), gulls (*Larus* spp.), and belted kingfishers (*Megaceryle alcyon*). Avian predators of adult salmonids include bald eagles (*Haliaeetus leucocephalus*) and osprey (*Pandion haliaetus*) (Pearcy, 1997). Caspian terns (*Sterna caspia*) and cormorants (*Phalacrocorax* spp.) also take significant numbers of juvenile or adult salmon. Stream-type juveniles, especially yearling smolts from spring-run populations, are vulnerable to bird predation in the estuary. This vulnerability is due to salmonid use of the deeper, less turbid water over the channel, which is located near habitat preferred by piscivorous birds (Binelli, Ricciardi, Riva, & Provini, 2005). Recent research shows that subyearlings from the LCR Chinook salmon ESU are also subject to tern predation. This may be due to the long estuarine residence time of the LCR Chinook salmon (Ryan et al., 2006). Caspian terns and cormorants may be responsible for the mortality of up to 6% of the outmigrating stream-type juveniles in the Columbia River basin (Collis, 2007; D.D. Roby et al., 2006).

Antolos *et al.* (2005) quantified predation on juvenile salmonids by Caspian terns nesting on Crescent Island in the mid-Columbia reach. Between 1,000 and 1,300 adult terns were associated with the colony during 2000 and 2001, respectively. These birds consumed about 465,000 juvenile salmonids in the first and approximately 679,000 salmonids in the second year. However, caspian tern predation in the estuary was reduced from a total of 13,790,000 smolts to 8,201,000 smolts after relocation of the colony from Rice to East Sand Island in 1999. Based on PIT-tag recoveries at the colony, these were primarily steelhead for Upper Columbia River stocks. Less than 0.1% of the inriver migrating yearling Chinook salmon from the Snake River and less than 1% of the yearling Chinook salmon from the Upper Columbia were consumed. PIT-tagged coho smolts (originating above Bonneville Dam) were second only to steelhead in predation rates at the East Sand Island colony in 2007 (Daniel D. Roby et al., 2008). There are few quantitative data on avian predation rates on Snake River sockeye salmon. Based on the above, avian predators are assumed to have a minimal effect on the long-term survival of Pacific salmon[9].

Fish Predation

Pikeminnows (*Ptychocheilus oregonensis*) are significant predators of yearling juvenile migrants (Friesen & Ward, 1999). Chinook salmon were 29% of the prey of northern pikeminnows in lower Columbia reservoirs, 49% in the lower Snake River, and 64% downstream of Bonneville Dam. Sockeye smolts comprise a very small fraction of the

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[9] On March 15, NMFS authorized lethal removal of up to 460 sea lions over the next five years. The Humane Society of the U.S. sued to stop the killing and sought injunctive relief. The court denied emergency injunctive relief but will consider additional injunctive relief most likely by the end of May, and will consider the merits of the case later this year or early next year. Since the court's denial of an emergency injunction, several sea lions have been euthanized.

overall number of migrating smolts (Ferguson, 2006) in any given year. The significance of fish predation on juvenile chum is unknown. There is little direct evidence that piscivorous fish in the Columbia River consume juvenile sockeye salmon. The ongoing Northern Pikeminnow Management Program (NPMP) has reduced predation-related juvenile salmonid mortality since 1990. Benefits of recent northern pikeminnow management activities to chum salmon are unknown. However, it may be comparable to those for other salmon species with a sub-yearling juvenile life history (Friesen & Ward, 1999).

The primary fish predators in estuaries are probably adult salmonids or juvenile salmonids which emigrate at older and larger sizes than others. They include cutthroat trout (*O. clarki*) or steelhead smolts preying on chum or pink salmon smolts. Outside estuaries, many large non-salmonid populations reside just offshore and may consume large numbers of smolts. These fishes include Pacific hake (*Merluccius productus*), Pacific mackerel (*Scomber japonicus*), lingcod (*Ophiodon elongates*), spiny dogfish (*Squalus acanthias*), various rock fish, and lamprey (R.J. Beamish & Neville, 1995; R .J. Beamish, Thomson, & Farlane, 1992; Pearcy, 1992).

Wildland Fire

Wildland fires that are allowed to burn naturally in riparian or upland areas may benefit or harm aquatic species, depending on the degree of departure from natural fire regimes. Although most fires are small in size, large size fires increase the chances of adverse effects on aquatic species. Large fires that burn near the shores of streams and rivers can have biologically significant short-term effects. They include increased water temperatures, ash, nutrients, pH, sediment, toxic chemicals, and large woody debris (Buchwalter, Sandahl, Jenkins, & Curtis, 2004; Rinne, 2004). Nevertheless, fire is also one of the dominant habitat-forming processes in mountain streams (P.A. Bisson et al., 2003). As a result, many large fires burning near streams can result in fish kills with the survivors actively moving downstream to avoid poor water quality conditions (Greswell, 1999; Rinne, 2004). The patchy, mosaic pattern burned by fires provides a refuge for those fish and invertebrates that leave a burning area or simply spares some fish that were in a different location at the time of the fire (USFS, 2000). Small fires or fires that burn entirely in upland areas also cause ash to enter rivers and increase smoke in the atmosphere, contributing to ammonia concentrations in rivers as the smoke adsorbs into the water (Greswell, 1999).

The presence of ash also has indirect effects on aquatic species depending on the amount of ash entry into the water. All ESA-listed salmonids rely on macroinvertebrates as a food source for at least a portion of their life histories. When small amounts of ash enter the water, there are usually no noticeable changes to the macroinvertebrate community or the water quality (Bowman & Minshall, 2000). When significant amounts of ash are deposited into rivers, the macroinvertebrate community density and composition may be moderately to drastically reduced for a full year with long-term effects lasting 10 years or more (Buchwalter, Jenkins, & Curtis, 2003; Buchwalter, et al., 2004; Minshall, Royer, & Robinson, 2001). Larger fires can also indirectly affect fish by altering water quality. Ash and smoke contribute to elevated ammonium, nitrate, phosphorous, potassium, and pH, which can remain elevated for up to four months after forest fires (Buchwalter, et al., 2003).

Oceanographic Features, Climatic Variability and Climate Change

Oceanographic features of the action area may influence prey availability and habitat for Pacific salmonids. These features comprise climate regimes which may suffer regime shifts due to climate changes or other unknown influences. The action area includes important spawning and rearing grounds and physical and biological features essential to the conservation of listed Pacific salmonids - *i.e.*, water quality, prey, and passage conditions. These Pacific oceanographic conditions, climatic variability, and climate change may affect salmonids in the action area.

There is evidence that Pacific salmon abundance may have fluctuated for centuries as a consequence of dynamic oceanographic conditions (R. J. Beamish & Bouillon, 1993; R. J. Beamish, Sweeting, & Neville, 2009; Finney, Gregory-Eaves, Douglas, & Smol, 2002). Sediment cores reconstructed for 2,200-year records have shown that Northeastern

Pacific fish stocks have historically been regulated by these climate regimes (Finney, et al., 2002). The long-term pattern of the Aleutian Low pressure system has corresponded to the trends in salmon catch, to copepod production, and to other climate indices, indicating that climate and the marine environment may play an important role in salmon production. Pacific salmon abundance and corresponding worldwide catches tend to be large during naturally-occurring periods of strong Aleutian low pressure causing stormier winters and upwelling, positive Pacific Decadal Oscillation (PDO), and an above average Pacific circulation index (R. J. Beamish, et al., 2009). A trend of an increasing Aleutian Low pressure indicates high pink and chum salmon production and low production of coho and Chinook salmon (R. J. Beamish, et al., 2009). The abundance and distribution of salmon and zooplankton also relate to shifts in North Pacific atmosphere and ocean climate (Francis & Hare, 1994).

Over the past century, regime shifts have occurred as a result of the North Pacific's natural climate regime. Reversals in the prevailing polarity of the PDO occurred around 1925, 1947, 1977, and 1989 (Hare & Mantua., 2000; Mantua, Hare, Zhang, Wallace, & Francis, 1997). The reversals in 1947 and 1977 correspond to dramatic shifts in salmon production regimes in the North Pacific Ocean (Mantua, et al., 1997). During the pre-1977 climate regime, the productivity of salmon populations from the Snake River exceeded expectations (residuals were positive) when values of the PDO were negative (Levin, 2003). During the post-1977 regime when ocean productivity was generally lower (residuals were negative), the PDO was negative (Levin, 2003).

A smaller, less pervasive regime shift occurred in 1989 (Hare & Mantua., 2000). Beamish *et al.*(2000) analyzed this shift and found a decrease in marine survival of coho salmon in Puget Sound and off the coast of California to Washington. Trends in coho salmon survival were linked over the southern area of their distribution in the Northeast Pacific to a common climatic event. The Aleutian Low Pressure Index and the April flows from the Fraser River also changed abruptly about this time (R. J. Beamish, et al., 2000).

The Intergovernmental Panel on Climate Change (IPCC) has high confidence that some hydrological systems have been affected through increased runoff and earlier spring peak discharge in glacier- and snow-fed rivers and through effects on thermal structure and water quality of warming rivers and lakes (IPCC, 2007). Oceanographic models project a weakening of the thermohaline circulation resulting in a reduction of heat transport into high latitudes of Europe, an increase in the mass of the Antarctic ice sheet, and a decrease in the Greenland ice sheet (IPCC, 2001). These changes, coupled with increased acidification of ocean waters, are expected to have substantial effects on marine and hydrological productivity and food webs, including populations of salmon and other salmonid prey (Hard, et al., 1992).

Carbon dioxide emissions are also predicted to have major environmental impacts along the west coast of North America during the 21st century and beyond (Climate Impacts Group (CIG), 2004; IPCC, 2001). Eleven of the past 12 years (1995 - 2006) rank among the 12 warmest years in the instrumental record of global surface temperature since 1850 (IPCC, 2007). The IPCC predicts that, for the next two decades, a warming of about 0.2°C per decade will occur for a range of predicted carbon dioxide emissions scenarios (IPCC, 2007). This warming trend continues in both water and air. Global average sea level has risen since 1961 at an average rate of 1.8 mm/year and since 1993 at 3.1 mm/year, with contributions from thermal expansion, melting glaciers and ice caps, and the polar ice sheets (IPCC, 2007).

Poor environmental conditions for salmon survival and growth may be more prevalent with projected warming increases. Increasing climate temperatures can influence smolt development which is limited by time and temperature (McCormick et al., 2009). Food availability and water temperature may affect proper maturation and smoltification and feeding behavior (Mangel, 1994). Climate change may also have profound effects on seawater entry and marine performance of anadromous fish, including increased salinity intrusion in estuaries due to higher sea levels, as well as a projected decrease of seawater pH (Orr et al., 2005). There is evidence that Chinook salmon survival in the Pacific during climate anomalies and El Nino events changes as a result of a shift from predation- to competition-based mortality in response to declines in predator and prey abundances and increases in pink salmon abundance (Ruggerone & Goetz, 2004). If climate change leads to an overall decrease in the availability of food, then returning fish will likely be smaller (Mangel, 1994). Finally, future climatic warming could lead to alterations of river temperature regimes, which could further reduce available fish habitat (Yates et al., 2008).

Although the impacts of global climate change are less clear in the ocean environment, early modeling efforts suggest that increased temperatures will likely increase ocean stratification. This stratification coincides with relatively poor ocean habitat for most Pacific Northwest salmon populations (Climate Impacts Group (CIG), 2004; IPCC, 2001).

We expect changing weather and oceanographic conditions may affect prey availability, temperature and water flow in habitat conditions, and growth for all 28 ESUs/DPSs. Consequently, we expect the long-term survival and reproductive success for listed salmonids to be greatly affected by global climate change.

In addition to changes in hydrological regimes that will affect salmon, climate change will affect agriculture as rainfall and temperature patterns shift. Some crops currently well-suited for particular regions may instead be grown in alternate locations, Agricultural pest pressures are also likely to change over time. Both the shifts in crop location and pest pressure are likely to change pesticide use patterns.

Anthropogenic Mortality Factors

In this section we address anthropogenic threats in the geographic regions across the action area. Land use activities associated with logging, road construction, urban development, mining, agriculture, and recreation have significantly altered fish habitat quantity and quality. Impacts associated with these activites include: (1) alteration of streambank and channel morphology; (2) alteration of ambient stream temperatures; (3) degradation of water quality; (4) elimination or degradation of spawning and rearing habitat; (5) fragmentation of available habitats: and (6) removal or impairment of riparian vegetation – resulting in increased water temperatures and streambank erosion.

Prior to discussion of each geographic region, three major issues are highlighted: pesticide contamination, elevated water temperature, and loss of habitat/habitat connectivity. These three factors are the most relevant to the current analysis. We provide information on pesticide detections in the aquatic environment and highlight their background levels from past and ongoing anthropogenic activities. This information is pertinent to EPA's proposed registration of oryzalin, pendimethalin, and trifluralin in the U.S. and its territories. Some of these chemicals have been in use for multiple decades, they have documented presence in our nation's rivers, and thus over the years have contributing effects to the environmental baseline. As water temperature plays such a strong role in salmonid distribution, we also provide a general discussion of anthropogenic temperature impacts. Next, we discuss the health of riparian systems and floodplain connectivity, as this habitat is vital to salmonid survival. Finally, we provide a brief overview of the results of section 7 consultations relevant to this analysis.

Baseline Pesticide Detections in Aquatic Environments

In the environmental baseline, we address pesticide detections reported as part of the U.S. Geological Survey (USGS) National Water-Quality Assessment Program's (NAWQA) national assessment (Gilliom et al., 2006). We chose this approach because the NAWQA studies present the same level of analysis for each area. Further, given the lack of uniform reporting standards, we are unable to present a comprehensive basin-specific analysis of detections from other sources.

According to Gilliom *et al.* (2006), the distributions of the most prevalent pesticides in streams and ground water correlate with land use patterns and associated present or past pesticide use. When pesticides are released into the environment, they frequently end up as contaminants in aquatic environments. Depending on their physical properties some are rapidly transformed via chemical, photochemical, and biologically mediated reactions into other compounds, known as degradates. These degradates may become as prevalent as the parent pesticides depending on their rate of formation and their relative persistence.

In the *Exposure* section of the *Effects of the Proposed Action* we present a more comprehensive discussion of available monitoring data from the NAWQA program, state databases maintained by California, Oregon, and Washington, and other targeted monitoring studies.

National Water-Quality Assessment Program

From 1992 - 2001, the USGS sampled water from 186 stream sites within 51 study units; bed-sediment samples from 1,052 stream sites, and fish from 700 stream sites across the continental U.S. Concentrations of pesticides were detected in streams and groundwater within most areas sampled with substantial agricultural or urban land uses. NAWQA results further detected at least one pesticide or degradate more than 90% of the time in water, in more than 80% in fish samples, and greater than 50% of bed-sediment samples from streams in watersheds with agricultural, urban, and mixed land use (Gilliom, et al., 2006).

Twenty-four pesticides and one degradate were each detected in over 10% of streams in agricultural, urban, or mixed land use areas. These 25 compounds include 11 agriculture-use herbicides and the atrazine degradate deethylatrazine; 7 urban-use herbicides; and 6 insecticides used in both agricultural and urbanareas. Five of the insecticides were carbaryl, carbofuran, chlorpyrifos, diazinon, and malathion. NMFS assessed the effects of these five insecticides on listed salmonids in its 2008 and 2009 Opinions (NMFS, 2008e, 2009c).

Another dimension of pesticides and their degradates in the aquatic environment is their simultaneous occurrence as mixtures (Gilliom, et al., 2006). Mixtures result from the use of different pesticides for multiple purposes within a watershed or groundwater recharge area. Pesticides generally occur more often in natural waterbodies as mixtures than as individual compounds. Mixtures of pesticides were detected more often in streams than in ground water and at relatively similar frequencies in streams draining areas of agricultural, urban, and mixed land use. More than 90% of the time, water from streams in these developed land use settings had detections of two or more pesticides or degradates. About 70% and 20% of the time, streams had five or more and ten or more pesticides or degradates, respectively (Gilliom, et al., 2006). Fish exposed to multiple pesticides at once may also experience additive and synergistic effects. If the effects on a biological endpoint from concurrent exposure to multiple pesticides can be predicted by adding the potency of the pesticides involved, the effects are said to be additive. If, however, the response to a mixture leads to a greater than expected effect on the endpoint, and the pesticides within the mixture enhance the toxicity of one another, the effects are characterized as synergistic. These effects are of particular concern when the pesticides share a mode of action. NAWQA analysis of all detections indicates that more than 6,000 unique mixtures of 5 pesticides were detected in agricultural streams (Gilliom, et al., 2006). The number of unique mixtures varied with land use.

More than half of all agricultural streams sampled and more than three-quarters of all urban streams had concentrations of pesticides in water that exceeded one or more benchmarks for aquatic life. Aquatic life criteria are EPA water-quality guidelines for protection of aquatic life. Exceedance of an aquatic life benchmark level indicates a strong probability that aquatic species are being adversely affected. However, aquatic species may also be affected at levels below criteria. In agricultural streams, most concentrations that exceeded an aquatic life benchmark involved chlorpyrifos (21%), azinphos methyl (19%), atrazine (18%), *p,p'*-DDE (16%), and alachlor (15%) (Gilliom, et al., 2006). Finally, organochlorine pesticides that were discontinued 15 to 30 years ago still exceeded benchmarks for aquatic life and fish-eating wildlife in bed sediment or fish tissue samples from many streams.

National Pollutant Discharge Elimination System

Pollution originating from a discrete location such as a pipe discharge or wastewater treatment outfall is known as a point source. Point sources of pollution require a National Pollutant Discharge Elimination System (NPDES) permit. These permits are issued for aquaculture, concentrated animal feeding operations, industrial wastewater treatment plants, biosolids (sewer/sludge), pre-treatment and stormwater overflows. The EPA administers the NPDES permit program and states certify that NPDES permit holders comply with state water quality standards. Nonpoint source discharges do not originate from discrete points; thus, nonpoint sources are difficult to identify, quantify, and are not regulated. Examples of nonpoint source pollution include, but are not limited to, urban runoff from impervious surfaces, areas of fertilizer and pesticide application, sedimentation, and manure.

According to EPA's database of NPDES permits, about 243 NPDES individual permits are co-located with listed Pacific salmonids in California. Collectively, the total number of EPA-recorded NPDES permits in Idaho, Oregon, and Washington, that are co-located with listed Pacific salmonids is 1,978. See ESU/DPS maps for NPDES permits co-located within listed salmonid ESUs/DPSs within the states of California, Idaho, Oregon, and Washington in the *Status of Listed Resources* chapter.

On November 27, 2006, EPA issued a final rule which exempted pesticides from the NPDES permit process, provided that application was approved under FIFRA. The NPDES permits, then, do not include any point source application of pesticides to waterways in accordance with FIFRA labels. On January 7, 2009, the Sixth Circuit Court of Appeals vacated this rule (National Cotton Council v. EPA, 553 F.3d 927 (6th Cir. 2009)). The result of the vacature, according to the Sixth Circuit, is that "discharges of pesticide pollutants are subject to the NPDES permitting program" under the CWA. In response, EPA has developed a Pesticide General Permit through the NPDES permitting program to regulate such discharges. The permit is currently undergoing Section 7 consultation.

Baseline Water Temperature - Clean Water Act

Elevated temperature is considered a pollutant in most states with approved Water Quality Standards under the federal Clean Water Act (CWA) of 1972. Under the authority of the CWA, states periodically prepare a list of all surface waters in the state for which beneficial uses - such as drinking, recreation, aquatic habitat, and industrial use

– are impaired by pollutants. This process is in accordance with section 303(d) of the CWA. Estuaries, lakes, and streams listed under 303(d) are those that are considered impaired or threatened by pollution. They are water quality limited, do not meet state surface water quality standards, and are not expected to improve within the next two years.

Each state has separate and different 303(d) listing criteria and processes. Generally a water body is listed separately for each standard it exceeds, so it may appear on the list more than once. If a water body is not on the 303(d) list, it is not necessarily contaminant-free; rather it may not have been tested. Therefore, the 303(d) list is a minimum list for the each state regarding polluted water bodies by parameter.

After states develop their lists of impaired waters, they are required to prioritize and submit their lists to EPA for review and approval. Each state establishes a priority ranking for such waters, considering the severity of the pollution and the uses to be made of such waters. States are expected to identify high priority waters targeted for Total Maximum Daily Load (TMDL) development within two years of the 303(d) listing process.

Temperature is significant for the health of aquatic life. Water temperatures affect the distribution, health, and survival of native cold-blooded salmonids in the Pacific Northwest. These fish will experience adverse health effects when exposed to temperatures outside their optimal range. For listed Pacific salmonids, water temperature tolerance varies between species and life stages. Optimal temperatures for rearing salmonids range from 10ºC to 16ºC. In general, the increased exposure to stressful water temperatures and the reduction of suitable habitat caused by drought conditions reduce the abundance of salmon. Warm temperatures can reduce fecundity, reduce egg survival, retard growth of fry and smolts, reduce rearing densities, increase susceptibility to disease, decrease the ability of young salmon and trout to compete with other species for food, and to avoid predation (McCullough, 1999; B.C. Spence, et al., 1996). Migrating adult salmonids and upstream migration can be delayed by excessively warm stream temperatures. Excessive stream temperatures may also negatively affect incubating and rearing salmonids (S. V. Gregory & Bisson, 1997).

Sublethal temperatures (above 24ºC) could be detrimental to salmon by increasing susceptibility to disease (Colgrove & Wood, 1966) or elevating metabolic demand (J.R. Brett, 1995). Substantial research demonstrates that many fish diseases become more virulent at temperatures over 15.6ºC (McCullough, 1999). Due to the sensitivity of salmonids to temperature, states have established lower temperature thresholds for salmonid habitat as part of their water quality standards. A water body is listed for temperature on the 303(d) list if the 7-day average of the daily maximum temperatures

Table 52. Washington State water temperature thresholds for salmonid habitat. These temperatures are representative of limits set by California, Idaho, and Oregon (WSDE, 2006).

Category	Highest 7-DADMax
Salmon and Trout Spawning	13°C (55.4°F)
Core Summer Salmonid Habitat	16°C (60.8°F)
Salmonid Spawning, Rearing, and Migration	17.5°C (63.5°F)
Salmonid Rearing and Migration Only	17.5°C (63.5°F)

Water bodies that are not designated salmonid habitat are also listed if they have a one-day maximum over a given background temperature. Using publicly available Geographic Information System (GIS) layers, we determined the number of km on the 303(d) list for exceeding temperature thresholds within the boundaries of each ESU/DPS (Table 53). Because the 303(d) list is limited to the subset of rivers tested, the chart values should be regarded as lower-end estimates. Each of the four states are in the process of finalizing their 2010 Water Quality Integrated Reports, complete with 303(d) list.

While some ESU/DPS ranges do not contain any 303(d) rivers listed for temperature, others show considerable overlap. These comparisons demonstrate the relative significance of elevated temperature among ESUs/DPSs. Increased water temperature may result from wastewater discharge, decreased water flow, minimal shading by riparian areas, and climatic variation.

Table 53. Number of kilometers of river, stream and estuaries included in state 303(d) lists due to temperature that are located within each salmonid ESU/DPS. Data was taken from the most recent GIS layers available from state water quality assessments reports.*

Species	ESU	California	Oregon	Washington	Idaho	Total
Chinook Salmon	Puget Sound	–	–	373.7	–	373.7
	Lower Columbia River	–	147.0	218.6	–	365.6
	Upper Columbia River Spring - Run	–	–	19.3	–	19.3
	Snake River Fall - Run	–	-	113.4	160.2	273.6
	Snake River Spring/Summer - Run	–	121.1	111.7	275.9	508.7
	Upper Willamette River	–	533.0	–	–	533.0
	California Coastal	9,623.5	–	–	–	9,623.5
	Central Valley Spring - Run	29.9	–	–	–	29.9
	Sacramento River Winter - Run	29.9	–	–	–	29.9
Chum Salmon	Hood Canal Summer - Run	–	–	47.7	–	47.7
	Columbia River	–	95.0	216.2	–	311.2
Coho Salmon	Lower Columbia River	–	99.2	221.5	–	320.7
	Oregon Coast	–	920.4	–	–	920.4
	Southern Oregon and Northern California Coast	11,044.5	694.5	–	–	11,739.0
	Central California Coast	4,731.7	–	–	–	4,731.7
Sockeye Salmon	Ozette Lake	–	–	22.5	–	22.5
	Snake River	–	–	–	0.0	0.0
Steelhead	Puget Sound	–	–	373.7	–	373.7
	Lower Columbia River	–	147.0	140.3	–	287.3
	Upper Willamette River	–	299.0	–	–	299.0
	Middle Columbia River	–	1498.5	209.4	–	1707.9
	Upper Columbia River	–	–	33.5	–	33.5
	Snake River	–	121.1	111.7	739.8	972.6
	Northern California	6,7920.0	–	–	–	6,7920.0
	Central California Coast	2,948.8	–	–	–	2,948.8
	California Central Valley	367.8	–	–	–	367.8
	South-Central California Coast	282.8	–	–	–	282.8

	Southern California	151.5	–	–	–	151.5

*CA 2010, Oregon 2004-06, Washington 2008, and Idaho 2008. (California EPA TMDL Program 2011, Oregon Department of Environmental Quality 2008, Washington State Department of Ecology 2009, Idaho Department of Environmental Quality 2009).

Baseline Habitat Condition

As noted above in the *Status of the Species* section, the riparian zones for many of the ESUs/DPSs are degraded. Riparian zones are the areas of land adjacent to rivers and streams. These systems serve as the interface between the aquatic and terrestrial environments. Riparian vegetation is characterized by emergent aquatic plants and species that thrive on close proximity to water, such as willows. This vegetation maintains a healthy river system by reducing erosion, stabilizing main channels, and providing shade. Leaf litter that enters the river becomes an important source of nutrients for invertebrates (P. A. Bisson & Bilby, 2001). Riparian zones are also the major source of large woody debris (LWD). When trees fall and enter the water, they become an important part of the ecosystem. The LWD alters the flow, creating the pools of slower moving water preferred by salmon (R. E. Bilby, Fransen, Walter, & Scarlett, 2001). While not necessary for pool formation, LWD is associated with around 80% of pools in northern California, Washington, and the Idaho pan-handle (R. E. Bilby & Bisson, 2001).

Bilby and Bisson (2001) discuss several studies that associate increased LWD with increased pools, and both pools and LWD with salmonid productivity. Their review also includes documented decreases in salmonid productivity following the removal of LWD. Other benefits of LWD include deeper pools, increased sediment retention, and channel stabilization.

Floodplains are relatively flat areas adjacent to larger streams and rivers. They allow for the lateral movement of the main channel and provide storage for floodwaters during periods of high flow. Water stored in the floodplain is later released during periods of low flow. This process ensures adequate flows for salmonids during the summer months, and reduces the possibility of high-energy flood events destroying salmonid redds (C. J. Smith, 2005).

Periodic flooding of these areas creates habitat used by salmonids. Thus, floodplain areas vary in depth and widths and may be intermittent or seasonal. Storms also wash sediment and LWD into the main stem river, often resulting in blockages. These blockages may force the water to take an alternate path and result in the formation of side channels and sloughs (Benda, Miller, Dunne, Reeves, & Agee, 2001). Side channels and sloughs are important spawning and rearing habitat for salmonids. The degree to which these off-channel habitats are linked to the main channel via surface water connections is referred to as connectivity (PNERC, 2002). As river height increases with heavier flows, more side channels form and connectivity increases. Juvenile salmonids migrate to and rear in these channels for a certain period of time before swimming out to the open sea.

Healthy riparian habitat and floodplain connectivity are vital for supporting a salmonid population. Chinook salmon and steelhead have life history strategies that rely on floodplains during their juvenile life stages. Chum salmon use adjacent floodplain areas for spawning. Soon after their emergence, chum salmon use the riverine system to rapidly reach the estuary where they mature, rear, and migrate to the ocean. Coho salmon use the floodplain landscape extensively for rearing. Estuarine floodplains can provide value to juveniles of all species once they reach the salt water interface.

Once floodplain areas have been disturbed, it can take decades for their recovery (C. J. Smith, 2005). Consequently, most land use practices cause some degree of impairment. Development leads to construction of levees and dikes, which isolate the mainstem river from the floodplain. Agricultural development and grazing in riparian areas also significantly change the landscape. Riparian areas managed for logging, or logged in the past, are often impaired by a change in species composition. Most areas in the northwest were historically dominated by conifers. Logging results in recruitment of deciduous trees, decreasing the quality of LWD in the rivers. Deciduous trees have smaller diameters than conifers; they decompose faster and are more likely to be displaced (C. J. Smith, 2005).

Without a properly functioning riparian zone, salmonids contend with a number of limiting factors. They face reductions in quantity and quality of both off-channel and pool habitats. Also, when seasonal flows are not moderated, both higher and lower flow conditions exist. Higher flows can displace fish and destroy redds, while lower flows cut off access to parts of their habitat. Finally, decreased vegetation limits the available shade and cover, exposing individuals to higher temperatures and increased predation.

Baseline Pesticide Consultations

NMFS has consulted with EPA on the registration of several pesticides. NMFS (NMFS, 2008c) determined that current use of chlorpyrifos, diazinon, and malathion is likely to jeopardize the continued existence of 27 listed salmonid ESUs/DPSs. NMFS (NMFS, 2009b) further determined that current use of carbaryl and carbofuran is likely to jeopardize the continued existence of 22 ESUs/DPSs; and the current use of methomyl is likely to jeopardize the continued existence of 18 ESUs/DPSs of listed salmonids. NMFS also published conclusions regarding the registration of 12 different a.i.s (NMFS, 2010). NMFS concluded that pesticide products containing azinphos methyl, disulfoton, fenamiphos, methamidophos, or methyl parathion are not likely to jeopardize the continuing existence of any listed Pacific Salmon or destroy or adversely modify designated critical habitat. NMFS also concluded that the effects of products containing bensulide, dimethoate, ethoprop, methidathion, naled, phorate, or phosmet are likely to jeopardize the continued existence of some listed Pacific Salmonids and to destroy or adversely modify designated habitat of some listed salmonids. Most recently, NMFS issued a biological opinion on the effects of four herbicides and two fungicides (link to Batch 4 Opinion). NMFS concluded that products containing 2,4-D are likely to jeopardize the existence of all listed salmonids, and adversely modify or destroy the critical habitat of dome ESU / DPSs. Products containing chlorothalonil or diuron were also likely to adversely modify or destroy critical habitat, but not likely to jeopardize listed salmonids. NMFS also concluded that products containing captan, linuron, or triclopyr BEE do not jeopardize the continued existence of any ESUs/DPSs of listed Pacific salmonids or adversely modify designated critical habitat.

Geographic Regions

For a more fine scale analysis, we divided the action area into geographic regions: the Southwest Coast Region (California and the southern parts of the State of Oregon) and the Pacific Northwest Region (Idaho, Oregon, and Washington). The Pacific Northwest Region was further subdivided according to ecoregions or other natural features important to NMFS trust resources. Use of these geographic regions is consistent with previous NMFS consultations conducted at the national level (NMFS, 2007). We summarize the principal anthropogenic factors occurring in the environment that influence the current status of listed species within each region. Table 54 provides a breakdown of these regions and includes the USGS subregions and accounting units for each region. It also provides a list of ESUs/DPSs found in each accounting unit, as indicated by Federal Register listing notices.

Table 54. USGS Subregions and accounting units within the Northwest and Southwest Regions, along with ESUs/DPSs present within the area (Seaber, Kapinos, & Knapp, 1987).

Region	USGS Subregion	Accounting Unit	State	HUC no.	ESU/DPS
Pacific Northwest: Columbia River Basin	Upper Columbia River Basin	—	WA	170200	Upper Columbia Spring-run Chinook; Upper Columbia Steelhead; Middle Columbia Steelhead
	Yakima River Basin	—	WA	170300	Middle Columbia Steelhead
	Lower Snake River Basin	Lower Snake River Basin	ID, OR, WA	170601	Snake River Steelhead; Snake River Spring/Summer-run Chinook; Snake River Fall-run Chinook; Snake River Sockeye
		Salmon River Basin	ID	170602	Snake River Steelhead; Snake River Spring/Summer - Run Chinook; Snake River Fall - Run Chinook; Snake River Sockeye

Region	USGS Subregion	Accounting Unit	State	HUC no.	ESU/DPS
		Clearwater River Basin	ID, WA	170603	Snake River Steelhead; Snake River Fall - Run Chinook
	Middle Columbia River Basin	Middle Columbia River Basin	OR, WA	170701	Middle Columbia Steelhead; Lower Columbia Chinook; Columbia Chum; Lower Columbia Coho
		John Day River Basin	OR	170702	Middle Columbia Steelhead
		Deschutes River Basin	OR	170703	Middle Columbia Steelhead
	Lower Columbia River Basin	—	OR, WA	170800	Lower Columbia Chinook; Columbia Chum; Lower Columbia Steelhead; Lower Columbia Coho
	Willamette River Basin	—	OR	170900	Upper Willamette Chinook; Upper Willamette Steelhead; Lower Columbia Chinook; Lower Columbia Steelhead; Lower Columbia Coho
Pacific Northwest: Coastal Drainages	Oregon-Washington Coastal Basin	Washington Coastal	WA	171001	Ozette Lake Sockeye
		Northern Oregon Coastal	OR	171002	Oregon Coast Coho
		Southern Oregon Coastal	OR	171003	Oregon Coast Coho; Southern Oregon and Northern California Coast Coho
Pacific Northwest: Puget Sound	Puget Sound	—	WA	171100	Puget Sound Chinook; Hood Canal Summer - Run Chum; Puget Sound Steelhead
Southwest Coast	Klamath-Northern California Coastal	Northern California Coastal	CA	180101	Southern Oregon and Northern California Coast Coho; California Coastal Chinook; Northern California Steelhead; Central California Coast Steelhead; Central California Coast Coho
		Klamath River Basin	CA, OR	180102	Southern Oregon and Northern California Coast Coho

Region	USGS Subregion	Accounting Unit	State	HUC no.	ESU/DPS
	Sacramento River Basin	Lower Sacramento River Basin	CA	180201	Central Valley Spring-run Chinook; California Central Valley Steelhead; Sacramento River Winter-run Chinook
	San Joaquin River Basin	—	CA	180400	California Central Valley Steelhead
	San Francisco Bay	—	CA	180500	Central California Coast Steelhead; Southern Oregon and Northern California Coast Coho; Central California Coast Coho; Sacramento River Winter-run Chinook
	Central California Coastal	—	CA	180600	Central California Coast Steelhead; Southern Oregon and Northern California Coast Coho; South-Central California Coast Steelhead; Southern California Steelhead; Central California Coast Coho; Sacramento River Winter-run Chinook
	Southern California Coastal	Ventura-San Gabriel Coastal	CA	180701	Southern California Steelhead
		Laguna-San Diego Coastal	CA	180703	Southern California Steelhead

Southwest Coast Region

The basins in this section occur in the States of California and the southern parts of Oregon. Ten of the 28 species addressed in the Opinion occur in the Southwest Coast Region. They are the California Coastal Chinook (CC) salmon, Central Valley (CV) Spring-run Chinook salmon, Sacramento River winter-run Chinook salmon, Southern Oregon/Northern California Coast (SONCC) coho salmon, Central California Coast (CCC) coho salmon, Northern California (NC) steelhead, Central California Coast (CCC) steelhead, California Central Valley (CCV) steelhead, South-Central California Coast (S-

CCC) steelhead, and Southern California (SC) steelhead (Table 54). Table 55 and Table 56 show land area in km² for each ESU/DPS located in the Southwest Coast Region.

Table 55. Area of land use categories within the range Chinook and Coho Salmon ESUs in km². The total area for each category is given in bold. Land cover was determined via the National Land Cover Database 2006, developed by the Multi-Resolution Land Characteristics (MRLC) Consortium, a consortium of nine federal agencies (USGS, EPA, USFS, NOAA, NASA, BLM, NPS, NRCS, and USFWS). Land cover class definitions are available at: http://www.mrlc.gov/nlcd_definitions.php

Land Cover		Chinook Salmon			Coho Salmon	
sub category	code	CA Coastal	Central Valley	Sacramento River	S Oregon and N CA	Central CA Coast
Water		**128**	**367**	**367**	**205**	**158**
Open Water	11	128	367	367	194	158
Perennial Snow/Ice	12	0	0	0	11	0
Developed Land		**1,139**	**2,755**	**2,755**	**1,979**	**996**
Open Space	21	828	1,174	1,174	1,390	630
Low Intensity	22	140	635	635	238	173
Medium Intensity	23	98	616	567	97	141
High Intensity	24	11	153	153	24	32
Barren Land	31	62	178	178	230	21
Undeveloped Land		**19,067**	**15,063**	**15,063**	**43,324**	**9,169**
Deciduous Forest	41	838	657	657	1,041	208
Evergreen Forest	42	10,642	3,707	3,707	27,253	4,744
Mixed Forest	43	1,547	476	476	2,394	921
Shrub/Scrub	52	3,858	3,245	3,245	9,652	1,630
Herbaceous	71	2,118	6,261	6,261	2,798	1,628
Woody Wetlands	90	43	189	189	130	25
Emergent Wetlands	95	20	527	527	56	13
Agriculture		**406**	**5,796**	**5,796**	**1,189**	**249**
Hay/Pasture	81	182	754	754	719	6
Cultivated Crops	82	224	5,043	5,043	470	243
TOTAL (inc. open water)		20,740	23,982	23,982	46,697	10,572
TOTAL (w/o open water)		20,612	23,615	23,615	46,503	10,414

Table 56. Area of Land Use Categories within the Range of Steelhead Trout DPSs (km²). The total area for each category is given in bold. Land cover was determined via the National Land Cover Database 2006, developed by the Multi-Resolution Land Characteristics (MRLC) Consortium, a consortium of nine federal agencies (USGS, EPA, USFS, NOAA, NASA, BLM, NPS, NRCS, and USFWS). Land cover class definitions are available at: http://www.mrlc.gov/nlcd_definitions.php

Land Cover			Steelhead				
	sub category	code	Northern CA	Central CA Coast	CA Central Valley	South-Central CA coast	Southern CA
Water			**92**	**1,426**	**422**	**114**	**161**
	Open Water	11	92	1,426	422	114	161
	Perennial Snow/Ice	12	0	0	0	0	0
Developed Land			**748**	**3,725**	**3,534**	**1,765**	**7,517**
	Open Space	21	612	1,234	1,472	1,019	2,013
	Low Intensity	22	50	890	792	249	1,825
	Medium Intensity	23	32	1,244	837	173	2,800
	High Intensity	24	3	333	211	23	780
	Barren Land	31	53	24	222	300	99
Undeveloped Land			**16,139**	**10,949**	**19,138**	**14,968**	**12,911**
	Deciduous Forest	41	752	179	744	2	1
	Evergreen Forest	42	9,751	2,501	3,942	1,730	932
	Mixed Forest	43	1,154	2,092	593	1,924	989
	Shrub/Scrub	52	2,936	2,262	3,786	4,957	8,265
	Herbaceous	71	1,495	3,509	9,396	6,193	2,594
	Woody Wetlands	90	33	37	245	93	8379
	Emergent Wetlands	95	19	369	431	69	51
Agriculture			**194**	**545**	**10,507**	**1,497**	**1,016**
	Hay/Pasture	81	178	35	1,640	196	161
	Cultivated Crops	82	15	511	8,867	1,301	8550
	TOTAL (inc. open water)		17,173	16,645	33,601	18,344	21,604
	TOTAL (w/o open water)		17,081	15,220	33,179	18,230	21,443

Select watersheds described herein characterize the past, present, and future human activities and their impacts on the area. The Southwest Coast region encompasses all Pacific Coast rivers south of Cape Blanco, Oregon through southern California. NMFS has identified the Cape Blanco area as an ESU biogeographic boundary for Chinook and coho salmon, and steelhead based on strong genetic, life history, ecological and habitat differences north and south of this landmark. Major rivers contained in this grouping of watersheds are the Sacramento, San Joaquin, Salinas, Klamath, Russian, Santa Ana, and Santa Margarita Rivers (Table 57).

Table 57. Select rivers in the southwest coast region (Carter & Resh, 2005).

Watershed	Approx Length (mi)	Basin Size (mi^2)	Physiographic Provinces*	Mean Annual Precipitation (in)	Mean Discharge (cfs)	No. Fish Species (native)	No. Endangered Species
Rogue River	211	5,154	CS, PB	38	10,065	23 (14)	11
Klamath River	287	15,679	PB, B/R, CS	33	17,693	48 (30)	41
Eel River	200	3,651	PB	52	7,416	25 (15)	12
Russian River	110	1,439	PB	41	2,331	41 (20)	43
Sacramento River	400	27,850	PB, CS, B/R	35	23,202	69 (29)	>50 T & E spp.
San Joaquin River	348	83,409	PB, CS	49	4,662	63	>50 T & E spp.
Salinas River	179	4,241	PB	14	448	36 (16)	42 T & E spp.
Santa Ana River	110	2,438	PB	13	60	45 (9)	54
Santa Margarita River	27	1,896	LC, PB	49.5	42	17 (6)	52

* Physiographic Provinces: PB = Pacific Border, CS = Cascades-Sierra Nevada Range, B/R = Basin & Range.

Land Use

Table 58 displays major landuse categories in California. Within the Southwest Coast Region, forest and vacant land are the dominant land uses. Grass, shrubland, and urban uses are the dominant land uses in the southern basins (Table 58). Overall, the most developed watersheds are the Santa Ana, Russian, and Santa Margarita rivers. The Santa Ana watershed encompasses portions of San Bernardino, Los Angeles, Riverside, and Orange counties. About 50% of the coastal subbasin in the Santa Ana watershed is dominated by urban land uses and the population density is about 1,500 people per square mile. When steep and undevelopable lands are excluded from this area, the population density in the watershed is about 3,000 people per square mile. However, the most densely populated portion of the basin is near the City of Santa Ana. Here, the population density reaches 20,000 people per square mile (Belitz et al., 2004; Burton, Izbicki, & Paybins, 1998). The basin is home to nearly 5 million people and this population is projected to increase two-fold in the next 50 years (Belitz, et al., 2004; Burton, et al., 1998).

Table 58. Land uses and population density in several southwest coast watersheds (Carter & Resh, 2005).

Watershed	Land Use Categories (Percent)				Density (people/mi^2)
	Agriculture	Forest	Urban	Other	
Rogue River	6	83	<1	9 grass & shrub	32
Klamath River	6	66	<1	24 grass, shrub, wetland	5
Eel River	2	65	<1	31 grass & shrub	9
Russian River	14	50	3	31 (23 grassland)	162
Sacramento River	15	49	2	30 grass & shrub	61
San Joaquin River	30	27	2	36 grass & shrub	76
Salinas River	13	17	1	65 (49 grassland)	26
Santa Ana River	11	57	32	---	865
Santa Margarita River	12	11	3	71 grass & shrub	135

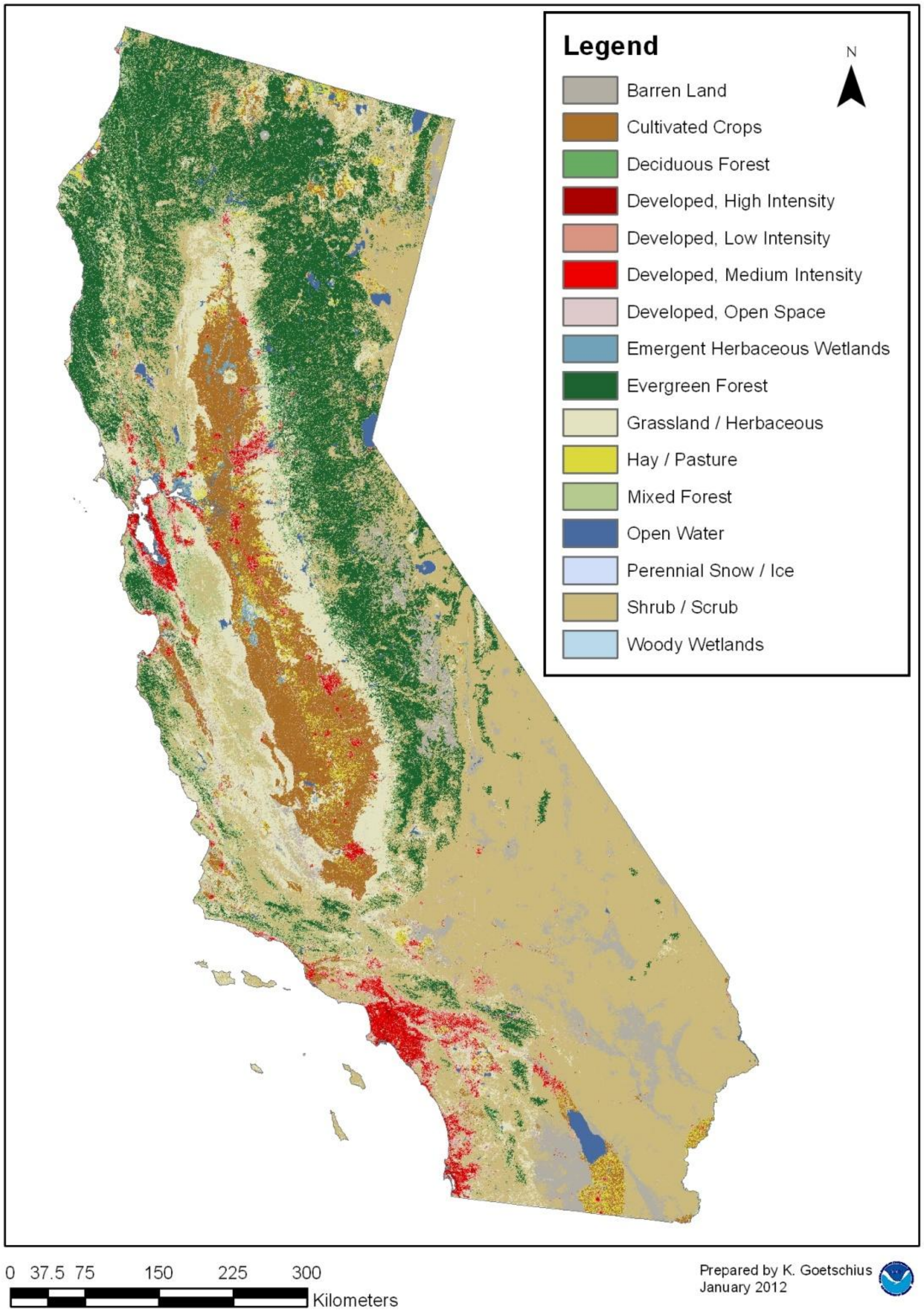


Figure 50. Landuse in Southwest Region. Using the National Land Cover Database 2006.

As a watershed becomes urbanized, human population increases and changes occur in stream habitat, water chemistry, and the biota (plants and animals) that live there. The most obvious effect of urbanization is the loss of natural vegetation which results in an increase in impervious cover and dramatic changes to the natural hydrology of urban streams. Urbanization generally results in land clearing, soil compaction, modification and/or loss of riparian buffers, and modifications to natural drainage features (Richter, 2002). The increased impervious cover in urban areas leads to increased volumes of runoff, increased peak flows and flow duration, and greater stream velocity during storm events.

Runoff from urban areas also contains all the chemical pollutants from automobile traffic and roads as well as those from industrial sources and residential use. Urban runoff is also typically warmer than receiving waters and can significantly increase temperatures in small urban streams. Warm stream water is detrimental to native aquatic life resident fish and the rearing and spawning needs of anadromous fish. Wastewater treatment plants (WWTP) replace septic systems, resulting in point discharges of nutrients and other contaminants not removed in the processing. Additionally, some cities have combined sewer/stormwater overflows and older systems may discharge untreated sewage following heavy rainstorms. WWTP outfalls often discharge directly into the rivers containing salmonids. These urban nonpoint and point source discharges affect the water quality and quantity in basin surface waters.

In many basins, agriculture is the major water user and the major source of water pollution to surface waters. During general agricultural operations, pesticides are applied on a variety of crops for pest control. These pesticides may contaminate surface water via runoff especially after rain events following application. Agricultural uses of the a.i.s are described in the *Description of the Proposed Action*. Pesticide detection data for these same a.i.s are reported in the Monitoring subsection of the *Effects* chapter.

Pesticide Reduction Programs in the Southwest Coast Region

When using these three a.i.s, growers must adhere to the court-ordered injunctive relief, requiring buffers of 20 yards for ground application and 100 yards for any aerial application. These measures are mandatory in all four states, pending completion of consultation.

California State Code does not include specific limitations on pesticide application aside from human health protections. It only includes statements advising that applicators are required to follow all federal, state, and local regulations.

Additionally, pesticide reduction programs already exist in California to minimize levels of the above a.i.s into the aquatic environment. Monitoring of water resources is handled by the California Environmental Protection Agency's Regional Water Boards. Each Regional Board makes water quality decisions for its region including setting standards and determining waste discharge requirements. The Central Valley Regional Water Quality Control Board (CVRWQCB) addresses issues in the Sacramento and San Joaquin River Basins. These river basins are characterized by crop land, specifically orchards, which historically rely heavily on organophosphates for pest control.

In 2003, the CVRWQCB adopted the Irrigated Lands Waiver Program (ILWP). Participation was required for all growers with irrigated lands that discharge waste which may degrade water quality. However, the ILWP allowed growers to select one of three methods for regulatory coverage (Markle, Kalman, & Klassen, 2005). These options included: 1) join a Coalition Group approved by the CVRWQCB, 2) file for an Individual Discharger Conditional Waiver, and 3) comply with zero discharge regulation (Markle, et al., 2005). Many growers opted to join a Coalition as the other options were more costly. Coalition Groups were charged with completing two reports – a Watershed Evaluation Report and a Monitoring and Reporting Plan. The Watershed Evaluation Report included information on crop patterns and pesticide/nutrient use, as well as mitigation measures that would prevent orchard runoff from impairing water quality. Similar programs are in development in other agricultural areas of California.

As a part of the Waiver program, the Central Valley Coalitions undertook monitoring of “agriculture dominated waterways”. Some of the monitored waterways are small agricultural streams and sloughs that carry farm drainage to larger waterways. The coalition was also required to develop a management plan to address exceedance of State water quality standards. Currently, the Coalitions monitor toxicity to test organisms, stream parameters (*e.g.*, flow, temperature, etc.), nutrient levels, and pesticides used in the region, including diazinon and chlorpyrifos. Diazinon exceedances within the Sacramento and Feather Rivers resulted in the development of a TMDL. The Coalitions were charged with developing and implementing management and monitoring plans to address the TMDL and reduce diazinon runoff.

The Coalition for Urban/Rural Environmental Stewardship (CURES) is a non-profit organization that was founded in 1997 to support educational efforts for agricultural and urban communities focusing on the proper and judicious use of pest control products. CURES educates growers on methods to decrease diazinon surface water contamination in the Sacramento River Basin. The organization has developed best-practice literature for pesticide use in both urban and agricultural settings (www.curesworks.org). CURES also works with California’s Watershed Coalitions to standardize their Watershed Evaluation Reports and to keep the Coalitions informed. The organization has worked with local organizations, such as the California Dried Plum Board and the Almond Board of California, to address concerns about diazinon, pyrethroids, and sulfur. The CURES site discusses alternatives to organophosphate dormant spray applications. It lists pyrethroids and carbaryl as alternatives, but cautions that these compounds may impact non-target organisms. The CURES literature does not specifically address the a.i.s discussed in this Opinion.

California also has PURS legislation whereby all agricultural uses of registered pesticides must be reported. In this case “agricultural” use includes applications to parks, golf courses, and most livestock uses.

In 2006, CDPR put limitations on dormant spay application of most insecticides in orchards, in part to adequately protect aquatic life in the Central Valley region. While the legislation was prompted by diazinon and chlorpyrifos exceedences, these limitations also apply to other organophosphates, pyrethroids, and carbamates.

The CDPR publishes voluntary interim measures for mitigating the potential impacts of pesticide usage to listed species. These measures are available online as county bulletins (http://www.cdpr.ca.gov/docs/endspec/colist.htm). Measures that apply to oryzalin, pendimethalin, and trifluralin use in salmonid habitat are:

- Do not use in currently occupied habitat except as specified in Habitat Descriptors, in organized habitat recovery programs, or for selective control of exotic plants.

- For sprayable or dust formulations: when the air is calm or moving away from habitat, commence applications on the side nearest the habitat and proceed away from the habitat. When air currents are moving toward habitat, do not make applications within 200 yards by air or 40 yards by ground upwind from occupied habitat. The county agricultural commissioner may reduce or waive buffer zones following a site inspection, if there is an adequate hedgerow, windbreak, riparian corridor or other physical barrier that substantially reduces the probability of drift.

Water Diversions for Agriculture in the Southwest Coast Region

Agricultural land use further impacts salmonid aquatic habitats through water diversions or withdrawals from rivers and tributaries. In 1990, nearly 95% of the water diverted from the San Joaquin River was diverted for agriculture. Additionally, 1.5% of the water was diverted for livestock (Carter & Resh, 2005). The amount and extent of water withdrawals or diversions for agriculture impact streams and their inhabitants via reduced water flow/velocity and dissolved oxygen levels. For example, adequate water flow is required for migrating salmon along freshwater, estuarine, and marine environments in order to complete their life cycle. Low flow events may delay salmonid migration or lengthen fish presence in a particular water body until favorable flow conditions permit fish migration along the migratory corridor or into the open ocean.

Water diversions may also increase nutrient load, sediments (from bank erosion), and temperature. Flow management and climate changes have decreased the delivery of suspended particulate matter and fine sediment to the estuary. The conditions of the habitat (shade, woody debris, overhanging vegetation) whereby salmonids are constrained by low flows also may make them more or less vulnerable to predation, elevated temperatures, crowding, and disease. Water flow effects on salmonids may seriously impact adult migration and water quality conditions for spawning and rearing salmonids. High temperature may also result from the loss of vegetation along streams that used to shade the water and from new land uses (buildings and pavement) whereby rainfall picks up heat before it enters into an adjacent stream. Runoff inputs from multiple land use may further pollute receiving waters inhabited by fish or along fish migratory corridors.

Surface and Ground Water Contaminants

California's most recent 303(d) list is the 2010 Integrated Report, which was approved by EPA on October 11, 2011. The 2010 list includes 3,489 stream segments, rivers, lakes, and estuaries and 13 pollutant categories (Figure 51).

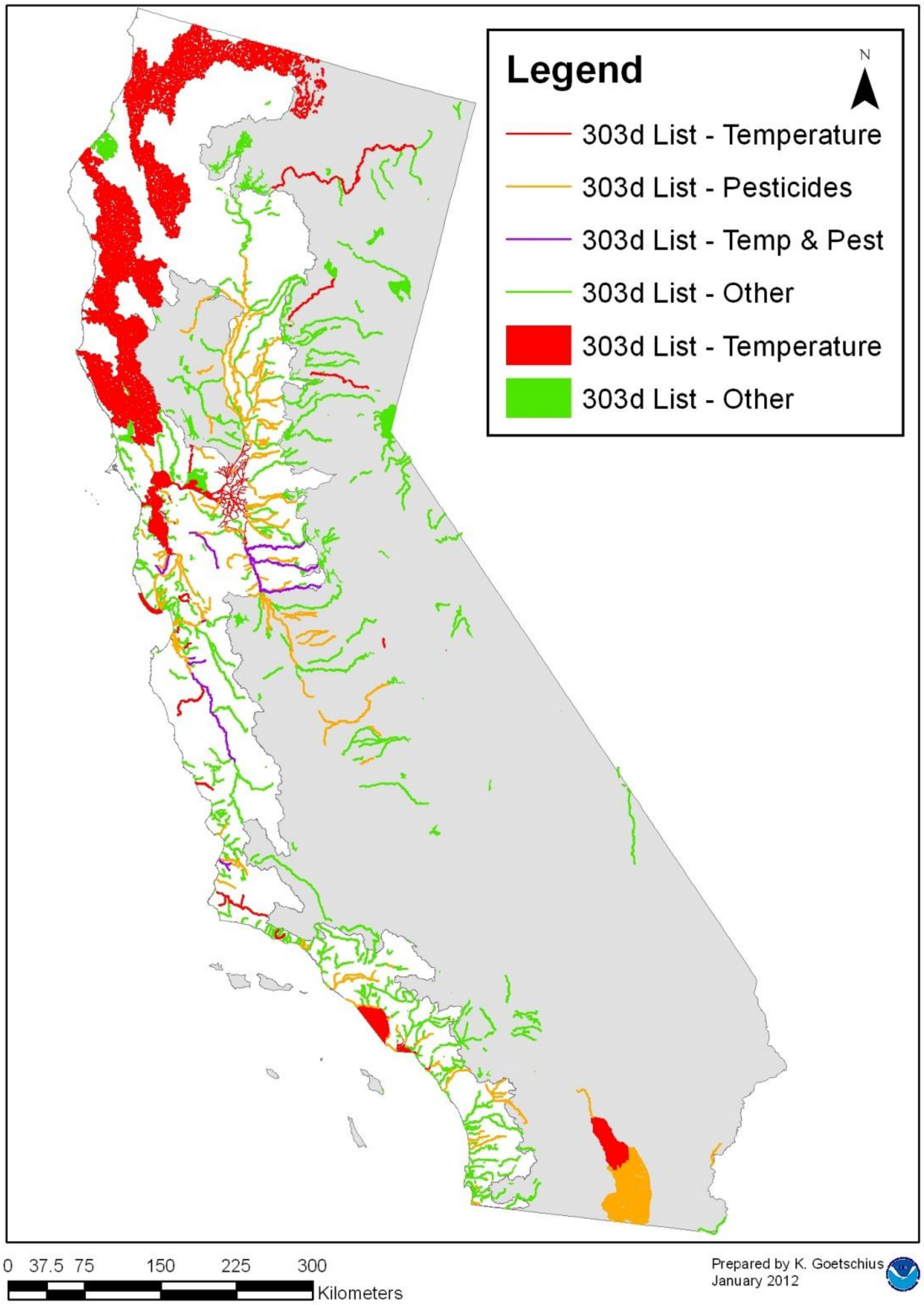


Figure 51. California 303(d) List: Water bodies and stream segments included in the 2010 Integrated Report.

Pollutants represented on the list include pesticides, metals, sediments, nutrients or low dissolved oxygen, temperature, bacteria and pathogens, and trash or debris. The 2010 303(d) list identifies water bodies listed due to elevated temperature (Table 59).

Table 59. California's 2010 Integrated Report, Section 303(d) List of Water Quality Limited Segments: segments listed for exceeding temperature limits which require the development of a TMDL.

Pollutant	Estuary Acres Affected	River / Stream Km Affected	# Water Bodies
Temperature	-	18,332.0	69

Estuary systems of the region are consistently exposed to anthropogenic pressures stemming from high human density sources. For example, the largest west coast estuary is the San Francisco Estuary. This water body provides drinking water to 23 million people, irrigates 4.5 million acres of farmland, and drains roughly 40% of California's land area. As a result of high use, many environmental measures of the San Francisco Estuary are poor. Water quality suffers from high phosphorus and nitrogen loads, primarily from agricultural, sewage, and storm water runoff. Water clarity is also compromised. Sediments from urban runoff and historical activities contain high levels of contaminants. They include pesticides, polychlorinated biphenyls (PCBs), nickel, selenium, cadmium, mercury, copper, and silver. Specific pesticides include pyrethroids, malathion, carbaryl, and diazinon. Other pollutants include DDT and polynuclear aromatic hydrocarbons (PAHs).

Other wastes are also discharged into San Francisco Bay. Approximately 150 industries discharge wastewater into the bay. Discharge of hot water from power plants and industrial sources may elevate temperatures and negatively affect aquatic life. Additionally, about 60 sewage treatment plants discharge treated effluent into the bay and elevate nutrient loads. However, since 1993, many of the point sources of pollution have been greatly reduced. Pollution from oil spills also occur due to refineries in the bay area. Gold mining has also reduced estuary depths in much of the region, causing drastic changes to habitat. As these stressors persist in the marine environment, the estuary system will likely carry loads for future years, even with strict regulation.

Large urban centers are foci for contaminants. Contaminant levels in surface waters near San Francisco, Oakland, and San Jose are highest. These areas are also where water clarity is at its worst. Some of the most persistent contaminants (PCBs, dioxins, DDT, etc.) are bioaccumulated by aquatic biota and can biomagnify in the food chain. Fish tissues contain high levels of PCB and mercury. Concentrations of PCB were 10 times above human health guidelines for consumption. Birds, some of which are endangered (clapper rail and least tern), have also concentrated these toxins.

As mentioned earlier in this chapter, the distribution of the most prevalent pesticides in streams and ground water correlate with land use patterns and associated past or present pesticide use. The USGS conducted NAWQA analyses for three basins within the Southwest Coast Region. Data for these basins are summarized below:

Santa Ana Basin: NAWQA Analysis

The Santa Ana watershed is the most heavily populated study site out of more than 50 assessment sites studied across the nation by the NAWQA Program. According to Belitz *et al.* (2004), treated wastewater effluent is the primary source of baseflow to the Santa Ana River. Secondary sources that influence peak river flows include stormwater runoff from urban, agricultural, and undeveloped lands (Belitz, et al., 2004). Stormwater and agricultural runoff frequently contain pesticides, fertilizers, sediments, nutrients, pathogenic bacteria, and other chemical pollutants to waterways and degrade water quality. The above inputs have resulted in elevated concentrations of nitrates and pesticides in surface waters of the basin. Nitrates and pesticides were more frequently detected here than in other national NAWQA sites (Belitz, et al., 2004). Additionally, Belitz *et al.* (2004) found that pesticides and volatile organic compounds (VOCs) were frequently detected in surface and ground water in the Santa Ana Basin.

Of the 103 pesticides and degradates routinely analyzed for in surface and ground water, 58 were detected. Pesticides included diuron, diazinon, carbaryl, chlorpyrifos, lindane, malathion, and chlorothalonil. Diuron was detected in 92% of urban samples – a rate much higher than the national frequency of 25 % (Belitz, et al., 2004). Of the 85 VOCs routinely analyzed for, 49 were detected. VOCs included methyl *tert*-butyl ether (MTBE), chloroform, and trichloroethylene (TCE). Organochlorine compounds were also detected in bed sediment and fish tissue. Organochlorine concentrations were also higher at urban sites than at undeveloped sites in the Santa Ana Basin. Organochlorine compounds include DDT and its breakdown product diphenyl dicloroethylene (DDE), and chlordane. Other contaminants detected at high levels included trace elements such as lead, zinc, and arsenic. According to Belitz *et al.* (2004), the biological community in the basin is heavily altered as a result from these pollutants.

San Joaquin-Tulare Basin: NAWQA Analysis

A study was conducted by the USGS in the mid-1990s on water quality within the San Joaquin-Tulare basins. Concentrations of dissolved pesticides in this study unit were among the highest of all NAWQA sites nationwide. The USGS detected 49 of the 83 pesticides it tested for in the mainstem and three subbasins. Pesticides were detected in all but one of the 143 samples. The most common detections were of the herbicides simazine, dacthal, metolachlor, and EPTC (Eptam), and the insecticides diazinon and chlorpyrifos. Twenty-two pesticides were detected in over 20% of the samples (Dubrovsky, Kratzer, Brown, Gronberg, & Burow, 1998). Further, many samples contained mixtures of at least 7 pesticides, with a maximum of 22 different compounds. Diuron was detected in all three subbasins, despite land use differences.

Organochlorine insecticides in bed sediment and tissues of fish or clams were also detected. They include DDT and toxaphene. Levels at some sites were among the highest in the nation. Concentrations of trace elements in bed sediment generally were higher than concentrations found in other NAWQA study units (Dubrovsky, et al., 1998).

Sacramento River Basin: NAWQA Analysis

Another study conducted by the USGS from 1996 - 1998 within the Sacramento River Basin compared the pesticides in surface waters at four specific sites – urban, agricultural, and two integration sites (Domagalski, 2000). Pesticides included thiobencarb, carbofuran, molinate, simazine, metolachlor, dacthal, chlorpyrifos, carbaryl, and diazinon – as well as the three herbicides assessed in this Opinion. Land use differences between sites are reflected in pesticide detections. Thiobencarb was detected in 90.5 % of agricultural samples, but only 3.3% of urban samples (Domagalski, 2000). This finding is unsurprising as rice is the dominant crop within the agricultural basin. Some pesticides were detected at concentrations higher than criteria for the protection of aquatic life in the smaller streams, but were diluted to safer levels in the mainstem river. Intensive agricultural activities also impact water chemistry. In the Salinas River and in areas with intense agriculture use, water hardness, alkalinity, nutrients, and conductivity are also high.

Other Land Uses in the Southwest Coast Region

Habitat Modification

The Central Valley area, including San Francisco Bay and the Sacramento and San Joaquin River Basins, has been drastically changed by development. Salmonid habitat has been reduced to 300 miles from historic estimates of 6,000 miles (CDFG, 1993). In the San Joaquin Basin alone, the historic floodplain covered 1.5 million acres with 2 million acres of riparian vegetation (CDFG, 1993). Roughly 5% of the Sacramento River Basin's riparian forests remain. Impacts of development include loss of LWD, increased bank erosion and bed scour, changes in sediment loadings, elevated stream temperature, and decreased base flow. Thus, lower quantity and quality of LWD and modified hydrology reduce and degrade salmonid rearing habitat.

The Klamath Basin in Northern California has been heavily modified as well. Water diversions have reduced spring flows to 10% of historical rates in the Shasta River, and dams block access to 22% of historical salmonid habitat. The Scott and Trinity Rivers have similar histories. Agricultural development has reduced riparian cover and diverted water for irrigation (NRC, 2003). Riparian habitat has decreased due to extensive logging and grazing. Dams and water diversions are also common. These physical changes resulted in water temperatures too high to sustain salmonid populations. The Salmon River, however, is comparatively pristine; some reaches are designated as Wild and Scenic Rivers. The main cause of riparian loss in the Salmon River basin is likely wild fires – the effects of which have been exacerbated by salvage logging (NRC, 2003).

Mining

Famous for the gold rush of the mid-1800s, California has a long history of mining. Extraction methods such as suction dredging, hydraulic mining, and strip mining may cause water pollution problems. In 2004, California ranked top in the nation for non-fuel mineral production with 8.23% of total production (NMA, 2007). Today, gold, silver, and iron ore comprise only 1% of the production value. Primary minerals include construction sand, gravel, cement, boron, and crushed stone. California is the only state to produce boron, rare-earth metals, and asbestos (NMA, 2007).

California contains approximately 1,500 abandoned mines. Roughly 1% of these mines are suspected of discharging metal-rich waters into the basins. The Iron Metal Mine in the Sacramento Basin releases more than 1,100 lbs of copper and more than 770 lbs of zinc to the Keswick Reservoir below Shasta Dam. The Iron Metal Mine also released elevated levels of lead (Cain et al. 2000 in Carter & Resh, 2005). Metal contamination reduces the biological productivity within a basin. Metal contamination can result in fish kills at high levels or sublethal effects at low levels. Sublethal effects include a reduction in feeding, overall activity levels, and growth. The Sacramento Basin and the San Francisco Bay watershed are two of the most heavily impacted basins within the state from mining activities. The basin drains some of the most productive mineral deposits in the region. Methyl mercury contamination within San Francisco Bay, the result of 19th century mining practices using mercury to amalgamate gold in the Sierra Nevada Mountains, remains a persistent problem today. Based on sediment cores, pre-mining concentrations were about five times lower than concentrations detected within San Francisco Bay today (Conaway, Squire, Mason, & Flegal, 2003).

Hydromodification Projects

Several of the rivers within California have been modified by dams, water diversions, drainage systems for agriculture and drinking water, and some of the most drastic channelization projects in the nation (Figure 52). There are about 1,400 dams within the State of California, more than 5,000 miles of levees, and more than 140 aqueducts (Mount, 1995). In general, the southern basins have a warmer and drier climate and the more northern, coastal-influenced basins are cooler and wetter. About 75% of the runoff occurs in basins in the northern half of California, while 80% of the water demand is in the southern half. Two water diversion projects meet these demands—the federal Central Valley Project (CVP) and the California State Water Project (CSWP). The CVP is one of the world's largest water storage and transport systems. The CVP has more than 20 reservoirs and delivers about 7 million acre-ft per year to southern California. The CSWP has 20 major reservoirs and holds nearly 6 million acre-ft of water. The CSWP delivers about 3 million acre-ft of water for human use. Together, both diversions irrigate about 4 million acres of farmland and deliver drinking water to roughly 22 million residents.

Both the Sacramento and San Joaquin rivers are heavily modified, each with hundreds of dams. The Rogue, Russian, and Santa Ana rivers each have more than 50 dams, and the Eel, Salinas, and the Klamath Rivers have between 14 and 24 dams each. The Santa Margarita is considered one of the last free flowing rivers in coastal southern California with nine dams occurring in its watershed. All major tributaries of the San Joaquin River are impounded at least once and most have multiple dams or diversions. The Stanislaus River, a tributary of the San Joaquin River, has over 40 dams. As a result, the hydrograph of the San Joaquin River is seriously altered from its natural state. Alteration of the temperature and sediment transport regimes had profound influences on the biological community within the basin. These modifications generally result in a reduction of suitable habitat for native species and frequent increases in suitable habitat for non-native species. The Friant Dam on the San Joaquin River is attributed with the extirpation of spring-run Chinook salmon within the basin. A run of the spring-run Chinook salmon once produced about 300,000 to 500,000 fish (Carter & Resh, 2005).

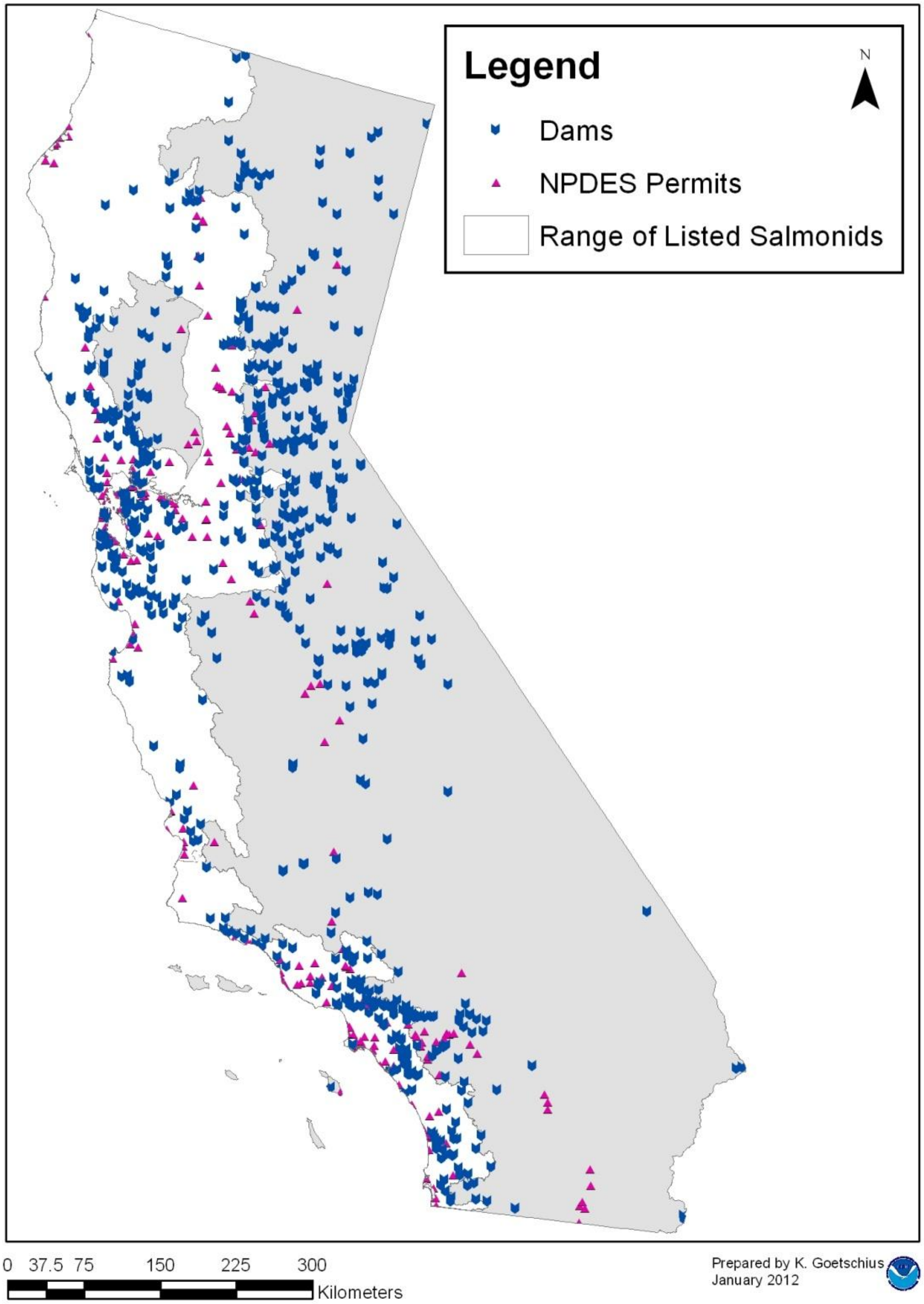


Figure 52. Southwest Coast dams and NPDES permit sites.

Artificial Propagation

Anadromous fish hatcheries have existed in California since establishment of the McCloud River hatchery in 1872. There are nine state hatcheries: the Iron Gate (Klamath River), Mad River, Trinity (Trinity River), Feather (Feather River), Warm Springs (Russian River), Nimbus (American River), Mokelumne (Mokelumne River), and Merced (Merced River). The California Department of Fish and Game (CDFG) also manages artificial production programs on the Noyo and Eel rivers. The Coleman National Fish Hatchery, located on Battle Creek in the upper Sacramento River, is a federal hatchery operated by the USFWS. The USFWS also operates an artificial propagation program for Sacramento River winter run Chinook salmon.

Of these, the Feather River, Nimbus, Mokelumne, and Merced River facilities comprise the Central Valley Hatcheries. Over the last ten years, the Central Valley Hatcheries have released over 30 million young salmon. State and the federal (Coleman) hatcheries work together to meet overall goals. State hatcheries are expected to release 18.6 million smolts in 2008 and Coleman is aiming for more than 12 million. There has been no significant change in hatchery practices over the year that would adversely affect the current year class of fish. A new program marking 25% of the 32 million Sacramento River Fall-run Chinook smolts may provide data on hatchery fish contributions to the fisheries in the near future.

Commercial and Recreational Fishing

The region is home to many commercial fisheries. The largest in terms of total California landings in 2006 were northern anchovy, Pacific sardine, Chinook salmon, sablefish, Dover sole, Pacific whiting, squid, red sea urchin, and Dungeness crab (CDFG, 2007). Red abalone is also harvested.

Despite regulated fishing programs for salmonids, listed salmonids are also caught as bycatch. There are several approaches under the ESA to address tribal and state take of ESA-listed species that may occur as a result of harvest activities. Section 10 of the ESA provides for permits to operate fishery harvest programs. ESA section 4(d) rules provide exemptions from take for resource, harvest, and hatchery management plans.

Management of salmon fisheries in the Southwest Coast Region is a cooperative process involving federal, state, and tribal representatives. The Pacific Fishery Management Council sets annual fisheries in federal waters from three to 200 miles off the coasts of Washington, Oregon, and California. Inland fisheries are those within state boundaries, including those extending out three miles from state coastlines. The states of Oregon, Idaho, California, and Washington issue salmon fishing licenses for inland fisheries. The California Fish and Game Commission (CFGC) establish the salmon seasons and issues permits for all California waters and the Oregon Department of Fish and Game sets the salmon seasons and issues permits for all Oregon waters.

In 2008, there was an unprecedented collapse of the Sacramento River fall-run Chinook salmon that led to complete closure of the commercial and sport Chinook fisheries in California and in Oregon south of Cape Falcon. U.S. Department of Commerce Secretary Gary Locke released a 2008 West Coast salmon disaster declaration for California and Oregon in response to poor salmon returns to the Sacramento River, which led to federal management reducing commercial salmon fishing off southern Oregon and California to near zero. Secretary Locke also released $53.1 million in disaster funds to aid affected fishing communities.

In 2009, federal fishery managers severely limited commercial salmon fishing in California and Oregon for the second year in a row due to low Sacramento River fall-rn Chinook salmon returns. California State sport and commercial ocean salmon seasons were closed by the CFGC through August 28, 2009. There was a 10-day ocean sport fishery in the Klamath Management Zone (Horse Mountain to the California-Oregon border) from August 29 through September 7, 2009. A limited in-river salmon season was considered by the CFGC at its May meeting. The CFGC decided to leave open the Sacramento River between the Highway 113 bridge near Knight's Landing and just below the Lower Red Bluff (Sycamore) Boat Ramp from November 16 through December 31,

2009. The Klamath-Trinity River Basin had a salmon sport fishing season for Klamath River fall Chinook salmon that began August 15, 2009.

Non-native Species

Plants and animals that are introduced into habitats where they do not naturally occur are called non-native species. They are also known as non-indigenous, exotic, introduced, or invasive species, and have been known to affect ecosystems. Non-native species are introduced through infested stock for aquaculture and fishery enhancement, through ballast water discharge and from the pet and recreational fishing industries (http://biology.usgs.gov/s+t/noframe/x191.htm.). The Aquatic Nuisance Species Task Force suggests that it is inevitable that cultured species will eventually escape confinement and enter U.S. waterways. Non-native species were cited as a contributing cause in the extinction of 27 species and 13 subspecies of North American fishes over the past 100 years (R. R. Miller, Williams, & Williams, 1989). Wilcove, Rothstein *et al.* (1998) note that 25% of ESA-listed fish are threatened by non-native species. By competing with native species for food and habitat as well as preying on them, non-native species can reduce or eliminate populations of native species.

Surveys performed by CDFG state that at least 607 non-native species are found in California coastal waterways (Foss, Ode, Sowby, & Ashe, 2007). The majority of these species are representatives of four phyla: annelids (33%), arthropods (22%), chordates (13%), and mollusks (10%). Non-native chordate species are primarily fish and tunicates which inhabit fresh and brackish water habitats such as the Sacramento-San Joaquin Delta (Foss, et al., 2007). The California Aquatic Invasive Species Management Plan includes goals and strategies for reducing the introduction rate of new invasive species as well as removing those with established populations.

Pacific Northwest Region

This region encompasses Idaho, Oregon, and Washington and includes parts of Nevada, Montana, Wyoming, and British Columbia. In this section we discuss three major areas that support salmonid populations within the action area. They include the Columbia

River Basin and its tributaries, the Puget Sound Region, and the coastal drainages north of the Columbia River (Figure 53).

Eighteen of the 28 ESUs/DPSs addressed in the Opinion occur within the Pacific Northwest Region. They are the Puget Sound Chinook salmon, Lower Columbia River (LCR) Chinook salmon, Upper Columbia River (UCR) Spring-run Chinook salmon, Snake River (SR) Fall-run Chinook salmon, SR Spring/Summer-run Chinook salmon, Upper Willamette River (UWR) Chinook salmon, Hood Canal (HC) Summer-run chum, Columbia River (CR) chum, LCR coho, Oregon Coast (OC) coho, Ozette Lake sockeye, SR sockeye, Puget Sound steelhead, LCR steelhead, UWR steelhead, Middle Columbia River (MCR) steelhead, UCR steelhead, and the SR steelhead (Table 54). Table 60, Table 61, and Table 62 show the types and areas of land use within each salmonid ESU/DPS.

Table 60. Area of land use categories within Chinook Salmon ESUs in km². The total area for each category is given in bold. Land cover was determined via the National Land Cover Database 2006, developed by the Multi-Resolution Land Characteristics (MRLC) Consortium, a consortium of nine federal agencies (USGS, EPA, USFS, NOAA, NASA, BLM, NPS, NRCS, and USFWS). Land cover class definitions are available at: http://www.mrlc.gov/nlcd_definitions.php

Landcover Type		**Chinook Salmon**					
sub category	code	Puget Sound	Lower Columbia River	Upper Columbia River Spring Run	Snake River Fall Run	Snake River Spring/ Summer Run	Upper Willamette River
Water		**6,447**	**662**	**200**	**219**	**283**	**127**
Open Water	11	6,147	651	186	219	252	122
Perennial Snow/Ice	12	300	11	14	0	32	6
Developed Land		**5,311**	**1,949**	**875**	**484**	**981**	**2,008**
Open Space	21	1,624	708	205	350	329	646
Low Intensity	22	1,734	571	234	70	114	750
Medium Intensity	23	405	310	61	19	31	333
High Intensity	24	277	126	12	2	2	117
Barren Land	31	971	234	362	43	506	162
Undeveloped Land		**22,502**	**13,005**	**16,123**	**21,437**	**52,608**	**14,251**
Deciduous Forest	41	987	553	21	57	10	239
Evergreen Forest	42	13,983	8,006	7,589	10,704	27,215	9,046
Mixed Forest	43	2,532	933	7	5	4	1,068
Shrub/Scrub	52	2,896	2,298	6,539	5,063	14,208	2,350
Herbaceous	71	956	570	1,818	5,583	10,933	1,032
Woody Wetlands	90	651	395	91	29	99	439
Emergent Wetlands	95	496	250	59	28	102	76
Agriculture		**1,404**	**944**	**952**	**5,179**	**4,288**	**5,883**
Hay/Pasture	81	1,152	636	317	57	444	3,585
Cultivated Crops	82	251	308	635	5,122	3,843	2,298
TOTAL (inc. open water)		35,663	16,560	18,150	27,319	58,160	22,269
TOTAL (w/o open water)		29,516	15,910	17,964	27,100	57,908	22,148

Table 61. Area of land cover types within chum, coho, and sockeye ESUs in km². The total area for each category is given in bold. Land cover was determined via the National Land Cover Database 2006, developed by the Multi-Resolution Land Characteristics (MRLC) Consortium, a consortium of nine federal agencies (USGS, EPA, USFS, NOAA, NASA, BLM, NPS, NRCS, and USFWS). Land cover class definitions are available at: http://www.mrlc.gov/nlcd_definitions.php

Land Cover Category		**Chum Salmon**		**Coho Salmon**		**Sockeye Salmon**	
sub category	code	Hood Canal	Columbia River	Lower Columbia River	Oregon Coast	Ozette Lake	Snake River
Water		**750**	**652**	**681**	**203**	**30**	**33**
Open Water	11	703	651	670	203	30	19
Perennial Snow/Ice	12	47	1	11	0	0	15
Developed Land		**392**	**1,658**	**1,977**	**1,577**	**1**	**15**
Open Space	21	135	614	719	1,113	1	3
Low Intensity	22	79	476	583	168	0	2
Medium Intensity	23	20	265	314	51	0	0
High Intensity	24	6	112	127	20	0	0
Barren Land	31	152	191	235	225	0	10
Undeveloped Land		**3,343**	**8,284**	**13,345**	**24,832**	**197**	**1,262**
Deciduous Forest	41	97	537	564	414	3	0
Evergreen Forest	42	2,371	4,008	8,157	14,133	148	741
Mixed Forest	43	197	844	948	3,898	2	0
Shrub/Scrub	52	425	1,759	2,417	4,065	27	198
Herbaceous	71	134	515	612	1,822	7	271
Woody Wetlands	90	62	373	396	26	8	16
Emergent Wetlands	95	57	248	251	235	1	35
Agriculture		**64**	**690**	**956**	**908**	**0**	**12**
Hay/Pasture	81	62	505	644	846	0	12
Cultivated Crops	82	2	185	312	62	0	0
TOTAL (inc. open water)		4,548	11,284	16,959	27,520	228	1,323
TOTAL (w/o open water)		3,845	10,633	16,289	27,320	199	1,304

Table 62. Area of land use categories within steelhead DPSs in km^2. The total area for each category is given in bold. Land cover was determined via the National Land Cover Database 2006, developed by the Multi-Resolution Land Characteristics (MRLC) Consortium, a consortium of nine federal agencies (USGS, EPA, USFS, NOAA, NASA, BLM, NPS, NRCS, and USFWS). Land cover class definitions are available at: http://www.mrlc.gov/nlcd_definitions.php

Land Cover Category		Steelhead					
sub category	code	Puget Sound	Lower Columbia River	Upper Willamette River	Middle Columbia River	Upper Columbia River	Snake River
Water		**6,444**	**256**	**61**	**585**	**371**	**315**
Open Water	11	6,144	245	61	574	357	283
Perennial Snow/Ice	12	300	12	0	12	14	33
Developed Land		**5,314**	**1,621**	**1,269**	**2,354**	**1,127**	**1,209**
Open Space	21	1,624	529	393	1,289	348	514
Low Intensity	22	1,734	522	533	655	315	144
Medium Intensity	23	705	295	239	204	90	40
High Intensity	24	277	118	79	27	15	3
Barren Land	31	974	158	25	180	359	508
Undeveloped Land		**22,504**	**10,390**	**7,026**	**53,559**	**19,590**	**67,891**
Deciduous Forest	41	987	379	164	53	25	35
Evergreen Forest	42	13,983	6,839	3,837	17,923	7,668	39,965
Mixed Forest	43	2,532	581	743	39	8	18
Shrub/Scrub	52	2,897	1,835	1,282	32,161	9,794	16,335
Herbaceous	71	957	401	655	2,869	1,906	12,298
Woody Wetlands	90	651	247	298	229	107	119
Emergent Wetlands	95	497	109	46	285	82	121
Agriculture		**1,405**	**862**	**4,299**	**12,953**	**3,663**	**6,643**
Hay/Pasture	81	1,153	66	2,501	854	437	449
Cultivated Crops	82	252	295	1,798	12,099	3,226	6,194
TOTAL (inc. open water)		35,667	13,128	12,655	69,451	24,750	76,059
TOTAL (w/o open water)		29,522	12,884	12,593	68,877	24,394	75,776

Pesticide Reduction Programs in the Pacific Northwest Region

When using any of the a.i.s addressed in this Opinion, growers must adhere to the court-ordered injunctive relief, requiring buffers of 20 yards for ground application and 100 yards for any aerial application. These measures are mandatory in all four states, pending completion of consultation. Additionally, pesticide reduction programs exist in Idaho, Oregon, and Washington to minimize levels of pesticides in the aquatic environment. Washington's Department of Transportation also has limitations on the use of pesticides on rights-of way. Oryzalin and pendimethalin are approved for use in the one to three foot gravel shoulder of roads with some restrictions. The shoulder is typically treated once annually. Oryzalin is also approved for use on ornamental planting beds, while pendimethalin may be used on ornamentals and turf. Oryzalin may not be used within 60 feet of water. Pendimethalin cannot be used at all on the west side of WA, and cannot be used within 60 feet of water on the eastside. Trifluralin has not been approved for rights-of-way uses.

The Idaho State Department of Agriculture has published a BMP guide for pesticide use. The BMPs include eight "core" voluntary measures that will prevent pesticides from leaching into soil and groundwater. These measures include applying pest-specific controls, being aware of the depth to ground water, and developing an Irrigation Water Management Plan.

Oregon has PURS legislation that requires all agricultural uses of registered pesticides be reported. In this case "agricultural" use includes applications to parks, golf courses, and most livestock uses. Oregon requires reporting if application is part of a business, for a government agency, or in a public place. However, the Governor of Oregon has suspended the PURS program until January 2013 due to budget shortages.

Oregon has also implemented a voluntary program. The Pesticide Stewardship Partnerships (PSP) program began in 1999 through the Oregon Department of Environmental Quality. The PSP's goal is to involve growers and other stakeholders in water quality management at a local level. Effectiveness monitoring is used to provide feedback on the success of mitigation measures. As of 2006, there were six pilot PSPs planned or in place. Early results from the first PSPs in the Columbia Gorge Hood River and in Mill Creek demonstrate reductions in chlorpyrifos and diazinon levels and detection frequencies. DEQ's pilot programs suggest that PSPs can help reduce contamination of surface waters.

Oregon is in the process of developing a Pesticide Management Plan for Water Quality Protection, as required under FIFRA. This plan describes how government agencies and stakeholders will collaboratively reduce pesticides in Oregon water supplies. The PSP program is a component of this plan, and will provide information on the effectiveness of mitigation measures.

Washington State has a Surface Water Monitoring Program that looks at pesticide concentrations in some salmonid bearing streams and rivers. The program was initiated in 2003 and now monitors four areas. Three of these were chosen due to high overlap with agriculture: the Skagit-Samish watershed, the Lower Yakima Watershed, and the Wenatchee and Entiat watersheds. The final area, in the Cedar-Sammamish watershed, is an urban location, intended to look at runoff in a non-agriculture setting. It was chosen due to detection of pesticides coincident with pre-spawning mortality in coho salmon. The Surface Water Monitoring program is relatively new and will continue to add watersheds and testing for additional pesticides over time.

Washington State also has a voluntary program that assists growers in addressing water rights issues within a watershed. Several watersheds have elected to participate, forming Comprehensive Irrigation District Management Plans (CIDMPs). The CIDMP is a collaborative process between government and landowners and growers; the parties determine how they will ensure growers get the necessary volume of water while also guarding water quality. This structure allows for greater flexibility in implementing mitigation measures to comply with both the CWA and the ESA.

The Columbia Gorge Fruit Growers Association is a non-profit organization dedicated to the needs of growers in the mid-Columbia area. The association brings together over 440 growers and 20 shippers of fruit from Oregon and Washington. It has issued a BMP handbook for OPs, including information on alternative methods of pest control. The mid-Columbia area is of particular concern, as many orchards are in close proximity to streams.

Stewardship Partners is a non-profit organization in Washington State that works to build partnerships between landowners, government, and non-profit organizations. In large part, its work focuses on helping landowners to restore fish and wildlife habitat while maintaining the economic viability of their farmland. Projects include restoring riparian areas, reestablishing floodplain connectivity, and removing blocks to fish passage. Another current project is to promote rain gardens as a method of reducing surface water runoff from developed areas. Rain gardens mimic natural hydrology, allowing water to collect and infiltrate the soil.

Stewardship Partners also collaborates with the Oregon-based Salmon-Safe certification program (www.salmonsafe.org). Salmon-Safe is an independent eco-label recognizing organizations who have adopted conservation practices that help restore native salmon habitat in Pacific Northwest, California, and British Columbia. These practices protect water quality, fish and wildlife habitat, and overall watershed health. While the program began with a focus on agriculture, it has since expanded to include industrial and urban sites as well. The certification process includes pesticide restrictions. Salmon-Safe has produced a list of “high risk” pesticides which, if used, would prevent a site from becoming certified. If a grower wants an exception, they must provide written documentation that demonstrates a clear need for use of the pesticide, that no safer alternatives exist, and that the method of application (such as timing, location, and amount used) represents a negligible risk to water quality and fish habitat. Trifluralin and oryzalin are both on the high risk list. Over 300 farms, 250 vineyards, and 240 parks currently have the Salmon-Safe certification. Salmon-Safe has also worked with over 20 corporate / industrial sites and is beginning programs that focus on golf courses and nurseries.

In addition to pesticide usage for agriculture, this land use further affects available salmonid aquatic habitat. The amount and extent of water withdrawals or diversions for agriculture impact streams and their inhabitants via reduced water flow/velocity and dissolved oxygen levels. These impacts are described below.

Columbia River Basin

The most notable basin within the Pacific Northwest region is the Columbia River. The Columbia River is the largest river in the Pacific Northwest and the fourth largest river in terms of average discharge in the U.S. The Columbia River drains over 258,000 square miles, and is the sixth largest in terms of drainage area. Major tributaries include the Snake, Willamette, Salmon, Flathead, and Yakima rivers. Smaller rivers include the Owyhee, Grande Ronde, Clearwater, Spokane, Methow, Cowlitz, and the John Day Rivers (see Table 63 for a description of select Columbia River tributaries). The Snake River is the largest tributary at more than 1,000 miles long. The headwaters of the Snake River originate in Yellowstone National Park, Wyoming. The second largest tributary is the Willamette River in Oregon (Hinck et al., 2004; Kammerer, 1990). The Willamette River is also the 19th largest river in the nation in terms of average annual discharge (Kammerer, 1990). The basins drain portions of the Rocky Mountains, Bitteroot Range, and the Cascade Range.

Table 63. Select tributaries of the Columbia River (Carter & Resh, 2005).

Watershed	Approx Length (mi)	Basin Size (mi^2)	Physiographic Provinces*	Mean Annual Precipitation (in)	Mean Discharge (cfs)	No. Fish Species (native)	No. Endangered Species
Snake/Salmon rivers	870	108,495	CU, NR, MR, B/R	14	55,267	39 (19)	5 fish (4 T, 1 E), 6 (1 T, 5 E) snails, 1 plant (T)
Yakima River	214	6,139	CS, CU	7	3,602	50	2 fish (T)
Willamette River	143	11,478	CS, PB	60	32,384	61 (~31)	5 fish (4 T, 1 E),

* Physiographic Provinces: CU = Columbia-Snake River Plateaus, NR = Northern Rocky Mountains, MR = Middle Rocky Mountains, B/R = Basin & Range, CS = Cascade-Sierra Mountains, PB = Pacific Border

The Columbia River and estuary were once home to more than 200 distinct runs of Pacific salmon and steelhead with unique adaptations to local environments within a tributary (Stanford, Hauer, Gregory, & Synder, 2005). Salmonids within the basin include Chinook salmon, chum salmon, coho salmon, sockeye salmon, steelhead, redband trout, bull trout, and cutthroat trout.

Land Use in the Columbia River Basin

More than 50% of the U.S. portion of the Columbia River Basin is in federal ownership (most of which occurs in high desert and mountain areas). Approximately 39% is in private land ownership (most of which occurs in river valleys and plateaus). The remaining 11% is divided among the tribes, state, and local governments (Hinck, et al., 2004). See Table 64 for a summary of land uses and population densities in several subbasins within the Columbia River watershed [data from (Stanford, et al., 2005)].

Table 64. Land use and population density in select tributaries of the Columbia River (Stanford, et al., 2005).

Watershed	Land Use Categories (Percent)				Density (people/mi^2)
	Agriculture	Forest	Urban	Other	
Snake/Salmon rivers	30	10-15	1	54 scrub/rangeland/barren	39
Yakima River	16	36	1	47 shrub	80
Willamette River	19	68	5	--	171

The interior Columbia Basin has been altered substantially by humans causing dramatic changes and declines in native fish populations. In general, the basin supports a variety of mixed uses. Predominant human uses include logging, agriculture, ranching, hydroelectric power generation, mining, fishing, a variety of recreational activities, and urban uses. The decline of salmon runs in the Columbia River is attributed to loss of habitat, blocked migratory corridors, altered river flows, pollution, overharvest, and competition from hatchery fish. In the Yakima River, 72 stream and river segments are listed as impaired by the Washington State Department of Ecology (DOE) and 83% exceed temperature standards. In the Yakima River, non-native grasses and other plants are commonly found along the lower reaches of the river (Stanford, et al., 2005). In the Willamette River, riparian vegetation was greatly reduced by land conversion. By 1990, only 37% of the riparian area within 120 m was forested, 30% was agricultural fields, and 16% was urban or suburban lands.

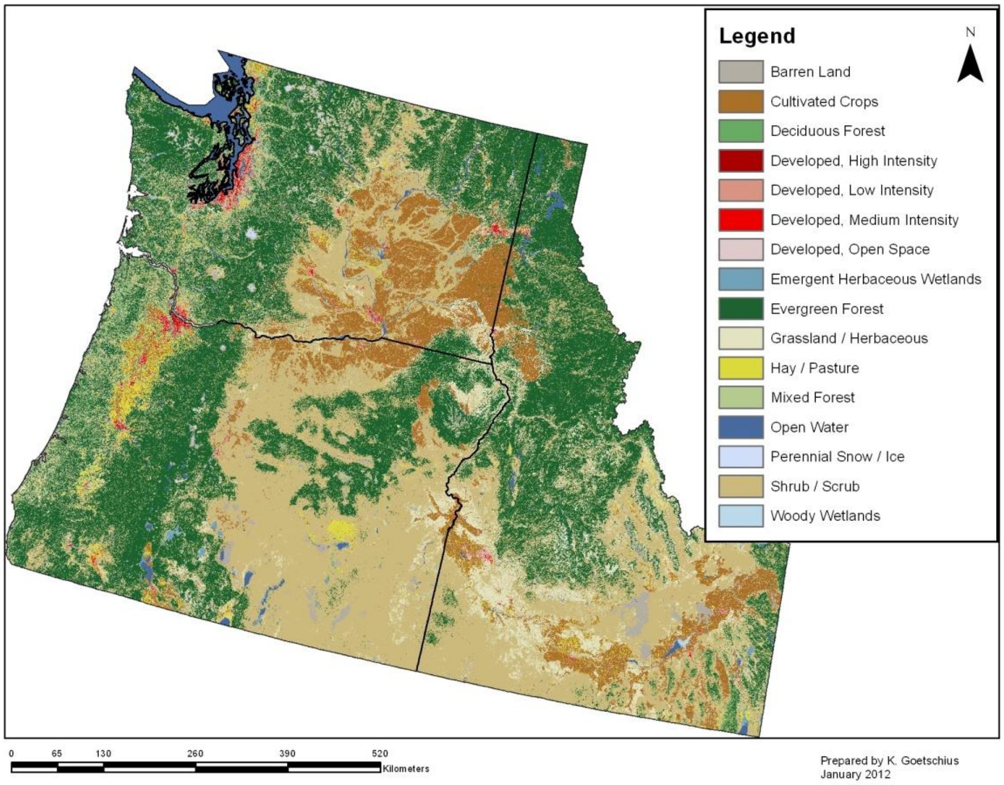


Figure 53. Pacific Northwest: National Land Cover Database 2006.

Ranching and Agriculture

Ranching, agriculture, and related services in the Pacific Northwest employ more than nine times the national average [19% of the households within the basin (NRC, 2004)]. Ranching practices have led to increased soil erosion and sediment loads within adjacent tributaries. The worst of these effects may have occurred in the late 1800s and early 1900s from deliberate burning to increase grass production (NRC, 2004). Several measures are currently in place to reduce the impacts of grazing. Measures include restricted grazing in degraded areas, reduced grazing allotments, and lowered stocking rates. Today, the agricultural industry impacts water quality within the basin. Agriculture is second only to the large-scale influences of hydromodification projects regarding power generation and irrigation. Water quality impacts from agricultural activities include alteration of the natural temperature regime, insecticide and herbicide contamination, and increased suspended sediments. During general agricultural operations, pesticides are applied on a variety of crops for pest control. These pesticides may contaminate surface water via runoff especially after rain events following application. Agricultural uses of the a.i.s assessed in this Opinion are discussed in the *Description of the Proposed Action*, while detection data is discussed in the Monitoring subsection of the *Effects of the Proposed Action* chapter.

Water Diversions for Agriculture in the Pacific Northwest Region

Agriculture and ranching increased steadily within the Columbia River basin from the mid- to late-1800s. By the early 1900s, agricultural opportunities began increasing at a much more rapid pace with the creation of more irrigation canals and the passage of the Reclamation Act of 1902 (NRC, 2004). Today, agriculture represents the largest water user within the basin (>90%).

Roughly 6% of the annual flow from the Columbia River is diverted for the irrigation of 7.3 million acres of croplands within the basin. The vast majority of these agricultural lands are located along the lower Columbia River, the Willamette, Yakima, Hood, and Snake rivers, and the Columbia Plateau (Hinck, et al., 2004).

The impacts of these water diversions include an increase nutrient load, sediments (from bank erosion), and temperature. Flow management and climate changes have further decreased the delivery of suspended particulate matter and fine sediment to the estuary. The conditions of the habitat (shade, woody debris, overhanging vegetation) whereby salmonids are constrained by low flows also may make fish more or less vulnerable to predation, elevated temperatures, crowding, and disease. Water flow effects on salmonids may seriously impact adult migration and water quality conditions for spawning and rearing salmonids. High temperature may also result from the loss of vegetation along streams that used to shade the water and from new land uses (buildings and pavement) whereby rainfall picks up heat before it enters into an adjacent stream. Runoff inputs from multiple land use may further pollute receiving waters inhabited by fish or along fish migratory corridors.

Surface and Ground Water Contaminants

NAWQA analyses were conducted for five basins within the Pacific Northwest Region. The USGS has a number of fixed water quality sampling sites throughout various tributaries of the Columbia River. Many of the water quality sampling sites have been in place for decades. Water volumes, crop rotation patterns, crop type, and basin location are some of the variables that influence the distribution and frequency of pesticides within a tributary. Detection frequencies for a particular pesticide can vary widely. In addition to current use-chemicals, legacy chemicals continue to pose a serious problem to water quality and fish communities despite their ban in the 1970s and 1980s (Hinck, et al., 2004).

Fish and macroinvertebrate communities exhibit an almost linear decline in condition as the level of agriculture intensity increases within a basin (Cuffney, Meador, Porter, & Gurtz, 1997; Fuhrer et al., 2004). A study conducted in the late 1990s examined 11 species of fish, including anadromous and resident fish collected throughout the basin, for a suite of 132 contaminants. They included 51 semi-volatile chemicals, 26 pesticides, 18 metals, 7 PCBs, 20 dioxins, and 10 furans. Sampled fish tissues revealed PCBs, metals, chlorinated dioxins and furans (products of wood pulp bleaching operations), and other contaminants.

Yakima River Basin: NAWQA Analysis

The Yakima River Basin is one of the most agriculturally productive areas in the U.S. (Fuhrer, et al., 2004). Croplands within the Yakima Basin account for about 16% of the total basin area of which 77% is irrigated. The extensive irrigation-water delivery and drainage system in the Yakima River Basin greatly controls water quality conditions and aquatic health in agricultural streams, drains, and the Yakima River (Fuhrer, et al., 2004). From 1999 to 2000, the USGS conducted a NAWQA study in the Yakima River Basin. Fuhrer *et al.* (2004) reported that nitrate and orthophosphate were the dominant forms of nitrogen and phosphorus found in the Yakima River and its agricultural tributaries. Arsenic, a known human carcinogen, was also detected in agricultural drains at elevated concentrations.

The USGS also detected 76 pesticide compounds in the Yakima River Basin. They include 38 herbicides, 17 insecticides (such as carbaryl, diazinon, and malathion), 15 breakdown products, and 6 others (Fuhrer, et al., 2004). In agricultural drainages, insecticides were detected in 80% of samples and herbicides were present in 91%. They were also detected in mixed landuse streams – 71% and 90 %, respectively. The most frequently detected pesticides were 2,4-D, terbacil, azinphos methyl, atrazine, carbaryl, and deethylatrazine. Generally, compounds were detected in tributaries more often than in the Yakima River itself.

Ninety-one percent of the samples collected from the small agricultural watersheds contained at least two pesticides or pesticide breakdown products. Samples contained a median of 8 and a maximum of 26 chemicals (Fuhrer, et al., 2004). The herbicide 2,4-D, occurred most often in the mixtures, along with azinphos methyl, the most heavily applied pesticide, and atrazine, one of the most aquatic mobile pesticides (Fuhrer, et al., 2004). The most frequently detected pesticides in the Yakima River Basin are total DDTs, dichloro-diphenyl-dichloroethane (DDD), and dieldrin (Fuhrer, et al., 2004; A. Johnson & Newman, 1983; Joy, 2002; Joy & Madrone, 2002). Nevertheless, concentrations of total DDT in water have decreased since 1991. These reductions are attributed to erosion-controlling best management practices (BMPs).

Another study conducted by the USGS between May 1999 and January 2000 in the surface waters of Yakima Basin detected 25 pesticide compounds (J. Ebbert & Embry, 2001). Atrazine was the most widely detected herbicide and azinphos methyl was the most widely detected insecticide. Other detected compounds include simazine, terbacil, trifluralin; deethylatrazine, carbaryl, diazinon, malathion, and DDE.

Central Columbia Plateau: NAWQA Analysis

The Central Columbia Plateau is a prominent apple growing region. The USGS sampled 31 surface-water sites representing agricultural land use, with different crops, irrigation methods, and other agricultural practices for pesticides in Idaho and Washington from

1992 - 1995 (Williamson et al., 1998). Pesticides were detected in samples from all sites, except for the Palouse River at Laird Park (a headwaters site in a forested area). Many pesticides were detected in surface water at very low concentrations. Concentrations of six pesticides exceeded freshwater-chronic criteria for the protection of aquatic life in one or more surface-water samples. They include the herbicide triallate and five insecticides (azinphos methyl, chlorpyrifos, diazinon, *gamma*-HCH, and parathion).

Detections at four sites were high, ranging from 12 to 45 pesticides. The two sites with the highest detection frequencies are in the Quincy-Pasco subunit, where irrigation and high chemical use combine to increase transport of pesticides to surface waters. Pesticide detection frequencies at sites in the dryland farming (non-irrigated) areas of the North-Central and Palouse subunits are below the national median for NAWQA sites. All four sites had at least one pesticide concentration that exceeded a water-quality standard or guideline.

Concentrations of organochlorine pesticides and PCBs are higher than the national median (50th percentile) at seven of 11 sites; four sites were in the upper 25% of all NAWQA sites. Although most of these compounds have been banned, they still persist in the environment. Elevated concentrations were observed in dryland farming areas and irrigated areas.

Williamette Basin: NAWQA Analysis

From 1991 to 1995, the USGS also sampled surface waters in the Willamette Basin, Oregon. Wentz *et al.* (1998) reported that 50 pesticides and pesticide degradates of the 86 were detected in streams. Atrazine, simazine, metolachlor, deethylatrazine, diuron, and diazinon were detected in more than one-half of stream samples (Wentz, et al., 1998). The highest pesticide concentrations generally occurred in streams draining predominately agricultural land. Forty-nine pesticides were detected in streams draining predominantly agricultural land. About 25 pesticides were detected in streams draining mostly urban areas.

Lower Clackamas River Basin: NAWQA Analysis

Carpenter *et al.* (2008) summarized four different studies that monitored pesticide levels in the lower Clackamas River from 2000 to 2005. Water samples were collected from sites in the lower mainstem Clackamas River, its tributaries, and in pre- and post-treatment drinking-water. In all, 63 pesticide compounds (33 herbicides, 15 insecticides, 6 fungicides, and 9 degradates) were detected in samples collected during storm and nonstorm conditions. Fifty-seven pesticides or degradates were detected in the tributaries (mostly during storms), whereas fewer compounds (26) were detected in samples of source water from the lower mainstem Clackamas River, with fewest (15) occurring in drinking water. The two most commonly detected pesticides were the triazine herbicide simazine and atrazine, which occurred in abut one- half of samples. The a.i. in common household herbicides RoundUP (glyphosate) and Cross bow (triclopyr and 2,4-D) were frequently detected together.

Upper Snake River Basin: NAWQA Analysis

The USGS conducted a water quality study from 1992 - 1995 in the upper Snake River basin, Idaho and Wyoming (Clark et al., 1998). This basin does not overlap with any of the 28 ESU/DPSs, though it does feed into the migratory corridor of all Snake River species, and eventually into the Columbia River. In basin wide stream sampling in May and June 1994, Eptam, atrazine (and desethylatrazine), metolachlor, and alachlor were the most commonly detected pesticides. These compounds accounted for 75% of all detections. Seventeen different pesticides were detected downstream from American Falls Reservoir.

Hood River Basin

The Hood River Basin ranks fourth in the state of Oregon in total agricultural pesticide usage (Jenkins, Jepson, Bolte, & Vache, 2004). The land in Hood River basin is used to grow five crops: alfalfa, apples, cherries, grapes, and pears. About 61 a.i.s, totaling 1.1 million lbs, are applied annually to roughly 21,000 acres. Of the top nine, three are carbamates and three are organophosphate insecticides (Table 65).

Table 65. Summaraized detection information from (Carpenter, et al., 2008). Note that percentages aren't comparable because results were pooled from multiple sources.

Active Ingredient	Class	Lbs applied
Oil	-	624,392
Lime Sulfur	-	121,703
Mancozeb	Carbamate	86,872
Sulfur	-	60,552
Ziram	Carbamate	45,965
Azinphos methyl	Organo-phosphate	22,294
Metam-Sodium	Carbamate	17,114
Phosmet	Organo-phosphate	15,919
Chlorpyrifos	Organo-phosphate	14,833

The Hood River basin contains approximately 400 miles of perennial stream channel, of which an estimated 100 miles is accessible to anadromous fish. These channels are important rearing and spawning habitat for salmonids, making pesticide drift a major concern for the area.

Other Land Use in the Pacific Northwest Region

Urban and Industrial Development

The largest urban area in the basin is the greater Portland metropolitan area, located at the mouth of the Willamette River. Portland's population exceeds 500,000 (Hinck, et al., 2004). Although the basin's land cover is about 8% of the U.S. total land mass, its human population is one-third the national average (about 1.2% of the U.S. population) (Hinck, et al., 2004).

Discharges from sewage treatment plants, paper manufacturing, and chemical and metal production represent the top three permitted sources of contaminants within the lower basin according to discharge volumes and concentrations (Rosetta & Borys, 1996). Rosetta and Borys (1996) review of 1993 data indicate that 52% of the point source waste water discharge volume is from sewage treatment plants, 39% from paper and allied products, 5% from chemical and allied products, and 3% from primary metals. However, the paper and allied products industry are the primary sources of the suspended sediment load (71%). Additionally, 26% of the point source waste water discharge volume comes from sewage treatment plants and 1% is from the chemical and allied products industry. Nonpoint source discharges (urban stormwater runoff) account for significant pollutant loading to the lower basin, including most organics and over half of the metals. Although rural nonpoint sources contributions were not calculated, Rosetta and Borys (1996) surmised that in some areas and for some contaminants, rural areas may contribute a large portion of the nonpoint source discharge. This is particularly true for pesticide contamination in the upper river basin where agriculture is the predominant land use.

Water quality has been reduced by phosphorus loads and decreased water clarity, primarily along the lower and middle sections of the Columbia River Estuary. Although sediment quality is generally very good, benthic indices have not been established within the estuary. Fish tissue contaminant loads (PCBs, DDT, DDD, DDE, and mercury) are high and present a persistent and long lasting effect on estuary biology. Health advisories have been recently issued for people eating fish in the area that contain high levels of dioxins, PCBs, and pesticides.

Habitat Modification

This section briefly describes how anthropogenic land use has altered aquatic habitat conditions for salmonids in the Pacific Northwest Region. Basin wide, critical ecological connectivity (mainstem to tributaries and riparian floodplains) has been disconnected by dams and associated activities such as floodplain deforestation and urbanization. Dams have flooded historical spawning and rearing habitat with the creation of massive water storage reservoirs. More than 55% of the Columbia River Basin that was accessible to salmon and steelhead before 1939 has been blocked by large dams (NWPPC, 1986). Construction of the Grand Coulee Dam blocked 1,000 miles (1,609 km) of habitat from migrating salmon and steelhead (Wydoski & Whitney, 1979). Similarly, over one third (2,000 km) of coho salmon habitat is no longer accessible (T. P. Good, et al., 2005). The mainstem habitats of the lower Columbia and Willamette rivers have been reduced primarily to a single channel. As a result, floodplain area is reduced, off-channel habitat features have been eliminated or disconnected from the main channel, and the amount of LWD in the mainstem has been reduced. Remaining areas are affected by flow fluctuations associated with reservoir management for power generation, flood control, and irrigation. Overbank flow events, important to habitat diversity, have become rare as a result of controlling peak flows and associated revetments. Portions of the basin are also subject to impacts from cattle grazing and irrigation withdrawals. Consequently, estuary dynamics have changed substantially.

Habitat loss has fragmented habitat and human density increase has created additional loads of pollutants and contaminants within the Columbia River Estuary (P. D. Anderson, Dugger, & Burke, 2007b). About 77% of swamps, 57% of marshes, and over 20% of tree cover have been lost to development and industry. Twenty four threatened and endangered species occur in the estuary, some of which are recovering while others (*i.e.*, Chinook salmon) are not.

Stream habitat degradation in Columbia Central Plateau is relatively high (Williamson, et al., 1998). In the most recent NAWQA survey, a total of 16 sites were evaluated - all of which showed signs of degradation (Williamson, et al., 1998). Streams in this area have an average of 20% canopy cover and 70% bank erosion. These factors have severely affected the quality of habitat available to salmonids. The Palouse subunit of the Lower Snake River exceeds temperature levels for the protection of aquatic life (Williamson, et al., 1998).

The Willamette Basin Valley has been dramatically changed by modern settlement. The complexity of the mainstem river and extent of riparian forest have both been reduced by 80% (PNERC, 2002). About 75% of what was formerly prairie and 60% of what was wetland have been converted to agricultural purposes. These actions, combined with urban development, extensive (96 miles) bank stabilization, and in-river and nearshore gravel mining, have resulted in a loss of floodplain connectivity and off-channel habitat (PNERC, 2002).

Habitat Restoration

Since 2000, land management practices included improving access by replacing culverts and fish habitat restoration activities at Federal Energy Regulatory Commission (FERC)-licensed dams. Habitat restoration in the upper (reducing excess sediment loads) and lower Grays River watersheds may benefit the Grays River chum salmon population as it has a sub-yearling juvenile life history type and rears in such habitats. Short-term daily flow fluctuations at Bonneville Dam sometimes create a barrier (*i.e.*, entrapment on shallow sand flats) for fry moving into the mainstem rearing and migration corridor. Some chum fry have been stranded on shallow water flats on Pierce Island from daily flow fluctuations. Coho salmon are likely to be affected by flow and sediment delivery changes in the Columbia River plume. Steelhead may be affected by flow and sediment delivery changes in the plume (Casillas, 1999).

In 2000, NOAA Fisheries completed consultation on issuance of a 50-year incidental take permit to the State of Washington for its Washington State Forest Practices Habitat Conservation Plan (HCP). The HCP is expected to improve habitat conditions on state forest lands within the action area. Improvements include removing barriers to migration, restoring hydrologic processes, increasing the number of large trees in riparian zones, improving stream bank integrity, and reducing fine sediment inputs (NMFS, 2008d).

Mining

Most of the mining in the basin is focused on minerals such as phosphate, limestone, dolomite, perlite, or metals such as gold, silver, copper, iron, and zinc. Mining in the region is conducted in a variety of methods and places within the basin. Alluvial or glacial deposits are often mined for gold or aggregate. Ores are often excavated from the hard bedrocks of the Idaho batholiths. Eleven percent of the nation’s output of gold has come from mining operations in Washington, Montana, and Idaho. More than half of the nation’s silver output has come from a few select silver deposits.

Many of the streams and river reaches in the basin are impaired from mining. Several abandoned and former mining sites are also designated as superfund cleanup areas (P. D. Anderson, et al., 2007b; Stanford, et al., 2005). According to the U.S. Bureau of Mines, there are about 14,000 inactive or abandoned mines within the Columbia River Basin. Of these, nearly 200 pose a potential hazard to the environment [Quigley, 1997 *in* (Hinck, et al., 2004)]. Contaminants detected in the water include lead and other trace metals.

Hydromodification Projects

More than 400 dams exist in the basin, ranging from mega dams that store large amounts of water to small diversion dams for irrigation (Figure 54). Every major tributary of the Columbia River except the Salmon River is totally or partially regulated by dams and diversions. More than 150 dams are major hydroelectric projects. Of these, 18 dams are located on the mainstem Columbia River and its major tributary, the Snake River. The FCRPS encompasses the operations of 14 major dams and reservoirs on the Columbia and Snake rivers. These dams and reservoirs operate as a coordinated system. The Corps operates 9 of 10 major federal projects on the Columbia and Snake rivers, and the Dworshak, Libby and Albeni Falls dams. The BOR operates the Grand Coulee and Hungry Horse dams. These federal projects are a major source of power in the region. These same projects provide flood control, navigation, recreation, fish and wildlife, municipal and industrial water supply, and irrigation benefits.

BOR has operated irrigation projects within the basin since 1904. The irrigation system delivers water to about 2.9 million acres of agricultural lands. About 1.1 million acres of land are irrigated using water delivered by two structures, the Columbia River Project (Grand Coulee Dam) and the Yakima Project. The Grand Coulee Dam delivers water for the irrigation of over 670,000 acres of croplands and the Yakima Project delivers water to nearly 500,000 acres of croplands (Bouldin, Farris, Moore, Smith, & Cooper, 2007).

The Bonneville Power Administration (BPA), an agency of the U.S. Department of Energy, wholesales electric power produced at 31 federal dams (67% of its production) and non-hydropower facilities in the Columbia-Snake Basin. The BPA sells about half the electric power consumed in the Pacific Northwest. The federal dams were developed over a 37-year period starting in 1938 with Bonneville Dam and Grand Coulee in 1941, and ending with construction of Libby Dam in 1973 and Lower Granite Dam in 1975.

Development of the Pacific Northwest regional hydroelectric power system, dating to the early 20th century, has had profound effects on the ecosystems of the Columbia River Basin (ISG, 1996). These effects have been especially adverse to the survival of anadromous salmonids. The construction of the FCRPS modified migratory habitat of adult and juvenile salmonids. In many cases, the FCRPS presented a complete barrier to habitat access for salmonids. Approximately 80% of historical spawning and rearing habitat of Snake River fall-run Chinook salmon is now inaccessible due to dams. The Snake River spring/summer run has been limited to the Salmon, Grande Ronde, Imnaha, and Tuscanon rivers. Damming has cut off access to the majority of Snake River Chinook salmon spawning habitat. The Sunbeam Dam on the Salmon River is believed to have limited the range of Snake River sockeye salmon as well.

Both upstream and downstream migrating fish are impeded by the dams. Additionally, a substantial number of juvenile salmonids are killed and injured during downstream migrations. Physical injury and direct mortality occurs as juveniles pass through turbines, bypasses, and spillways. Indirect effects of passage through all routes may include disorientation, stress, delay in passage, exposure to high concentrations of dissolved gases, warm water, and increased predation. Non-federal hydropower facilities on Columbia River tributaries have also partially or completely blocked higher elevation spawning.

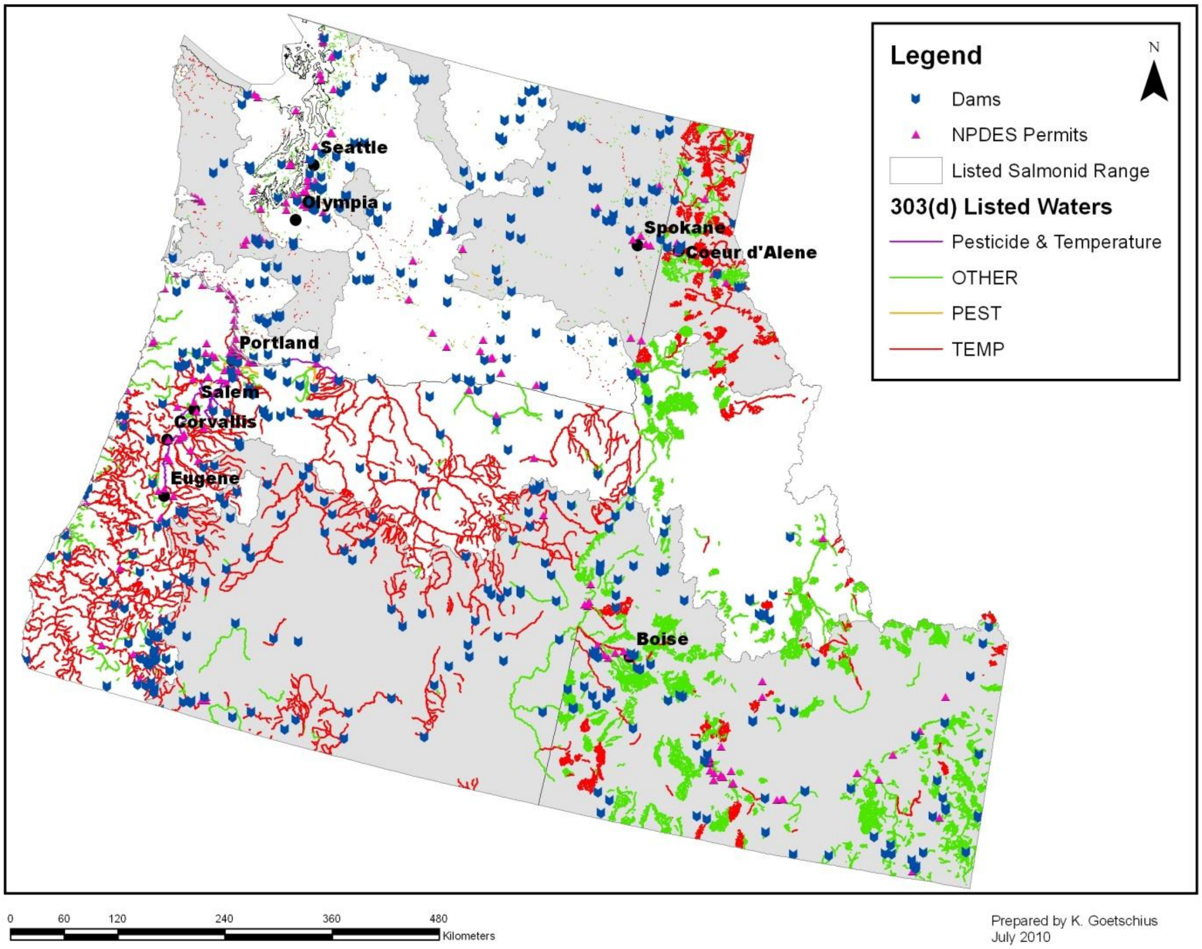
Qualitatively, several hydromodification projects have improved the productivity of naturally produced SR Fall-run Chinook salmon. Improvements include flow augmentation to enhance water flows through the lower Snake and Columbia Rivers [USBR 1998 *in* (NMFS, 2008d)]; providing stable outflows at Hells Canyon Dam during the fall Chinook salmon spawning season and maintaining these flows as minimums throughout the incubation period to enhance survival of incubating fall-run Chinook salmon; and reduced summer temperatures and enhanced summer flow in the lower

Snake River [see (Corps, BPA, & Reclamation, 2007), *Appendix 1 in* (NMFS, 2008d)]. Providing suitable water temperatures for over-summer rearing within the Snake River reservoirs allows the expression of productive “yearling” life history strategy that was previously unavailable to SR Fall-run Chinook salmon.

The mainstem FCRPS corridor has also improved safe passage through the hydrosystem for juvenile steelhead and yearling Chinook salmon with the construction and operation of surface bypass routes at Lower Granite, Ice Harbor, and Bonneville dams and other configuration improvements (Corps, et al., 2007).

For salmon, with a stream-type juvenile life history, projects that have protected or restored riparian areas and breached or lowered dikes and levees in the tidally influenced zone of the estuary have improved the function of the juvenile migration corridor. The FCRPS action agencies recently implemented 18 estuary habitat projects that removed passage barriers. These activities provide fish access to good quality habitat.

The Corps *et al.* (2007) estimated that hydropower configuration and operational improvements implemented from 2000 to 2006 have resulted in an 11.3% increase in survival for yearling juvenile LCR Chinook salmon from populations that pass Bonneville Dam. Improvements during this period included the installation of a corner collector at Powerhouse II (PH2) and the partial installation of minimum gap runners at Powerhouse 1 (PH1) and of structures that improve fish guidance efficiency at PH2. Spill operations have been improved and PH2 is used as the first priority powerhouse for power production because bypass survival is higher than at PH1. Additionally, drawing water towards PH2 moves fish toward the corner collector. The bypass system screen was removed from PH1 because tests showed that turbine survival was higher than through the bypass system at that location.



Prepared by K. Goetschius
July 2010

Figure 54. Pacific Northwest 303(d) waters, dams, and NPDES permit sites.

Artificial Propagation

There are several artificial propagation programs for salmon production within the Columbia River Basin. These programs were instituted under federal law to lessen the effects of lost natural salmon production within the basin from the dams. Federal, state, and tribal managers operate the hatcheries. For more than 100 years, hatcheries in the Pacific Northwest have been used to produce fish for harvest and replace natural production lost to dam construction. Hatcheries have only minimally been used to protect and rebuild naturally produced salmonid populations (*e.g.,* Redfish Lake sockeye salmon). In 1987, 95% of the coho salmon, 70% of the spring Chinook salmon, 80% of the summer Chinook salmon, 50% of the fall-run Chinook salmon, and 70% of the steelhead returning to the Columbia River Basin originated in hatcheries (CBFWA, 1990). More recent estimates suggest that almost half of the total number of smolts produced in the basin come from hatcheries (T. J. Beechie, Liermann, Beamer, & Henderson, 2005).

The impact of artificial propagation on the total production of Pacific salmon and steelhead has been extensive (Hard, et al., 1992). Hatchery practices, among other factors, are a contributing factor to the 90% reduction in natural coho salmon runs in the lower Columbia River over the past 30 years (Flagg, Waknitz, Maynard, Milner, & Mahnken, 1995). Past hatchery and stocking practices have resulted in the transplantation of salmon and steelhead from non-native basins. The impacts of these hatchery practices are largely unknown. Adverse effects of these practices likely included: loss of genetic variability within and among populations (Busack, 1990; Hard, et al., 1992; Reisenbichler, 1997; Riggs, 1990), disease transfer, increased competition for food, habitat, or mates, increased predation, altered migration, and the displacement of natural fish (K. D. Fresh, 1997; Hard, et al., 1992; Steward & Bjornn, 1990). Species with extended freshwater residence may face higher risk of domestication, predation, or altered migration than species that spend only a brief time in freshwater (Hard, et al., 1992). Nonetheless, artificial propagation may also contribute to the conservation of listed salmon and steelhead. However, it is unclear whether or how much artificial propagation during the recovery process will compromise the distinctiveness of natural populations (Hard, et al., 1992).

The states of Oregon and Washington and other fisheries co-managers are engaged in a substantial review of hatchery management practices through the Hatchery Scientific Review Group (HSRG). The HSRG was established and funded by Congress to provide an independent review of current hatchery program in the Columbia River Basin. The HSRG has completed its work on Lower Columbia River populations and provided its recommendations. A general conclusion is that the current production programs are inconsistent with practices that reduce impacts on naturally-spawning populations, and will have to be modified to reduce adverse effects on key natural populations identified in the Interim Recovery Plan. The adverse effects are caused by hatchery-origin adults spawning with natural-origin fish or competing with natural-origin fish for spawning sites (NMFS, 2008d). Oregon and Washington initiated a comprehensive program of hatchery and associated harvest reforms (ODFW, 2007; Washington Department of Fish and Wildlife (WDFW), 2005). The program is designed to achieve HSRG objectives related to controlling the number of hatchery-origin fish on the spawning grounds and in the hatchery broodstock.

Coho salmon hatchery programs in the lower Columbia have been tasked to compensate for impacts of fisheries. However, hatchery programs in the LCR have not operated specifically to conserve LCR coho salmon. These programs threaten the viability of natural populations. The long-term domestication of hatchery fish has eroded the fitness of these fish in the wild and has reduced the productivity of wild stocks where significant numbers of hatchery fish spawn with wild fish. Large numbers of hatchery fish have also contributed to more intensive mixed stock fisheries. These programs largely overexploited wild populations weakened by habitat degradation. Most LCR coho salmon populations have been heavily influenced by hatchery production over the years.

Commercial, Recreational, and Subsistence Fishing

Despite regulated fishing programs for salmonids, listed salmonids are also caught as bycatch. There are several approaches under the ESA to address tribal and state take of ESA-listed species that may occur as a result of harvest activities. Section 10 of the ESA provides for permits to operate fishery harvest programs. ESA section 4(d) rules provide exemptions from take for resource, harvest, and hatchery management plans. Furthermore, there are several treaties that have reserved the right of fishing to tribes in the North West Region.

Management of salmon fisheries in the Columbia River Basin is a cooperative process involving federal, state, and tribal representatives. The Pacific Fishery Management Council sets annual fisheries in federal waters from three to 200 miles off the coasts of Washington, Oregon, and California. Salmon and steelhead fisheries in the Columbia River and its tributaries are co-managed by the states of Washington, Oregon, Idaho, four treaty tribes, and other tribes that traditionally have fished in those waters. A federal court oversees Columbia River harvest management through the U.S. v. Oregon proceedings. Inland fisheries are those in waters within state boundaries, including those extending out three miles from the coasts. The states of Oregon, Idaho, and Washington issue salmon fishing licenses for theses areas.

Fisheries in the Columbia River basin are managed within the winter/spring, summer, and fall seasons. There are Treaty Indian and non-Treaty fisheries which are managed subject to state and tribal regulation, consistent with provisions of a U.S. v. Oregon 2008 agreement. The winter/spring season extends from January 1 to June 15. Commercial, recreational, and ceremonial subsistence fisheries target primarily upriver spring Chinook stocks and spring Chinook salmon that return to the Willamette and lower Columbia River tributaries. Some steelhead are also caught incidentally in these fisheries. The summer season extends from June 16 to July 31. Commercial, recreational, and ceremonial and subsistence fisheries are managed primarily to provide harvest opportunity directed at unlisted UCR summer Chinook salmon. Summer fisheries are constrained primarily by the available opportunity for UCR summer Chinook salmon, and by specific harvest rate limits for SR sockeye salmon and harvest rate limits on steelhead in non-Treaty fisheries. Fall season fisheries begin on August 1 and end on December 31. Commercial, recreational, and ceremonial and subsistence fisheries target primarily harvestable hatchery and natural origin fall Chinook and coho salmon. Fall season fisheries are constrained by specific ESA related harvest rate limits for listed SR fall Chinook salmon, and SR steelhead.

Treaty Indian fisheries are managed subject to the regulation of the Columbia River Treaty Tribes. They include all mainstem Columbia River fisheries between Bonneville Dam and

McNary Dam, and any fishery impacts from tribal fishing that occurs below Bonneville Dam. Tribal fisheries within specified tributaries to the Columbia River are included.

Non-Treaty fisheries are managed under the jurisdiction of the states. These include mainstem Columbia River commercial and recreational salmonid fisheries at the river mouth of Bonneville Damn, designated off channel Select Area fisheries, mainstem recreational fisheries between Bonneville Dam and McNary Dam, recreational fisheries between McNary Dam and Highway 305 Bridge in Pasco, Washington, recreational and Wanapum tribal spring Chinook fisheries from McNary Dam to Priest Rapids Dam, and recreational spring Chinook fisheries in the Snake River upstream to Lower Granite Dam.

Archeological records indicate that indigenous people caught salmon in the Columbia River more than 7,000 years ago. One of the most well known tribal fishing sites within the basin was located near Celilo Falls, an area in the lower river that has been occupied by Dalles Dam since 1957. Salmon fishing increased with better fishing methods and preservation techniques, such as drying and smoking. Salmon harvest substantially increased in the mid-1800s with canning techniques. Harvest techniques also changed over time, from early use of hand-held spears and dip nets, to riverboats using seines and gill nets. Harvest techniques eventually transitioned to large ocean-going vessels with trolling gear and nets and the harvest of Columbia River salmon and steelhead from California to Alaska (T. J. Beechie, et al., 2005).

During the mid-1800s, an estimated 10 to 16 million adult salmon of all species entered the Columbia River each year. Large annual harvests of returning adult salmon during the late 1800s ranging from 20 million to 40 million lbs of salmon and steelhead significantly reduced population productivity (T. J. Beechie, et al., 2005). The largest known harvest of Chinook salmon occurred in 1883 when Columbia River canneries processed 43 million lbs of salmon (Lichatowich, 1999). Commercial landings declined steadily from the 1920s to a low in 1993. At that time, just over one million lbs of Chinook salmon were harvested (T. J. Beechie, et al., 2005).

Harvested and spawning adults reached 2.8 million in the early 2000s, of which almost half are hatchery produced (T. J. Beechie, et al., 2005). Most of the fish caught in the river are steelhead and spring/summer run Chinook salmon. Ocean harvest consists largely of coho and fall-run Chinook salmon. Most ocean catches are made north of Cape Falcon, Oregon. Over the past five years, the number of spring and fall salmon commercially harvested in tribal fisheries has averaged between 25,000 and 110,000 fish (T. J. Beechie, et al., 2005). Recreational catch in both ocean and in-river fisheries varies from 140,000 to 150,000 individuals (T. J. Beechie, et al., 2005).

Non-Indian fisheries in the lower Columbia River are limited to a harvest rate of 1%. Treaty Indian fisheries are limited to a harvest rate of 5 to 7%, depending on the run size of upriver Snake River sockeye stocks. Actual harvest rates over the last 10 years have ranged from 0 to 0.9%, and 2.8 to 6.1%, respectively [see TAC 2008, Table 15 *in* (NMFS, 2008d)].

Columbia River chum salmon are not caught incidentally in tribal fisheries above Bonneville Dam. However, Columbia River chum salmon are incidentally caught occasionally in non-Indian fall season fisheries below Bonneville Dam. There are no fisheries in the Columbia River that target hatchery or natural-origin chum salmon. The species' later fall return timing make them vulnerable to relatively little potential harvest in fisheries that target Chinook salmon and coho salmon. CR chum salmon rarely take the sport gear used to target other species. Incidental catch of chum amounts to a few tens of fish per year (TAC 2008). The harvest rate of CR chum salmon in proposed state fisheries in the lower river is estimated to be 1.6% per year and is less than 5%.

LCR coho salmon are harvested in the ocean and in the Columbia River and tributary freshwater fisheries of Oregon and Washington. Incidental take of coho salmon prior to the 1990s fluctuated from approximately 60 to 90%. However, this number has been reduced since its listing to 15 to 25% (LCFRB, 2004). The exploitation of hatchery coho salmon has remained approximately 50% through the use of selective fisheries.

LCR steelhead are harvested in Columbia River and tributary freshwater fisheries of Oregon and Washington. Fishery impacts of LCR steelhead have been limited to less than 10% since implementation of mark-selective fisheries during the 1980s. Recent harvest rates on UCR steelhead in non-Treaty and treaty Indian fisheries ranged from 1% to 2%, and 4.1% to 12.4%, respectively (NMFS, 2008d).

Non-native Species

Many non-native species have been introduced to the Columbia River Basin since the 1880s. At least 81 non-native species have currently been identified, composing one-fifth of all species in some areas. New non-native species are discovered in the basin regularly; a new aquatic invertebrate is discovered approximately every 5 months (Sytsma, Cordell, Chapman, & Draheim, 2004). It is clear that the introduction of non-native species has changed the environment, though whether these changes will impact salmonid populations is uncertain (Sytsma, et al., 2004).

Puget Sound Region

Puget Sound is the second largest estuary in the U.S. It has about 1,330 miles of shoreline and extends from the mouth of the Strait of Juan de Fuca east. Puget Sound includes the San Juan Islands and south to Olympia, and is fed by more than 10,000 rivers and streams.

Puget Sound is generally divided into four major geographic marine basins: Hood Canal, South Sound, Whidbey Basin, and the Main Basin. The Main Basin has been further subdivided into two subbasins: Admiralty Inlet and Central Basin. About 43% of the Puget Sound's tideland is located in the Whidbey Island Basin. This reflects the large influence of the Skagit River, which is the largest river in the Puget Sound system and whose sediments are responsible for the extensive mudflats and tidelands of Skagit Bay.

Habitat types that occur within the nearshore environment include eelgrass meadows, kelp forest, mud flats, tidal marshes, sub-estuaries (tidally influenced portions of river and stream mouths), sand spits, beaches and backshore, banks and bluffs, and marine riparian vegetation. These habitats provide critical functions such as primary food production and support habitat for invertebrates, fish, birds, and other wildlife.

Major rivers draining to Puget Sound from the Cascade Mountains include the Skagit, Snohomish, Nooksack, Puyallup, and Green rivers, as well as the Lake Washington/Cedar River watershed. Major rivers from the Olympic Mountains include the Hamma Hamma, the Duckabush, the Quilcene, and the Skokomish rivers. Numerous other smaller rivers drain to the Sound, many of which are significant salmonid production areas despite their small size.

The Puget Sound basin is home to more than 200 fish and 140 mammalian species. Salmonids within the region include coho, Chinook, sockeye, chum, and pink salmon, kokanee, steelhead, rainbow, cutthroat, and bull trout (Kruckeberg, 1991; Wydoski & Whitney, 1979). Important commercial fishes include the five Pacific salmon and several rockfish species. A number of introduced species occur within the region, including brown and brook trout, Atlantic salmon, bass, tunicates (sea squirts), and a saltmarsh grass (*Spartina* spp.). Estimates suggest that over

90 species have been intentionally or accidentally introduced in the region (M. H. Ruckelshaus & McClure, 2007). At present, over 40 species in the region are listed as threatened and endangered under the ESA.

Puget Sound is unique among the nation's estuaries as it is a deep fjord-like structure that contains many urban areas within its drainage basin (Collier, O'Neill, & Scholz, 2006). Because several sills limit entry of oceanic water into Puget Sound, it is relatively poorly flushed compared to other urbanized estuaries of North America. Thus, toxic chemicals that enter Puget Sound have longer residence times within the system. This entrainment of toxics can result in biota exposure to increased levels of contaminant for a given input, compared to other large estuaries. This hydrologic isolation puts the Puget Sound ecosystem at higher risk from other types of populations that enter the system, such as nutrients and pathogens.

Because Puget Sound is a deep, almost oceanic habitat, the tendency of a number of species to migrate outside of Puget Sound is limited relative to similar species in other large urban estuaries. This high degree of residency for many marine species, combined with the poor flushing of Puget Sound, results in a more protracted exposure to contaminants. The combination of hydrologic and biological isolation makes the Puget Sound ecosystem highly susceptible to inputs of toxic chemicals compared to other major estuarine ecosystems (Collier, et al., 2006).

An indication of this sensitivity occurs in Pacific herring, one of Puget Sound's keystone forage fish species (Collier, et al., 2006). These fish spend almost all of their lives in pelagic waters and feed at the lower end of the food chain. Pacific herring should be among the least contaminated of fish species. However, monitoring has shown that herring from the main basins of Puget Sound have higher body burdens of persistent chemicals (*e.g.*, PCBs) compared to herring from the severely contaminated Baltic Sea. Thus, the pelagic food web of Puget Sound appears to be more seriously contaminated than previously anticipated.

Chinook salmon that are resident in Puget Sound (a result of hatchery practices and natural migration patterns) are several times more contaminated with persistent bioaccumulative contaminants than other salmon populations along the West Coast (Collier, et al., 2006). Because of associated human health concerns, fish consumption guidelines for Puget Sound salmon are under review by the Washington State Department of Health.

Extremely high levels of chemical contaminants are also found in Puget Sound's top predators, including harbor seals and ESA-listed southern resident killer whales (Collier, et al., 2006). In addition to carrying elevated loads of toxic chemicals in their tissues, Puget Sound's biota also show a wide range of adverse health outcomes associated with exposure to chemical contaminants. They include widespread cancer and reproductive impairment in bottom fish, increased susceptibility to disease in juvenile salmon, acute die-offs of adult salmon returning to spawn in urban watersheds, and egg and larval mortality in a variety of fish. Given current regional projections for population growth and coastal development, the loadings of chemical contaminants into Puget Sound will increase dramatically in future years.

Land Use

The Puget Sound Lowland contains the most densely populated area of Washington. The regional population in 2003 was an estimated 3.8 million people, with 86% residing in King, Pierce, and Snohomish counties (Snohomish, Cedar-Sammamish Basin, Green-Duwamish, and Puyallup River watersheds). The area is expected to attract 4 to 6 million new human residents in the next 20 years (M. H. Ruckelshaus & McClure, 2007). The Snohomish River watershed, one of the fastest growing watersheds in the region, increased about 16% in the same period.

Land use in the Puget Sound lowland is composed of agricultural areas (including forests for timber production), urban areas (industrial and residential use), and rural areas (low density residential with some agricultural activity). Pesticides are regularly applied to agricultural and non-agricultural lands and are found virtually in every land use area. Pesticides and other contaminants drain into ditches in agricultural areas and eventually to stream systems. Roads bring surface water runoff to stream systems from industrial, residential, and landscaped areas in the urban environment. Pesticides are also typically found in the right-of-ways of infrastructure that connect the major landscape types. Right-of-ways are associated with roads, railways, utility lines, and pipelines.

In the 1930s, all of western Washington contained about 15.5 million acres of “harvestable” forestland. By 2004, the total acreage was nearly half that originally surveyed (PSAT, 2007). Forest cover in Puget Sound alone was about 5.4 million acres in the early 1990s. About a decade later, the region had lost another 200,000 acres of forest cover with some watersheds losing more than half the total forested acreage. The most intensive loss of forest cover occurred in the Urban Growth Boundary, which encompasses specific parts of the Puget Lowland. In this area, forest cover declined by 11% between 1991 and 1999 (M. H. Ruckelshaus & McClure, 2007). Projected land cover changes indicate that trends are likely to continue over the next several decades with population changes (M. H. Ruckelshaus & McClure, 2007). Coniferous forests are also projected to decline at an alarming rate as urban uses increase.

According to the 2001 State of the Sound report (PSAT, 2007), impervious surfaces covered 3.3% of the region, with 7.3% of lowland areas (below 1,000 ft elevation) covered by impervious surfaces. From 1991 to 2001, the amount of impervious surfaces increased 10.4% region wide. Consequently, changes in rainfall delivery to streams alter stream flow regimes. Peak flows are increased and subsequent base flows are decreased and alter in-stream habitat. Stream channels are widened and deepened and riparian vegetation is typically removed which can cause increases in water temperature and will reduce the amounts of woody debris and organic matter to the stream system.

Pollutants carried into streams from urban runoff include pesticides, heavy metals, PCBs, polybrominated diphenyl ethers (PBDEs) compounds, PAHs, nutrients (phosphorus and nitrogen), and sediment (Table 66). Other ions generally elevated in urban streams include calcium, sodium, potassium, magnesium, and chloride ions where sodium chloride is used as the principal road deicing salt (Paul & Meyer, 2001). The combined effect of increased concentrations of ions in streams is the elevated conductivity observed in most urban streams.

Table 66. Examples of Water Quality Contaminants in Residential and Urban Areas.

Contaminant groups	Select constituents	Select example(s)	Source and Use Information
Fertilizers	Nutrients	Phosphorus Nitrogen	lawns, golf courses, urban landscaping
Heavy Metals	Pb, Zn, Cr, Cu, Cd, Ni, Hg, Mg	Cu	brake pad dust, highway and parking lot runoff, rooftops
Pesticides including- Insecticides (I) Herbicides (H) Fungicides (F) Wood Treatment chemicals (WT) Legacy Pesticides (LP) Other ingredients in pesticide formulations (OI)	Organophosphates (I) Carbamates (I) Organochlorines (I) Pyrethroids (I) Triazines (H) Chloroacetanilides (H) Chlorophenoxy acids (H) Triazoles (F) Copper containing fungicides (F) Organochlorines (LP) Surfactants/adjuvants (OI)	Chlorpyrifos (I) Diazinon (I) Carbaryl (I) Atrazine (H) Esfenvalerate (I) Creosote (WT) DDT (LP) Copper sulfate (F) Metalaxyl (F) Nonylphenol (OI)	golf courses, right of ways, lawn and plant care products, pilings, bulkheads, fences
Pharmaceuticals and personal care products	Natural and synthetic hormones soaps and detergents	Ethinyl estradiol Nonylphenol	hospitals, dental facilities, residences, municipal and industrial waste water discharges
Polyaromatic hydrocarbons (PAHs)	Tricyclic PAHs	Phenanthrene	fossil fuel combustion, oil and gasoline leaks, highway runoff, creosote-treated wood
Industrial chemicals	PCBs PBDEs Dioxins	Penta-PBDE	utility infrastructure, flame retardants, electronic equipment

Many other metals have been found in elevated concentrations in urban stream sediments including arsenic, iron, boron, cobalt, silver, strontium, rubidium, antimony, scandium, molybdenum, lithium, and tin (Wheeler, Angermeier, & Rosenberger, 2005). The concentration, storage, and transport of metals in urban streams are connected to particulate organic matter content and sediment characteristics. Organic matter has a high binding capacity for metals and both bed and suspended sediments with high organic matter content frequently exhibit 50 - 7,500 times higher concentrations of zinc, lead, chromium, copper, mercury, and cadmium than sediments with lower organic matter content.

Although urban areas occupy only 2% of the Pacific Northwest land base, the impacts of urbanization on aquatic ecosystems are severe and long lasting (B.C. Spence, et al., 1996). O'Neill *et al.* (2006) found that Chinook salmon returning to Puget Sound had significantly higher concentrations of PCBs and PBDEs compared to other Pacific coast salmon populations. Furthermore, Chinook salmon that resided in Puget Sound in the winter rather than migrate to the

Pacific Ocean (residents) had the highest concentrations of persistent organic pollutants (POPs), followed by Puget Sound fish populations believed to be more ocean-reared. Fall-run Chinook salmon from Puget Sound have a more localized marine distribution in Puget Sound and the Georgia Basin than other populations of Chinook salmon from the west coast of North America. This ESU is more contaminated with PCBs (2 to 6 times) and PBDEs (5 to 17 times). O'Neill *et al.* (2006) concluded that regional body burdens of contaminants in Pacific salmon, and Chinook salmon in particular, could contribute to the higher levels of contaminants in federally-listed endangered southern resident killer whales.

Endocrine disrupting compounds are chemicals that mimic natural hormones, inhibit the action of hormones and/or alter normal regulatory functions of the immune, nervous and endocrine systems and can be discharged with treated effluent (King County, 2002). Endocrine disruption has been attributed to DDT and other organochlorine pesticides, dioxins, PAHs, alkylphenolic compounds, phthalate plasticizers, naturally occurring compounds, synthetic hormones and metals. Natural mammalian hormones such as 17β-estradiol are also classified as endocrine disruptors. Both natural and synthetic mammalian hormones are excreted through the urine and are known to be present in wastewater discharges.

Jobling *et al.* (1995) reported that ten chemicals known to occur in sewage effluent interacted with the fish estrogen receptor by reducing binding of 17β-estradiol to its receptor, stimulating transcriptional activity of the estrogen receptor or inhibiting transcription activity. Binding of the ten chemicals with the fish endocrine receptor indicates that the chemicals could be endocrine disruptors and forms the basis of concern about WWTP effluent and fish endocrine disruption.

Fish communities are impacted by urbanization (Wheeler, et al., 2005). Urban stream fish communities have lower overall abundance, diversity, taxa richness and are dominated by pollution tolerant species. Lead content in fish tissue is higher in urban areas. Furthermore, the proximity of urban streams to humans increases the risk of non-native species introduction and establishment. Thirty-nine non-native species were collected in Puget Sound during the 1998 Puget Sound Expedition Rapid Assessment Survey (Brennan, et al., 2004). Lake Washington, located within a highly urban area, has 15 non-native species identified (Ajawani, 1956).

PAH compounds also have distinct and specific effects on fish at early life history stages (Incardona, Collier, & Scholz, 2004). PAHs tend to adsorb to organic or inorganic matter in sediments, where they can be trapped in long-term reservoirs (L. Johnson, Collier, & Stein, 2002). Only a portion of sediment-adsorbed PAHs are readily bioavailable to marine organisms, but there is substantial uptake of these compounds by resident benthic fish through the diet, through exposure to contaminated water in the benthic boundary layer, and through direct contact with sediment. Benthic invertebrate prey are a particularly important source of PAH exposure for marine fishes, as PAHs are bioaccumulated in many invertebrate species (Meador, Stein, Reichert, & Varanasi, 1995; Varanasi, Stein, & Nishimoto, 1989; Varanasi et al., 1992).

PAHs and their metabolites in invertebrate prey can be passed on to consuming fish species, PAHs are metabolized extensively in vertebrates, including fishes (L. Johnson, et al., 2002). Although PAHs do not bioaccumulate in vertebrate tissues, PAHs cause a variety of deleterious effects in exposed animals. Some PAHs are known to be immunotoxic and to have adverse effects on reproduction and development. Studies show that PAHs exhibit many of the same toxic effects in fish as they do in mammals (L. Johnson, et al., 2002).

Habitat Modification

Much of the estuarine wetlands in Puget Sound have been heavily modified, primarily from agricultural land conversion and urban development (NRC, 1996). Although most estuarine wetland losses result from conversions to agricultural land by ditching, draining, or diking, these wetlands also experience increasing effects from industrial and urban causes. By 1980, an estimated 27,180 acres of intertidal or shore wetlands had been lost at 11 deltas in Puget Sound (Bortleson, Chrzastowski, & Helgerson, 1980). Tidal wetlands in Puget Sound amount to roughly 18% of their historical extent (Collins & Sheikh, 2005). Coastal marshes close to seaports and population centers have been especially vulnerable to conversion with losses of 50 - 90%. By 1980, an estimated 27,180 acres of intertidal or shore wetlands had been lost at eleven deltas in Puget Sound (Bortleson, et al., 1980). More recently, tidal wetlands in Puget Sound amount to about 17 - 19% of their historical extent (Collins & Sheikh, 2005). Coastal marshes close to seaports and population centers have been especially vulnerable to conversion with losses of 50 - 90% common for individual estuaries. Salmon use freshwater and estuarine wetlands for physiological transition to and from salt water and rearing habitat. The land conversions and losses of Pacific Northwest wetlands constitute a major impact. Salmon use marine nearshore areas for rearing and migration, with juveniles using shallow shoreline habitats (Brennan, et al., 2004).

About 800 miles of Puget Sound's shorelines are hardened or dredged (PSAT, 2004; M. H. Ruckelshaus & McClure, 2007). The area most intensely modified is the urban corridor (eastern shores of Puget Sound from Mukilteo to Tacoma). Here, nearly 80% of the shoreline has been altered, mostly from shoreline armoring associated with the Burlington Northern Railroad tracks (M. H. Ruckelshaus & McClure, 2007). Levee development within the rivers and their deltas has isolated significant portions of former floodplain habitat that was historically used by salmon and trout during rising flood waters.

Urbanization has caused direct loss of riparian vegetation and soils and has significantly altered hydrologic and erosion rates. Watershed development and associated urbanization throughout the Puget Sound, Hood Canal, and Strait of Juan de Fuca regions have increased sedimentation, raised water temperatures, decreased LWD recruitment, decreased gravel recruitment, reduced river pools and spawning areas, and dredged and filled estuarine rearing areas (Bishop and Morgan 1996 in (NMFS, 2008b)). Large areas of the lower rivers have been channelized and diked for flood control and to protect agricultural, industrial, and residential development.

The principal factor for decline of Puget Sound steelhead is the destruction, modification, and curtailment of its habitat and range. Barriers to fish passage and adverse effects on water quality and quantity resulting from dams, the loss of wetland and riparian habitats, and agricultural and urban development activities have contributed and continue to contribute to the loss and degradation of steelhead habitats in Puget Sound (NMFS, 2008b).

Industrial Development

More than 100 years of industrial pollution and urban development have affected water quality and sediments in Puget Sound. Many different kinds of activities and substances release contamination into Puget Sound and the contributing waters. According to the State of the Sound Report (PSAT, 2007) in 2004, more than 1,400 fresh and marine waters in the region were listed as “impaired.” Almost two-thirds of these water bodies were listed as impaired due to contaminants, such as toxics, pathogens, and low dissolved oxygen or high temperatures, and less than one-third had established cleanup plans. More than 5,000 acres of submerged lands (primarily in urban areas; 1% of the study area) are contaminated with high levels of toxic substances, including polybrominated diphenyl ethers (PBDEs; flame retardants), and roughly one-third (180,000 acres) of submerged lands within Puget Sound are considered moderately contaminated. In 2005 the Puget Sound Action Team (PSAT) identified the primary pollutants of concern in Puget Sound and their sources listed below in Table 67.

Table 67. Pollutants of Concern in Puget Sound (PSAT, 2005).

Pollutant	Sources
Heavy Metals: Pb, Hg, Cu, and others	vehicles, batteries, paints, dyes, stormwater runoff, spills, pipes.
Organic Compounds: Polycyclic aromatic hydrocarbons (PAHs)	Burning of petroleum, coal, oil spills, leaking underground fuel tanks, creosote, asphalt.
Polychlorinated biphenyls (PCBs)	Solvents electrical coolants and lubricants, pesticides, herbicides, treated wood.
Dioxins, Furans	Byproducts of industrial processes.
Dichloro-diphenyl-trichloroethane (DDTs)	Chlorinated pesticides.
Phthalates	Plastic materials, soaps, and other personal care products. Many of these compounds are in wastewater from sewage treatment plants.
Polybrominated diphenyl ethers (PBDEs)	PBDEs are added to a wide range of textiles and plastics as a flame retardant. They easily leach from these materials and have been found throughout the environment and in human breast milk.

Puget Sound Basin: NAWQA Analysis

The USGS sampled waters in the Puget Sound Basin between 1996 and 1998. Ebbert et al. (2000) reported that 26 of 47 analyzed pesticides were detected. A total of 74 manmade organic chemicals were detected in streams and rivers, with different mixtures of chemicals linked to agricultural and urban settings NAWQA results reported that the herbicides atrazine, prometon, simazine and tebuthiuron were the most frequently detected herbicides in surface and ground water (Bortleson & Ebbert, 2000). Herbicides were the most common type of pesticide found in an agricultural stream (Fishtrap Creek) and the only type of pesticide found in shallow ground water underlying agricultural land (Bortleson & Ebbert, 2000). The most commonly detected VOC in the agricultural land use study area was associated with the application of fumigants to soils prior to planting (Bortleson & Ebbert, 2000). One or more fumigant-related compounds (1,2-dichloropropane, 1,2,2-trichloropropane, and 1,2,3-trichloropropane) were detected in over half of the samples. Insecticides, in addition to herbicides, were detected frequently in urban streams (Bortleson & Ebbert, 2000). Sampled urban streams showed the highest detection rate for the three insecticides: carbaryl, diazinon, and malathion. No insecticides were found in shallow ground water below urban residential land (Bortleson & Ebbert, 2000).

Habitat Restoration

Positive changes in water quality in the region are evident. One of the most notable improvements was the elimination of sewage effluent to Lake Washington in the mid-1960s. This significantly reduced problems within the lake from phosphorus pollution and triggered a concomitant reduction in cyanobacteria (M. H. Ruckelshaus & McClure, 2007). Even so, as the population and industry has risen in the region a number of new and legacy pollutants are of concern.

Mining

Mining has a long history in Washington. In 2004, the state was ranked 13th nationally in total nonfuel mineral production value and 17th in coal production (NMA, 2007; Palmisano, Ellis, & Kaczynski, 1993). Metal mining for all metals (zinc, copper, lead, silver, and gold) peaked between 1940 and 1970 (Palmisano, et al., 1993). Today, construction sand and gravel, Portland cement, and crushed stone are the predominant materials mined. Where sand and gravel is mined from riverbeds (gravel bars and floodplains) it may result in changes in channel elevations and patterns, instream sediment loads, and seriously alter instream habitat. In some cases, instream or floodplain mining has resulted in large scale river avulsions. The effect of mining in a stream or reach depends upon the rate of harvest and the natural rate of replenishment, as well as flood and precipitation conditions during or after the mining operations.

Artificial Propagation

The artificial propagation of late-returning Chinook salmon is widespread throughout Puget Sound (T. P. Good, et al., 2005). Summer/fall Chinook salmon transfers between watersheds within and outside the region have been commonplace throughout this century. Therefore, the purity of naturally spawning stocks varies from river to river. Nearly 2 billion Chinook salmon have been released into Puget Sound tributaries since the 1950s. The vast majority of these have been derived from local late-returning adults.

Returns to hatcheries have accounted for 57% of the total spawning escapement. However, the hatchery contribution to spawner escapement is probably much higher than that due to hatchery-derived strays on the spawning grounds. The genetic similarity between Green River late-returning Chinook salmon and several other late-returning Chinook salmon in Puget Sound suggests that there may have been a significant and lasting effect from some hatchery transplants (A. R. Marshall et al., 1995).

Overall, the use of Green River stock throughout much of the extensive hatchery network in this ESU may reduce the genetic diversity and fitness of naturally spawning populations (T. P. Good, et al., 2005).

Hydromodification Projects

More than 20 dams occur within the region's rivers and overlap with the distribution of salmonids. A number of basins contain water withdrawal projects or small impoundments that can impede migrating salmon. The resultant impact of these and land use changes (forest cover loss and impervious surface increases) has been a significant modification in the seasonal flow patterns of area rivers and streams, and the volume and quality of water delivered to Puget Sound waters. Several rivers have been modified by other means including levees and revetments, bank hardening for erosion control, and agriculture uses. Since the first dike on the Skagit River delta was built in 1863 for agricultural development (M. H. Ruckelshaus & McClure, 2007), other basins like the Snohomish River are diked and have active drainage systems to drain water after high flows that top the dikes. Dams were also built on the Cedar, Nisqually, White, Elwha, Skokomish, Skagit, and several other rivers in the early 1900s to supply urban areas with water, prevent downstream flooding, allow for floodplain activities (like agriculture or development), and to power local timber mills (M. H. Ruckelshaus & McClure, 2007).

Over the next few years, however, a highly publicized and long discussed dam removal project is expected to begin in the Elwha River. The removal of two dams in the Elwha River, a short but formerly very productive salmon river, is expected to open up more than 70 miles of high quality salmon habitat (M. H. Ruckelshaus & McClure, 2007; Wunderlich, Winter, & Meyer, 1994). Estimates suggest that nearly 400,000 salmon could begin using the basin within 30 years after the dams are removed (PSAT, 2007).

In 1990, only one-third of the water withdrawn in the Pacific Northwest was returned to the streams and lakes (NRC, 1996). Water that returns to a stream from an agricultural irrigation is often substantially degraded. Problems associated with return flows include increased water temperature, which can alter patterns of adult and smolt migration; increased toxicant concentrations associated with pesticides and fertilizers; increased salinity; increased pathogen populations; decreased dissolved oxygen concentration; and increased sedimentation (NRC, 1996). Water-level fluctuations and flow alterations due to water storage and withdrawal can affect substrate availability and quality, temperature, and other habitat requirements of salmon. Indirect effects include reduction of food sources; loss of spawning, rearing, and adult habitat; increased susceptibility of juveniles to predation; delay in adult spawning migration; increased egg and alevin mortalities; stranding of fry; and delays in downstream migration of smolts (NRC, 1996).

Commercial and Recreational Fishing

Despite regulated fishing programs for salmonids, listed salmonids are also caught as bycatch. There are several approaches under the ESA to address tribal and state take of ESA-listed species that may occur as a result of harvest activities. Section 10 of the ESA provides for permits to operate fishery harvest programs. ESA section 4(d) rules provide exemptions from take for resource, harvest, and hatchery management plans. Furthermore, there are several treaties that have reserved the right of fishing to tribes in the North West Region.

Management of salmon fisheries in the Puget Sound Region is a cooperative process involving federal, state, tribal, and Canadian representatives. The Pacific Fishery Management Council sets annual fisheries in federal waters from three to 200 miles off the coasts of Washington, Oregon, and California. The annual North of Falcon process sets salmon fishing seasons in waters such as Puget Sound, Willapa Bay, Grays Harbor, and Washington State rivers. Inland fisheries are those in waters within state boundaries, including those extending out three miles from the coasts. The states of Oregon, Idaho, and Washington issue salmon fishing licenses for theses areas. Adult salmon returning to Washington migrate through both U.S. and Canadian waters and are harvested by fishermen from both countries. The 1985 Pacific Salmon Treaty helps fulfill conservation goals for all members and is implemented by the eight-member bilateral Pacific Salmon Commission. The Commission does not regulate salmon fisheries, but provides regulatory advice.

Most of the commercial landings in the region are groundfish, Dungeness crab, shrimp, and salmon. Many of the same species are sought by Tribal fisheries and by charter and recreational anglers. Nets and trolling are used in commercial and Tribal fisheries. Recreational anglers typically use hook and line, and may fish from boat, river bank, or docks. Entanglement of marine mammals in fishing gear is not uncommon and can lead to mortality or serious injury.

Harvest impacts on Puget Sound Chinook salmon populations average 75% in the earliest five years of data availability and have dropped to an average of 44% in the most recent five-year period (T. P. Good, et al., 2005). Populations in Puget Sound have not experienced the strong increases in numbers seen in the late 1990s in many other ESUs. Although more populations have increased than decreased since the last BRT assessment, after adjusting for changes in harvest rates, trends in productivity are less favorable. Most populations are relatively small, and recent abundance within the ESU is only a small fraction of estimated historic run size.

Oregon-Washington-Northern California Coastal Drainages

This region encompasses drainages originating in the Klamath Mountains, the Oregon Coast Mountains, and the Olympic Mountains. More than 15 watersheds drain the region’s steep slopes including the Umpqua, Alsea, Yaquina, Nehalem, Chehalis, Quillayute, Queets, and Hoh rivers. Numerous other small to moderately sized streams dot the coastline. Many of the basins in this region are relatively small. The Umpqua River drains a basin of 4,685 square miles and is slightly over 110 miles long. The Nehalem River drains a basin of 855 square miles and is almost 120 miles long. However, systems here represent some of the most biologically diverse basins in the Pacific Northwest (Belitz, et al., 2004; Carter & Resh, 2005; Kagan, Hak, Csuti, Kiilsgaard, & Gaines, 1999).

Land Use

The rugged topography of the western Olympic Peninsula and the Oregon Coastal Range has limited the development of dense population centers. For instance, the Nehalem River and the Umpqua River basins consist of less than 1% urban land uses. Most basins in this region have long been exploited for timber production, and are still dominated by forest lands. In Washington State, roughly 90% of the coastal region is forested (Palmisano, et al., 1993). Roughly 80% of the Oregon Coastal Range is forested as well (S. Gregory, 2000). Approximately 92% of the Nehalem River basin is forested, with only 4% considered agricultural (Belitz, et al., 2004). Similarly, in the Umpqua River basin, about 86% is forested land, 5% agriculture, and 0.5% is considered urban lands. Roughly half the basin is under federal management (Carter & Resh, 2005).

Habitat Modification

While much of the coastal region is forested, it has still been impacted by land use practices. Less than 3% of the Oregon coastal forest is old growth conifers (S. Gregory, 2000). The lack of mature conifers indicates high levels of habitat modification. As such, overall salmonid habitat quality is poor, though it varies by watershed. The amount of remaining high quality habitat ranges from 0% in the Sixes to 74% in the Siltcoos (ODFW, 2005). Approximately 14% of freshwater winter habitat available to juvenile coho is of high quality. Much of the winter habitat is unsuitable due to high temperatures. For example, 77% of coho salmon habitat in the Umpqua basin exceeds temperature standards.

Reduction in stream complexity is the most significant limiting factor in the Oregon coastal region. An analysis of the Oregon coastal range determined the primary and secondary life cycle bottlenecks for the 21 populations of coastal coho salmon (Nicholas, McIntosh, & Bowles, 2005). Nicholas *et al.* (2005) determined that stream complexity is either the primary (13) or secondary (7) bottleneck for every population. Stream complexity has been reduced through past practices such as splash damming, removing riparian vegetation, removing LWD, diking tidelands, filling floodplains, and channelizing rivers.

Habitat loss through wetland fills is also a significant factor. Table 68 summarizes the change in area of tidal wetlands for several Oregon estuaries (J. W. Good, 2000).

Table 68. Change in total area (acres2) of tidal wetlands in Oregon (tidal marshes and swamps) due to filling and diking between 1870 and 1970 (J. W. Good, 2000).

Estuary	Diked or Filled Tidal Wetland	Percent of 1870 Habitat Lost
Necanicum	15	10
Nehalem	1,571	75
Tillamook	3,274	79
Netarts	16	7
Sand Lake	9	2
Nestucca	2,160	91
Salmon	313	57
Siletz	401	59
Yaquina	1,493	71
Alsea	665	59
Siuslaw	1,256	63
Umpqua	1,218	50
Coos Bay	3,360	66
Coquille	4,600	94
Rogue	30	41
Chetco	5	56
Total	20,386	72%

The only listed salmonid population in coastal Washington is the Ozette Lake sockeye. The range of this ESU is small, including only one lake (31 km^2) and 71 km of stream. Like the Oregon Coastal drainages, the Ozette Lake area has been heavily managed for logging. Logging resulted in road building and the removal of LWD, which affected the nearshore ecosystem (NMFS Salmon Recovery Division, 2008). LWD along the shore offered both shelter from predators and a barrier to encroaching vegetation (NMFS Salmon Recovery Division, 2008). Aerial photograph analysis shows near-shore vegetation has increased significantly over the past 50 years (Ritchie, 2005). Further, there is strong evidence that water levels in Ozette Lake have dropped between 1.5 and 3.3 ft from historic levels [Herrera 2005 *in* (NMFS Salmon Recovery Division, 2008)]. The impact of this water level drop is unknown. Possible effects include increased desiccation of sockeye redds and loss of spawning habitat. Loss of LWD has also contributed to an increase in silt deposition, which impairs the quality and quantity of spawning habitat. Very little is known about the relative health of the Ozette Lake tributaries and their impact on the sockeye salmon population.

Mining

Oregon is ranked 35th nationally in total nonfuel mineral production value in 2004. In that same year, Washington was ranked 13th nationally in total nonfuel mineral production value and 17th in coal production (NMA, 2007; Palmisano, et al., 1993). Metal mining for all metals (*e.g.*, zinc, copper, lead, silver, and gold) peaked in Washington between 1940 and 1970 (Palmisano, et al., 1993). Today, construction sand, gravel, Portland cement, and crushed stone are the predominant materials mined in both Oregon and Washington. Where sand and gravel is mined from riverbeds (gravel bars and floodplains) changes in channel elevations and patterns, and also changes in instream sediment loads, may result and alter instream habitat. In some cases, instream or floodplain mining has resulted in large scale river avulsions. The effect of mining in a stream or reach depends upon the rate of harvest and the natural rate of replenishment. Additionally, the severity of the effects is influenced by flood and precipitation conditions during or after the mining operations.

Hydromodification Projects

Compared to other areas in the greater Northwest Region, the coastal region has fewer dams and several rivers remain free flowing (*e.g.*, Clearwater River). The Umpqua River is fragmented by 64 dams, the fewest number of dams on any large river basin in Oregon (Carter & Resh, 2005). According to Palmisano *et al.* (1993) dams in the coastal streams of Washington permanently block only about 30 miles of salmon habitat (Figure 54). In the past, temporary splash dams were constructed throughout the region to transport logs out of mountainous reaches. The general practice involved building a temporary dam in the creek adjacent to the area being logged, and filling the pond with logs. When the dam broke the floodwater would carry the logs to downstream reaches where they could be rafted and moved to market or downstream mills. Thousands of splash dams were constructed across the Northwest in the late 1800s and early 1900s. While the dams typically only temporarily blocked salmon habitat, in some cases dams remained long enough to wipe out entire salmon runs. The effects of the channel scouring and loss of channel complexity resulted in the long-term loss of salmon habitat (NRC, 1996).

Commercial and Recreational Fishing

Despite regulated fishing programs for salmonids, listed salmonids are also caught as bycatch. There are several approaches under the ESA to address tribal and state take of ESA-listed species that may occur as a result of harvest activities. Section 10 of the ESA provides for permits to operate fishery harvest programs. ESA section 4(d) rules provide exemptions from take for resource, harvest, and hatchery management plans.

Management of salmon fisheries in the Washington-Oregon-Northern California drainage is a cooperative process involving federal, state, and tribal representatives. The Pacific Fishery Management Council sets annual fisheries in federal waters from three to 200 miles off the coasts of Washington, Oregon, and California. Inland fisheries are those within state boundaries, including those extending out three miles from state coastlines. The states of Oregon, Idaho, California and Washington issue salmon fishing licenses for theses areas.

Most commercial landings in the region are groundfish, Dungeness crab, shrimp, and salmon. Many of the same species are sought by Tribal fisheries, as well as by charter, and recreational anglers. Nets and trolling are used in commercial and Tribal fisheries. Recreational anglers typically use hook and line and may fish from boat, river bank, or docks.

Integration of Environmental Baseline Effects on Listed Resources

Collectively, the components of the environmental baseline for the action area include sources of natural mortality as well as influences from natural oceanographic and climatic features in the action area. Climatic variability may affect the growth, reproductive success, and survival of listed Pacific salmonids in the action area. Temperature and water level changes may lead to: (1) Reduced summer and fall stream flow, leading to loss of spawning habitat and difficulty reaching spawning beds; (2) increased winter flooding and disturbance of eggs; (3) changes in peak stream flow timing affecting juvenile migration; and (4) rising water temperature may exceed the upper temperature limit for salmonids at 64ºF (18ºC) (JISAO, 2007). Additional indirect impacts include changes in the distribution and abundance of the prey and the distribution and abundance of competitors or predators for salmonids. These conditions will influence the population structure and abundance for all listed Pacific salmonids.

The baseline also includes human activities resulting in disturbance, injury, or mortality of individual salmon. These activities include hydropower, hatcheries, harvest, and habitat degradation, including poor water quality and reduced availability of spawning and rearing habitat for all 28 ESUs/DPSs. As such, these activities degrade salmonid habitat, including all designated critical habitat and their PCEs. While each area is affected by a unique combination of stressors, the two major impacts to listed Pacific salmonid critical habitat are habitat loss and decreased prey abundance. Although habitat restoration and hydropower modification measures are ongoing, the long-term beneficial effects of these actions on Pacific salmonids, although anticipated, remain to be realized. Thus, we are unable to quantify these potential beneficial effects at this time.

Listed Pacific salmonids and designated critical habitat may be adversely affected by the proposed registration of oryzalin, pendimethalin, and trifluralin in California, Idaho, Oregon, and Washington. These salmonids are and have been exposed to the components of the environmental baseline for decades. The activities discussed above have some level of effect on all 28 ESUs/DPSs in the proposed action area. They have also eroded the quality and quantity of salmonid habitat – including designated critical habitat. We expect the combined consequences of those effects, including impaired water quality, temperature, and reduced prey abundance, may increase the vulnerability and susceptibility of overall fish health to disease, predation, and competition for available suitable habitat and prey items. The continued trend of anthropogenic impairment of water quality and quantity on Pacific salmonids and their habitats may further compound the declining status and trends of listed salmonids, unless measures are implemented to reverse this trend.

Effects of the Proposed Action to Threatened and Endangered Pacific Salmonids

The analysis includes three primary components: exposure, response, and risk characterization. We analyze exposure and response, and integrate the two in the risk characterization phase where we address support for risk hypotheses. These risk hypotheses are predicated on effects to salmonids. Designated critical habitat is analyzed separately.

Exposure Analysis

In this section, we evaluate potential exposure of salmonids to stressors of the action (Figure 1, Figure 55). We begin by presenting general life history information for Pacific salmon and steelhead to identify approximately when vulnerable lifestages will be present in freshwater and estuarine habitats. This is further refined with a run-timing analysis for each ESU/DPS.To identify spatial co-occurrences we group authorized use sites with into four broad landuse categories and overlay the landuse on the ESU/DPS using GIS.. Landuse categories we use are agriculture, forestry, urban/developed, and rights-of-way. All except rights-of-way correspond with land classifications in the NLCD. Rights-of-way (road, railroads, utility lines, etc.) can occur anywhere within all landuse categories, although they tend to be more concentrated near developed areas.

We discuss chemical fate and transport properties based primarily on information provided by EPA in their BEs and other documents. This includes a discussion of how quickly and via what pathways the a.i.s degrade, what degradates have been identified, and in which environmental compartments we expect the parent a.i. and degradates to occur. We determine the range of potential water concentrations using both modeling estimates (estimated environmental concentrations (EECs)) and monitoring data (measured environmental concentrations (MECs)). EECs we consider come from two models – PRZM-EXAMs and AgDrift. MECs come from several sources, including the USGS NAWQA database, state water quality databases, and targeted monitoring studies available in open literature and/or government reports.

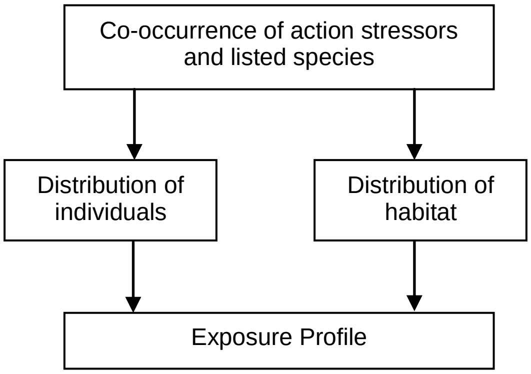


Figure 55 Exposure analysis.

Threatened and Endangered Pacific Salmonids' use of Aquatic Habitats

Within the Status Section we discussed salmonid lifecycles, life histories, and the use and significance of aquatic habitats. Listed salmonids occupy a variety of aquatic habitats that range from shallow, low-flow freshwaters to open reaches of the Pacific Ocean. All listed Pacific salmonid species use freshwater, estuarine, and marine habitats at some point during their life. The temporal and spatial use of habitats by salmonids depends on the species and the individuals' life history and life stage. General life history descriptions describing use of aquatic habitats is provided below in Table 69. Additional information regarding when individual fish are present in each ESU/DPS is provided in the run timing analysis (Appendix 5). Many species undertake significant migrations during their lifetimes, and may encounter contaminants from multiple sources, and/or encounter them at multiple lifestages.

Table 69 General life-histories of Pacific salmonids.

Species (number of listed ESUs or DPSs)	General Life History Descriptions		
	Spawning Migration	Spawning Habitat	Juvenile Rearing and Migration
Chinook (9)	Mature adults (usually three to five years old) enter rivers (spring through fall, depending on run). Adults migrate and spawn in river reaches extending from above the tidewater to as far as 1,200 miles from the sea. Chinook salmon migrate and spawn in four distinct runs (spring, fall, summer, and winter). Chinook salmon are semelparous[1].	Generally spawn in the middle and upper reaches of main stem rivers and larger tributary streams.	The alevin life stage primarily resides just below the gravel surface until they approach or reach the fry stage. Immediately after leaving the gravel, fry distribute to habitats that provide refuge from fast currents and predators. Juveniles exhibit two general life history types: Ocean-type fish migrate to sea in their first year, usually within six months of hatching. Ocean-type juveniles may rear in the estuary for extended periods. Stream-type fish migrate to the sea in the spring of their second year.
Coho (4)	Mature adults (usually two to four years old) enter the rivers in the fall. The timing varies depending on location and other variables. Coho salmon are semelparous.	Spawn throughout smaller coastal tributaries, usually penetrating to the upper reaches to spawn. Spawning takes place from October to March.	Following emergence, fry move to shallow areas near stream banks. As fry grow they distribute up and downstream and establish territories in small streams, lakes, and off-channel ponds. Here they rear for 12-18 months. In the spring of their second year juveniles rapidly migrate to sea. Initially, they remain in nearshore waters of the estuary close to the natal stream following downstream migration.
Chum (2)	Mature adults (usually three to four years old) enter rivers as early as July, with arrival on the spawning grounds occurring from September to January. Chum salmon are semelparous.	Generally spawn from just above tidewater in the lower reaches of mainstem rivers, tributary stream, or side channels to 100 km upstream.	The alevin life stage primarily resides just below the gravel surface until they approach or reach the fry stage. Immediately after leaving the gravel, swim-up fry migrate downstream to estuarine areas. They reside in estuaries near the shoreline for one or more weeks before migrating for extended distances, usually in a narrow band along the Pacific Ocean's coast.

Species (number of listed ESUs or DPSs)	General Life History Descriptions		
	Spawning Migration	Spawning Habitat	Juvenile Rearing and Migration
Sockeye (2)	Mature adults (usually four to five years old) begin entering rivers from May to October. Sockeye are semelparous.	Spawn along lakeshores where springs occur and in outlet or inlet streams to lakes.	The alevin life stage primarily resides just below the gravel surface until they approach or reach the fry stage. Immediately after leaving the gravel, swim-up fry migrate to nursery lakes or intermediate feeding areas along the banks of rivers. Populations that migrate directly to nursery lakes typically occupy shallow beach areas of the lake's littoral zone; a few cm in depth. As they grow larger they disperse into deeper habitats. Juveniles usually reside in the lakes for one to three years before migrating to off shore habitats in the ocean. Some are residual, and complete their entire lifecycle in freshwater.
Steelhead (11)	Mature adults (typically three to five years old) may enter rivers any month of the year, and spawn in late winter or spring. Migration in the Columbia River system extends up to 900 miles from the ocean in the Snake River. Steelhead are iteroparous[2].	Usually spawn in fine gravel in a riffle above a pool.	The alevin life stage primarily resides just below the gravel surface until they approach or reach the fry stage. Immediately after leaving the gravel, swim-up fry usually inhabit shallow water along banks of stream or aquatic habitats on streams margins. Steelhead rear in a wide variety of freshwater habitats, generally for two to three years, but up to six or seven years is possible. They smolt and migrate to sea in the spring.

1 spawn only once
2 spawn more than once

Freshwater, estuarine, and marine near-shore habitats are areas subject to pesticide loading from runoff and drift given their proximity to pesticide application sites. Small streams and many floodplain habitats are more susceptible to higher pesticide concentrations than other aquatic habitats used by salmon because their physical characteristics provide less dilution and dissipation. Examples of floodplain habitats include alcoves, channel edge sloughs, overflow channels, backwaters, terrace tributaries, off-channel dredge ponds, off-channel ponds, and braids (S. E. Anderson, 1999; T. Beechie & Bolton, 1999; Swift III, 1979). The transition from yolksac fry to exogenous feeding is a critical life stage for all salmon species and depends upon availability of prey. Diverse, abundant communities of invertebrates (many of which are salmonid prey items), also populate floodplain habitats and, in part, are responsible for juvenile salmonids reliance on these habitats. Juvenile coho salmon, stream-type Chinook salmon, and steelhead use floodplain habitats for extended durations (several months). Although these habitats typically vary in surface area, volume, and flow, they are frequently shallow, low to no-flow systems protected from a river's or a stream's primary flow. Thus, rearing and migrating juvenile salmonids use these habitats extensively (T. Beechie & Bolton, 1999; T. J. Beechie, et al., 2005; Caffrey, 1996; Henning, Gresswell, & Fleming, 2006; Montgomery, Beamer, Pess, & Quinn, 1999; Morley, Garcia, Bennett, & Roni, 2005; Opperman & Merenlender, 2004; Roni, 2002).

Exposure Pathways to Salmonid Habitats

Aquatic habitats can be contaminated by pesticides applied to terrestrial target sites through several alternative pathways. For example, spray drift or primary drift refers to the off-target deposition of droplets from spray-applied pesticides at the time of application. The likelihood of spray drift to an aquatic habitat is determined by the application method, the proximity to the habitat, and meteorological conditions at the time of application. Some pesticides are applied directly to surface water for control of plants, mosquitoes, and other aquatic pests. Other pathways of surface water contamination are influenced primarily by the environmental fate properties of the chemical. For example, secondary drift or vapor drift is dependent on a chemical's volatility and refers to the redistribution of pesticides from plant and soil surfaces through volatilization and subsequent atmospheric deposition. Runoff and leaching, the horizontal and vertical movement of pesticides with rainwater or irrigation water, are influenced by chemical-specific properties that determine the compound’s persistence and mobility in soil and water. Standardized tests are typically used to characterize mobility (*e.g.* solubility, K_d and K_{oc}) and persistence under different environmental conditions (*e.g.* hydrolysis, photolysis, and metabolism half-lives in aerobic and anaerobic environments). Below we present environmental fate properties of the three a.i.s to characterize the relative importance of these exposure pathways in terms of the potential for the active ingredients and their toxic degradates to contaminate salmonid bearing habitats and designated critical habitats.

Exposure of salmonid habitats to the stressors of the action

Co-occurrence associated with pesticide uses.

We evaluated co-occurrence of listed salmonids with other uses of the three pesticides by comparing the spatial and temporal distribution of salmon (*Appendix 4* and *5*) with potential use of pesticides based on label specifications. To evaluate areal extent of application sites near salmon-bearing waters, NMFS used a GIS overlay containing landuse classifications and salmon distributions to determine overlap. Agricultural uses are authorized for all three active ingredients (*Description of the Action*). Oryzalin, pendimethalin and trifluralin labels allow application to a variety of crop and uncultivated agricultural lands, including pastures and rangeland. These compounds are also approved for use on a variety of developed use sites including residential, urban, and industrial areas. Oryzalin, pendimethalin and trifluralin are not authorized for use in aquatic habitats or forested areas. While pendimethalin is authorized for use on rice, authorization is for dry seeded rice or wet seeded rice only after water has drained and the soil surface is dry.

Agricultural use of oryzalin is limited to orchard and vineyard crops. This limitation allowed us to further define areas of higher expected exposure within the agriculture landuse classification. While orchards and vineyards may occur within any ESU, some areas are known for fruit and nut production. NMFS used the NASS database and the Generic Endangered Species Task Force’s analysis (Kay, 2011) as other lines of evidence to identify areas of higher expected exposure to oryzalin.

Rights-of-way uses are authorized for all three a.i.s examined in this Opinion. These use sites are the most difficult to analyze as they are not tied to a particular landuse classification. EPA classifies three specific kinds of rights-of-way: highway, railroad, and utility (including pipeline) (EPA, 2003a). By definition, they are tied to the transportation of goods and services, which cross urban, agricultural, and wilderness areas alike. Highways and utilities are ubiquitous and rights-of-way applications may occur during the freshwater residence of all of the listed Pacific salmonids (*Appendix 4*). We make the reasonable assumption rights-of-way are present in all ESUs to varying degrees. Exposure from these uses is less likely in less populated areas and for species that spend less time in freshwater habitats.

Table 70. Summary of land use categories approved on active labels.

ACTIVE INGREDIENT	AQUATIC[1]	AGRICULTURAL[2]	DEVELOPED[3]	FORESTRY[4]	RIGHTS OF WAY[5]
Oryzalin	No	Yes	Yes	No	Yes
Pendimethalin	No	Yes	Yes	No	Yes
Trifluralin	No	Yes	Yes	No	Yes

[1] Direct application to surface water accessible to listed salmonids. Does not include application to rice paddies

[2] Applications to crop lands, pastures, and non-crop areas on agricultural lands

[3] Applications to parks, golf-courses, urban and residential lands, industrial lands, and for landscaping

[4] Applications to forested lands

[5] Applications to highway, railroad, or utility rights-of-way

Because cropping patterns and registered use sites may change over time, landuse classifications (agricultural, forestry, urban/developed) are used rather than specific crops. Details of the GIS analysis and the maps are provided in *Appendix 4*. A summary of our findings is presented in Table 71. “NA” denotes uses that are not applicable because they are not authorized through labeling. “Y” indicates both spatial and temporal overlap of potential pesticide use with species presence. “N” denotes labeled uses are authorized but spatial or temporal overlap with the species is lacking. Most of the listed Pacific salmonids occur in freshwater year-round in some lifestage. The only exceptions include the two Chum ESUs and California Coastal Chinook salmon; these species occur in freshwater 9 – 11 months of the year. Additionally, all of the ESUs/DPSs contained pesticide use sites within the watersheds where the species spawn and rear. Considering that all listed Pacific salmonid ESUs/DPSs use watersheds where the use of the three a.i.s are authorized and that these pesticides are permitted for use in close proximity to salmonid habitats, we expect all listed Pacific salmonid ESUs/DPSs and their designated critical habitats may be exposed to the stressors from one or more of these authorized uses.

Table 71. Co-occurrence of listed Pacific salmonids with potential use sites

Species	ESU	LandUse Category	Percentage of Range	Are there labeled uses for this category?		
				Oryzalin	Pendimethalin	Trifluralin
Chinook	Puget Sound	Agricultural	5%	Yes	Yes	Yes
		Developed	18%	Yes	Yes	Yes
		Forestry	76%	No	No	No
		Rights-of-Way	100%	Yes	Yes	Yes
	Lower Columbia River	Agricultural	6%	Yes	Yes	Yes
		Developed	12%	Yes	Yes	Yes
		Forestry	82%	No	No	No
		Rights-of-Way	100%	Yes	Yes	Yes
	Upper Columbia River Spring Run	Agricultural	5%	Yes	Yes	Yes
		Developed	5%	Yes	Yes	Yes
		Forestry	90%	No	No	No
		Rights-of-Way	100%	Yes	Yes	Yes
	Snake River Fall Run	Agricultural	19%	Yes	Yes	Yes
		Developed	2%	Yes	Yes	Yes
		Forestry	79%	No	No	No
		Rights-of-Way	100%	Yes	Yes	Yes
	Snake River Spring/ Summer Run	Agricultural	7%	Yes	Yes	Yes
		Developed	2%	Yes	Yes	Yes
		Forestry	91%	No	No	No
		Rights-of-Way	100%	Yes	Yes	Yes
	Upper Willamette River	Agricultural	27%	Yes	Yes	Yes
		Developed	9%	Yes	Yes	Yes
		Forestry	64%	No	No	No
		Rights-of-Way	100%	Yes	Yes	Yes
	California Coastal	Agricultural	2%	Yes	Yes	Yes
		Developed	6%	Yes	Yes	Yes
		Forestry	93%	No	No	No
		Rights-of-Way	100%	Yes	Yes	Yes
	Central Valley Spring Run	Agricultural	25%	Yes	Yes	Yes
		Developed	12%	Yes	Yes	Yes
		Forestry	64%	No	No	No
		Rights-of-Way	100%	Yes	Yes	Yes
	Sacramento River Winter Run	Agricultural	25%	Yes	Yes	Yes
		Developed	12%	Yes	Yes	Yes
		Forestry	64%	No	No	No
		Rights-of-Way	100%	Yes	Yes	Yes

Species	ESU	LandUse Category	Percentage of Range	Are there labeled uses for this category?		
				Oryzalin	Pendimethalin	Trifluralin
Chum	Hood Canal Summer Run	Agricultural	2%	Yes	Yes	Yes
		Developed	10%	Yes	Yes	Yes
		Forestry	87%	No	No	No
		Rights-of-Way	100%	Yes	Yes	Yes
	Columbia River	Agricultural	6%	Yes	Yes	Yes
		Developed	16%	Yes	Yes	Yes
		Forestry	78%	No	No	No
		Rights-of-Way	100%	Yes	Yes	Yes
Coho	Lower Columbia River	Agricultural	6%	Yes	Yes	Yes
		Developed	12%	Yes	Yes	Yes
		Forestry	82%	No	No	No
		Rights-of-Way	100%	Yes	Yes	Yes
	Oregon Coast	Agricultural	3%	Yes	Yes	Yes
		Developed	6%	Yes	Yes	Yes
		Forestry	91%	No	No	No
		Rights-of-Way	100%	Yes	Yes	Yes
	Southern Oregon and Northern California Coast	Agricultural	3%	Yes	Yes	Yes
		Developed	4%	Yes	Yes	Yes
		Forestry	93%	No	No	No
		Rights-of-Way	100%	Yes	Yes	Yes
	Central California Coast	Agricultural	2%	Yes	Yes	Yes
		Developed	10%	Yes	Yes	Yes
		Forestry	88%	No	No	No
		Rights-of-Way	100%	Yes	Yes	Yes
Sockeye	Ozette Lake	Agricultural	0%	Yes	Yes	Yes
		Developed	1%	Yes	Yes	Yes
		Forestry	99%	No	No	No
		Rights-of-Way	100%	Yes	Yes	Yes
	Snake River	Agricultural	1%	Yes	Yes	Yes
		Developed	1%	Yes	Yes	Yes
		Forestry	97%	No	No	No
		Rights-of-Way	100%	Yes	Yes	Yes

Species	ESU	LandUse Category	Percentage of Range	Are there labeled uses for this category?		
				Oryzalin	Pendimethalin	Trifluralin
Steelhead	Puget Sound	Agricultural	5%	Yes	Yes	Yes
		Developed	18%	Yes	Yes	Yes
		Forestry	76%	No	No	No
		Rights-of-Way	100%	Yes	Yes	Yes
	Lower Columbia River	Agricultural	7%	Yes	Yes	Yes
		Developed	13%	Yes	Yes	Yes
		Forestry	81%	No	No	No
		Rights-of-Way	100%	Yes	Yes	Yes
	Upper Willamette River	Agricultural	34%	Yes	Yes	Yes
		Developed	10%	Yes	Yes	Yes
		Forestry	56%	No	No	No
		Rights-of-Way	100%	Yes	Yes	Yes
	Middle Columbia River	Agricultural	19%	Yes	Yes	Yes
		Developed	3%	Yes	Yes	Yes
		Forestry	78%	No	No	No
		Rights-of-Way	100%	Yes	Yes	Yes
	Upper Columbia River	Agricultural	15%	Yes	Yes	Yes
		Developed	5%	Yes	Yes	Yes
		Forestry	80%	No	No	No
		Rights-of-Way	100%	Yes	Yes	Yes
	Snake River	Agricultural	9%	Yes	Yes	Yes
		Developed	2%	Yes	Yes	Yes
		Forestry	90%	No	No	No
		Rights-of-Way	100%	Yes	Yes	Yes
	Northern California	Agricultural	1%	Yes	Yes	Yes
		Developed	4%	Yes	Yes	Yes
		Forestry	94%	No	No	No
		Rights-of-Way	100%	Yes	Yes	Yes
	Central California Coast	Agricultural	4%	Yes	Yes	Yes
		Developed	24%	Yes	Yes	Yes
		Forestry	72%	No	No	No
		Rights-of-Way	100%	Yes	Yes	Yes
	California Central	Agricultural	32%	Yes	Yes	Yes
		Developed	11%	Yes	Yes	Yes

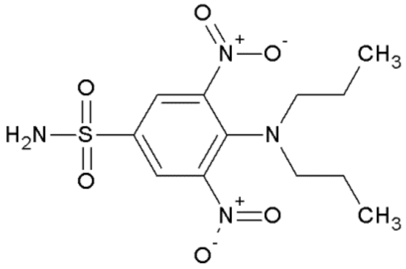
Species	ESU	LandUse Category	Percentage of Range	Are there labeled uses for this category?		
				Oryzalin	Pendimethalin	Trifluralin
	Valley	Forestry	58%	No	No	No
		Rights-of-Way	100%	Yes	Yes	Yes
	South-Central California Coast	Agricultural	8%	Yes	Yes	Yes
		Developed	10%	Yes	Yes	Yes
		Forestry	82%	No	No	No
		Rights-of-Way	100%	Yes	Yes	Yes
	Southern California	Agricultural	5%	Yes	Yes	Yes
		Developed	35%	Yes	Yes	Yes
		Forestry	60%	No	No	No
		Rights-of-Way	100%	Yes	Yes	Yes

Summary of Chemical Fate of the Three Active Ingredients

Pesticides can contaminate surface waters via runoff, erosion, leaching, spray drift from application at terrestrial sites or direct application to aquatic habitats, and atmospheric deposition. Oryzalin and trifluralin are registered for terrestrial applications only. Pendimethalin is registered for terrestrial use. It also may be used on rice, but is applied 5-7 days prior to flooding (Costello, 2009). Water must be held in the paddy for 90 days prior to release.

Fish may be exposed to the three a.i.s when they are present in the water column in the dissolved phase. This is the most bioavailable form, and the chemicals may be taken up via respiration (*i.e.*, across the gills) and/or affect sensory organs directly exposed to water (*e.g.,* olfactory sensory neurons, lateral line). Another route of exposure is particulate-borne chemicals. In this case the a.i. is sorbed to suspended sediment or other organic matter, and may end up in bed sediment, or ingested by lower trophic organisms, thus entering the food chain. Below we summarize chemical fate properties of the three a.i.s reported by EPA in the salmon BEs and other EPA BEs (EPA, 2003b, 2004b, 2004c, 2008, 2009a, 2009b, 2010b). We note these are the fate parameters and not the model inputs EPA used for PRZM-EXAMS modeling. Where discrepancies existed between the assessments, we deferred to the more recent document.

Oryzalin



Oryzalin

Figure 56 Chemical structure of oryzalin

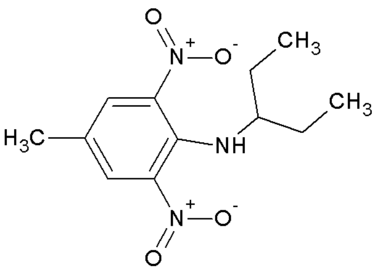
Oryzalin (Figure 56) is a dinitroaniline herbicide. The physical and chemical fate parameters of oryzalin are provided in Table 72. These properties suggest the major route of oryzalin dissipation is through aqueous photolysis and photodegradation on the soil surface. In the soil, oryzalin is moderately persistent under aerobic conditions with a half life of approximately two months. Field studies suggest the dissipation of oryzalin is biphasic, with first phase half-lives in soil ranging from 58 – 77 days and second phase half-lives reported at 138 – 146 days (EPA, 2010b). The soil residual activity is 4 – 10 months depending on application rate. The soil partition coefficients suggest that oryzalin mobility will vary from slightly-moderately mobile. Field studies have not detected the parent below 12 inches in soil depth (EPA, 2010b). Oryzalin is less likely to contaminate groundwater than surface water because it is metabolized relatively quickly under anaerobic soil conditions, which may help limit vertical mobility. The vapor pressure and the Henry’s law constant for oryzalin suggest that volatilization from soil or water is not expected to be a significant source of dissipation. Oryzalin has the potential to contaminate surface water via spray drift and runoff. Substantial quantities of oryzalin could be available for runoff for a few days to months post-application depending on the degree of exposure to sunlight. The soil partitioning coefficients of oryzalin indicates that fractions of oryzalin could be transported via both dissolution in runoff water and adsorption to eroding soil in the event of significant rainfall occurring after application prior to soil incorporation. Based upon its K_{oc}, significant fractions of the oryzalin in receiving surface waters should exist both dissolved in the water column and adsorbed to suspended sediment. The susceptibility of oryzalin to direct photolysis in water (half-life = 1.4 hours) should limit its persistence in clear shallow waters with low light attenuation. However, its resistance to abiotic hydrolysis coupled with only a moderate susceptibility to aerobic biodegradation indicate that it will be somewhat more persistent in receiving surface waters that are deeper, have high light attenuation, low microbiological activities and long hydrological resident times (EPA, 2010b).

Table 72. Environmental fate characteristics of oryzalin (EPA, 2010b).

Parameter	Value
Water solubility	2.5 mg/L at 20° C
Vapor pressure	1.0 x 10^{-7}mm Hg at 25° C
Henry's law constant	1.82 x 10^{-8} atm m^3 mol^{-1}
Octanol/Water partition coefficient	Log K_{ow} = 3.73
Hydrolysis (t1/2) pH 5, pH 7, & pH 9	Stable
Aqueous photolysis (t½)	0.06 d
Soil photolysis (t½)	3.8 d
Aerobic soil metabolism (t½)	63 d
Anaerobic soil metabolism (t½)	10 d
Aerobic aquatic metabolism (t½)	Not specified[1]
Anaerobic aquatic metabolism (t½)	Not specified[1]
Soil partition coefficient	K_{oc} = 602 – 1109 L/kg_{soil}
Fish Bioconcentration Factor (BCF)	32x (edible)105x (non-edible) 66x (whole fish)

[1] Data gap, EPA requested data call in

Pendimethalin



Pendimethalin

Figure 57. Chemical structure of pendimethalin

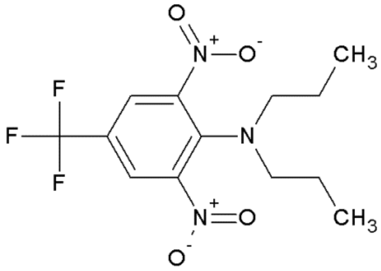
Pendimethalin (Figure 57) is a persistent dinitroaniline herbicide with half-lives of 172 days in soil and 208 to 330 days in anaerobic and aerobic aquatic systems, respectively (Table 73). While pendimethalin is stable to soil photolysis, volatilization from moist soil occurs at a half-life of about 12.5 days and aqueous photolysis occurs at a half-life of 16.5 to 42 days. These relatively rapid fate processes are mediated by the strong tendency for pendimethalin to sorb to sediment and soil (log K_{ow} = 5.18, average K_{oc} = 17,040 mL/g OC). The relatively high K_{oc}s reported for pendimethalin range from 13,000 to 29,400 mL/g OC, indicating that pendimethalin is immobile in soil. With a vapor pressure of $<1.0\times10^{-5}$mm Hg at 25°C, pendimethalin is semi-volatile and the Henry's Law Constant suggests it can volatilize from water. The magnitude of transport via secondary drift depends on the pendimethalin's ability to be mobilized into air and its eventual removal through wet and dry deposition of gases/particles and photochemical reactions in the atmosphere (EPA, 2009a).

Pendimethalin residues accumulated in bluegill sunfish exposed to 3 µg/L of pendimethalin, with BCFs of 1400X for edible, 5800X for nonedible, and 5100X for whole fish. Depuration was rapid, with 87- 91% of ^{14}C-labeled material eliminated from the fish tissues by 14 days of depuration.

Table 73. Environmental fate characteristics of pendimethalin(EPA, 2009a).

Parameter	Value
Water solubility	375 mg/L
Vapor pressure	2.9×10^{-6} Torr at 20°C
Henry's law constant	8.6E-7 atm-m^3-mol^{-1}
Octanol/Water partition coefficient	Log K_{ow} = 5.18
Hydrolysis (t½) pH 5, pH 7, & pH 9	Stable
Aqueous photolysis (t½)	42 d
Soil photolysis (t½)	Stable
Aerobic soil metabolism (t½)	172 d; 42-1322 d
Anaerobic soil metabolism (t½)	Stable
Aerobic aquatic metabolism (t½)	208 d
Anaerobic aquatic metabolism (t½)	330 d
Soil partition coefficient	K_{oc} = 17040 mL/g OC
Fish Bioconcentration Factor (BCF)	negligible (guppy – whole) 1600x (catfish – whole) 5100x (sunfish – whole)

Trifluralin



Trifluralin

Figure 58. Chemical structure of trifluralin

Trifluralin (Figure 58) is also a dinitroaniline herbicide. However, the physical and chemical parameters are quite different from oryzalin (Table 74) (EPA, 2009b). The higher vapor pressure and Henry's Law Constant suggest a greater likelihood of dissipation of trifluralin in soil and water through volatilization. Trifluralin has an estimated half life of 5.3 hours in the vapor phase. Volatility may be a major route of dissipation from soil depending on application method. Volatilization of trifluralin ranges from 41-68% when applied to surface surfaces versus <2% when the product is soil incorporated immediately after application.

The aqueous photolysis study suggests rapid abiotic degration may occur under conditions of low light attenuation (half life approximately 9 hrs). Photodegration occurs more slowly in soils ($t_{1/2}$ 41 d). Trifluralin is stable to hydrolysis. Soil metabolism studies suggest trifluralin can be relatively persistent under anaerobic and aerobic conditions ($t_{1/2}$ of 25-59 d and 116-201 d, respectively). Trifluralin is relatively immobile in aerobic soils with high organic matter. Its high soil/water partitioning coefficient indicates concentrations of trifluralin adsorbed to sediment will be substantially greater than its dissolved concentrations in water (EPA, 2009b).

Dow AgroSciences provided four additional studies addressing various aspects of aquatic degradation of trifluralin (J. K. Smith, 1999; Yon & Kloppel, 1992a, 1992b);(W. L. Cook & Meitl, 2004).

Smith 1999 is a study of aqueous photolysis in natural water (J. K. Smith, 1999). This study produced a half-life ($t_{1/2}$) of 1 hour as compared to the $t_{1/2}$ of 8.9 hours determined in the guideline test, which is conducted in sterile water. Authors attribute difference in photolytic rate to "biotic activity and photosensitizing compounds found in natural water systems. Based on this information, we conclude standard rates used in EPA's aquatic modeling are conservative estimates of aquatic degradation.

Cook 2004 is a study of trifluralin degradation in sediment when that sediment is part of a sediment-pond water system (W. L. Cook & Meitl, 2004). Trifluralin was applied to the sediment, and the system (a 55 mL testube was flooded. The trifluralin remained associated with the sediment phase. Three major degradates, TR-4, TR-7, and TR-14 were produced, and they also remained associated with the sediment phase. All of these degradates have also been identified in anaerobic soil metabolism tests submitted to EPA. Degradation half-life (DT_{50}) reported for trifluralin in the sediment only ranged from 7 – 15 d, which is shorter than the 25 – 59 d anerobic soil metabolism half-life reported in EPA's BE. Data from this report are generally consistent with existing fate information provided in EPA's BEs.

Yon and Kloppel (1992a) evaluated dissipation of trifluralin in aerated sediment-water systems, with the trifluralin added to the water. Tests were conducted according to two different standards: the BBA, which involves blowing air across the top of the water column) and the Dutch, which involves bubbling air into the water column. Trifluralin quickly sorbed to the sediment (74-97% after 6 h) and volatilized due to the aeration. Degradates found in the sediment included TR-4 and TR-13. A second study by Yon and Kloppel (1992b) was similar to the Cook 2004 study in that trifluralin was added to the sediment, and then the test system was flooded and aerated. In these tests, the water column was aerated in accordance with Two test the BBA Guideline and the Dutch Guideline. Degradates TR-4, TR-5, and TR-14 were formed in the sediment, with TR-4 in the highest concentrations. All of these degradates have also been identified in anaerobic soil metabolism tests submitted to EPA. Degradation half-life of trifluralin in the system (DT_{50}) was 18.5 d. Data from these studies are generally consistent with existing fate information provided in EPA's BEs.

Table 74. Environmental fate characteristics of trifluralin (EPA, 2009b)

Parameter	Value
Water solubility	0.3 mg/L at 25° C
Vapor pressure	1.10×10^{-4} mm Hg
Henry's law constant	1.6×10^{-4} atm m^3 mol^{-1}
Octanol/Water partition coefficient	Log K_{ow} = 5.27
Hydrolysis (t½)	Stable at pH 5,7,9[2]
Aqueous photolysis (t½)	0.371 d[1]
Soil photolysis (t½)	41 d[1]
Aerobic soil metabolism (t½)	116 – 201 d[1]
Anaerobic soil metabolism (t½)	25 – 59 d[1]
Aerobic aquatic metabolism (t½)	Not Specified
Anaerobic aquatic metabolism (t½)	Not Specified
Soil partition coefficient	K_d = 18.6-155.6; K_{oc} = 6,413 – 13,413 L/kg_{soil}[1]
Fish Bioconcentration Factor (BCF)	5674x (whole fish)

[1] Study does not meet guideline requirements for FIFRA, classified as supplemental data.

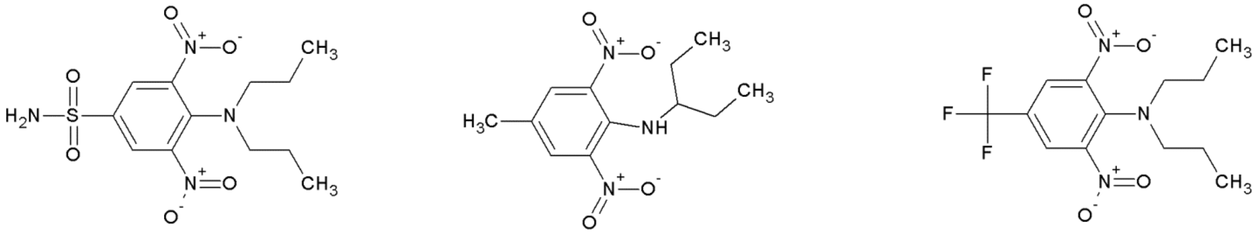
Degradates

Integration of Exposure and Response considers the potential effects of each of the parent dinitroanilines, but does not include any effects associated with degradates. Oryzalin and trifluralin degrade slowly by pathways other than photolysis and pendimethalin degrades slowly by all pathways. In most cases, any specific degradate produced falls below the 10% of applied threshold EPA uses to define a "major" degradate, which are often included in their analyses. For all three of the a.i.s, degradates include compounds retaining the characteristic dinitroaniline structure. For oryzalin, this is a mixed group of benzensulfonamides. For pendimethalin, degradates include a 2,6-dinitro-3,4-dimethyl aniline and a 2,6-dinitro-3,4-dimethyl xylidine. For trifluralin degradates include α,α,α-trifluoro-2,6-dinitro-*p*-cresol. All trifluralin degradates still have the trifluoro sidechain. Table 75is a list of known degradates, as detailed in EPA's assessements (EPA, 2009a, 2009b, 2010b). Figure 58 shows the parent dinitroanilines, and Figure 60 shows the structure of example degradates with the benzene ring structure as well as nitro- and trifluoro- sidechains. Figure 61 shows examples of the benzimidazole degradates formed by oryzalin and trifluralin.

Table 75. Known degradates of oryzalin, pendimethalin, and trifluralin

Active Ingredient	Transformation Product	Environmental Process	Process Half-life (t $_{1/2}$)	Percent of Applied
Oryzalin	*Benzenesulfonamides*			
	3,5-dinitro-4-amino benzenesulfonamide (OR-3)	Aqueous photolysis	0.06 d	5.7
		Soil photolysis	3.8 d	2.6
	4-hydroxy-3,5-dinitro-benzenesulfonamide (OR-20)	Aerobic soil metabolism	63 d	4.7
		Anaerobic soil metabolism	10 d	<0.2
	3-amino-4-propylamino-5-nitrobenzensulfonamide (OR-5)	Aqueous photolysis	0.06 d	4.0
	3,5-dinitro-4-(propylamino) benzenesulfonamide (OR-2)	Aerobic soil metabolism	63 d	≤2.4
		Anaerobic soil metabolism	10 d	<0.2
	3-amino-4-(dipropylamino)-5-nitrobenzenesulfonamide (OR-4)	Aerobic soil metabolism	63 d	≤2.4
		Anaerobic soil metabolism	10 d	≤2.4
	3,4,5-triaminobenzenesulfonamide (OR-9)	Aerobic soil metabolism	63 d	≤2.4
	4-[(2hydroxypropylamino)]-3,5-dinitrobenzenesulfonamide (OR-41)	Aerobic soil metabolism	63 d	≤2.4
	3,3’-azoxybis[(4-propylamino)-5-nitro] benzenesulfonamide (UN-1)	Aerobic soil metabolism	63 d	≤2.4
		Anaerobic soil metabolism	10 d	≤2.4
	Benzimidazole sulfonamides			
	2-ethyl-7-nitro-1-propyl-1*H*benzimidazole-5-sulfonamide-3-oxide (UN-2)	Aqueous photolysis	0.06 d	14
		Aerobic soil metabolism	63 d	≤2.4
	2-ethyl-7-nitro-1-propyl-1*H*benzimidazole-5-sulfonamide (OR-13)	Aerobic soil metabolism	63 d	≤2.4
		Anaerobic soil metabolism	10 d	≤2.4
	2-ethyl-7-nitro-1*H*benzimidazole-5-sulfonamide (OR-15)	Soil photolysis	3.8	3.2
		Aerobic soil metabolism	0.06	≤2.4
		Anaerobic soil metabolism	10 d	<0.2
	Other compounds			
	3,4-dinitro-4-(dipropylamino) sulfanilic acid (OR-21)	Soil photolysis	3.8 d	4.6
Pendimethalin	2,6-dinitro-3,4-dimethyl aniline	Aqueous photolysis	42 d	9.3%
	2,6-dinitro-3,4-xylidine	Anaerobic soil metabolism	172 d	<2.0
		Aerobic soil metabolism	stable	NS
	4-[(1-ethylpropyl) amino]-2-methyl-3,5-dinitro benzyl alcohol	Anaerobic soil metabolism	172 d	<2.0
		Aerobic soil metabolism	stable	NS
	4-[(1-ethylpropyl) amino]-2-methyl-3,5-dinitro-*o*-toluic acid	Anaerobic soil metabolism	172 d	<2.0

Active Ingredient	Transformation Product	Environmental Process	Process Half-life ($t_{1/2}$)	Percent of Applied
		Aerobic soil metabolism	stable	NS
Trifluralin	*Variants on benzene ring structures -toluidines, toluenes, and cresols*			
	5-trifluoromethyl-3-nitro-1,2-benzenediamine (TR-6)	Aqueous photolysis	0.37 d	≤29.8
	α,α,α-trifluoro-5-nitro-*N4,N4*-dipropyl-toluene-3,4-diamine (TR-4)	Anaerobic soil metabolism	25-59 d	≤13.2
	α,α,α-trifluoro-2,6-dinitro-*N*-propyl-p-toluidine (TR-2)	Aqueous photolysis	0.37d	≤9.6
		Soil photolysis	41 d	≤6.0
		Aerobic soil metabolism	116-201 d	≤4.6
		Anaerobic soil metabolism	25-59 d	≤2.1
	α,α,α-trifluoro-N4,N4-dipropyltoluene-3,4,5-triamine (TR-7)	Anaerobic soil metabolism	25-59 d	≤4.1
	α,α,α-trifluoro-2,6-dinitro-*p*-cresol (TR-20)	Aerobic soil metabolism	116-201 d	≤2.7
	α,α,α-trifluoro-5-nitro-4-propyl-toluene-3,4-diamine (TR-5)	Aerobic soil metabolism	116-201 d	≤2.1
		Anaerobic soil metabolism	25-59 d	≤2.1
	2,2'azoxybis-trifluoro-6-nitro-*N*-propyl-p-toludine (TR-28)	Aerobic soil metabolism	116-201 d	≤3.0
		Anaerobic soil metabolism	25-59 d	≤2.1
	Trifluoromethyl benzimidazoles			
	2-ethyl-7-nitro-5-(trifluoromethyl) benzimidazole (TR-15)	Aqueous photolysis	0.37 d	≤47.4
		Aerobic soil metabolism	116-201 d	≤2.6
	7-amino-2-ethyl-1-propyl-5-(trifluoromethyl) benzimidazole (TR-14)	Anaerobic soil metabolism	25-59 d	≤8.3
	2-ethyl-7-nitro-5-(trifluoromethyl) benzimidazole-3-oxide (TR-12)	Soil photolysis	41 d	≤7.1
	2-ethyl-7-nitro-1-propyl-5-(trifluoromethyl) benzimidazole (TR-13)	Anaerobic soil metabolism	25-59 d	≤2.1
		Aerobic soil metabolism	116-201 d	≤1.0
	2-ethyl-7-nitro-1-propyl-5-(trifluoromethyl) benzimidazole–3-oxide (TR-11)	Aerobic soil metabolism	116-201 d	≤0.3

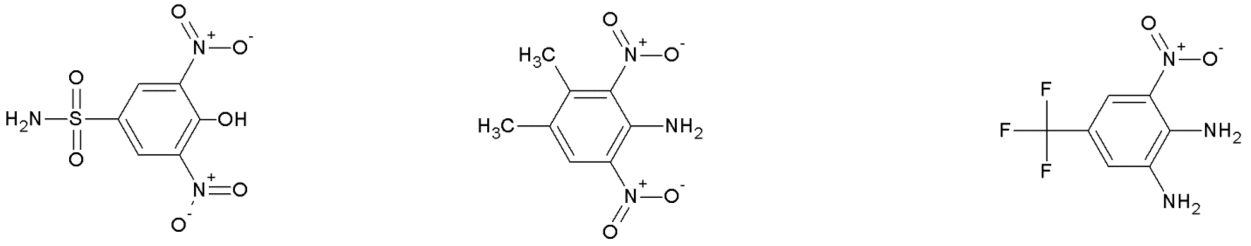


Oryzalin

Pendimethalin

Trifluralin

Figure 59. Parent dinitroanilines



4-hydroxy-3,5-dinitro
benzenesulfonamide
(OR-20)

2,6-dinitro-3,4-dimethyl
aniline

5-trifluoromethyl-3-nitro
-1,2-benzenediamine
(TR-6)

Figure 60 Examples of degradates with benzene ring structures

2-ethyl-7-nitro-1-propyl-1*H*
benzimidazole-5-sulfonamide
-3-oxide (UN-2)

2-ethyl-7-nitro-5-(trifluoromethyl)
benzimidazole (TR-15)

Figure 61. Examples of degradates with benzimidazole structures

EPA notes there is no information on dinitroaniline degradates within information submitted by the applicants or in the toxicological literature in the most recent BEs (EPA, 2009a, 2009b, 2010b). Our literature survey confirms this. The oryzalin assessment for the California tiger salamander also states:

> Several degradates have been identified for oryzalin of which the main degradate is 4hydroxy-3, 5-dinitrobenzenesulfonamide (OR 20). There is no evidence that any of these degradates are of toxicological concern, and none of them are found in significant amounts (>10.0%) except 2-ethyl-7-nitro-1-propyl-5-sulfonylaminobenzimidazole 3oxide at 14% in an aquatic photodegradation study. Since 2-ethyl-7-nitro-1-propyl-5sulfonylamino benzimidazole 3-oxide is not of toxicological concern (as determined by EPA's MARC committee and through structural analysis), this assessment is based on parent oryzalin only (EPA, 2010b).

While NMFS concurs with EPA's MARC committee that 2-ethyl-7-nitro-1-propyl-5sulfonylamino benzimidazole 3 is likely not of toxicological concern we question the assumption that a lack of evidence regarding other degradates is sufficient to not consider them. We find it reasonable to assume degradate chemicals which retain the characteristic dinitroaniline structure may also be toxic in the same fashion as the parent. We do not know to what extent, although it may be possible to estimate at least relative strength using QSAR (Quantitative Structure Activity Relationships). The benzimidazole sulfonamides formed by oryzalin do not contain the two nitro groups which we presume to be involved in the herbicidal activity of the dinitroaniline a.i.s and thus are likely to be less active, at least via known mechanisms.

The EPA assessment on pendimethalin was silent on the issue of degradate toxicity. We located no other information on degradates, nor did the applicants provide any. Pendimethalin degrades slowly in aerobic soil metabolism studies, and is stable in anerobic soil metabolism studies. Given its high $K_{oc,}$ parent pendimethalin which is bound to sediment or soil is likely to stay bound.

Trifluralin forms two groups of degradates: variants on the ring structure (toludines, toluenes, and cresols), and benzimidazoles (Table 75). The first group includes TR-2, TR-4, TR-5, TR-6, TR-7, TR-20, and TR-28. TR-2 is structurally very similar to parent trifluralin, as it has both dinitro groups and the trifluoromethyl sidechain. The benzimidazole group contains TR-11, TR-12, TR-13, TR-14, and TR-15. The benzimidazoles formed by trifluralin do not contain the two nitro groups which we presume to be involved in the herbicidal activity of the dinitroaniline a.i.s and thus are likely to be less active, at least via known mechanisms. The trifluoromethyl sidechain is still present in all identified degradates.

Dow provided two studies (C. R. Picard, 2008; C. R. Picard, 2008) were studies regarding effects of trifluralin degradates on sediment dwelling oligochaetes. Neither of the degradates tested (TR-7 and TR-14) are considered major degradates under EPA's definition of ≥10% of applied. Both degradates are formed by anaerobic soil metabolism, as would occur in sediment. One of the tested compounds, TR-14 is a trifluoromethyl benzimidazole compound. The other degradate tested, TR-7, is one of the degradates which retain the trifluoromethyl sidechain but not the characteristic dinitro structure. Based on fate characteristics of trifluralin, we anticipate the parent and similarly structured degradates will bind to soil or sediment and not be bioavailable. The test on the oligochaetes produced a No Observable Effects Concentration (NOEC) of 100 mg/kg dwt for TR-14, and an NOEC of 100 mg/kg dwt for TR-7.

The EPA RLF BE (EPA 2009) included toxicity data for two other trifluralin degradates, TR-6 and TR-15. TR-6 and TR-15 are major degradates produced by aquatic photolysis (respectively, ≤29.8% and ≤47.4% of applied). TR-6 is a variant on the benzene ring structure, with the trifluoromethyl sidechain and one -NO_2 group. TR-15 is a trifluoromethyl benzimidazole compound. Both are 1-2 orders of magnitude less toxic to fish, aquatic invertebrates, and green algae than parent trifluralin on an acute basis. On the qualitative scale used by EPA, TR-6 is highly toxic to fish and moderately toxic to aquatic invertebrates. TR-15 is moderately toxic to fish and aquatic invertebrates. We did not locate any information on potential effects on growth, reproduction or sublethal effects.

The trifluoro- sidechain in trifluralin appears to be the source of the most sensitive effects, the vertebral deformities. Given it is present in all known degradates, which are hydrophobic to a certain extent, fluoride ions from the degradates may also bioconcentrate in fish. Environmental fate modeling in the BEs does not specifically account for presence of degradates in the environment. Clearly, fate parameters of the degradates change slightly as well, and degradates may be more or less mobile and persistent. On the whole, however, we believe EPA's analysis may slightly underestimate the total toxicity of the parents plus degradates in the aquatic environment.

There was monitoring data for one possible degradate, 4-hydroxypendimethalin, in the NAWQA data. It was not detected (less than 0.143 μg/L) in 61 ground water samples and 85 surface water samples, all taken from the San Joaquin-Tulare Basin (EPA, 2009b). Our more recent summary of the NAWQA database indicates that 4-hydroxypendimethalin was not detected in surface water samples collected in California (n=36), Oregon (n=24) or Washington (n=25).

Environmental Compartments and Persistence Considerations

EPA's BEs mostly address the potential effects of exposure to the three dinitroanilines in the dissolved phase. This is the compartment in which it is most bioavailable to aquatic organisms. It is also the route of exposure evaluated by the guideline tests and the medium for which we have measured and estimated exposure concentrations. However, there are other routes of exposure not commonly addressed in the pesticide assessments developed by OPP. Anticipated concentrations in various environmental compartments can be estimated using various models. Fugacity-based models, which estimate concentrations and partitioning based on physic-chemical properties, are widely accepted in environmental toxicology. Table 76 shows how the three a.i.s would partition between various environmental compartment and the corresponding half-lives for those compartments. These values were generated using EPA's EPISuite software. NMFS accessed them from the Royal Society of Chemistry's ChemSpider website and did not determine input parameters. These estimates rely heavily on log K_{OW}. We did compare the input log K_{OW}s, which are shown in the printout with the ones given in EPA documents (EPA, 2009a, 2009b, 2010b). Those for oryzalin (EPA 3.73, RSC 3.73) and trifluralin (EPA 5.27, RSC 5.34) correspond closely, although pendimethalin does not (EPA 5.18, RSC 2.62). Due to this discrepancy, we view the pendimethalin estimates with caution. However, the modeling for the other two chemicals indicates what would be expected based on their fate parameters: that the majority of the chemical applied ends up in soil. Oryzalin is more likely to be in the water than trifluralin, and slightly over a quarter of trifluralin is likely to end up in the sediment. Half-lives of the chemicals range from 60 – 180 days in water, which has important implications for aquatic systems downstream of the original input site. They also have an extended half-life in sediment – over a year for oryzalin and ~ 4.5 years for trifluralin. This may or may not be a toxicological concern for benthic animals, as the chemicals may be sorbed tightly enough to the sediment as to not be bioavailable. However, depending on where the sediment is (*e.g.,* on the bottom of the waterbody or on a sometimes exposed point bar) and the degree of aeration, trace amounts may still exert herbicidal properties on emergent plants. We believe it is unlikely the chemicals will repartition to dissolved phase in appreciable amounts.

Table 76. Percentage and Half Life of Dinitroanilines in Various Environmental Compartments

Environmental Compartment	Oryzalin		Pendimethalin		Trifluralin	
	Percent of Applied^1	Half-Life ($t_{1/2}$ in d)	Percent of Applied^1	Half-Life ($t_{1/2}$ in d)	Percent of Applied^1	Half-Life ($t_{1/2}$ in d)
Air	0.391	0.45	2.66x10^{-6}	8.45	0.0985	0.45
Water	9.58	60	13.4	60	2.63	180
Soil	88.9	120	86.5	120	70.9	360
Sediment	1.47	542	0.145	542	26.4	1,621
Overall environmental persistence time	▨	108	▨	103	▨	244

From Level III Fugacity Models, as calculated by EPI-Suite available on the ChemSpider website Accessed 01/31/12, input parameters established by site owner, (Royal Society of Chemistry, RSC):
oryzalin http://www.chemspider.com/Chemical-Structure.27326.html?rid=582b8753-9d75-4d6b-957c-7d8d8b1384f8
pendimethalin http://www.chemspider.com/Chemical-Structure.35265.html
trifluralin http://www.chemspider.com/Chemical-Structure.5368.html?rid=56f49acf-ef8b-4a15-b1e6-7e906691933e
Original half-life data given in hours, converted by NMFS to days (hours/24)
1 Total percent of applied adds up to 100%, assumes no loss or drift from model world

Methods to Evalutate Water Concentrations

NMFS uses three ways to estimate water concentrations of the a.i.s to which salmon might be exposed. One method is the Estimated Environmental Concentrations (EECs) generated by EPA using the PRZM-EXAMS modeling system. Another method is EECs caused by spray drift into shallow or low-flow habitats, generated by NMFS using the model AgDrift. The third method is Measured Environmental Concentrations (MECs) available in various water quality monitoring databases maintained by federal and state agencies. Water concentrations can vary widely both spatially and temporally, and it is difficult to predict exactly when and where specific concentrations might occur, especially at a regional- or national-level scale. NMFS believes salmon can experience the full range of concentrations at various points during their lifetime, and thus considers all three estimation methods. Typically, MECs from water quality monitoring programs are the lowest, but these programs often miss peak concentrations or are not taken at locations proximate to input sources. The PRZM-EXAMS EECs are derived from a model world where runoff and spray drift from the use site enter a small waterbody. These EECs more accurately reflect peak concentrations than the monitoring data, but do not actually capture the highest concentrations due to the volume of the water body and time-averaging methods.

PRZM-EXAMS modeling does include various degradation processes which occur in the water body, and can provide EECs across time. The AgDrift EECs represent a high end exposure estimate in a vulnerable water body. AgDrift EECs are instantaneous concentrations (i.e., the concentration when the a.i. hits the water). AgDrift modeling does not include various degradation processes which occur in the water body.

The dinitroaniline herbicides considered in this Opinion all partition rapidly to particles in the water column and to sediment. The PRZM-EXAMS modeling accounts for this partitioning, but the AgDrift modeling does not. Thus, although NMFS considers all three sources of water concentration information, we weight the PRZM-EXAMS concentrations more heavily in our analysis of these a.i.s.

Modeling: Estimates of Exposure

EPA PRZM-EXAMS EECs

Pesticides containing oryzalin, pendimethalin and trifluralin are approved for a variety of uses and may be applied to agricultural lands, developed lands, and rights-of-ways. The salmonid BEs for the three a.i.s evaluated some, but not all registered uses of the compounds (Table 77). In general, the salmonid BEs provided few estimates of exposure given the number and variety of uses currently authorized.

Table 77. Examples of current registered uses of the three a.i.s and the exposure method used by EPA in salmonid BEs.

Active Ingredient	Examples of Registered Uses	Exposure Methods Applied in BEs
Oryzalin	Crops: Christmas tree plantations, avocado, berries/small fruits, citrus, fig, kiwi, olive, pomegranate, pome fruit, stone fruit, nuts, vineyards, ornamentals, turf/grasses	PRZM-EXAMS for grapes and almonds
	Other use sites: landscape maintenance, rights-of-way, residential areas/lawns, ornamentals, parks, golf courses	None
Pendimethalin	Crops: Christmas tree plantations, soybeans, almond, apple, apricot, beans, carrot, cherry, citrus fruits, corn, fig, garbanzos, garlic, grapes, nectarine, olive, onion, peas, cowpea/blackeyed pea, peanuts, peach, pear, pecan, pistachio, plum, potato, prune, rice, shallot, sorghum, soybeans, sugarcane, sunflower and walnut	PRZM-EXAMS for almonds, potatoes, peas and corn
	Other use sites: Landscape maintenance, residential areas, outdoor buildings/structures and industrial areas, golf course turf, jojoba, nonagricultural,	PRZM-EXAMS for turf

Active Ingredient	Examples of Registered Uses	Exposure Methods Applied in BEs
	ornamental and/or shade trees, ornamentals, tobacco, rights-of-way/fence rows/hedgerows.	
Trifluralin	Crops: alfalfa, asparagus, beans, Bermuda grass grown for seed, broccoli raab, cereal grains, field corn, carrots, celery, chickory, clover grown for seed (CA), cole crops, collards, cotton, cottonwood trees grown for pulp, crambe, cucurbits, durum, eggplant, flax, field grown roses, grain sorghum, greens (kale, mustard, turnip), guar, hops, kenaf, lupine, okra, onions, peas, peppers, peppermint, potatoes, radishes, rapeseed, safflower, soybeans, no-till soybeans, spearmint, sugar beets, sugarcane, tomatoes, citrus trees (bearing and non-bearing), stone fruit trees, nut trees, vineyards, wheat, Christmas tree plantations, and ornamentals	PRZM-EXAMS for alfalfa, carrots, cotton, grape, safflower, tomato
	Other use sites: ground cover, established flowers, ornamental bulbs, non-bearing trees and vines, turf, golf courses, graveyards, athletic fields, under paved surfaces, industrial sites, utility substations, highway rights-of-way, and residential ornamentals, residential lawns, flower gardens, vegetable gardens	None

Assessments by EPA provide a more comprehensive evaluation of the three a.i.s, including BEs for the California red-legged frog and the California tiger salamander (Table 78). Although estimates for the red-legged frog were specific to registered uses in California only, they provided additional surface water estimates for pesticides authorized for crop and non-crop uses of the active ingredients. These EECs were primarily generated using the PRZM-EXAMS model (Table 78). No exposure estimates were provided for other identified stressors of the action including inert/other ingredients, other active ingredients with formulations, and for the toxic degradates of the active ingredients. These missing estimates introduce substantial uncertainty into the exposure analysis.

Table 78. PRZM-EXAMS exposure estimates from EPA's BEs.

Ural Use Site Scenario: State, crop	Application: rate (lbs a.i./A)/ method/ number of applications	Acute EEC peak (μg/L)	Chronic EEC 60-d average (μg/L)
Oryzalin			
Agricultural Lands			
Crop (CA, almond) [A]	6[1]/ground/2[1]	19.6	7.9
Crop (CA, almond) [D]	6[1]/ground/2[1]	49.36	14.15
Crop (CA, avacado) [D]	6[1]/ground/2[1]	39.10	9.59
Crop (CA, grape) [A]	6[1]/ground/2[1]	6.4	2.6
Crop (CA, grape) [D]	6[1]/ground/2[1]	21.45	5.84
Crop (CA, winegrape) [D]	6[1]/ground/2[1]	52.98	15.87
Crop (CA, citrus) [D]	6[1]/ground/2[1]	9.74	2.68
Crop (CA, fruits) [D]	6[1]/ground/2[1]	22.85	6.23
Crop (CA, olive) [D]	6[1]/ground/2[1]	21.65	6.39
Crop (CA, Christmas tree) [D]	6[1]/ground/2[1] 4[2]/ground/2[1]	68.59 33.50	19.82 9.90
Non-crop (CA, Rangeland) [D]	6[1]/ground/2[1]	93.82	24.10
Developed Lands			
Ornamentals (CA, nursery) [D]	4[1]/ground/3[1,3] 4[1]/ground/3[1,4] 1.5 + 0.75[1]/ground/2[1, 3] 1.5 + 0.75[1]/ground/2[1, 4]	47.64 72.61 16.44 16.32	15.03 21.03 4.37 4.31
Turf (CA, turf) [D]	2[2]/ground/3[1,3] 1.5[2]/ground/2[2,4]	5.42 8.21	1.65 1.92
Residential (CA, residential) [D]	2[2]/ground/3[1]	3.50	1.21
Rights-of-way			
(CA, rights-of-way) [D]	6[1]/ground/2[1]	141.89	38.52
Pendimethalin			
Agricultural Lands			
crop (CA, alfalfa)[C]	3[1]/ground spray, broadcast/1[1] 3[1]/aerial spray/1[1]	1.39 6.7	0.14 0.5
crop (CA, alfalfa)[F]	3.98[1] [1]/aerial spray /1[1]	11.28	1.95
crop (CA, almond)[F]	5.985 [1]/ground spray /1[1] 3.96 [1]/aerial spray /1[1]	6.56 11.71	1.61 2.30
crop (CA, almonds)[C]	1.25[1]/ground spray, broadcast/1[1]	0.96 2.8	0.15 0.3
crop (CA, citrus)[F]	5.985 [1]/ground spray /1[1] 3.96 [1]/aerial spray /1[1]	3.42 11.06	0.58 1.52
crop (CA, colecrop)[F]	0.99 [1]/aerial spray /1[1]	3.16	0.98
crop (OR, corn)[C]	2.4[1]/ground spray, broadcast/1[1]	6.1 7.8	1.9 1.9

Ural Use Site Scenario: State, crop	Application: rate (lbs a.i./A)/ method/ number of applications	Acute EEC peak (µg/L)	Chronic EEC 60-d average (µg/L)
	2.4[1]/aerial spray/1[1]		
crop (CA, corn)[F]	1.98 [1]/aerial spray /1[1]	6.84	1.54
crop (CA, cotton)[F]	1.98 [1]/aerial spray /1[1]	5.75	0.99
crop (CA, fruit)[F]	3.96 [1]/aerial spray /1[1]	11.18	1.85
crop (CA, forestry)[F]	3.96 [1]/aerial spray /1[1]	16.60	4.93
crop (CA, garlic)[F]	1.485 [1]/aerial spray /1[1]	4.31	0.73
crop (CA, grapes)[F]	5.845 [1]/ground spray /1[1] 3.96 [1]/aerial spray /1[1]	4.06 11.44	0.95 1.83
crop (CA, melons)[F]	1.485 [1]/aerial spray /1[1]	4.22	0.62
crop (CA, olive)[F]	3.96 [1]/aerial spray /1[1]	11.16	1.70
crop (CA, onion)[F]	1.98 [1]/aerial spray /1[1]	5.55	0.80
crop (OR, peas)[C]	1.8[1]/ground spray, broadcast/1[1] 1.8[1]/aerial spray/1[1]	4.2 4.9	1.3 1.3
crop (OR, WA, potato)[C]	1.8/ground spray, broadcast/1[1] 1.8/aerial spray/1[1]	1.00 4.1	0.19 0.5
crop (CA, potato)[F]	1.485 /aerial spray /1[1]	4.14	0.57
crop (Tier 1 Rice Model)[F]	0.99 /aerial spray /1[1]	48	---
crop (CA, rowcrop)[F]	3.895 /aerial spray /1[1]	11.92	2.86
crop (CA, strawberry)[F]	1.485 /aerial spray /1[1]	4.74	1.36
crop (CA, tomato)[F]	1.485 /aerial spray /1[1]	4.21	0.66
crop (CA, wheat)[F]	1.485 /aerial spray /1[1]	6.10	2.13
Developed Lands			
Turf[C]	2.4/ground spray/1	3.0	0.367
Rights-of-way			
CA rights-of-way[F] CA impervious[F]	3.96[1]/aerial spray/1[1]	1.74	0.36
Trifluralin			
Agricultural lands			
Crop (CA, alfalfa) [B]	2[1]/no drift assumed/1[2] 2[1]/ground spray/1[2] 2[1]/aerial spray/1[2]	0.06 1.12 5.59	0.02 0.17 0.87
Crop (CA, alfalfa) [E]	2[1]/ground/2 [4] 2[1]/aerial spray/1 [3] 2[1]/ground spray/1 [3]	0.32 5.14 1.12	0.07 0.58 0.17
Crop (CA, almond) [E]	4[1]/ground/3[2, 4] 2[1]/aerial spray/1[2, 3] 2[1]/ground spray/1[2, 3]	2.23 5.65 1.23	0.72 0.60 0.18
Crop (CA, avocado) [E]	4[1]/ground/3[2, 4]	5.81	0.73
Crop (CA, carrot) [B]	1[1]/no drift assumed/1[1] 1[1]/ground spray/1[1] 1[1]/aerial spray/1[1]	0.17 0.46 2.30	0.04 0.12 0.49

Ural Use Site Scenario: State, crop	Application: rate (lbs a.i./A)/ method/ number of applications	Acute EEC peak (µg/L)	Chronic EEC 60-d average (µg/L)
Crop (CA, citrus) ^{E}	4^1/ground/$3^{2, 4}$ 2^1/aerial spray/$1^{2, 3}$ 2^1/ground spray/$1^{2, 3}$	0.74 5.48 1.10	0.14 0.54 0.11
Crop (CA, cole) ^{E}	1^1/aerial spray/1^3 1^1/ground spray/1^3	2.79 0.59	0.29 0.10
Crop (CA, corn) ^{E}	1^1/aerial spray/1^3 1^1/ground spray/1^3	2.74 0.55	0.26 0.10
Crop (CA, cotton) ^{B}	2^1/no drift assumed/1^2 2^1/ground spray/1^2 2^1/aerial spray/1^2	0.04 1.12 5.59	0.01 0.17 0.83
Crop (CA, cotton) ^{E}	2^1/aerial spray/1^3 2^1/ground spray/1^3	5.55 1.48	0.65 0.24
Crop (CA, fruit) ^{E}	4^1/ground/$3^{2, 4}$ 2^1/aerial spray/$1^{2, 3}$ 2^1/ground spray/$1^{2, 3}$	2.52 5.51 1.12	0.40 0.55 0.13
Crop (CA, grape) ^{B}	2^1/no drift assumed/1^2 2^1/ground spray/1^2 2^1/aerial spray/1^2	0.001 1.12 5.59	0.0002 0.16 0.78
Crop (CA, grape) ^{E}	4^1/ground/$3^{2, 4}$ 2^1/aerial spray/$1^{2, 3}$ 2^1/ground spray/$1^{2, 3}$	4.00 5.50 1.18	0.62 0.54 0.12
Crop (CA, lettuce) ^{E}	1^1/aerial spray/$1^{2, 3}$ 1^1/ground spray/$1^{2, 3}$	2.77 0.58	0.27 0.08
Crop (CA, melon) ^{E}	1^1/ground/1^3	0.73	0.13
Crop (CA, olive) ^{E}	4^1/ground/$3^{2, 4}$	4.45	0.77
Crop (CA, onion) ^{E}	1^1/aerial spray/1^3 1^1/ground spray/1^3	1.96 0.39	0.21 0.05
Crop (CA, potato) ^{E}	1^1/ground spray/1^3	0.55	0.05
Crop (CA, row crop) ^{E}	2^1/aerial spray/1^3 2^1/ground spray/1^3	5.49 1.01	0.45 0.09
Crop (CA, safflower) ^{B}	1^2/no drift assumed/1^1 1^2/ground spray/1^1 1^2/aerial spray/1^1	0.95 0.94 2.38	0.27 0.27 0.45
Crop (CA, sugar beet) ^{E}	0.75^1/aerial spray/1^3 0.75^1/ground spray/1^3	1.96 0.39	0.17 0.03
Crop (CA, tomato) ^{B}	1^1/no drift assumed/1^1 1^1/ground spray/1^1 1^1/aerial spray/1^1	0.47 0.57 2.80	0.12 0.13 0.42
Crop (CA, wheat) ^{E}	1^1/aerial spray/1^3 1^1/ground spray/1^3	2.77 0.57	0.17 0.03
Crop (CA, Christmas tree) ^{E}	4^1/ground/$3^{2, 4}$ 2^1/aerial spray/$1^{2, 3}$ 2^1/ground spray/$1^{2, 3}$	2.25 5.50 1.17	0.39 0.63 0.19
Non-crop (CA, rangeland) ^{E}	2^1/ground/1^4	0.68	0.12
Developed Lands			
CA nursery	4^1/ground/3^4 4^1/ground spray/3^3	6.55 6.53	0.86 0.87
CA residential	1.5^2/ground/2^4	0.0002	0.00005

Ural Use Site Scenario: State, crop	Application: rate (lbs a.i./A)/ method/ number of applications	Acute EEC peak (μg/L)	Chronic EEC 60-d average (μg/L)
CA turf	1.5[7]/ground/2 [4]	0.16	0.02
Rights-of-way			
CA rights-of-way	4[2]/ground/3 [4]	0.002	0.0005

1- Model input is consistent with current label restrictions
2- Model input assumes less than is allowed with current label restrictions
3- Liquid formulation
4- Granular formulation
5- PRZM-EXAMS estimates were not applicable for application to rice paddies
6- 14-day time-weighted-average concentration.
7- Model input assumes more than is allowed with current label restrictions
A- Oryzalin Salmon BE
B- Trifluralin salmon BE
C- Thiobencarb salmon BE
D- Oryazlin tiger salamander
E- Trifluralin red-legged frog BE

The PRZM-EXAMS model generates pesticide concentrations for a generic "farm pond". EPA assumes the pond represent all aquatic habitats including rivers, streams, floodplain habitats, estuaries, and near shore ocean environments. EPA's BEs indicate that the PRZM-EXAMS scenarios provide "worst-case" estimates of salmonid exposure and EPA "believes that the EECs from the farm pond model do represent first order streams, such as those in headwaters areas" used by listed salmon.

NMFS exposure estimates for floodplain habitats

Model inputs used in the BEs are not representative of the most vulnerable salmonid habitats. The EECs within EPA's BEs were derived primarily using the PRZM-EXAMS model. The EPA "farm pond" scenario is likely a good surrogate for some habitats used by listed salmonids. However, other habitats may be more or less susceptible to higher pesticide concentrations given their physical characteristics. Small streams and some floodplain habitats represent examples of habitats used by salmonids that can have a lower capacity to dilute pesticide inputs than the farm pond. The PRZM-EXAM estimates assume that a 10-hectare (approximately 25 acres) drainage area is treated and the aquatic habitat is assumed to be static (no inflow or outflow). Pesticide treatment areas of 10-hectares and larger occur frequently in agricultural crops, particularly under pest eradication programs. Additionally, aquatic habitats used by salmon vary in volume and recharge rates and consequently have different dilution capacities to spray drift and runoff events. The assumed drainage area to water volume ratio (100,000 m^2: 20,000 m^3) is easily exceeded for small water bodies. For example, a one-acre pond with an average depth of 1 m would exceed this ratio for treated drainage areas of approximately five acres in size and larger. The assumed aquatic habitat and size of the treated area for the PRZM-EXAMS scenarios suggest that exposure is underestimated for listed salmonids that use relatively small aquatic habitats with low dilution capacities.

Direct over-spray of pesticides to aquatic habitats

The active labels for the three a.i.s do not authorize direct application of pesticides to surface water. While pendimethalin is registered for use on rice, it is applied only to non-flooded rice paddies which are flooded 5-7 days after application and flushed after about 90 days. We do not expect that treated paddies will be accessible to listed salmon. However, contaminated paddy water may seep or be directly discharged into salmonid habitats. There are no models available to estimate EECs for rice paddies that are treated when dry and subsequently flooded. Tier I and Tier II EEC models for agricultural fields do not assess the effects of field flooding and flushing on pesticides applied to dry soil and the Tier I Rice model provides an EEC estimate of pesticide concentration in a flooded rice paddy the day of application. The Red Legged Frog BE used the Tier I Rice model, providing an EEC of 48 μg/L. This EEC is likely not representative of actual concentrations.

The effects determination for Endangered and Threatened Salmonids and Steelhead did not attempt to model aquatic exposure concentrations for rice. Rather, the science chapter for the BE placed exposure to pendimethalin applied to dry rice paddies in context of another use that could be modeled. Since the use rate for rice is lower than that for cotton and since pendimethalin it sorbs strongly to soil and sediment and is not expected to be redistributed through post application flood and flushing, exposure from rice usage is not expected to be greater than that from use on cotton. However, the chapter estimated GEEC for cotton using an application rate of 1 lb per acre, the same rate as for rice. Tier II EECs for cotton were not included in the effects determination for Salmon and Steelhead, but were estimated for cotton in the Red Legged Frog effects determination at 5.75 μg/L peak EEC and 0.99 μg/L chronic EEC after application at a rate of 1.485 lbs a.i./A (Table 12).

Application of pesticides to adjacent terrestrial habitat

Some products include no-application buffer to aquatic habitat. However, no setbacks to salmonid habitats are required for the three a.i.s discussed in this Opinion. Primary drift is a likely transport mechanism for pesticides applications that occur immediately adjacent to aquatic habitats including shallow floodplain habitats where juvenile salmonids rear and shelter. We derived exposure estimates for floodplain habitats that incorporated label-specified application requirements (

Table 79). These estimates were derived using the AgDrift model and estimate downwind deposition from pesticide drift (Teske, 2001). This method does not incorporate additional contributions that may occur through the runoff pathway. The drift estimates derived represent average projected drift. Although AgDrift reasonably predicts drift, drift is highly variable and is influenced by site-specific conditions and application equipment (Bird, Perry, Ray, & Teske, 2002). Our simulations assumed an aquatic habitat that was 0.1 m deep and 2 m wide. These dimensions are represent the more vulnerable habitats used by salmonids.

Some drift calculations based strictly on application rates produce water concentrations which are greater than the water solubility of the TGAI. Water solubility values for the TGAI are based on laboratory tests conducted at a standard temperature (25°C) in water containing no dissolved organic carbon (DOC). In natural waters, which typically contain DOC, water solubility of the a.i. may be higher. Additionally, some ingredients in the formulated products may also increase solubility of the a.i. in the environment. However, we have no reliable way to estimate what the increase in solubility may be. Estimates from AgDrift which are above solubility of the a.i. are denoted with an “AS” in

Table 79. In other summary tables containing EECs (Table 87 and Table 108) and accompanying discussions of those EECs, the laboratory water solubilities are used as an upper bound. Laboratory water solubilites are 2,500 μg/L for oryzalin, 375 μg/L for pendimethalin, and 300 μg/L for trifluralin.

Table 79. Estimated average initial pesticide concentrations in a floodplain habitat that is 2m wide and 0.1m deep using AgDrift 2.0.05.

a.i. (reference labels)	Land Use Category (Use Site)	Simulation: Rate in lbs a.i./A	Buffer (feet)	Average Initial Concentration in Surface Water (µg/L)
Oryzalin (66222-138, 53883-168, 66222-207)	Agriculture (crop and noncrop, pasture, and rangeland)	Ground[1]: 2 4 6	0	368 736 1,100
	Developed (residential and Industrial)	Ground[1]: 2 3 4 6	0	368 552 736 1,100
	Rights-of-way	Ground[1]: 2 4 6	0	368 736 1,100
Pendimethalin 10404-100, 10404-101 10404-102 19713-621 241-245 279-3359 34704-830 35512-37 52287-17 538-172	Agriculture (crops)	Ground[1]: 1 2 3 4 6 Air[2]: 1 2 3 4	0	184 552 367 734 (AS) 1,100 (AS) 378 (AS) 956 (AS) 736 (AS) 1,912 (AS)
Trifluralin (62719-131, 68516-4, 62719-97, 68156-4)	Agricultural (crops)	Ground[1]: 0.5 1 2 Air[2]: 0.5 1 2	0	92 184 367 (AS) 239 378 (AS) 956 (AS)
	Developed (residential and industrial)	Ground[1]: 0.5 1 2 4 16	0	92 184 367 734 (AS) 2,940 (AS)
	Rights-of-way (road beds)	Ground[1]: 16	0	2,940 (AS)

1 – Tier 1 ground, Low ground boom spray, ASAE fine to medium/course distribution, 50th percentile estimate

2 – Tier 1 aerial spray, ASAE medium to course droplet distribution

AS – Above water solubility of TGAI in laboratory tests @ 25°C

Monitoring Data: Measured Concentrations of Parent Compounds and Degradates in Surface Waters

We reviewed two types of pesticide monitoring data: 1) ambient data that measure concentrations of pesticides and other contaminants in surface waters, but are not targeted at the field level with any specific pesticide application, and 2) data from more targeted studies, frequently found in published scientific literature and gray literature, which collected samples in waters near where the pesticide of interest was used. We evaluated data from five sources: USGS' NAWQA database, state databases maintained by California, Oregon and Washington and targeted monitoring studies that may not be included in monitoring databases. Idaho does not currently maintain a state database. The NAWQA data are typically general monitoring data, with sampling stations distributed across a range of land uses, although some data may be from investigations into specific uses. The California and Washington databases contain data from studies that fall into both categories while the Oregon database contains only ambient monitoring data. In the following section we describe study design considerations for assessing the utility of monitoring data for evaluating exposure of pesticides to salmon.

EPA assessment and effects determination documents sometimes reported information from monitoring studies; where water concentrations or the percentage of runoff is associated with particular application rates and/or methods. We describe those studies in this section, and where available, information regarding ambient air concentrations and atmospheric transport of pesticides.

Data Described in USEPA Assessments

Monitoring data summarized by EPA in its assessments and BEs originate from the NAWQA, STORET and state databases, reports submitted in support of pesticide registration and open literature monitoring data collected using ambient or targeted sampling designs. Our review of targeted monitoring data from the open literature and the NAWQA and state monitoring databases is more recent, so we do not reiterate EPA's summaries from these sources.

Oryzalin. EPA's environmental risk assessment for oryzalin (EPA, 2003b), the Reregistration Eligibility Document (EPA, 1994) and the oryzalin effects determinations for the red-legged frog

(*Rana aurora draytonii*) (EPA, 2008) and California tiger salamander (*Ambystoma californiense*) (EPA, 2010b) did not identify or summarize monitoring data for surface or ground water which could be associated with application rates or cultivation practices. EPA stated in the oryzalin RED that the CDPR air monitoring database does not contain data for oryzalin.[10]

Pendimethalin. Monitoring data were not found in the more recent effects determinations for threatened and endangered California species while Attachment E (Costello, 2009) to the 2004 Effects Determination for salmonids repeated information from two studies summarized in the 1997 Pendimethalin Reregistration Eligibility Document (EPA, 1997). Pendimethalin was detected in surface water samples from numerous river transport stations during a 1982-1985 study of sediment, nutrient, and pesticide transport in Lower Great Lake Tributaries. Maximum concentrations of pendimethalin were 3.66 μg/L (Upper Honey Creek) for 1983; 1.25 μg/μg/L (Honey Creek) for 1984, and 0.31 μg/L (Lost Creek) for 1985 (Baker, 1988). Dissolved pendimethalin was not detected in surface water samples above the reporting limit of 0.018 μg/L in a study of the spatial and temporal distributions of pesticides and nutrients in the Mississippi River and its tributaries (Coupe, Henebry, & Branham, 1993).

Trifluralin. Monitoring data used by EPA in the trifluralin effects determination for California red-legged frog (*Rana aurora draytonii*), Delta smelt (*Hypomesus transpacificus*), San Francisco garter snake (*Thamnophis sirtalis tetrataenia*), and San Joaquin kit fox (*Vulpes macrotis mutica*) included surface water monitoring data from CDPR and from ambient monitoring studies found in reports and open literature (EPA, 2009b).

Among the open literature ambient monitoring data, a study of Suisun Bay during the spring and summer of 2000 detected trifluralin in 32 of 54 surface water samples where 44 ng/L was the highest measured concentration (Kuivila & Moon, 2002). Another study was conducted during the first flush of suspended sediments into Suisun Bay at Mallard Island in December 1995 (Bergamaschi, Kuivila, & Fram, 2001). Trifluralin was detected on 4 days of the 16 day study

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[10] There is no CDPR ambient monitoring database for air. The database EPA was referring to was an inventory of pesticide use and associated estimates of VOC contribution to ozone.

with values ranging from 0.2 to1.3 ng/g per dry weight of sediment. Based on sampling of suspended sediments during February 1992 in the San Joaquin River (at Vernalis, California), trifluralin concentrations in ranged from 4.6 to 31.3 ng/L in dry weight of sediment (Bergamaschi, Crepeau, & Kuivila, 1997). In a study of pesticide inputs to Yolo Bypass in 2004 and 2005 trifluralin was detected in surface water at 17 of 44 sites with values ranging from 4.1 to 66.4 ng/L (Smalling, Orlando, & Kuivila, 2005). In the same study, trifluralin was detected in sediment at 4 of 6 sites with a high concentration of 24 µg/kg.

USGS NAWQA Data for California, Idaho, Oregon, and Washington

We obtained updated data from the USGS NAWQA database to evaluate the occurrence of oryzalin, trifluralin, and pendimethalin in surface waters monitored in California, Idaho, Oregon, and Washington. We searched for, but did not find, data for degradates. Land uses associated with the sampling stations included agriculture, forest, rangeland, urban, and mixed use. The database query resulted in greater than 5500 samples in which one or more of the a.i.s was an analyte. Approximately unique sampling locations were represented, with sample sites located in NAWQA basins located throughout California, Idaho, Oregon and Washington (Table 81). Some waterbodies and/or basins in this dataset do not contain listed salmonids and several of the species have had no sampling within their freshwater and coastal habitats (Table 80). Most notable are those ESUs/DPSs along the coasts of Oregon and California as well as listed salmonid habitats within Idaho. Available data included samples collected from 1992-2011.

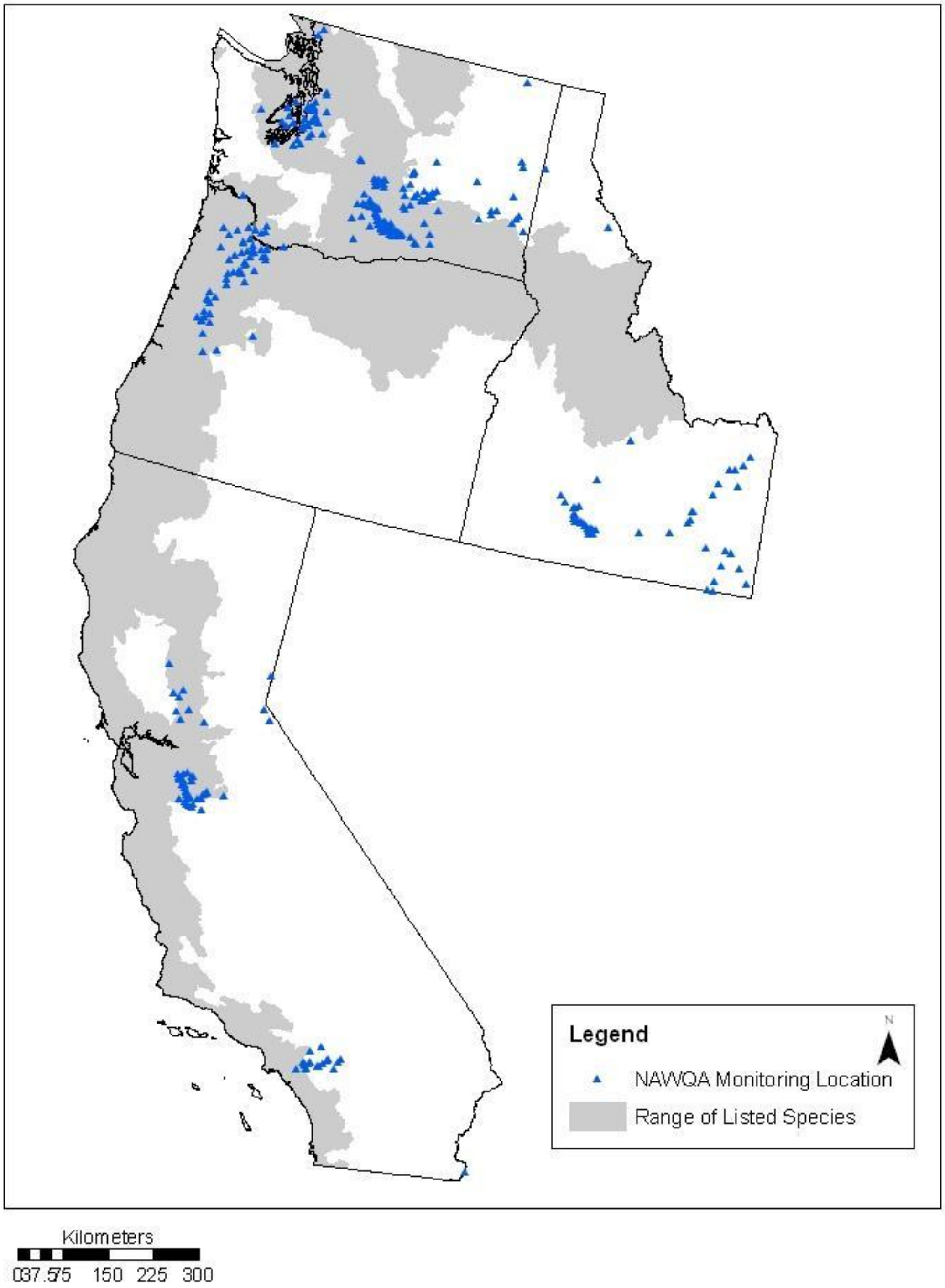

Figure 62 Distribution of NAWQA monitoring sites relative to range of threatened and endangered Pacific salmonids.

Table 80 . Number of NAWQA sample sites within the distribution of listed Pacific salmonids, as determined through GIS analysis.

Species	ESU	Kilometers of Stream Inhabited	Sites in Spawning and Rearing Habitat	Sites in Migratory Corridor*
Chinook	California Coastal	2,422.44	0	na
	Central Valley Spring - Run	2,212.94	5	0
	Lower Columbia River	2,443.29	18	na
	Upper Columbia River Spring - Run	1,646.75	0	4
	Puget Sound	3,639.65	39	na
	Sacramento River Winter – Run	546.84	5	0
	Snake River Fall - Run	1,370.44	1	2
	Snake River Spring/Summer - Run	5,288.23	1	2
	Upper Willamette River	3,013.85	44	3
Chum	Columbia River	1,162.18	12	na
	Hood Canal Summer - Run	141.89	2	0
Coho	Central California Coast	1,287.78	0	na
	Lower Columbia River	3,307.78	18	na
	Southern Oregon and Northern California Coast	5,619.58	0	na
	Oregon Coast	10,220.00	0	na
Sockeye	Ozette Lake	70.98	0	0
	Snake River	1,493.94	0	3
Steelhead	Central California Coast	4,620.72	0	na
	California Central Valley	4,273.66	33	0
	Lower Columbia River	4,302.03	17	1
	Middle Columbia River	10,196.80	92	2
	Northern California	5,324.31	0	na
	Puget Sound	3,849.64	39	0
	Snake River	13,423.40	1	2
	South-Central California Coast	5,104.56	0	na
	Southern California	3,015.86	2	na
	Upper Columbia River	2,143.15	7	2
	Upper Willamette River	3,063.07	27	3

* This is only determined for species with migratory corridors outside of their range. All other species are listed as “na”.

Greater than 30% of sites were sampled a single time during the span of 19 years, and a relatively small number of sites accounted for the majority of the data. Approximately 70% of the data was collected from 30 sites, including sites that fell outside the distribution of listed salmonids. For oryzalin, 73% of the observations came from 30 of the 216 observation sites. Similarly, approximately 60% of pendimethalin observation came from 30 of the 373 observation sites, and 30% of trifluralin samples came from 30 of 373 sites. The temporal and spatial distribution of sampling is inconsistent with temporal and spatial aspects of salmonid distribution. Consequently, we do not expect the data set to be representative of exposure distributions for listed salmonids.

The frequency of detection is a combination of the actual occurrence of pesticides in the water and the sampling intensity. NAWQA surface water detections represent the dissolved phase, as the water sample is filtered through a 0.7 micron glass fiber filter. Chemicals transported primarily in the particulate phase would be underreported in this data set. No tissue data were available from USGS for these compounds. Trifluralin and pendimethalin were screened for in sediment samples collected from 21 NAWQA sites in the Puget Sound basin during May of 2007. Trifluralin was not detected above the LRL of 1.7 μg/kg and pendimethalin was detected in one sample at an estimated concentration of 0.52 μg/kg (LRL=0.6 μg/kg). The limited availability of data for sediment is also a recognized uncertainty and compromises our ability to determine toxicity of contaminated sediments. Because the USGS monitoring program does not generally coordinate sampling efforts with specific pesticide applications or runoff events, detected concentrations are likely to be lower than actual peak concentrations that occur immediately following drift or a runoff event. Summary information for quantifiable concentrations of the pesticides addressed in this Opinion (Table 81) is presented below. In the USGS database, non-detects are reported as less than ("<") the laboratory reporting level (LRL) for that sample. Other than total number of samples (n), summary statistics were calculated on samples not designated as ("<"). The LRL ranges reported were estimated based on "<"-qualified data. Nearly all of the concentrations that could be quantified were designated as "E," meaning the concentrations were estimated. These data are included in the summary statistics.

Table 81. Concentrations of parent pesticides in NAWQA database.

Statistic	Oryzalin	Pendimethalin	Trifluralin
Number of Stations	216	373	373
Number of Observations	1,392	5,499	5,499
Detects	35	437	650
Percent Detections	3%	8%	12%
Median (μg/L)	0.17	0.024	0.007
Range (μg/L)	0.007-1.8	0.001-0.679	0.0005-1.74
LRL (μg/L)	0.012-0.719	0.004-0.075	0.002-0.029
Year range	1993-2010	1992-2011	1992-2011

Trifluralin was the most frequently screened for and detected pesticide, occurring in 12% of the nearly 5500 samples screened, ranging from 0.0005 to 1.74 μg/L (median, 0.007 μg/L). Pendimethalin was detected in 8% of samples screened, broadly ranging from 0.001 to 0.679 μg/L (median, 0.024 μg/L). Oryzalin ranged from 0.007 to 1.8 μg/L in 3% of the samples screened (median, 0.17 μg/L).

Monitoring Data from California

We evaluated monitoring data from the California Department of Pesticide Regulation (CDPR), public database of pesticide monitoring data for surface waters in Califronia. Datasets[11] within the database originate from monitoring studies conducted by CDPR, USGS, state, city and county water resource agencies along with some studies conducted by non-governmental or inter-governmental groups such as Deltakeeper. The contents of the database for the a.i.s assessed in this Biological Opinion are summarized in Table 82 while the individual studies are described below in the text. The CDPR requires a formal QA/QC protocol for data submitted or does a separate QA/QC review, thus only data subject to appropriate QA/QC procedures are included in the surface water database. Unlike the USGS NAWQA data set, the CDPR database may contain whole water samples as well as filtered samples. If whole water concentrations are reported for compounds that sorb significantly to the particulate phase, concentrations would appear higher than in a filtered sample, which represents only the dissolved phase. With the exception of some studies evaluating rice pesticides, the majority of the CDPR studies are not targeted at correlating water concentrations with specific application practices. The database,

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[11] (www.cdpr.ca.gov/docs/emon/surfwtr/surfdata.htm)

last updated in June 2011, consists of approximately 375,000 records. Each record reports a specific sampling site, date, and analyte. In this database, detections below the LRL are reported as 0 μg/L. Our summary statistics for the datasets were calculated on samples with values above the LRL. The number of records associated with a particular compound is indicative of monitoring intensity rather than actual occurrence in surface waters.

The database includes monitoring data from the USGS NAWQA program for monitoring studies conducted in the Sacramento, San Joaquin and Tuolumne River Basins and other sites within the state of California. Data from these river basin monitoring studies are repeated within the nationwide NAWQA database, which was summarized in the previous section. To avoid redundant use of these data, USGS data found in the CDPR database are excluded from this summary.

The Sacramento River Watershed Program monitored for trifluralin in the years from 1999 to 2002 and for oryzalin and pendimethalin in 2002. Oryzalin was screened for, but not detected, in seven samples from four stations (LRL=0.4 μg/L). Pendimethalin was screened for at five stations and was detected in one of the five samples collected (2.1 μg/L, LRL=0.5 μg/L). Trifluralin was screened for, but not detected in 202 samples taken from 21 stations (LRL=0.1 μg/L).

The Central Valley Regional Water Quality Control Board included trifluralin and pendimethalin among the analytes screened for during its investigation into the sources and concentrations of diazinon in the Sacramento watershed during the 1994 spray season. Trifluralin was detected in a single sample at 0.023 μg/L among the 28 samples collected from four stations (LRL=0.012). Pendimethalin was detected in 35 of 64 samples taken from eight stations during this study (median 0.012 μg/L, range 0.008-0.042 μg/L, LRL = 0.008 μg/L).

Data for trifluralin from the State Water Resources Control Board included toxicity monitoring data for the Colorado River Basin in 1993-1994 and the Pajaro River in 1994-1995. Trifluralin was not detected in the 14 samples collected from 7 stations monitored during the Pajaro River study (LRL=0.1 μg/L) and was detected in one of 48 samples collected from 11 stations monitored during the Colorado River Basin Study (0.1 µg/L, LRL=0.1 µg/L). Trifluralin was screened for, but not detected in monitoring performed by the City and County of Sacramento through the Stormwater NPDES Monitoring Program (1995-1996, 20 samples from 3 stations, LRL=0.1 µg/L). Similarly, the City of Modesto monitored, but did not detect trifluralin in a 1999 study evaluating toxicity in urban runoff (5 samples from 2 stations, LRL=0.1 µg/L).

Table 82 . Concentrations of parent pesticides in CDPR database.

Statistic	Oryzalin	Pendimethalin	Trifluralin
Number of Studies	3	10	9
Number of Stations	88	155	159
Number of Observations	685	1237	1197
Detects	44	82	38
Percent Detections	6%	7%	3%
Median (µg/L)	1.7	0.32	0.235
Range (µg/L)	0.06-170	0.03-3.3	0.01-2
LRL (µg/L)	0.06-170	0.01-2	0.005-0.05
Year range	2002-2009	1992-2009	1992-2009

Monitoring Data from Washington

Data from monitoring studies conducted in the state of Washington are included in the Department of Ecology's Environmental Information Management (EIM) database (http://www.ecy.wa.gov/eim/). Observations in the database may include data for whole water samples as well as filtered samples. The EIM requires a formal QA/QC protocol for data submitted or does a separate QA/QC review, thus only data subject to appropriate QA/QC procedures are included. Some of the studies contained in this database are targeted with respect to specific pesticide uses, while others are more generalized water quality surveys. The general water quality surveys are summarized below and the targeted monitoring data are discussed in a later section. The procedure for reporting in the EIM database includes reporting non-detects as the reporting limit for that particular sample, and adding a "U" data qualifier. The reporting limit was not specified in the data accessed by NMFS, thus LRL ranges were estimated based on "U"-qualified data. Where calculated, summary statistics were calculated on samples with values above the LRL (*i.e.*, not qualified with a "U" or "UJ"). Statistics include data qualified with a "J" (analyte positively identified, resulting value an estimate) and data qualified with an "NJ" (analyte tentatively identified, resulting value an estimate).

While the database contains information on the oryzalin degradate 4-chlorotoluene, these data are from toxics investigations which are not associated with pesticide use. A majority of the data for oryzalin, pendimethalin, and trifluralin originate from a monitoring efforts conducted by the Washington Department of Ecology in some of Washington's salmon-bearing streams. Final reports are publically available on their website (http://agr.wa.gov/PestFert/natresources/SWM). Monitoring was conducted as recently as 2010, but the report is not yet available. A separate summary of data from those investigations is provided below (Table 83). Water samples are not filtered, and thus concentrations reported include pesticides in both dissolved and particulate phases, although the sampling protocol specifies an attempt to avoid collection of excessive particulates (A. Johnson & Cowles, 2003). Whole water concentrations for compounds that sorb significantly to the particulate phase will appear higher than those for a filtered sample, which represents only the dissolved phase. The Washington program sampled between 6 and 17 sites, depending on the year (Figure 63) (P. D. Anderson, Dugger, & Burke, 2007a; Burke, Anderson, & Dugger, 2006; A. Johnson & Cowles, 2003).

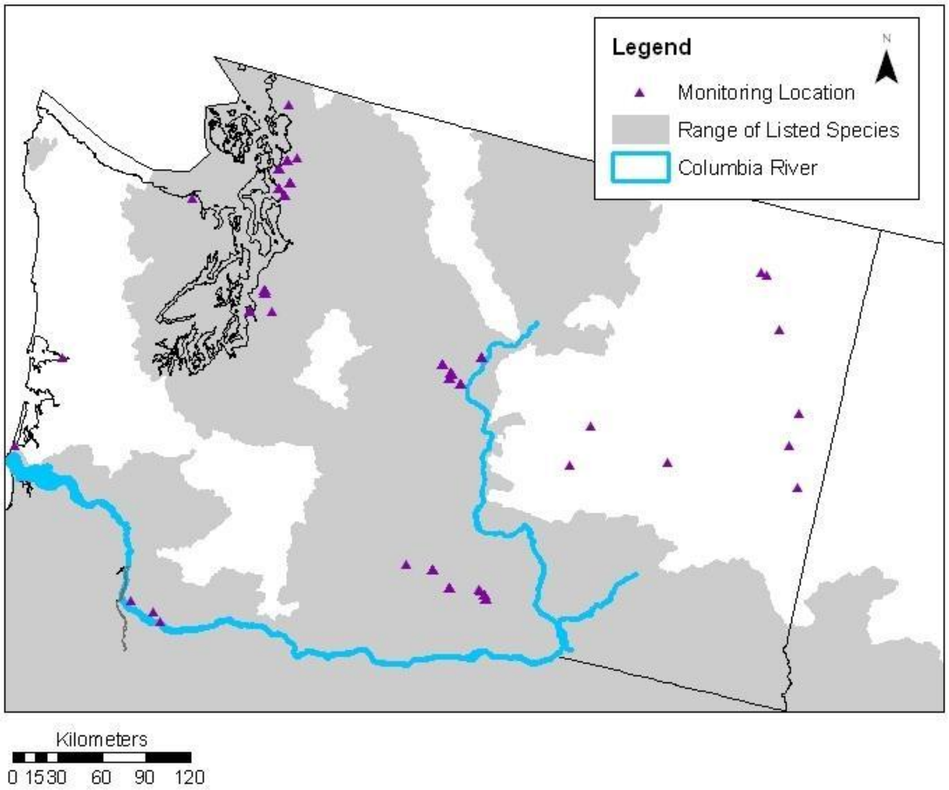

Figure 63. Washington Ecology Monitoring Sites: distribution in relation to the range of listed Pacific salmonids.

Sampling frequency varied in these studies from daily to every 16 days between March and September at the various sites, but the specific sampling design has changed somewhat over the years. Sampling stations were located primarily in agricultural-dominated watersheds. A single watershed, the Cedar-Sammamish (Thornton Creek) represented the urban sites. Three sites were sampled in Thornton Creek in 2003, and 2 sites from 2004-2007. Agricultural sites were distributed in four watersheds (Lower Yakima, Skagit/Samish, Wenatchee and Entiat), but only the Lower Yakima sites have been sampled since 2003. Sites in the Skagit/Sammish watershed were added in 2006 and sites in the Wenatchee and Entiat were added in 2007. Data from this program includes intensive daily monitoring effort in the Marion Drain (2007) and Skagit-Samish (2009).

Sample analyses for data within the EIM favored the detection of multiple pesticides, rather than peak concentrations in habitats used by listed salmonids. The majority of the data for the pesticides evaluated in this BiOp are estimated values reported at or near the reporting limit. The limited number and spatial distribution of samples sites in the EIM does not reflect the distribution of listed salmonids in the state. Additionally, NMFS does not believe these sites represent the full range of habitats and potential exposure to pesticides for the ESUs/DPSs located in Washington State and therefore should not be used to represent distribution of pesticide exposure in a probabilistic assessment for salmonids. As such, the data are considered in context of detection frequency and the presence of any temporal pattern in pesticide detection which might suggest whether and when pesticide may occur at unmonitored sites with similar land use.

Table 83. Concentrations of parent pesticides in Washington EIM database.

Statistic	Oryzalin	Pendimethalin	Trifluralin
Number of Studies	7	28	27
Number of Stations	28	130	122
Number of Observations	1,814	2,868	2,851
Detects	8	99	68
Percent Detections	0.4%	3.5%	2.4%
Median (μg/L)	0.305	0.039	0.0135
Range (μg/L)	0.086-1	0.0031-0.21	0.0003-0.076
LRL (μg/L)	0.0025-4.1	0.008-0.26	0.0049-0.26
Year range	1992-2010	1992-2010	1992-2010

Oryzalin was not detected in a study conducted in May through June of 1992. This study used high detection limits of 3.7 to 4.1 μg/L. The remaining studies which monitored for oryzalin were from the salmonid stream monitoring program and had LRLs as low as 0.0025 ug/L. The salmonid stream program monitored for oryzalin between 2007 and 2010. It was detected infrequently in the springtime at stations within the Cedar/Green, Lower Yakima, Skagit/Stillaguamish and Wenatchee basins. There were few oryzalin detections for the years 2008 and 2009. Detections in 2010 were attributed to improvements in the analytical methodology used.

Eleven of the studies which monitored for pendimethalin were salmonid stream monitoring program surveys conducted between 2003 and 2010. Observations in this series of studies bracketed the range of pendimethalin concentrations found within the entire dataset (0.0031-0.21 μg/L). Approximately 70% of pendimethalin detections occurred in April or May. Samples collected during these months make up only 1/3 of the samples screened for pendimethalin in the database.

Twelve of the studies which monitored for trifluralin were also from the salmonid stream monitoring program. Trifluralin was monitored under the program between 2003 and 2010. It was detected most frequently in the years 2005-2007 and 2010, but without a distinct difference in detections among months. Trifluralin was detected sporadically without seasonal pattern in the remaining studies.

The EIM also includes observations for pendimethalin and trifluralin in fish tissue. Pendimethalin was not detected above the LRL of 20 μg/kg in 21 samples collected between 1999 and 2003 for EPA's National Study of Chemical Residues in Lake Fish Tissue. The 1995 Washington State Pesticide Monitoring Program investigation of pesticides in fish tissue included samples of largemouth bass, carp, rainbow trout, yellow perch, mountain whitefish, and largescale sucker. Reported trifluralin concentrations ranged from 0.5 to 1.5 μg/kg in largemouth bass muscle samples (n=9) and was 3.6 μg/kg in a single carp muscle. Trifluralin was not detected in muscle tissues of rainbow trout (n=3), yellow perch (n=3) or mountain whitefish (n=2). Some whole organism concentrations were measured. Largescale sucker whole organism samples had measured concentrations ranging from 9.8 to 12 μg/kg (n=5). Whole organism carp samples (n=3) ranged from 7.1 to 12 μg/kg. A number of other studies analyzed for, but did not detect trifluralin in fish tissue (LRL range=1.1-12 μg/kg).

Monitoring Data from Oregon

Data from monitoring studies conducted in Oregon are available in the Oregon Department of Environmental Quality's (ODEQ) Laboratory Analytical Storage and Retrieval (LASAR) database (http://deq12.deq.state.or.us/lasar2/). All data contained in LASAR are reviewed, verified, validated, and qualified by the Laboratory and Environmental Assessment Division at ODEQ. Studies of particular relevance in the database include monitoring conducted by ODEQ through its Pesticide Stewardship Partnerships (PSPs). The primary objective of these partnerships is to identify and improve water quality problems through voluntary adaptive management. The approach has been used since 1999, with initial surface water monitoring focused on twelve pesticides and some related degradates in a few watersheds and sub-basins where water quality standards had been frequently exceeded. In recent years the monitoring program has been expanded to include additional pesticides and areas. Currently, seven sub-basins are included in the program, with the Amazon Creek Watershed near Eugene, OR added in 2011. Since 2009, the PSP monitoring program has monitored 100 pesticides, including trifluralin. The sample locations for the study areas overlap with spawning and rearing habitat of several listed salmonids (Figure 64).

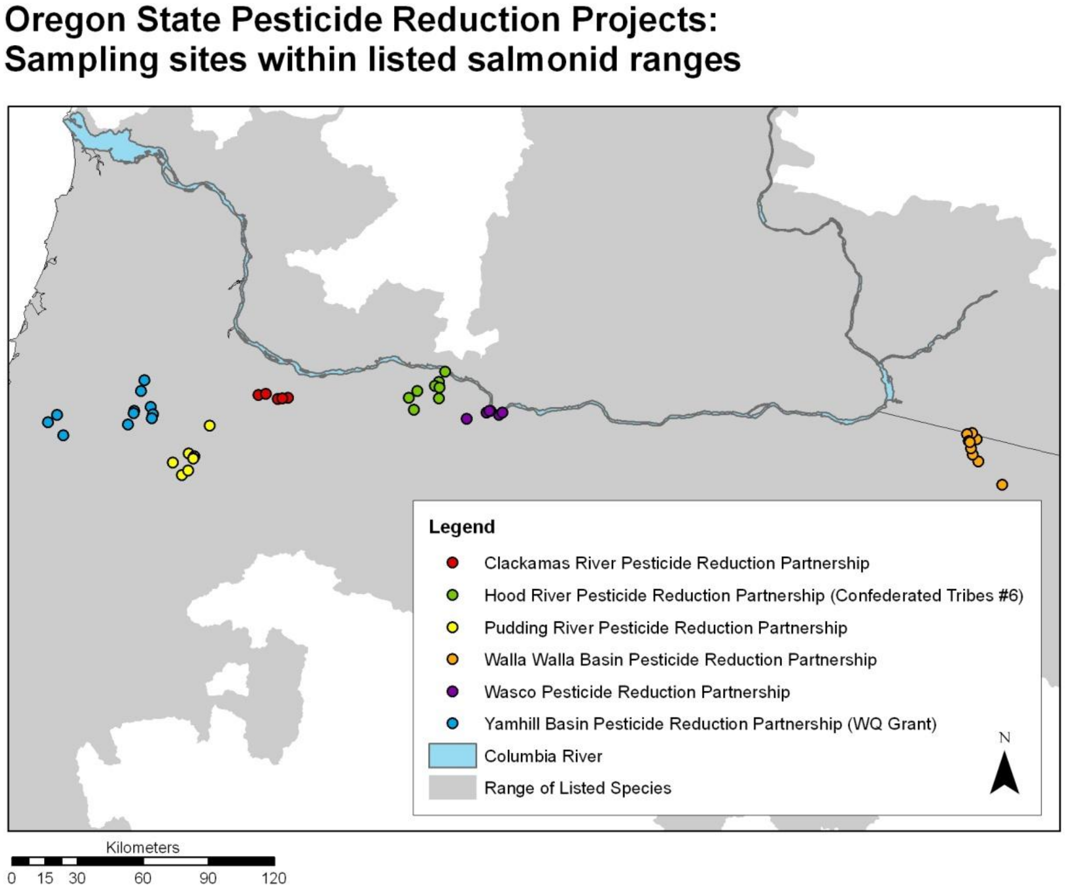

Figure 64 Distribution of Oregon Department of Environmental Quality sample stations compared to the distribution of listed ESU/DPSs.

The study locations and timing of sampling events were chosen considering pesticide use patterns based on local knowledge. Sampling stations are primarily located at publicly accessible sites. The spatial and temporal relationship of sampling to actual pesticide use is unknown. The study design allows for evaluation of ambient water quality trends within the monitored sub-basin (Masterson, 2011). Oryzalin was not among the pesticides screened for. A summary of the monitoring results is provided below in Table 84. Pendimethalin was screened for in 1,073 samples and detected in 47 samples at concentrations ranging from 0.019 to 0.47 µg/L. Detects occurred most frequently between March and June. The database also contained data for 1,088 samples with trifluralin detected in 27 samples. The highest concentrations among all surface water data were observed in samples from the Fletcher and Overstreet drains at up to 0.4 µg/L. The highest concentrations for stream data ranged up to 0.14 µg/L. The higher trifluralin and pendimethalin concentrations generally occurred in samples collected from March through June of 2009 and 2010 from stations associated with Deep Creek, which is within Clackamas River Pesticide Stewardship Partnership. These stations were not monitored in the intervening months. The majority of detections for these pesticides at other stations were at or near the quantitation limits.

Table 84. Concentrations of trifluralin and pendimentalin detected in recent studies by Oregon Department of Environmental Quality (2009-2010).

Statistic	Pendimethalin	Trifluralin
Number of Studies	25	26
Number of Stations	181	184
Number of Observations	1,073	1,088
Detects	47	27
Percent Detections	4.4%	2.5%
Median (μg/L)	0.047	0.026
Range (μg/L)	0.019-0.474	0.018-0.4
LRL (μg/L)	0.018-0.056	0.018-0.4
Year range	1999-2011	1991-2011

Moinitoring Data from Europe

In May of 2012, Dow provided a provided a summary of monitoring data for trifluralin in Europe (Horth & Wright, 2002). Data was collected from various monitoring programs in EU member states. Authors list application rate for trifluralin in the EU as 1,200 g a.s./ha, equivalent to 1.07 lb a.i./A. The application rate cited is similar to rates permitted on food crops in the U.S., which range from 0.375 – 2 lb a.i./A. Non-food uses in the U.S. can be higher, up to 4 lb a.i./A on ornamentals. No usage data was included in the report, nor was there any discussion of how sampling sites were located in relation to agricultural areas. The EU Drinking Water Directive sets a limit of 0.1 μg/L for any single pesticide in surface water sources used for drinking water. Maximum concentrations of trifluralin detected ranged from 0.2 - 0.7 μg/L. "In total, trifluralin was detected in only 1.5% of over 30,000 samples from over 4,500 sites." (Horth & Wright, 2002).

Targeted Monitoring Studies from California

The California Department of Pesticide Regulation (CDPR) database includes data from targeted monitoring studies that examined one or more of the pesticides covered by this Opinion. Among the CDPR data are Central Valley Regional Water Quality Control Board monitoring projects investigating water quality in agricultural drains of the Central Valley (hereafter "Irrigated Lands

Study") and an investigation of pesticide concentrations in water associated with applications on orchards and alfalfa (hereafter,"Orchard and Alfalfa Study"). The database also includes eight years of monitoring data collected by CDPR for pesticides used in rice cultivation (hereafter “Rice Pesticide Monitoring Program”).

Irrigated Lands Study. The irrigated lands study monitored stations located near agricultural drainages into creeks or rivers in catchments dominated by return flow from mixed row crops and/or alfalfa or areas where the primary land use was rice culture. The study design focused sampling efforts on periods of peak irrigation, especially the first major irrigation of the season. Oryzalin was detected at 17 sites, with the majority of detections occurring January through March. Pendimethalin was detected at 2 sites within the Sacramento River Basin and at 17 sites within the San Joaquin River Basin. The highest frequency of detects occurred in April. A total of 708 samples from 75 sites were screened for trifluralin. Trifluralin was detected at 4 sites within the Sacramento River Basin and at 17 sites within the San Joaquin River Basin with detection frequencies highest in February and again in June (Table 85). LOQ data were not provided with the irrigated lands study.

Table 85. Summary of Irrigated Lands Study data from the Central Valley Regional Water Quality Control Board (2004-2006).

Statistic	Oryzalin	Pendimethalin	Trifluralin
Number of Stations	60	75	70
Number of Observations	544	753	708
Detects	38	83	57
Percent Detections	7%	11%	8%
median (μg/L)	3.55	0.31	0.16
range (μg/L)	0.42-170	0.1-3.3	0.00335-1.45

Orchards and Alfalfa Study. The Central Valley Regional Water Quality Control Board Orchard study “Pesticides In Surface Water From Applications On Orchards And Alfalfa During The Winter And Spring 1991-92” screened 38 samples from 15 sites for both pendimethalin and trifluralin. Neither pesticide was detected during this study (LRL=0.1 μg/L).

Atmospheric Pesticide Monitoring Studies. The Parlier Project monitored pesticides in air samples in the area of Parlier California several days a week over 12 months. Oryzalin was not detected despite nearly 13 thousand pounds applied in the area over the course of about 700 applications during the 2006 monitoring period. Trace amounts of trifluralin were detected in 24 percent of samples with a highest 1 day concentration of 23.2 ng/m^3. Trifluralin was applied in the area on 16 occasions for a cumulative usage of 79 pounds. A ten week monitoring study in Lompoc California did not monitor for oryzalin and only trace levels of trifluralin were detected in 24% of samples with a highest 14day average of 4 ng/m^3. Trifluralin was applied prior to the monitoring period at 66.9 lbs in April and 52.7 lbs in May.

Targeted Monitoring Studies from Washington

The Washington Department of Ecology's EIM database includes data from two targeted studies; the Grayland Area Pesticide Reduction Evaluation and the 1998 Potholes Reservoir Pesticide Survey. The Grayland Area Pesticide Reduction Evaluation study was conducted to compare data related to cranberry growing operations on 303 (d) listed waters to data from past studies to determine progress in reducing concentrations in Grays Harbor and Pacific County ditches. Three sites were sampled between July 2nd and August 1st in 2002 at stations in Grays Harbor County ditch (GHCDD-1) and six stations in the Pacific County ditch (PCDD-1). Samples were collected one week prior to pesticide application, during the week of peak application, and two weeks following application. While both pendimethalin and trifluralin were screened for during the study, neither were detected above the reporting limits of 0.03-0.032 μg/L (Coots, 2003). The Potholes Reservoir Pesticide Survey collected water samples during the peak pesticide application season from the Potholes Reservoir, which primarily receives irrigation return water. Pendimethalin and trifluralin were not detected in any sample above reporting limits of 0.03-0.031 μg/L (Rogowski & Davis, 1998).

Open Literature Targeted Monitoring Studies

This section includes targeted studies found in open literature. Targeted studies are those which associate environmental concentrations with a particular agricultural practice, actual pesticide applications or usage or loss rates for the study area. These studies suggest the time frames and exposure intensities associated with registered use patterns for the monitored pesticides.

Trifluralin was among the pesticides monitored monthly at stations on the Lourdis and Axios Rivers and along the coast of the drainage area transporting agricultural runoff from Thessaloniki, Greece to the Thermaikos Gulf. Transport between the March 1988 and February 1989 was calculated to be 0.5% of applied herbicide. Crops grown in the area during the 1988-1989 study period include 27.7% cotton, 20.1% corn, 21% trees, 13.5%, rice, 4.8% tobacco, 3.1% alfalfa, and 9.9% other row crops. During the 1988 (May-October) cultivation season, about 29,000 lbs of trifluralin, associated primarily with cotton cultivation, was applied to 230,000 hectares of cultivated land. About 80% of the 724 million cubic meters of water used to irrigate the region was used between July and August. Pesticide residues in unfiltered samples were highest in the first half of the growing season between May and June and were generally twice as high in northern stations relative to stations by the coast. More rice is grown in the southern coastal area and the lower herbicide concentrations were attributed to dilution by the greater amount of irrigation required for growing rice. Observations of trifluralin at inland stations reached concentrations as high as 0.5 μg/L in the early growing season and declined thereafter. However, the highest observed trifluralin concentration observed was 0.95 μg/L and occurred during May sampling in May at a coastal station. Concentrations at that station declined in samples collected in the following months, reaching 0.1 μg/L by December. Observations at the other coastal stations had were between 0.05-0.15 μg/L trifluralin or were non-detects (Albanis, 1992). Pesticides in the Aliakmon River, another of the rivers draining this region, were screened every three months between 1990 and 1993. Maximum concentrations of trifluralin were similar to those found in the Lourdis River, with concentrations as high as 0.55 μg/L occurring at stations in the inland agricultural areas during pesticide application periods May-August (Albanis, Danis, & Hela, 1995). While application rates and details on climate and cultivation are not provided for the Aliakmon River, the authors state that similarities with data from the Lourdis and Axios rivers suggest these observations are representative of other rivers draining the Thessalonki plain.

A study assessing herbicide and plant nutrient inputs via drainage water reported that inputs of trifluralin into the South Saskatchewan River were less than 0.002% of the amount applied to flood-irrigated fields. Cultivation in the region was 80% cereal, oilseed and forage. Trifluralin was only detected at trace amounts within a drainage area treated with 45 kg trifluralin during the 1994 growing season. The pesticide was not applied during the 1995 or 1996 growing seasons and was not detected (Cessna, Elliott, Tollefson, & Nicholaichuk, 2001). However, in this study, water samples were filtered prior to herbicide extraction and the sediment remaining on filters was not analyzed. Since trifluralin has a high affinity towards organic matter which would be removed through filtration, the inputs of total trifluralin into the Saskatchewan River are likely higher than suggested by the study.

The relatively low water solubility of trifluralin was attributed to its total calculated runoff loss of 0.005% of the amount of applied (1.5 lbs/A) to soybean plots in Louisiana in June of 1991. Runoff samples were taken by an autosampler every 20 minutes during each of 13 growing season runoff events. Pesticide concentration and variability in unfiltered samples was consistent among three replicate plots until 89 days after application. Means ranged from 0.052-0.055 μg/L and standard deviations were between 0.020-0.024 μg/L (Kim & Feagley, 2002). Trifluralin was applied to experimental fields at Rosemaund in the west of England at a rate of 2.728 kg/A in November of 1992. The decline in trifluralin concentrations in runoff water was measured over time until April of 1992. During a storm event five days after application, monitoring site maximum concentrations ranged from 0.37 to 14.1 μg/L along an unnamed stream. A second storm event nine days after application resulted in maximum concentrations ranging from <0.08 to 2.2 μg/L. At 20 days, maximum runoff concentrations ranged from 0.13 to 1 μg/L in the three stations closest to field applications, but after 43 days, concentrations declined to 1.04 and 0.39 μg/L and below 0.2 μg/L thereafter (Turnbull *et al.*, 1997).

Surface water, sediment and rainwater were monitored in the northeastern Planalto and Pantanal basin of Brazil (located in southern Mato Grosso) during the main application season to provide information on pesticide distribution and dynamics. The Planalto is intensively used for cattle grazing and crops of soybean, cotton, corn and sugarcane, while the Pantanal lowlands have limited agricultural used in the form of pastures and small scale vegetable production. Stream stations were located in catchments with 40-60% agricultural land use. Trifluralin, which is used on soybean and cotton crops, was detected in 5.3% of filtered water samples from streams at concentrations ranging from 0.003-0.016 μg/L. Trifluralin also occurred in 15.4% of samples taken from river stations with concentrations ranging from 0.003-0.019 μg/L. Detection frequency was similar in samples from surface water stations of the Pantanaal plain area, occurring in 15.8% of samples, but concentrations ranged from a low of 0.017 μg/L to a maximum concentration of 0.019 μg/L. Trifluralin was analyzed for, but not detected in the residual sediments filtered from those water samples where trifluralin was detected.

Trifluralin was detected in 35.6% of the rain samples from the Planalto area at concentrations ranging from 0.003 to 0.318 μg/L. The maximum deposition rate for trifluralin to the Planalto, which received about 764 mm rainfall over the study period, was 27 $\mu g/m^2$. This contrasts with a trifluralin detection rate of 8.7% in Pantanaal rainwater samples, which ranged from 0.009-0.036 μg/L trifluralin resulting in a deposition rate of 4.7 $\mu g/m^2$. Rainfall among Pantanaal sites averaged 580 mm. The authors indicated that atmospheric input of pesticides appeared to be more important in tropical than temperate regions (Laabs *et al.*, 2002).

Trifluralin and pendimethalin were was measured in water, bedded sediment and suspended sediment samples from stations located upriver, at river mouths and off shore along three rivers that drain into the Salton Sea of California, a hypersaline lake within a heavily agricultural watershed with 143,259 ha under cultivation. Sampling occurred during the peak fall and spring pesticide application seasons. Trifluralin was the most highly used and most frequently detected pesticide and had the highest maximum and average concentrations. Pendimethalin also among the most frequently detected pesticides. Trifluralin applications were approximately 277,604 lbs during April 2000 to October 2000, 211,600 lbs during November 2000 to March 2001 and 66,004 lbs per acre April to October 2001. Pendimethalin applications were 28,770 lbs, 17,960 lbs and 10,810 lbs/acre for these same time periods. Concentrations of both pesticides were highest in samples collected in spring (Table 86). Among the three rivers, concentrations were highest in water and sediments of the Alamo River. Concentrations tended to be highest at the outlet of the river (upriver) than at near shore or off shore stations (LeBlanc & Kuivila, 2008; LeBlanc, Schroeder, Orlando, & Kuivila, 2004).

Table 86. Concentrations of pendimethalin and trifluralin in water (ng/L) and Sediment Samples (ng/L) from rivers draining into the Salton Sea, California (LeBlanc et al., 2004). [3]

		Alamo River			New River			Whitewater River		
		outlet	near shore	off shore	outlet	near shore	off shore	outlet	near shore	off shore
Pendimethalin										
Water	**Fall 2001**	59.5	nd[1]	nd	nd	nd	nd	nd	nd	nd
	Spring 2002	156	Nd	nd	65.3	27.3	nd	20	nd	nd
	Fall 2002	6.1	7.2	nd	nd	nd	nd	61.9	nd	nd
Bedded Sediment	**Spring 2002**	77.5	Nd	nd	nd	nd	nd	nd	nd	nd
Suspended Sediment	**Spring 2002**	42.4	Nd	nd	nd	nd	nd	nd	nd	nd
	Fall 2002	nd	Nd	nd	nd	nd	nd	36.2	nd	nd
Trifluralin										
Water	**Fall 2001**	37.4	37.6	nd	35	27.3	nd	22.5	nd	nd
	Spring 2002	600[3]	15.8	nd	215	80.3	nd	10.5	nd	nd
	Fall 2002	4.6	5.5	nd	12.4	nd	nd	(1.5)	nd	nd
Bedded Sediment	**Fall 2001**	nd	(0.7)[2]	nd	(1.2)	(1.9)	nd	(0.6)	(0.5)	nd
	Spring 2002	37.2	7.1	2.5	5	12.8	2	nd	nd	nd
	Fall 2002	2.6	Nd	nd	3.5	nd	nd	nd	nd	nd
Suspended Sediment	**Fall 2001**	9.7	12.2	nd	4.6	6.8	nd	(0.4)	nd	nd
	Spring 2002	106.4	19.2	nd	33.3	62.5	nd	(0.6)	nd	nd
	Fall 2002	3.1	8.6	nd	18.2	(0.4)	nd	nd	nd	nd

[1] nd means non detect

[2] Numbers in parentheses are observations below detection limits

[3] 600 ng/L concentration erroneously reported as 600 μg/L in the Draft Opinion (March 2012). Value was reported in tables and analyses but regarded as anomoulously high in comparsion to other monitoring data. It was not weighted heavily in risk conclusions, and the correction here does not change those risk conclusions.

Trifluralin was the only herbicide detected in the tissues of oysters in a 1997 year long study which sampled water and oysters from stations in the Patuxent River MD, which flows through rural, urban, and agricultural areas and in the Choptank River, which primarily flows through agricultural areas. Pendimethalin was detected at 0.018 μg/L in one Choptank water sample collected in mid-August . Concentrations of trifluralin in water samples from both rivers were similar and showed no temporal trend, with 0.30+/-0.12 ng/L in the Patuxent samples and 0.00030+/-0.00018 μg/1 in the Choptank samples. However trifluralin concentrations increased in oyster tissues during June and early July, which is the time period when trifluralin is most commonly applied and when oysters accumulate glycogen prior to spawning (Lehotay, Harman-Fetcho, & McConnell, 1998).

Information in the open literature for pendimethalin is scarce. The only paper found concerning the use of pendimethalin on rice fields analyzed for, but did not detect pendimethalin in the the paddy waters of IPM or non IPM rice fields (Arora, Mukherjee, & Trivedi, 2008). Another study reported that pendimethalin use in strawberry cultivation on the lands surrounding the estuary of Huleva Spain resulted in residues in the tideland zone water at 0.125 μg/L, at 0.37 μg/L in the lacustrine zone water and 0.72-0.78 ugL in the tributary streams (Barba-Brioso, Fernandez-Caliani, Miras, Cornejo, & Galan, 2010).

Considerations Regarding Exposure Estimates

The exposure analysis begins at the organism (individual) level of biological organization. We consider the life stage and life histories of the individuals likely to be exposed. To assess risk to individuals, we must consider the range of concentrations to which any individuals of the population may be exposed, including both the lowest and the highest.

Utility of PRZM-EXAMS EECs

The PRZM-EXAMS EECs are the concentrations EPA uses to make risk decisions. Although EPA initially characterized these exposure estimates as “worst case” in the salmonid BEs, they later acknowledged measured concentrations in the environment sometimes exceed PRZM-EXAMS EECs (EPA, 2007). EPA has subsequently clarified that rather than providing worst case estimates, PRZM-EXAMS estimates are high end estimates for the vast majority of applications and aquatic habitats (EPA, 2007). Potentially, some higher concentrations are not accounted for by the PRZMS-EXAMS modeling.

Higher concentrations may not be captured for the following reasons:

- Model outputs are 90th percentile time-weighted averages, not instantaneous peaks,
- Model inputs did not use maximum application rates, maximum number of applications, and minimum application intervals,
- Not all types of authorized uses have corresponding application scenarios,
- Crop scenarios may not be representative of all geographic locations within the action area,
- Co-applied a.i.s (multiple a.i. formulations or tank mixes) are not modeled.

Utility of AgDrift Estimates

Listed salmonids use aquatic habitats with physical characteristics which may result in higher pesticide concentrations than would be predicted with the "farm pond" used in the EXAMS model. Such characteristics include larger surface runoff to water volume ratios, less dissolved organic carbon, and/or a larger surface area for spray drift to deposit. AgDrift modeling used by NMFS in this and other opinions represents these more vulnerable habitats, and is a worst-case estimate. Juvenile salmonids frequently use shallow and low-flow waterbodies or areas of waterbodies for rearing. Some concerns with AgDrift modeling include;

- Defining appropriate size of modeled waterbody,
- Inability to account for fate processes in the waterbody,
- Dissipation in flow conditions different than those modeled.

Utility of Monitoring EECs

Surface water monitoring can provide useful information regarding real-time exposure and the occurrence of environmental mixtures. Available monitoring studies were conducted under a variety of protocols and for varying purposes. General water quality monitoring conducted in larger streams and rivers frequently does not capture "peak" concentrations because it is not correlated with applications and/or storm events following those applications and not all habitats types are sampled.

Common aspects limiting the utility of the available monitoring data as accurate depictions of exposure within listed salmonid habitats include:

- Protocols not designed to capture peak concentrations or durations of exposure in habitats occupied by listed species;

- Inability to correlate actual pesticide use with observed surface water concentrations.
- Reliability as a surrogate for other non-sampled surface waters;
- Representativeness of current and future pesticide uses and conditions;

Exposure Conclusions

Pacific salmon and steelhead use a wide range of freshwater, estuarine, and marine habitats and many migrate hundreds of miles to complete their life cycle. Relative to pesticides evaluated in previous Biological Opinions, the a.i.s addressed in this Opinion are detected infrequently in freshwater habitats within the four western states where listed Pacific salmonids are distributed. This is expected given the fate properties of the a.i.s, especially the tendency to sorb to sediment. Concentrations in the water quality monitoring data generally correspond with the PRZM-EXAMS chronic EECS, but are not usually as high as the PRZM-EXAMS acute concentrations. Salmon are most likely exposed to a range of concentrations from the low end of the values in the water quality monitoring data to the high end values in the PRZM-EXAMS acute EECs. They may also occasionally experience higher concentrations such as those predicted by AgDrift modeling.

Table 87. Summary of Measured and Estimated Exposure Concentrations

Active Ingredient	**Landuse Class**	**Measured in Databases and Targeted Monitoring**		**Estimated**		
		Conc Range in Databases (µg/L)	Max Conc in Targeted Studies (µg/L)	BE Conc Range Acute (µg/L)	BE Conc Range Chronic (µg/L)	NMFS Floodplain Spray Drift Conc Range (µg/L)
Oryzalin	Agriculture	0.007 - 170	170	6.4 – 53 (crops) 33.5 – 94 (Christmas trees, rangeland)	2.6 – 16 (crops) 9.9 – 24 (Christmas trees, rangeland)	368 – 1,100 (G only)
	Developed			3.5 – 72 (not ROW) 142 (ROW)	1.2 – 21 (not ROW) 39 (ROW)	
Pendimethalin	Agriculture	0.0013 – 0.26	0.156	1.0 – 6.6 (G, orchard) 1.3 – 6.1 (G, not orchard) 11.1 – 11.8 (A, orchard) 4.1 - 12 (A, not orchard)	0.2 - 1.6(G, orchard) 0.14 – 1.9 (G, not orchard) 1.5 – 2.3 (A orchard) 0.5 - 2.9 (A, not orchard)	184 – 375[1] (G) 375[1] – 375[1] (A)
	Developed			1.7 – 3.0 (turf & ROW)	0.36 – 0.37 (turf & ROW)	184 – 375[1] (G) 375[1] – 375[1] (A)
Trifluralin	Agriculture	0.0003 – 0.5	0.600	0.04 – 1.5 (G) 2.3 – 5.8 (G, non-bearing 4 lb, 3 app) 5.14 - 5.65 (A)	0.01 - 0.24 (G) 0.39 – 0.73 (G, non-bearing 4 lb, 3 app) 0.17 - 0.87 (A)	92 - 300[1] (G) 239 –300[1] (A)
	Developed			0.0002 – 6.5	0.00005 – 0.87	92 -300[1] (G) 300[1] (paving)

[1] In cases where upper bound estimates exceed laboratory water solubility @25°C solubility is reported
Oryzalin cannot be applied aerially
Trifluralin must be incorporated or watered in
Incorporation or watering in is recommended for both pendimethalin and oryzalin, but not required
Developed uses include commercial landscape maintenance uses, homeowner uses and rights-of-way
None of the dinitroanilines are registered for forestry uses
Concentrations from monitoring databases do not distinguish between landuse classes
G – ground, A - aerial

Response Analysis

In this section, we identify and evaluate toxicity information for the stressors of the action and organize the information under assessment endpoints relating to both individual and habitat responses (Figure 65). The assessment endpoints are biological attributes that, when adversely affected, may reduce fitness of individual salmonids or degrade PCEs (*e.g.*, prey abundance, water quality, and suitability of habitat).

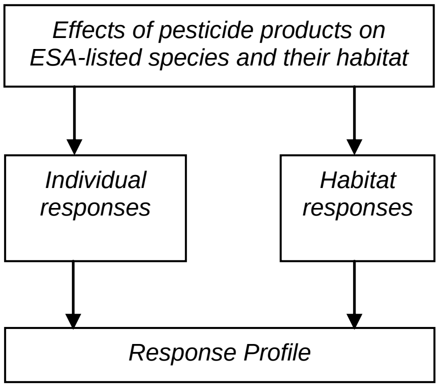

Figure 65. Response analysis.

We begin the response analysis by describing the toxic mode and mechanism of action of the a.i.s, then summarize information associated with relevant assessment endpoints. This portion of the analysis primarily addresses effects based on the a.i. alone. The registration of the a.i. is the federal action, and the a.i. is the chemical entity for which EPA requires toxicity data. In this section we do discuss information about other stressors of the action, if available. Although we cannot generally develop quantitative estimates for how these other stressors affect the toxicity of the a.i., we can do so qualitatively. Qualitative evaluations of other stressors of the action are discussed in *Risk Characterization*. Later, in *Integration and Synthesis,* we discuss how other environmental factors such as those discussed in the *Environmental Baseline*, interact with stressors of the action.

The information we evaluated is derived from published, peer-reviewed scientific journals, government agency reports (federal, state and local), theses and dissertations, books, information and data provided by the registrants identified as applicants, and independent reports. NMFS scientists evaluate the quality and applicability of all documents used, although unlike EPA, we do not develop formal data evaluation reports (DERs) for the sources we review. Typically, the most relevant study results are those which directly measure effects to an identified assessment endpoint and are derived from experiments with salmonids. Studies with listed Pacific salmonids or hatchery surrogates are preferable, but we present data from other fish species as well. Often, there is not a complete suite of information relating to effects on fish, especially for some of the sublethal endpoints. Where appropriate, we include information from studies on other taxa, recognizing and noting where there may be significant interspecies extrapolation. Likewise, we consider information from studies on chemicals that are structurally similar to the a.i.s addressed in this Opinion.

EPA's ecological risk assessments and BEs primarily summarize acute and chronic toxicity data from "standardized toxicity tests" submitted by pesticide registrants during the registration process, or tests from government laboratories available in EPA databases, or from published, peer-reviewed scientific publications (books and journals. Population-level endpoints and analyses were generally absent in the BEs, other than a few measurements of fish and aquatic invertebrate reproduction and adverse effects to organisms were not translated into consequences to populations. For Biological Opinions, NMFS evaluates the range of effects on individual salmonids to determine potential population-level consequences.

In the discussion of assessment endpoints for the specific a.i., we use a number of different terms to distinguish the types of studies. Under FIFRA, EPA requires pesticide applicants to submit standardized tudies based on specific published guidelines. These are referred to in our discussion as "guideline studies." Any test not conforming to these guidelines is a "non-guideline" test. EPA's Office of Research and Development (ORD) maintains a database called ECOTOX, which contains data from a wide range of publications. This database includes information on pesticides, but is not limited to pesticides, as EPA regulates many chemicals which do not have specific data requirements. Data in ECOTOX must meet certain criteria to be included, but does not have to come from a specific test protocol. OPP does not accept all data included in ECOTOX. Specific acceptance criteria are listed in the ECOTOX bibliographies in the BEs.

Survival Endpoints

Survival of individual fish is typically measured by incidences of death following 96 h exposures to the a.i. (acute test). Survival data may also include incidences of death following longer exposures (21 or more days, known as chronic tests) which are intended to evaluate effects on growth and reproductive endpoints. Tests are conducted on a subset of freshwater and marine fish species reared in laboratories under controlled conditions (temperature, pH, light, salinity, dissolved oxygen, *etc.,)* (EPA, 2004a). Lethality of the pesticide (a technical product or formulated product) is usually reported as the median lethal concentration (LC_{50}), the statistically-derived concentration sufficient to kill 50% of the test population. For aquatic invertebrates it may be reported as a median effective concentration (EC_{50}), because death of these organisms may be too difficult to confirm and immobilization is considered a terminal endpoint. An LC_{50} is derived from the number of surviving individuals at each concentration tested following a 96 h exposure and is estimated by probit or logit analysis and recently by statistical curve fitting techniques. In FIFRA guideline tests, LC_{50}s are typically calculated by probit analysis. If the data are not sufficient for a probit analysis, than either a moving average or binomial is used, resulting in no slope being reported. To maximize the utility of a given LC_{50} study, the slope of the dose-response curve, the variability around the LC_{50}, and a description of the experimental design, such as experimental concentrations tested, number of treatments and replicates used, solvent controls, *etc.*, should be reported. The slope of the observed dose-response relationship is particularly useful in estimating the magnitude of death at concentrations below or above an estimated LC_{50}. The variability around an LC_{50} is sometimes given by a 95% confidence interval (95% CI) or statement of standard deviation or standard error. These variability measures provide the degree of confidence associated with a given LC_{50} estimate. The smaller the range of uncertainty the higher the confidence in the estimate. Survival experiments are most useful when conducted with the most sensitive life stage of the listed species or a representative surrogate. In the case of ESA-listed Pacific salmonids, several surrogates are available for toxicity testing, including hatchery reared coho salmon, Chinook salmon, steelhead, and chum salmon, as well as rainbow trout[12]. Rainbow trout data are often available, as they are a preferred species in toxicological testing.

Toxicity data available for this consultation included some for salmonids. Unfortunately, slopes, estimates of variability for an LC_{50}, and experimental concentrations frequently were not reported. In our review of the salmonid BEs, we did not locate any reported slopes of dose-response curves, although some of this information was presented in some of the corresponding Science Chapters and the CRLF BEs. Death of individuals affects abundance, and may affect distribution of populations.

Growth Endpoints

Growth of individual organisms is an assessment endpoint derived from standard chronic fish and invertebrate toxicity tests summarized in the BEs. It is difficult to translate the significance of reduced growth derived from a guideline study on fish growth in aquatic ecosystems. The health of the fish, availability and abundance of prey items, and the ability of the fish to adequately feed are not assessed in standard chronic fish tests. These are important factors affecting the survival of wild fish. Typically, size or weight of fish is measured several times during an experiment. The test fish are usually fed twice daily, *ad libitum,* (*i.e.,* an over abundance of food is available to the fish). Therefore, any reductions in size are a result of fish being affected to such an extent that they are not feeding or are unable to metabolize food even when presented with an abundance of food. Subtle changes in feeding behaviors or availability of food would not be detected from these types of experiments. If growth is affected in these experiments, it is highly probable that growth of fish in natural aquatic systems would be severely affected. Reductions in juvenile growth may affect survival at sea and susceptibility to predation. Removal of the smaller juveniles from the population would affect abundance, and possibly distribution.

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[12] Rainbow trout and steelhead are the same genus species (*Oncorhynchus mykiss*), with the key differentiation that steelhead migrate to the ocean while rainbow trout remain in freshwaters. Rainbow trout are therefore good toxicological surrogates for freshwater life stages of steelhead, but are less useful as surrogates for life stages that use estuarine and ocean environments.

Reproduction Endpoints

Reproduction, at the scale of an individual, can be measured by the number of offspring per female (fecundity), and at the scale of a population by measuring the number of offspring per females in a population over multiple generations. The BEs summarized reproductive endpoints at the individual scale from chronic freshwater fish experiments where hatchability and larval-juvenile survival is measured. In biological opinions, NMFS also considers many other assessment measures of reproduction, including egg size, spawning success, sperm and egg viability, gonadal development, reproductive behaviors, and hormone levels, as these endpoints can have considerable effect on wild populations. Many of these endpoints are not measured in standardized toxicity assays used in pesticide registration, thus we often use data from other sources to evaluate these endpoints. Reproductive rate, along with abundance and distribution is a key determinant of species viability.

In order to have more data on sensitive lifestages such as the egg and embryo NMFS/OPR requested the NWFSC conduct toxicity tests on these lifestages. Zebrafish (*Danio rerio*) are commonly used in these types of tests because their early development is well documented and features are easily observable. Although not closely related to salmonids, the zebrafish was selected as the test organism due to the existing body of data available for this species. The testing report is included in the Opinion as *Appendix 6*. Fertilized eggs were exposed to the a.i.s for 5 days at concentrations ranging from 1 -10,000 μg/L. Percent survival was noted. Surviving fish were measured and scanned for developmental abnormalities. Results are reported in the discussions of specific a.i.s. Developmental abnormalities and/or smaller size can reduce the ability of the individual to forage, avoid predation, and in some cases, to reproduce normally. Survival of the embryos, size, and developmental abornormalities may affect abundance, distribution, or reproduction.

Sublethal Endpoints

Sometimes qualitative observations of sublethal effects are summarized from 96 h lethality dose-response bioassays in EPA's risk assessments. These observations generally were limited in the BEs and other dcouments, and when noted, pertained to impaired swimming behaviors such as disorientation, and resting on the bottom. None of these behaviors were rigorously measured and therefore are of limited value in assessing the effects of these pesticides on Pacific salmonids. We do, however, note a few of the observations when they pertained to a relevant assessment endpoint, such as impaired swimming. Some BEs presented toxicity information on degradates, metabolites, and formulations. Toxicity information on other or "inert" ingredients found in pesticide formulations was usually not presented.

Sublethal endpoints encompass a variety of physiological and biochemical measurements. NMFS is concerned about effects which reduce the ability of the fish to successfully complete its lifecycle and produce a subsequent generation (*i.e.,* a reduction in fitness). Types of sublethal effects expected and information regarding vary widely from chemical to chemical. Sometimes sublethal effects are not investigated for fish or aquatic invertebrates, but there may be information available regarding these effects for mammals. When appropriate, we extrapolate this information to salmon. Some sublethal endpoints may affect abundance or distribution, and others may affect reproduction.

Multi-species (Micro- and Mesocosm) Studies

Results from multiple species tests, called microcosm and mesocosm studies, were also discussed in the BEs to a varying degree. These types of experiments are likely closer approximations of potential ecosystem-level responses such as interactions among species (predator-prey dynamics), recovery of species, and indirect effects of pesticides on fish. However, the interpretation of results is complicated by how well the results represent natural aquatic ecosystems, and how well the studies apply to salmonid-specific assessment endpoints and risk hypotheses. These studies typically measure individual responses of aquatic organisms to contaminants in the presence of other species. Some studies are applicable to questions of trophic effects and invertebrate recovery, as well as providing pesticide fate information. The most useful mesocosm study results for this Opinion are those that directly pertain to identified assessment endpoints and risk hypotheses. We discuss study results in the context of salmonid prey responses, emphasizing the capacity of prey taxa to rebound following death of individuals as well as shifts in community structure. For herbicides, we also consider modifications in the plant communities in and around the waterbody. One of the notable limitations of most microand mesocosm studies is they do not typically represent real world aquatic ecosystems which are degraded from various stressors.

Potential effects of herbicides on salmonids and their critical habitats

Previous Opinions have addressed organophosphate and carbamate pesticides (Batch 1, Batch 3, and Batch 2, respectively), herbicides (Batch 4) and fugnicides (Batch 4). The a.i.s addressed in this Opinion, oryzalin, pendimethalin, and trifluralin, are all pre-emergent herbicides that primarily affect plant germination and emergence. Although they also have toxic effects on fish and other aquatic animals, a major concern in the evaluation of their effects on listed salmonids and designated critical habitat is if they alter the plant communities in and around salmon-bearing waters. In the Batch 4 opinion we reported generalized effects of herbicides on aquatic ecosystems based on an extensive literature survey (pg 454 – 467) (NMFS, 2011). We do not repeat that entire discussion herein, but present some of the key points from that survey in the following paragraphs.

Photosynthetic organisms are a critical component of aquatic communities. They serve as the primary producers (*i.e.*, the base energy source) and ultimately are one of the determinants of how much secondary production (*e.g.*, juvenile salmonids) a waterbody can support. Although there are a number of feedback loops between different trophic levels, and it may be difficult to link specific changes in plant communities to specifc changes in fish populations or community structure, it has been demonstrated that decreases or changes in do cause “bottom-up” shifts (Perry, Bradford, & Grout, 2003; Wallace, Eggert, Meyer, & Webster, 1999). Predicting the direction and extent of these shifts is difficult, and will vary from site to site. However, it has been well-established in ecological literature that they occur. Both in-stream plants and riparian vegetation can serve as energy sources for salmon-bearing waters. Use of herbicides near these waters could alter the abundance or community make-up of either or both. Several studies have shown declines in invertebrate communities following exposure of the system to herbicides (DeNoyelles, Kettle, & Sinn, 1982; Juttner, Peither, Lay, Kettrup, & Ormerod, 1995; Kasai & Hanazato, 1995). NMFS is unaware of any existing protocols or studies establishing a quantitative link between changes in primary productivity and fish production, thus we evaluate it on a qualitative basis.

In addition to an energy source, plants also provide an important structural component of aquatic communities. Submerged and emergent vegetation provide attachment points for photosynthetic organisms and aquatic invertebrates, refugia for juvenile fish, and stabilization of bed and bank sediment. Riparian vegetation also stabilizes stream banks, helps moderate temperature changes by shading, and reduces sediment, nutrient, and contaminant input by filtering runoff (Richardson, Taylor, Schluter, Pearson, & Hatfield, 2010).

Although herbicide-induced changes can vary widely from system to system, there are studies showing that generally algae are most sensitive to herbicides, followed by mcarophytes, then invertebrates and vertebrates (Van den Brink, Blake, Brock, & Maltby, 2006). However, for some herbicides, macrophytes may be more sensitive (Brock, Lahr, & Van den Brink, 2000; Van den Brink, et al., 2006). Microbial communities in both sediment and water may also be affected, changing the processing of organic matter (DeLorenzo, Lauth, Pennington, Scott, & Ross, 1999). Changes in the community metabolism may also affect water quality parameters such as dissolved oxygen and pH (Brock, et al., 2000; Pratt, Melendez, Barreiro, & Bowers, 1997).

In a review of herbicide effects, Brock et al. (2000) concluded indirect effects of herbicides on primary and secondary consumers occur at concentrations around the EC_{50}s from standard algae tests. These effects are likely due to reduced availability of food resources and sometimes are delayed relative to the exposure event. Other effects on the ecosystem (*e.g.* blooms of insensitive algae) can occur at lower concentrations (*e.g.*, 0.1 of algal EC_{50}s). Some studies published after the Brock et al. (2000) review note indirect effects at lower concentrations, but generally papers published since their review corroborate their findings.

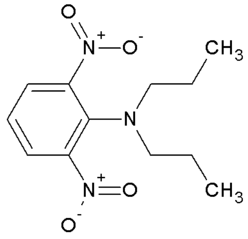
Oryzalin, Pendimethalin, and Trifluralin (Mitotic Disruptors)

Mode of Action

Oryzalin, pendimethalin and trifluralin are members of a class of herbicides known as dinitroanilines. Dinitroanilines disrupt mitosis by binding to the protein tubulin (Senseman, 2007; Vaughn & Lehnen, 1991). Tubulin is a subcomponent of the microtubules that form the spindle during mitosis (Lehninger, 1975). Chromosomes travel along the spindle to separate (Keeton, 1980), and the inability to move along the spindle stops mitosis in prometaphase (Vaughn & Lehnen, 1991). The tubulin protein consists of two subunits, α-tubulin and β-tubulin (Lehninger, 1975). Morissette, et. al (2004) found that dinitroanilines bind to the α-tubulin. There are slight differences between plant and animal cell mitosis (Keeton, 1980) and several sources note dinitroanilines do not disrupt mitosis in animal cells, although they do disrupt mitosis in protozoans as well as plants (Morrissette, et al., 2004; Vaughn & Lehnen, 1991). Dinitroanilines do not translocate in plants.

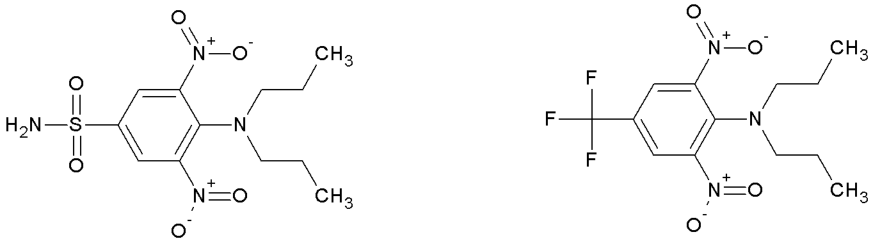
Dinitroaniline Structures

The basic structure for a dinitroaniline is the phenyl ring with an attached amino group ($-NH_2$) and two nitro ($-NO_2$) functional groups (Figure 66). One or both of the amino hydrogens may be substituted, as may the three other positions on the phenyl ring. Both oryzalin and trifluralin have two propyl groups ($-CH_2CH_2CH_3$). However, they differ markedly in the sidechain structure (Figure 67), which affects their relative toxicity. Oryzalin has a sulfonamide ($-SO_2NH_2$) group, and trifluralin has a methyl trifluralin group ($-CF_3$). Pendimethalin differs from oryzalin and trifluralin because rather than two 3-carbon (propyl-) groups on the aniline nitrogen, it instead has one branched 5-carbon (isoheptane-) group. The sidechain is a methyl group ($-CH_3$). These differences affect both toxicity and fate properties.



Dinitroaniline

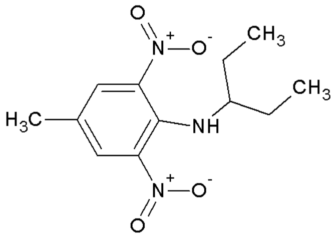
Figure 66. Common dinitroaniline structure for oryzalin and trifluralin



Oryzalin

Trifluralin

Figure 67. Structures of oryzalin and trifluralin



Pendimethalin

Figure 68. Structure of pendimethalin

Temperature and toxicity

Macek et al (1969) reported 24 h and 96 h LC_{50} data for 10 different pesticides tested on bluegill and rainbow trout across a range of temperatures. One of the pesticides tested was trifluralin. Although this data was acceptable for the ECOTOX database, it was rejected by OPP due to lack of control reporting ((EPA, 2009b), Appendix H). Macek was a researcher at the Fish Pesticide Research Laboratory, U.S. Bureau of Sport Fisheries and Wildlife, and methods reported are similar to current guideline tests. They report using controls, although they do not report control survival. Concentrations reported are nominal rather than measured. Given trifluralin's tendency to sorb, effective concentrations may be overestimated, especially in the 96 h tests. The results for the highest temperature tested for both species are most comparable to current guideline test conditions. For bluegill, the recommended test temperature is 22 ± 2.0° C, and for rainbow trout, the recommended test temperature is 12 ± 2.0° C (EPA, 2009b). Macek did not report any data for tests conducted at temperatures higher than optimum for fish, which tend to be more stressful than temperatures lower than optimum. Macek et al (1969) noted that generally both species were more susceptible to all pesticides as the temperature increased. This was the case for trifluralin, which showed a 3.2 X– 5.0 X increase in susceptibility across the temperature range tested for both species and both time periods. We cannot predict precisely how that trend will continue at temperatures higher than the ones tested, but we do believe LC_{50} values determined at standard test temperatures may underestimate toxicity at higher temperatures fish may encounter in the environment. We believe it is reasonable to apply this assumption to all of the dinitroanilines.

The 96 h LC_{50} values are consistently lower than the 24 h LC_{50} values for both species at all temperatures tested. Thus, it appears there is some time-to-effect for the acute response.

Table 88. Trifluralin temperature and time-to-effect data (Macek, et al., 1969)

Species	Exposure time	LC_{50} at 12.7°C (95% CI) µg/L	LC_{50} at 18.3°C (95% CI) µg/L	LC_{50} at 23.8°C (95% CI) µg/L
Bluegill *Lepomis macrochirus*	24 h	540 (460-640)	360 (300-430)	130 (110-150)
	96 h	190 (160-230)	120 (100-140)	47 (40-55)
		LC_{50} at 1.6°C (95% CI) µg/L	LC_{50} at 7.2°C (95% CI) µg/L	LC_{50} at 12.7°C (95% CI) µg/L
Rainbow trout *Onchorhyncus mykiss*	24 h	318[a] (270-375)	239 (196-267)	98 (85-113)
	96 h	210 (182-240)	152 (132-175)	42 (38-46)

[a] Shown as 3.8 in original table, however we believe that to be a typographical error, and calculated the value based the relative increase in susceptibility factors provided by author

We also note higher water temperatures can affect salmonids in two ways, regardless of specific chemical effects. Higher water temperatures will increase the metabolic rate for fish, thus increasing the rate at which they process the toxicant. Depending on the chemical, this may be either beneficial or detrimental. Additionally, water temperatures higher than optimum increase general physiological stress for salmonids, making them more susceptible to other stressors.

pH and toxicity

We located no information indicating pH specifically affects the toxicity of dintroanilines.

Toxicity of Oryzalin, Pendimethalin, and Trifluralin (Assessment Endpoints)

Information contained in this section comes from a several sources. Much is from EPA documents, including EPA's Pacific salmonid BEs, EPA's California Red-Legged Frog (RLF) BEs (some of which include other San Francisco Bay area species, such as delta smelt), EPA's

California Tiger Salamander (CTS) BEs, REDs, IREDs, and EFED science chapters. When information is taken from EPA documents, we reference the document by name and date, appendix location if not in the main body of the document, and original source when available. Original sources are cited as they were presented in the document, and sometimes are MRID numbers, sometimes ECOTOX numbers, and sometimes author-date references. We rely heavily on the more recent EPA BEs addressing the California species as they include a more comprehensive survey of toxicological literature, both in terms of compiled assessment endpoints (Ecological Effects appendices, Accepted ECOTOX data tables), and a bibliography of papers associated with the chemical that may or may not have met EPA's screening criteria. We have not included EPA's toxicity and/or literature appendices in this Opinion but they may be accessed at http://www.epa.gov/oppfead1/endanger/litstatus/effects/redleg-frog/index.html.

We discuss open literature information which we believe to be of good quality and relevant to the analysis. Comparisons between our use of references and EPA's use of references are shown in Table 93 (oryazlin) and Table 96 (trifluralin). We located little additional toxicity information for pendimethalin in the open literature. BASF submitted four studies addressing how pendimethalin affects aquatic biota in water-sediment systems (K. P. Ebke et al., 2001; P. Ebke et al., 2001; Egeler, 2001; Schafer, Kloppel, Mitchell, & Horton, 2001) These are discussed in the section on mesocosm studies.

Direct Effects to Salmonids

Survival

For all three chemicals, survival is evaluated primarily based on standardized tests used to determine the LC_{50} of a population of test fish exposed the chemical for 96 hours. These tests are conducted in a water-only solution. Some data are available for shorter or longer time durations, but this is not consistent across chemicals. We present the 96 h data.

Oryzalin

In EPA's BE for the California tiger salamander they report 96 h LC_{50}s from two tests for rainbow trout (3,260 μg/L and 3,450 μg/L) and bluegill (2,880 μg/L). On a qualitative scale, oryzalin is moderately toxic to fish (Kamrin, 1997).

Pendimethalin

In EPA's BE for the California red-legged frog they report 96 h LC_{50}s from guideline tests for rainbow trout (138 μg/L), bluegill (199 μg/L), and channel catfish (418 μg/L), using the technical grade a.i. (TGAI). They also report the 96 h LC_{50}s of three different formulations for rainbow trout and bluegill. The three formulations, designated as 3-E, 2-S, and 45% a.i., are generally less toxic to the fish on an acute basis. 96 h LC_{50} ranges are 1,000 - 1,040 μg/L, 866 – 904 μg/L, and 520 – 920 μg/L, respectively. On a qualitative scale, pendimethalin is highly toxic to fish on an acute basis (Kamrin, 1997). Available data indicate tested formulations are not more toxic to fish than the TGAI on an acute basis. However, we note the available formulation testing provides no insight into non-lethal effects potentially associated with other ingredients. Available data indicate estuarine species tested are slightly less sensitive to pendimethalin than all freshwater species tested.

Trifluralin

In EPA's BE for the California red-legged frog they report 96 h LC_{50}s from guideline tests for rainbow trout (43.6 μg/L) and bluegill (18.5 μg/L), noting concentrations are nominal and may overestimate effective concentrations due to trifluralin's tendency to sorb (EPA, 2009b). On a qualitative scale, trifluralin is very highly toxic to fish (Kamrin, 1997). Several other 96 hLC_{50} endpoints are reported in the appendix of ECOTOX data accepted by OPP, but do not appear to have been reviewed by EPA or incorporated into the assessment (

Table 90). One of those values is from a test conducted by the EPA Gulf Breeze Laboratory on sheepshead minnow, which reports a mean-measured 96 h LC_{50} of 190 μg/L(Parrish, Dyar, Enos, & Wilson, 1978). Parrish et al (1978) also conducted a full-life cycle test discussed in the chronic endpoints section. Minnows used in the acute test were wild-caught, and were of 1-1.5 cm in length at beginning of the test. We are uncertain specifically what age that represents. Concentrations of trifluralin were measured in both the acute test and chronic test. Percent recoveries of trifluralin ranged from 100 – 140% in water samples, indicating their analytical method worked well. However, mean-measured concentrations of trifluralin were 47 – 56 % of nominal during the acute test, indicating the trifluralin was sorbing to the test apparatus, breaking down, or being bioconcentrated by the fish during the test. The acute test was continued for 21 d to determine an "incipient LC_{50}". An incipient LC is "the calculated concentration below which 50% of the individuals would live indefinitely relative to the lethal effects of the toxicant (Newman, 1994). Authors estimated incipient LC_{50} of 84 μg/L after 10 days of exposure.

Mansour and Mohsen (1985) reported much higher LC_{50}s for the common carp and bunni fish (660 μg/L and 250μg/L, respectively). Common carp tend to be among the species more tolerant to various contaminants. We are not aware of other tests conducted on bunni fish.

Table 89. Acute toxicity of dinitroanilines to fish

Species		96-h LC_{50} Concentration (μg/L)	Source
Oryazalin			
Rainbow trout	*Oncorhynchus mykiss*	3,450	EPA CTS 2010 Appendix A TN 1078
Rainbow trout	*Oncorhynchus mykiss*	3,260	EPA CTS 2010 Appendix A MRID 00072595
Bluegill	*Lepomis macrochirus*	2,880	
Pendimethalin			
Rainbow trout	*Oncorhynchus mykiss*	199	EPA RLF 2009 Appendix A MRID 00037927 Bentley 1974
Bluegill	*Lepomis macrochirus*	138	
Channel catfish	*Ictalarus punctatus*	418	

Species		96-h LC$_{50}$ Concentration (µg/L)	Source
Trifluralin			
Rainbow trout	*Oncorhynchus mykiss*	43.6	EPA RLF 2009 Appendix F Mayer and Ellersieck 1986
Bluegill sunfish	*Lepomis macrochirus*	18.5	

Table 90. Acute fish toxicity data from open literature

Study	Species	Age	Exposure duration	No mortality (µg/L)	LC$_{50}$ (µg/L)
Oryzalin					
No additional data located					
Pendimethalin					
No additional data located					
Trifluralin					
Koyama 1996	Herring *Clupea pallasi*	"Larval fish", ranging in size 1.9 – 5.7 cm in length, and 0.20 – 3.15 g in weight, depending on species	96 h	<5	<5
	Yellowtail *Seriola quinqueradiata*			<5	<5
	Red sea bream (large) *Pagrus major*			6	21
	Red sea bream (medium) *Pagrus major*			<8	22
	Grunt *Parapristipoma trilineatum*			11	33
	Red sea bream (small) *Pagrus major*			13	26
	Mullet *Mugil cephalus*			16	32
	Black sea bream *Acanthopagrus shlegeli*			24	>56
	Japanese flounder *Paralichthys olivaceus*			30	56
	Longchin goby *Chasmichthys dolichognathus*			42	120
	Girella *Girella punctata*			61	110
Macek et al 1969	Bluegill *Lepomis macrochirus*	Larval fish 0.6 – 1.5 g	96 hr	NT	42
	Rainbo trout *Onchorhyncus mykiss*			NT	47
Mansour & Mohsen 1985	Common carp *Cyprinus carpio*	Not yet reviewed (9/7/11)	96 h	NT	660
	Bunni fish *Barbus sharpeyi*	Not yet reviewed (9/7/11)	96 h	NT	250
Parrish et al 1978	Sheepshead minnow *Cyprinodon varigatus*	Not reported 1-1.5 cm in length	96 h	NT	190

NT Not an endpoint determined in this study

Reproduction and Growth

Reproduction and growth are addressed by several endpoints measured in typical guideline studies. These include length and weight (growth endpoints), and measurements such as reduced survival of young, lower number of eggs or young produced, or smaller size of young (reproduction endpoints). Typically, the values are reported as a Lowest Observable Adverse Effect Concentration (LOAEC) and a No Observable Adverse Effect Concentration (NOAEC). These concentrations are approximate, and do not represent a definitive point where damage to the organism occurs. Test concentrations are typically a geometric series of concentrations and may span an order of magnitude.

Oryzalin

EPA ((EPA, 2010b), Appendix A) reported two chronic studies on fish, one conducted on rainbow trout, and one conducted on fathead minnow. No adverse effects were noted for the rainbow trout, and the NOAEC and LOAEC are both >460 μg/L. For the fathead minnow, the most sensitive endpoint was mean larval weights. The NOAEC established in this test was 220 μg/L, and the LOAEC was 430 μg/L. We located no other toxicity tests reporting effects on reproduction or growth in the open literature.

In support of this opinion, NWFSC conducted toxicity tests on zebrafish (*Danio rerio*) embryos exposed to oryzalin at concentrations of 3, 30 , 300, and 3,000 μg/L. Results were generally consistent with available data. Effects did not occur in a dose dependent-manner. Average length was statistically significantly affected at an oryzalin concentration of 3,000 μg/L (NWFSC, 2011).

Pendimethalin

The EPA RLF BE ((EPA, 2009a), Appendix A) reports one fish full life cycle test, conducted with TGAI. The NOAEC established in this test was 6.3 μg/L, and the LOAEC was 9.8 μg/L, based on reductions in egg production. Reduced hatchability of young was observed at test concentrations of 22 μg/L and 43 μg/L. No other chronic fish tests were reported by EPA, and we located none in the open literature.

In support of this opinion, NOAA's Northwest Fisheries Science Center (NWFSC) conducted toxicity tests on zebrafish (*Danio rerio*) embryos exposed to pendimethalin at concentrations of 0.15, 1.5, 15, and 150 μg/L. Results were generally consistent with available data. Percentage abnormalities were <10% in the 0.15, 1.5 , and15 μg/L test concentrations, and 100% at the 150 µg/L concentration. Abnormal embryos exhibited lethargy and difficulty swimming. Length was also significantly affected at 150 µg/L (NWFSC, 2011).

Trifluralin

Parrish et al (1978) conducted a full-life cycle test on sheepshead minnows, using embryo hatched from wild-caught minnows. Concentrations of trifluralin were measured during the test test. Percent recoveries of trifluralin ranged from 100 – 140% in water samples, indicating their analytical method worked well. However, mean-measured concentrations of trifluralin were 21 – 38 % of nominal during the chronic test, indicating the trifluralin was sorbing to the test apparatus, breaking down, or being bioconcentrated by the fish during the test. Exposure to trifluralin affected a number of the endpoints. The most sensitive endpoints was number of eggs spawned , which was reduced at 4.8 µg/L. At 9.6 µg/L, hatching success of juveniles was decreased and length of parental fish was reduced. Decreases in hatching success became more pronounced with longer exposure time. In the 4.8 µg/L and 9.6 µg/L treatments, fish had "darkened coloration in the caudal penduncle area". At 17.7 µg/L, a number of sublethal effects occurred, including loss of equilibirum, sluggishness, and darkened areas. Growth measurements showed that fish length was reduced, but weight was not. "On day 37 fish in the 17.7 µg/L were noticeably 'fatter' than control fish." We believe this to be due to the vertebral deformities, although the author does not report it as such.

In support of this opinion, NOAA's Northwest Fisheries Science Center (NWFSC) conducted toxicity tests on zebrafish (*Danio rerio*) embryos exposed to trifluralin at concentrations of 0.05, 0.5 , 5, and 50 µg/L. Results were generally consistent with available data. At 50 µg/L. average length of the larval fish was statistically significantly reduced, and 95.3% of fish were classified as abnormal. Lethargy was the most common abnormality. No observations of vertebral deformities were reported (NWFSC, 2011).

Table 91. Chronic toxicity data for fish.

Species		NOAEC LOAEC (µg/L)	Endpoint Affected	Source
		Oryzalin		
Rainbow trout	*Oncorhyncus mykiss*	>460 >460	No adverse effects	EPA CTS 2010 Appendix A MRID 00126842
Fathead minnow	*Pimephales promelas*	220 430	Mean larval weights	EPA CTS 2010 Appendix A MRID 00126841
Zebrafish	*Danio rerio*	300 3,000	Shorter embryos	NWFSC 2011
		Pendimethalin		
Fathead minnow	*Pimephales promelas*	6.3 9.8	Reduction in egg production	EPA RLF 2009 Appendix A MRID 00037940 EG&G Bionomics 1975
Zebrafish	*Danio rerio*	15 150	Higher rate of abnormality Decreased length	NWFSC 2011
		Trifluralin		
Rainbow trout	*Oncorhyncus mykiss*	2.2 4.2	Larval fish length and body weight	EPA RLF 2009 Appendix F MRID 41386202
Fathead minnow	*Pimephales promelas*	1.9 5.1	Survival	EPA RLF 2009 Appendix F Macek 1976
Sheepshead minnow	*Cyprinodon variagatus*	1.3 4.8	Reduction in fecundity of parental fish	Parrish et al 1978
Fathead minnow	*Pimephales promelas*	15.2 48.6	*Sediment/water exposure* Survival, length	Hoberg 2006
Zebrafish	*Danio rerio*	5 50	Higher rate of abnormality Decreased length	NWFSC 2011

Swimming

NMFS has evaluated effects on swimming for a number of other a.i.s known to inhibit cholinesterase or cause narcotic effects. For oryzalin, pendimethalin, and trifluralin, we have located no information indicating swimming might be impaired at concentrations other than those approaching mortality (LC_{50}) endpoints. Based on known mode of action in fish, we do not believe swimming will be one of the more sensitive endpoints, but cannot discount potential for effects at concentrations slightly lower than the LC_{50}. Vertebral deformities produced by exposure to trifluralin (discussed later), may affect swimming.

Olfaction

To our knowledge, oryzalin, pendimethalin, and trifluralin have not been tested to determine if they affect the olfactory system of salmonids or other fishes.

Endocrine Disruption - Oryzalin

In 2009, EPA published a final list of chemicals to be evaluated for endocrine disruption noting (77 FR 17579). Oryzalin was not on that list, but trifluralin and another dintiroaniline pesticide, benfluralin, were. EPA's Federal Register notice includes the following caveat: "Because this list of chemical was selected on the basis of exposure potential only, it should neither be construed as a list of known or likely endocrine disruptors nor characterized as such."

We located no information in EPA documents or open literature to indicate trifluralin has endocrine disrupting properties. However, there were two papers in open literature evaluating oryzalin and a common commercial formulation of oryzalin, Surflan™ (Hall, Okihiro, Johnson, & Teh, 2007; Hall, Rogers, Denison, & Johnson, 2005). Hall et al 2005 was not reviewed by EPA, as it was rejected for having no endpoints relevant to the assessment. Hall et al 2007 was reviewed by EPA as a potential source of chronic endpoints, but rejected due to high variability in the response of the treatment groups. Neither paper was discussed in the context of endocrine disruption. We note these two papers from the same lab group are the only substantive information we located on endocrine disruption by oryzalin.

Hall et al 2005 evaluated the affinity of oryzalin and Surflan™ for endocrine receptors (ERs) with *in vitro* tests, and their ability to induce two types of egg protein production (vitellogenin (Vg) and choriogenin (Cg) in male fish with *in vivo* tests. Authors do not specify why oryzalin was singled out for investigations, other than noting an association with thyroid tumors and a lack of information available regarding estrogenic effects. Two assays were used to examine effects at a cellular level. Positive and negative controls (17-β estradiol and dimethyl sulfoxide (DMSO)) were used to ensure assays provided accurate indication of response. Oryzalin and

Surflan™ both induced a response in test for ligand binding to the ER-receptor. A concentration of 0.5 µg/L oryzalin induced a 4% response compared to positive control, and a concentration of 5.0 µg/L oryzalin induced a 35% response compared to positive control. Both were statistically significant. Oryzalin competitively displaced 17-β estradiol at the estrogen receptor by 35% at a concentration of 0.346 µg/L (reported as 100 µM). Surflan™ induced a response in the ligand-binding assay but not the competitive displacement assay. *In vitro* tests with male Japanese medaka (*Oryzias latipes*) measured production of vitellogenin and choriogenin in the liver. Fish were exposed to dissolved concentrations of oryzalin for 3 days, and for 16 days in a second test. Nominal test concentrations were 3,300 µg/L, 2,200 µg/L, and 1,500 µg/L for oryzalin, and dilutions of Surflan™ apparently intended to provide similar concentrations of active ingredient (2.5, 1.3 and 0.67 µl/L). At the highest concentrations (3,300 µg/L a.i and 2.5 µl/L formulation) induction of Cg but not Vg occurred in both the 3 d and 16 d tests. Authors do not indicate if Cg production was statistically significant or if there was any type of dose-response relationship. We note the test concentration (3,300 µg/L) producing the response is within the range of LC_{50}s determined by guideline tests (2,880 – 3,450 µg/L).

Hall et al 2007 evaluated the potential endrocrine disruption effects by exposing the medaka to both oryzalin and Surflan™ for 21 d. Nominal exposure concentrations were 1,000 µg/L, 500 µg/L, and 250 µg/L oryzalin, and 3.8 µl/L, 2.0 µl/L, and 1.0 µl/L Surflan™. Fish were exposed for the 21 d period, then placed into clean water, and provided with an untreated mate. Authors tracked total daily egg production, number of non-fertilized eggs produced, and time-to-hatch. The study differs markedly from chronic guideline tests in terms of both the exposure protocol and the endpoints evaluated. Both EPA (http://www.epa.gov/endo/pubs/assayvalidation/status.html) and OECD (http://www.oecd.org/document/62/0,2340,en_2649_34377_2348606_1_1_1_1,00.html) are still evaluating test protocols for endocrine disruption in fish. Hall et al 2007 does not appear to resemble test protocols under evaluation by either of these organizations. We located no other similar tests, thus we have no larger context in which to evaluate the results. Authors concluded that some concentrations of oryzalin (250 µg/L and 500 µg/L) and Surflan™ (3.8 µl/L, and 2.0 µl/L) "adversely affected reproductive outcomes" (Hall et al 2007). EPA evaluated the study as a source of reproductive endpoints, and declared it invalid due to high control variability ((EPA, 2010b), Appendix A.) We do not find their data on egg production to be compelling evidence of endocrine disruptive effects. However, we do note effects observed occurred in the same range of concentrations noted in the chronic guideline tests on fathead minnow (NOAEC 220 μg/L, LOAEC 430 μg/L).

In addition to evaluating effects on egg production, authors also performed a histological examination on the gonads of both the male and female fish (testes and overies, respectively). They did note an increase in intersex lesions as compared to controls in both the oryzalin-treated fish, and the Surflan™ treated fish. Effects did not occur in a dose-dependent fashion. Dose-dependency may or may not be a relevant criteria for endocrine effects as they are heavily controlled by biological feedback mechanisms. When all concentration levels of the treated groups are compared to the controls, as authors do in Tables 6 & 7, there is clearly a difference in the amount of lesions. Authors describe the "biological significance of intersex lesions" as "unclear" and state "it is not known whether intersex lesions with a testis affect fertility" (Hall, et al., 2007).

Based on this body of work, NMFS's overall conclusion is that oryzalin may have some endocrine system effects, as binding to the ER-ligand does occur, and Cg is produced. However, the significance of those effects at an organismal level and in an ecological context is highly uncertain. Effects described by authors occur at exposure concentrations associated with more commonly used assessment endpoints, and we believe using data from those endpoints will be adequately protective for endpoints evaluated in these two studies.

Table 92. Endocrine disruption endpoints for oryzalin from open literature

Study reference	Species	Endpoint affected	Concentration μg/L
Hall et al 2005	Japanese medaka *(Oryzias latipes)*	Induction of choriogenin (Cg) in male fish during whole fish exposure	3,300
Hall et al 2007	Japanese medaka *(Oryzias latipes)*	Increase in intersex lesions in male fish during whole fish exposure, non-dose response pattern	250 – 1,000

Table 93 Nonguideline literature reviewed for oryzalin

Study reference	EPA Classification and Use	NMFS Use in this Opinion
Hall et al 2005	Acceptable for ECOTOX but not OPP Rejection code: No endpoint (EPA CTF 2010, Appendix H) Potential endocrine disruption effects not evaluated.	Evaluation of potential for endocrine disruption
Hall et al 2007	Acceptable for ECOTOX and OPP Reviewed by OPP, rejected as invalid (EPA CTF 2010, Appendix H) OPP review considered usefulness of data as chronic endpoints. Endpoints rejected due to high variability in the treatment groups. Potential endocrine disruption effects not evaluated.	Evaluation of potential for endocrine disruption

Vertebral Deformities - Trifluralin

There is a body of literature showing fish exposed to trifluralin develop vertebral deformities (Couch, 1984; Couch, Winstead, Hansen, & Goodman, 1979; Hoberg, 2006; Koyama, 1996; Wells & Cowan, 1982). These effects have been observed by several different research groups for a number of different fish species, including salmonids (Wells & Cowan, 1982). One study evaluating this effect was provided to NMFS by an applicant (Hoberg, 2006); Dow AgroSciences) in support of this consultation. The effect has been observed in a wild fish population, although the exposure was attributed to an accidental discharge directly into the water rather than runoff from agricultural or other applications (Wells & Cowan, 1982).

In the most recent endangered species BE produced by EPA (EPA, 2009b) some of the information on vertebral deformities available in the open literature was reviewed; others were not. Of those studies reviewed, some were considered acceptable as qualitative or quantitative endpoints. Table 96 lists the studies we have considered in this response section, along with their acceptability classification from EPA's ECOTOX screen.

Vertebral deformities associated with exposure to trifluralin appear to have been first reported by J.A. Couch, a researcher at EPA's Gulfbreeze Environmental Research Laboratory (Couch, et al., 1979). In a laboratory test, he exposed larval sheepshead minnows (*Cyprinodon varigatus*) to concentrations of 1.2 μg/L to 31 μg/L of trifluralin for 28 days. Exposure began at the zygote stage. The paper does not note whether the trifluralin was technical grade or a formulation. Test concentrations were measured, and concentrations reported are mean measured concentrations. Vertebral deformities were not noted at 2.7 μg/L. Fish exposed to concentrations of ≥ 5.5 μg/L of trifluralin exhibited vertebral deformities. Based on data presented, it is unclear if the effect is dose-dependent. Authors described these deformities as dysplasia, a maturation abnormality of the cells, noting they were characterized by hyperostosis, an excessive growth of bone. Fish were evaluated both radiologically and histologically. Vertebral walls in affected fish were thickened, ranging from 18 – 75 μm thick, compared to vertebral walls of 5 – 6 μm in control fish. "Pathological effects of the dysplasia included: (1) dorsal outgrowth of vertebrae into the neural canal, thus compressing the spinal cord, (2) ventral outgrowth of the vertebrae, thus compressing the mesonephric ducts draining the kidneys, and (3) fusion of vertebrae, resulting in apparent loss of somatic flexibility."

Authors postulated the dysplasia was associated with fluorosis (Couch, et al., 1979). Presuming they are correct, the toxic moiety associated with the vertebral deformities is the $–CF_3$ sidechain of trifluralin rather than the dinitroaniline. In a second test reported in the paper, adult sheepshead minnow were exposed to 16.6 μg/L trifluralin for 4 days and serum calcium concentrations were measured to investigate the possibility of fluorosis, which is associated with elevated calcium concentrations. Serum calcium concentrations were compared to control fish, feral fish, and fish exposed to Kepone, which also causes scoliosis but not via fluorosis. Serum calcium concentrations in the trifluralin exposed fish (27.4 mg/dl) were nearly double the concentrations measured in the other 3 groups of fish (15.7 mg/dl, 15.0 mg/dl, and 14.8 mg/dl, respectively.) Authors do not positively conclude fluorosis is the cause of the deformities. However, they do note the potential effects of hypertrophy of the vertebrae. "Such effects on fish in nature would reduce their individual survival potential, particularly in regard to escape from predators and in competition for prey. Reproductive behavior (courtship, etc.) would probably be inhibited in dysplastic individuals." Fish depurated for 41 days following exposure showed no further increase in vertebral deformities during the depuration period.

Couch later conducted an experiment in which sheepshead minnows were exposed to 1-5 µg/L[13] trifluralin for 19 months (Couch, 1984). He used two different age groups of fish in the exposure. One group was exposed from zygote to 19 months, and another group was exposed from 30 days of age to 19 months. A control group was maintained from zygote to 19 months. Each group consisted of 20 fish. Author measured changes in pituitary gland of the exposed fish and assessed vertebral changes radiologically and histologically. No changes were noted in the control group. Pituitary glands in exposed fish were significantly enlarged, and in many fish contained fluid-filled pseudocysts. Congestion and dilation of the blood vessels in the pituitary was also noted. Author postulates the changes in the pituitary may be associated with a calcium imbalance caused by the fluorine atoms in trifluralin affecting the pitiutiary directly, or indirectly via other endocrine glands. NOAEC and LOAEC for pituitary effects were not determined in this study. Vertebral deformities were noted in 17 of the fish exposed from the zygote stage, and 18 of the fish exposed from the age of 30 days, indicating the effects are not confined to early developmental stages. There were both enlarged pituitaries and histopathological changes 10 of the fish exposed from the zygote stage, and 11 of the fish exposed from the age of 30 days, suggesting the histopathological changes in the vertebrae may be a more sensitive indicator than the pituitary enlargement. Fish with dysplasia exhibited observable body thickening.

Wells and Cowan (1982) report a fish mortality incident on the Eden Water, Scotland, in 1974. The incident was attributed to an accidental discharge of trifluralin into the stream. A year later, brown trout (*Salmo trutta*) captured from the Eden Water exhibited visible spinal irregularities. Subsequent X-rays taken in the Tweed River Purification Board (TRPB) laboratory confirmed vertebral deformities. “The dominant features of this deformity were a hypertrophy of the vertebrae, in particular the centrum, and a fusion of the vertebrae with in some cases, a complete collapse of the notochordal tissue. In other parts, particularly in the caudal region, there was a separation of the vertebrae. However, the overall effect was a compression of the vertebral column, which in some cases resulted in scoliosis.” The effect appears to have persisted over time, as in a sample of 16 fish taken from the affected waters in 1976, six (38%) exhibited

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[13] One table reports concentrations as 1-5 mg/L, but another table and abstract report concentrations as 1-5 µg/L. Based on previous work by Couch and the reporting of 1-5 µg/L in the abstract, we believe the table listing concentrations as 1-5 mg/L is a typographical error.

significant vertebral deformities, and another two (13%) exhibited slight damage. Of the sixteen fish sampled from a nearby catchment (Blackadder Water) not contaminated by trifluralin, none had any spinal deformities. Wells and Cowan (1982) do not report a water concentration for the trifluralin incident. We note the etiology matches that seen by Couch (Couch, 1984; Couch, et al., 1979) for trifluralin exposure.

To investigate the spinal irregularities observed in the Eden Water fish, Wells and Cowan (1982) performed two laboratory experiments with Atlantic salmon (*Salmo salar*) parr. Trifluralin concentrations were selected "to simulate a high concentration-short duration exposure at a dose rate which was compatible with long-term survival, but which was likely to cause skeletal deformation." Treflan EC was used in the experiments, rather than technical grade trifluralin. In one experiment, they exposed salmon parr to three concentrations of trifluralin (500 μg/L, 250 μg/L, and 10 μg/L; nominal; 560 μg/L, 160 μg/L, and 7.6 μg/L; measured) for 16 hours. Five fish were tested at each concentration. After 10 days, fish were killed, X-rayed, and analyzed for trifluralin residues. Fish exposed to 560 μg/L and 160 μg/L trifluralin showed clear vertebral damage, both visually and on the X-ray. These fish also exhibited loss of equilibrium and remained at the bottom of the tank during the dosing period. Fish exposed to 7.6 μg/L of trifluralin appeared normal visually and on the X-ray. Due to the size of the fish (~53 mm) and resolution of the X-ray authors were unable to distinguish the details of the vertebral damage, but were able to distinguish gross effects, which they described with a Shape Factor (SF). The SF was the "ratio of the [vertebral] column length (L, from the atlas to urostyle vertebrae) and the depth (D) of the fish of the fish (from the anterior end of the dorsal fin to the lower edge of the vertebral column). The SF for fish exposed to 560 μg/L and 160 μg/L was significantly different from the controls.

In a second experiment, 100 fish were exposed to 500 μg/L trifluralin (nominal, no measured value given) for 11 hours, then raised for 12 months. Nine of the exposed fish died within the month after dosing, and 2 more died the following month. During this time there were no mortalities in the control group. Concentrations of trifluralin in fish were measured periodically, Authors calculated a first order rate constant (k) of 0.017 day^{-1} for depuration, and a half-life of

40.5 days. Ten fish were killed, X-rayed, and analyzed for trifluralin residue following exposure, than again one month, three months, and 12 months later. X-rays showed vertebral damage occurred soon after dosing, at a point the authors describe as “when the concentration in the fish tissue was at a maximum.” Authors also note “there was no apparent increase in the degree of damage after the first month following dosage.” Exposed fish changed shape, shifting from a fusiform outline to more compact, humpbacked shape. This shift is reflected in the SF, which was 6.53 for the exposed fish, and 7.90 for the control fish. Median length of the control fish changed little between late October when the fish were exposed and late November, but median length of the exposed fish actually decreased from 54 mm to 41 mm (after correcting for fish that were killed or died). Authors describe this as “trifluralin, rather than merely stunting growth, actually induced a contraction of the vertebral column.” The found 64% of the vertebrae were fused in fish killed and analyzed a year following the experimental exposure. The majority of the fusion occurred in the abdominal vertebrae. Patterns of vertebral fusion in the experimental fish were similar to those seen in the brown trout from the incident river.

Koyama, a scientist at the National Research Institute of Fisheries in Japan, evaluated trifluralin-caused vertebral deformities in ten species of marine fishes (Koyama, 1996). Fish were exposed for 96 hours in filtered sea water. Trifluralin concentrations were measured four times during the test period, and concentrations given are mean-measured values. Deformities noted in trifluralin exposed fish were described as fractures or dislocations, and appeared to occur with greater frequency in fish with < 27 vertebrae than in fish with >30 vertebrae. He determined a No Observable Deformity Concentration (NODC, correlative to an NOAEC) and a Lowest Observable Deformity Concentration (LODC, correlative to an LOAEC). NOAECs and LOAECs for the species tested are shown in Table 94. Koyama (1996) also established LC_{50}s and “no mortality concentrations” for the fish species tested. LC_{50}s and “no mortality concentrations are presented in the section on survival. He calculated two types of deformity rates; one for deformities occurring at concentrations below the no mortality concentration, and one for all deformities in fish that survived or died. Deformity rates below the no mortality concentrations ranged from 0 – 50% in the species tested, and total deformity rates ranged from 14 – 82 %. LC_{50}, NOAEC, LOAEC, and deformity rates were not determined for one fish species, as all values were outside the range tested (not included in table).

Prior to beginning the consultation, applicant Dow AgroScience provided NMFS and EPA with a study on fathead minnow (Hoberg, 2006) which evaluated vertebral deformities in addition to effects on length, weight, and survival. This study had not been previously submitted to EPA. The study was conducted under conditions similar to guideline tests, but was conducted in a sediment - water system. Trifluralin was added to the tanks at the initiation of the test, then water concentrations were monitored as it partitioned between the compartments in the tank. At the highest concentration (nominally 100 μg/L), an additional tank was dosed with radiolabeled trifluralin and the partitioning between the water and sediment tracked. Concentrations of trifluralin were measured in both filtered water (*i.e,* only dissolved phase) and unfiltered water (*i.e*, trifluralin in dissolved phase and trifluralin sorbed to suspended sediment). Trifluralin in the dissolved phase represents what is bioavailable. Trifluralin partitioned rapidly to the sediment. The mean-measured concentration of trifluralin in unfiltered water on day 0 was 117.5 μg/L. By day 1 it had declined to 70.8 μg/L and by day 3 it had declined to 8.77 μg/L. By day 7, concentrations in the unfiltered water were 5.93 μg/L. Concentrations remained at approximately this level for the remainder of the 35-day test. Concentrations in the filtered water (available for uptake by fish) also declined rapidly. Concentrations at day 0 were 86.5 μg/L, at day 1 were 55.4 μg/L and at day 3 were 7.72 μg/L. By day 7, concentrations in filtered water were below detection limits. The evaluation of partitioning behavior provides some insight into both how to calculate an “effective” concentration in the test, and how trifluralin might behave in natural water bodies. Soil used for sediment in the test system was a sandy loam (85% sand), with 1.9% organic matter (OM), and 1.1% organic carbon.

Gas chromatography was used to measure concentrations in replicates used to determine the NOAEC and LOAEC. The document does not specify if water from the test tank was filtered or not. At all test concentrations, nominally 3.2 μg/L, 10 μg/L, 32 μg/L, and 100 μg/L, aqueous concentrations of trifluralin declined rapidly. Rate of decline appeared to increase with initial concentration, although neither we nor the author calculated a rate constant. By day 1, concentrations in all treatments were 25 – 45% of nominal concentrations. By day 3, concentrations ranged from 0.8 – 3.5% of nominal. Trifluralin has a log K_{ow} of 5.27 (EPA, 2009b), thus it is expected to bioconcentrate. Guideline tests confirm it does bioconcentrate (EPA, 2009b). Other sources indicate the bioconcentration is rapid with an estimated trifluralin uptake constant of k_1= 756 day^{-1}for fathead minnow based on laboratory experiments ((Spacie, 1975) as cited in (Spacie & Hamelink, 1979)). Based on the measured concentrations in the experiment and the additional information on bioconcentrations, we estimated effective concentrations based on the average of the mean-measured concentrations from day 0, day 1, and day 3. Effective concentrations in the study were estimated to be 1.73 μg/L, 5.66 μg/L, 15.2 μg/L, and 48.6 μg/L. Fish likely continue to concentrate trifluralin as long as it is in the water.

Occurrence of vertebral deformities was determined by radiological examination of individual fish. "Minimal to slight thickening of vertebral bone density was observed in several fish in the control (12.2%) and the 3.2 μg a.i./L solution (6%). Observations of fish exposed to the 10 μg a.i./L solution indicated that 9.1% of the fish had a slight to moderate increase in bone density and 6.8% of the fish exhibited moderate abnormalities to the shape of occasional vertebrae (*i.e.*, moderate compression or fusion). A substantial amount (60.5%) of the fish exposed to the 32 μg a.i./L solution showed increased bone density, abnormally shaped vertebrae or fractures/misalignment of the vertebral column. Essentially all of the fish exposed to the 100 μg/L solution demonstrated one of more of the abnormalities noted in the 32 μg a.i./L solution." Based on professional judgement, the radiologist concluded the 3.2 μg/L concentration was the NOAEC and the 10 μg/L was the LOAEC. Corresponding effective concentrations are 1.73 μg/L for the NOAEC and 5.66 μg/L for the LOAEC. These values are presented in Table 94.

Table 94. NOAEC and LOAEC concentrations for vertebral deformities associated with trifluralin

Study	Species	Age	Exposure duration	NOAEC (μg/L)	LOAEC (μg/L)
Couch et al 1979	Sheepshead minnow *Cyprinodon variegatus*	Zygote	28 d	2.7	5.5
Wells &Cowan 1982	Atlantic salmon *Salmo salar*	Parr (1 year +)	16 h	7.6	160
Koyama 1996	Mullet *Mugil cephalus*	"Larval fish", ranging in size 1.9 – 5.7 cm in length, and 0.20 – 3.15 g in weight, depending on species	96 h	3	5
	Red sea bream (large) *Pagrus major*			<6	<6
	Black sea bream *Acanthopagrus shlegeli*			7	19
	Red sea bream (medium) *Pagrus major*			8	16
	Herring *Clupea pallasi*			9	13
	Grunt *Parapristipoma trilineatum*			12	19
	Longchin goby *Chasmichthys dolichognathus*			12	23
	Red sea bream (small) *Pagrus major*			13	13
	Japanese flounder *Paralichthys olivaceus*			20	30
	Girella *Girella punctata*			23	31
	Yellowtail *Seriola quinqueradiata*			ND	ND
Hoberg 2006	Fathead minnow *Pimephales promelas*	30 days	35 d	1.7	5.7

ND not determined, LC_{50} < lowest concentration tested

In summary, we believe there is a sufficient body of information to conclude that trifluralin exposed caused vertebral deformities in fish, that those effects can occur at concentrations between 1.7 μg/L and 5.7 μg/L (Hoberg, 2006), that effects are not limited to larval fish, and that exposure durations need only be 16 – 72 hours. Vertebral deformities in fish can affect silhouette (shape), causing reductions in swimming ability, which in turn affects ability to escape predators and/or capture prey. Other effects may also occur as a secondary result of the vertebral deformities, including disruption of the nervous system due to spinal impingement and pituitary enlargement due to liberation of bone calcium.

Bioconcentration, bioaccumulation, and biomagnifications - Trifluralin

Trifluralin has a log K_{ow} of 5.27 (at 20°C). It has been established in the toxicological literature that chemicals with log K_{ow}s in the range of 3 – 7 are likely to bioconcentrate. Bioconcentration occurs when organisms uptake a lipophilic chemical, resulting in a higher concentration in the organism than in the surrounding water. In bioconcentration, the exposure route is only water. In some cases, lipophilic chemicals may also be in food items, and the organism accumulates the chemical from both the food and the surrounding water. This is referred to as bioaccumulation. When concentrations of the chemical increase as trophic level increases, the chemical is said to biomagnify. Although a tendency to bioconcentrate can fairly reliably be predicted from physic-chemical properties, establishing whether or not a chemical will bioaccumulate or biomagnify requires more information. Once an organism, such as a fish has taken up the chemical, it may be able to metabolize it to another compound, or excrete it in the parent form. This is referred to as depuration or clearance. Uptake rate constants (k_1) and clearance rate constants (k_2), and half-lives in tissue ($t_{1/2}$) can be estimated from laboratory and field data.

We located several sources of information to evaluate the bioconcentration of trifluralin, including a guideline bioconcentration tests described in EPAs RLF BE (EPA, 2009b), and journal publications (Spacie & Hamelink, 1979; Wells & Cowan, 1982). In the guideline test, bluegill sunfish exposed to 5.9 µg/L trifluralin for 28 days concentrated 39.6 mg/kg in whole fish tissues (EPA, 2009b). After 15.8 days, fish reached 90% of steady state concentrations. During the 14 day duration period, fish eliminated 86-88% of the residues. Residues remaining were incompletely characterized but included multiple metabolites and some polar compounds. Neither rate constants nor a half life were not presented in EPA documentation, but the mean bioconcentration factor (BCF) for whole fish was 5,674x.

Wells and Cowan (1982) exposed Atlantic salmon parr (1+ yr), to a higher concentration of trifluralin (560 µg/L) for a shorter period of time (11 h) in an experiment designed to simulate short-term, high concentration exposure. Following the initial exposure, fish were raised in pesticide-free water. Trifluralin concentrations in whole fish were measured 5 times during the following year, at approximately 30d, 60 d, 120 d, 225 d, and 275 d post exposure.[14] Maximum accumulation of trifluralin in fish tissue was in the range of 100 mg/kg. The depuration curve was first-order, with a rate constant (k_2) of 0.017 d^{-1}(r = 0.955) and half-life ($t_{1/2}$) of 40.5 days.

Spacie and Hamelink (1979) conducted a 2 year study that included intensive monitoring of water concentrations and fish tissue concentrations in the Wabash River, Indiana. The Wabash River was receiving trifluralin-containing wastewater from a manufacturing plant at the time of the sampling (1974-1975). During the sampling period, an activated-carbon water treatment program was initiated, thus Spacie and Hamelink were able to do a before and after comparison of trifluralin concentrations in the water and fish. They calculated clearance rates, half-lives, and bioconcentration factors for trifluralin in the wild-caught fish. They supplemented their field data with laboratory experiments on fathead minnow. We note this situation likely resulted in higher water concentrations of trifluralin in some instances than might be expected from runoff after application. However, we do believe the clearance rates, half-lives and bioconcentration factors presented in this work are applicable.

Water concentrations were measured periodically in 1975. A total of 69 samples were quantified. These samples were distributed across 7 different locations in the river, and taken across the course of 8 months. Water samples were taken prior to carbon treatment, during intermittent treatment, and during continuous treatment. Prior to treatment, water concentrations near the discharge point appear to have been in the 3 – 8 μg/L range, although there was one spike of 548 μg/L that authors attribute to a spill in the plant. With treatment, water concentrations declined to the 0.2 – 1.3 μg/L range near the discharge point and <1 μg/L at other locations downstream.

Spacie and Hamelink (1979) report concentrations in lipid for 11 different species of fish sampled at various locations (n=643), although the majority of the samples (N=536) are from only three of those species. Authors calculated clearance rate constants (k_2) and half-lives or these three species, the sauger (*Stizostedion canadense*), shorthead redhorse (*Moxostoma*

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[14] Data are presented graphically (Figure 3). Sampling time is approximate based on the figure.

macrolepidotum), and golden redhorse (*Moxostoma erythrurum*), using pre- and post-treatment fish tissue concentrations. Half- life estimates for the field-caught fish ranged from 17 – 57 d, and are in good agreement with the 40.5 d half-life estimated by Wells and Cowan (1982). First-order clearance rate constants (k_2) ranged from 0.012 – 0.040 day^{-1} and are again in good agreement with the value estimated by Wells and Cowan (1982). BCFs estimated based on water concentrations before the carbon treatment (which authors believed more likely to reflect a steady-state condition), were 5,800 for the sauger, 2,800 for the shorthead redhorse, and 1,800 for the golden redhorse.

Spacie and Hamelink also did a laboratory experiment, exposing fat head minnows (*Pimephales promelas*) to 20 μg/L trifluralin TGAI for 40 h, and then depurating them for 642 h to establish a half-life and first-order clearance rate constant. The half-life was 3 d, uptake rate constant was 756 day^{-1} and clearance rate constant was 0.232 day^{-1}. Depuration followed first-order kinetics. BCF for the fathead minnow in this experiment was 3,261. Additionally, they report a BCF of 1,060 for fathead minnow based on a 61 d chronic exposure experiment conducted by Spacie (Spacie, 1975) but not described in the paper.

Although they apparently did not intend to evaluate trophic differences, several of the sauger (9) captured had undigested prey in their stomachs (minnow, *Notropis* sp.). They analyzed both the sauger and the *Notropis,* finding no significant differences in whole body concentrations between the predator and prey. Median whole body concentration for the *Notropis* was 10.78 mg/kg, and median whole body concentration for the sauger was 6.37 mg/kg.

Based on all information and analyses considered, authors concluded trifluralin concentrations in fish were proportional to water concentrations, accumulation was reversible, there did not appear to be major differences in accumulation between species, size or trophic guild, and field estimated BCFs correlated well with estimates from laboratory tests and partitioning correlations (Spacie & Hamelink, 1979).

Parrish et al (1978) found trifluralin was concentrated by both parental fish and juveniles in a full life cycle test. Adult fish exposed for 166 d and juveniles exposed for 28 d exhibited similar

BCFs. BCFs for jueveniles ranged from 1,500-11,500, and BCFs for adult fish ranged from 4,500-11,500. Authors did not calculate half-life or rate constants.

Table 95. Bioconcentration factors (BCFs), half-lives, and rate constants for trifluralin

Study	Species	BCF	Half-life ($t_{1/2}$) days	Uptake rate constant (k_1) day^{-1}	Clearance rate constant (k_2) day^{-1}
MRID 40673801 EPA RLF 2009	Bluegill *Lepomis macrochirus*	5,674	ND	ND	ND
Wells & Cowan 1982	Atlantic salmon *Salmo salar*	ND	41	ND	0.017
Spacie & Hamelink 1979[1]	Sauger *Stizostedion canadense*	5,800	22 31	ND	0.032 0.023
	Shorthead redhorse *Moxostoma macrolepidotum*	2,800	17 57	ND	0.040 0.012
	Golden redhorse *Moxostoma erythrurum*	1,800	23	ND	0.030
	Fathead minnow *Pimephales promelas*	3,261 1,060	3.0 ND	756 ND	0.232 ND
	Minnow *Notropis* sp.	6,000	ND	ND	ND
Parrish et al 1978	Sheepshead minnow	1,500-11,500	ND	ND	ND

ND Not determined

[1] Authors calculated multiple values based on different data sets for several species

Table 96 shows open literature used in evaluating trifluralin effects.

Table 96. Nonguideline references considered in evaluation of trifluralin effects

Study reference	EPA Classification and Use	NMFS Use in this Opinion
Couch et al 1979	Acceptable for ECOTOX but not OPP Rejection code: No endpoint Reviewed by OPP, accepted for qualitative use (EPA RLF 2009, Appendix H) Study summarized in effects section, discussed in risk characterization, concluded that delta smelt could develop vertebral dysplasia at concentrations noted in monitoring and estimated by PRZM-EXAMS (EPA RLF 2009)	Establish NOAEC and LOAEC for vertebral deformities associated with trifluralin exposure. Postulate mechanism of deformities (fluorosis).

Study reference	EPA Classification and Use	NMFS Use in this Opinion
Couch 1984	Acceptable for ECOTOX and OPP Reviewed by OPP, accepted for quantitative use (EPA RLF 2009, Appendix H) Study summarized in effects section, discussed in risk characterization, EPA concluded that delta smelt could develop vertebral dysplasia at concentrations noted in monitoring and estimated by PRZM-EXAMS (EPA RLF 2009)	Confirm effect of vertebral deformities. Establish deformities not associated with only early life stages. Establish effects on pituitary. Establish vertebral deformities do not continue to progress when fish are no longer exposed
Hoberg 2006	New submission to EPA, not yet reviewed Applicant provided to both agencies prior to consultation	Establish NOAEC and LOAEC for vertebral deformities. Evaluate partitioning behavior of trifluralin in a sediment-water system.
Koyama 1996	Acceptable for ECOTOX but not OPP Rejection code: No control Reviewed by OPP, accepted for quantitative use (EPA RLF 2009, Appendix H) Study summarized in effects section, discussed in risk characterization, EPA concluded that delta smelt could develop vertebral dysplasia at concentrations noted in monitoring and estimated by PRZM-EXAMS (EPA RLF 2009)	Establish vertebral deformity NOAECs and LOAECs for multiple fish species. Establish LC_{50}s for multiple fish species, including ednpoints lower than guideline tests
Parrish et al 1978	Acceptable for ECOTOX and OPP Not reviewed by OPP (EPA RLF 2009, Appendix H)	Establish range of acute toxicity endpoints for fish Establish range of chronic toxicity endpoints for fish Establish bioconcentration factor (BCF)
Macek et al 1969	Acceptable for ECOTOX but not OPP Rejection code: No control Not reviewed by OPP	Provide additional LC_{50} information Provide insight into temperature effects Provide insight into time-to effect
Mansour & Mohsen 1985	Acceptable for ECOTOX and OPP Not reviewed by OPP	Provide additional LC_{50} information
Spacie & Hamelink 1979	Acceptable for ECOTOX but not OPP Rejection code: No control Not reviewed by OPP (EPA RLF 2009, Appendix H)	Establish trifluralin bioconcentration occurs in natural waters Establish bioconcentration factor (BCF) and half-life Establish depuration constants Evaluate potential for bioaccumulation and biomagnification

Study reference	EPA Classification and Use	NMFS Use in this Opinion
Wells & Cowan 1982	Acceptable for ECOTOX and OPP Not reviewed by OPP (EPA RLF 2009, Appendix H)	Establish vertebral deformities can occur in natural waters. Establish deformities in natural populations can persist. Establish uptake occurs rapidly (11-16 h). Establish deformities have long term effect on fish growth, even after exposure is terminated. Estimate depuration rate and half life of trifluralin in fish (k=0.017 d^{1}, $t_{1/2}$ = 40.5 d)

Indirect Effects to Salmonids (Prey and Habitat Modifications)

Indirect effects caused by pesticides can include reduction in prey, either by direct lethality or decreased reproduction. Shifts in community structure caused by removal of more sensitive species and/or modification of the food sources for prey so that they are smaller can also affect salmon. Currently, the state of the science does not allow for quantitative connections between effects at these lower trophic levels and specific effects on listed salmonids. However, modification to prey and prey food sources can have noticeable effects on fish populations. These types of effects are considered under both the category of indirect effect, and as adverse modification to critical habitat.

Herbicides may also decrease the abundance of or shift the community structure of in-stream emergent plants, and or vegetation in the riparian zone.

Aquatic Invertebrates (Acute and Chronic Toxicity)

Few data were available regarding the effects of the dinitroaniline herbicides on aquatic invertebrates other than the guideline studies included as part of the EPA BEs. Based on the available acute data, all three of the a.i.s considered in this opinion are classified as moderately toxic to aquatic invertebrates, with 48 h EC_{50}s ranging from 251 μg/L (trifluralin) to 1,500 μg/L (oryzalin). Chronic effects occurred at much lower concentrations, with NOAECs ranging from 2.4 μg/L (trifluralin) to 358 μg/L (oryzalin). In the chronic study for pendimethalin, 100% mortality was noted at 35.8 μg/L (EPA, 2009a), a concentration 10x lower than the 48 h EC_{50} of

280 μg/L. Based on reporting in the EPA documentation, we cannot determine if the mortality was due to the extended exposure duration in the chronic tests or for some other reason. Toxicity patterns for aquatic invertebrates are the same as for fish, with trifluralin being the most toxic on both an acute and chronic basis, followed by pendimethalin, then oryzalin. Oryzalin is generally less toxic than the other two by approximately an order of magnitude in most tests for animals.

Table 97. Acute toxicity data for aquatic invertebrates.

Species		48 h EC_{50} Concentration[1] (μg/L)	Source
Oryzalin			
Waterflea (Cladoceran)	*Daphnia magna*	1,500	EPA CTS 2010 Appendix A MRID 00072596
Pendimethalin			
Waterflea (Cladoceran)	*Daphnia magna*	280	EPA RFL 2009 Appendix A MRID 00059738 LeBlanc 1976
Trifluralin			
Waterflea (Cladoceran)	*Daphnia magna*	251	EPA RLF 2009 Appendix F MRID 47807007 Kirk 1999

Table 98 Chronic toxicity data for aquatic invertebrates.

Species		NOAEC LOAEC (μg/L)	Endpoint Affected	Source
Oryzalin				
Waterflea (Cladoceran)	*Daphnia magna*	358 608	Dry weight of 1st generation	EPA CTS 2010 Appendix A MRID 43986901
Pendimethalin				
Waterflea (Cladoceran)	*Daphnia magna*	14.5 17.2	Reduced reproduction 100% mortality noted at 35.8 and 74.2 μg/L	EPA RLF 2009 Appendix A MRID 00100504 Graney 1981
Trifluralin				

Species		NOAEC LOAEC (μg/L)	Endpoint Affected	Source
Waterflea (Cladoceran)	*Daphnia magna*	2.4 7.2	Survival	EPA RLF 2009 Appendix F Grothe &Mohr 1990
Waterflea (Cladoceran)	*Daphnia magna*	50.7 (highest tested) ND	Survival	EPA RLF 2009 Appendix F Macek 1976

ND Not determined

Aquatic Plants (Phytoplankton and Vascular Plants)

Given oryzalin, pendimethalin, and trifluralin are all herbicides, we anticipate the most sensitive receptors in salmon habitat will be photosynthetic organisms. Instream plants include various types of algal species and vascular plants. Generally the phytoplankton provide an energy source for the stream and the macrophytes are a structural component, providing attachment sites for other organisms and refugia for juvenile fishes. Reductions in primary productivity or modifications in community structure via removal of sensitive species can result in “bottom-up” trophic cascades which may adversely affect salmonids. Loss of structure provided by macrophytes may result in decreased population of aquatic invertebrates or increased predation on juvenile salmonids.

Data for all five standard aquatic plant test species were available for oryzalin, pendimethalin, and trifluralin. Guideline tests typically include a green alga, fresh- and saltwater diatoms, a blue-green alga, and a vascular plant. These are intended to provide a range of ecologically important species. Green algae and diatoms often are important primary producers, serving as the base of the food chain for plankton and benthic invertebrates (Allen, 1995). Importance of these species varies by type of waterbody, but diatoms tend to be particularly important in small, fast-flowing streams. Green algae may be more important in slower moving waters, such as ponds, lakes, and sloughs. Blue-green algae are often considered less valuable as “food,” and many blue-green species are considered nuisance species contributing to harmful algal blooms. In these tests, vascular plants are represented by duckweed, which is a floating aquatic plant. While this allows for evaluating effects of dissolved pesticides, it does not consider what might be taken up from the sediment by root systems of emergent plants. Thus, test results associated with duckweed must be extrapolated to natural systems with caution.

Based on the information from guideline studies, toxicity of the dinitroanilines to aquatic plants is in a different order than toxicity to aquatic animals. Of the three a.i.s considered in this opinion, pendimethalin is the most toxic, followed by oryzalin, and then trifluralin. EC$_{50}$ ranges for green algae, diatoms, and duckweed are 5.2 – 12.5 μg/L, 13 – 42 μg/L, and 21 – 89 μg/L, respectively. Blue-green algae is much more resistant to all of the a.i.s than any of the other aquatic plants tested, with EC$_{50}$s ranging from 174 μg/L (pendimethalin) to 13,500 (oryzalin).

Table 99. Toxicity data for aquatic plants.

Species		EC$_{50}$ Concentration (μg./L)	Source
Oryzalin			
Green algae	*Selenastrum capricornutum*	52	EPA CTS 2010 Appendix A
Blue-green algae	*Anabaena flos-aquae*	>13,500	EPA CTS 2010 Appendix A
FW diatom	*Navicula pelliculosa*	42	EPA CTS 2010 Appendix A
SW diatom	*Skeletonema costatum*	51	EPA CTS 2010 Appendix A
Vascular plant	*Lemna gibba*	13	EPA CTS 2010 Appendix A
Pendimethalin			
Green algae	*Selenastrum capricornutum*	5.4	EPA RLF 2009 Appendix A MRID 42372204 Hughes 1992
Blue-green algae	*Anabaena flos-aquae*	>174	EPA RLF 2009 Appendix A MRID 42372207 Hughes 1992
FW diatom	*Navicula pelliculosa*	6.7	EPA RLF 2009 Appendix A MRID 42372206 Hughes 1992
SW diatom	*Skeletonema costatum*	5.2	EPA RLF 2009 Appendix A MRID 42372205 Hughes 1992
Vascular plant	*Lemna gibba*	12.5	EPA RLF 2009 Appendix A MRID 42372201 Hughes 1992

Species		EC_{50} Concentration (µg./L)	Source
Trifluralin			
Green algae	*Selenastrum capricornutum*	88.7	EPA RLF 2009 Appendix F MRID 41934502
FW Diatom	*Navicula pelliculosa*	37.9	EPA RLF 2009 Appendix F MRID 42834103
Blue-green algae	*Anabaena flos-aquae*	>273	EPA RLF 2009 Appendix F 42834102
SW diatom	*Skeletonema costatum*	21.9	EPA RLF 2009 Appendix F MRID 42834101
Duckweed	*Lemna gibba*	49.7	EPA RLF 2009 Appendix F MRID 42834104

Microbial Community Effects (Sediment, Soil, and Water Column)

Mitotic disruptors are known to affect microorganisms. We located no toxicity studies or microcosm studies evaluating effects on the microbial community. Pendimethalin and trifluralin both tend to sorb to sediment and persist.

Riparian Vegetation

Riparian vegetation is important for providing shade to the stream, stabilizing the stream banks, reducing sedimentation, and providing allochthonous input, both in terms of plant material and terrestrial insects. Generally there is not good data regarding the effects of herbicides on wild plants, other than weed species, but EPA requires submission of crop effects data as part of the registration process. We believe this provides a reasonable basis for evaluating effects on herbaceous plants. Based on mode of action for dinitroanilines, we believe they are unlikely to significantly affect established herbaceous vegetation, woody shrubs, and trees due to incidental overspray. All are most effective against germination of small seeded plants, and need to be in the root zone to be effective.

Although we did not locate specific toxicity data for those types of plants, we make the conservative assumption that sensitivity of wild herbaceous species is similar to the tested crops. Guideline studies determine EC_{25}s of end-use products on the endpoints of vegetative vigor and seedling emergence. We present the range of EC_{25}s for each plant type (monocots and dicots) in Table 100 based on data summarized in EPA California red-legged frog (pendimethalin, trifluralin) and California Tiger Salamander assessments (oryzalin) (EPA, 2009a, 2009b, 2010b).

Data show the seedling emergence endpoint is more slightly more sensitive than the vegetative vigor endpoint for oryzalin and pendimethalin, and much more sensitive for trifluralin. Seedling emergence EC_{25}s range from 0.03 - >6.0 lb a.i./A for the three herbicides. The ranges of EC_{25}s for the three chemicals overlap. Monocots and dicots appear to be equally sensitive, except in the case of trifluralin, to which dicots are slightly less sensitive. Vegetative vigor EC_{25}s range from 0.03 - >6.0 lb a.i./A. For pendimethalin and trifluralin there arppears to be little difference in sensitivity between monocots and dicots. However, for oryzalin, monocots are more sensitive.

Table 100. Terrestrial plant data.

Test	Monocot EC_{25} Range (lb ai/A)	Dicot EC_{25} (lb ai/A)	Source
Oryzalin			
Vegetative vigor	0.014 – 0.16	0.05 - >6.00	EPA CTS 2010 Appendix A
Seedling emergence	0.08 - >6.00	0.03 - >6.00	EPA CTS 2010 Appendix A
Pendimethalin			
Vegetative vigor	0.03 – 2.8	0.10 – 4.8	EPA RLF 2009 Appendix A
Seedling emergence	0.08 -1.0	0.09 -4.7	EPA RLF 2009 Appendix A
Trifluralin			
Vegetative vigor	1.09 – 2.65	0.80 – 2.64	EPA RLF 2009 Appendix F MRID 41934503
Seedling emergence	0.09 – 0.74	0.19 – 4.00	EPA RLF 2009 Appendix F MRID 43984401

Mesocosm and Sediment-containing Studies – Pendimethalin

BASF provided two mesocosom studies to NMFS(K. P. Ebke, et al., 2001; P. Ebke, et al., 2001). They also provided a zebrafish life cycle study with sediment in the system (Schafer, et al., 2001), and an oligochaete bioaccumulation study (Egeler, 2001). Pendimethalin has a high K_d, and sorbs readily to soil and sediment. Studies conducted in sediment-containing test systems provide insight into how pendimethalin will behave in natural ecosystems containing sediment. However, these types of studies are not a definitive source of for toxicity data on specific endpoints because the effect cannot be isolated.

One study was a test of the pendimethalin formulation STOMP® 400 in outdoor mesocosms containing water, sediment phytoplankton, zooplankton, and benthic organisms. STOMP® 400 was applied to the system a single time. Concentrations of pendimethalin in the water column and sediment were measured during the tests. Pendimethalin partitioned rapidly from the water column to the sediment, with half-lives ranging from 1.2 – 1.9 days. Phytoplankton was the most sensitive organism, with statistically significant reductions in green alga and chlorophyll a at 1.1 μg a.i./L. Study authors concluded the No Observed Effect Concentration (NOEC) was 0.23 μg a.i./L, and a Lowest Observed Effect Concentration (LOEC) of 1.1 μg a.i./L based on impact to phytoplankton populations. They describe the LOEC as "the highest treatment level where transient, recoverable effects were observed." Authors conclude a No Observed Adverse Ecological Effect Concentration (NOAEC) of 150 μg a.i./L for small static surface water bodies based on recovery from the single application over a 21 day period, and elimination of no species. The LOEC corresponds well with the guideline studies establishing an EC_{50} of 5.4 μg/L (EPA RLF 2009, MRID 42372204). The total exposure period to bioavailable pendimethalin was short, and this scenario reflects what might happen when a water body experience pendimethalin input only a single time. The recovery is not representative of a situation where the water body receives multiple inputs of pendimethalin.

A zebrafish life-cycle study was also submitted (Schafer, et al., 2001). Zebrafish of 3 different lifestages (fertilized eggs, juveniles, and nearly-mature adults) were exposed to a single application of technical grade pendimethalin in a static water-sediment system. A fate study using radio-labeled pendimethalin was conducted concurrently. The half-life of pendimethalin in the water was 2 – 4 days, with radioactivity accumulating in the sediment and algae. The pendimethalin partitioned to the sediment and was also rapidly taken up by the fish, with maximum tissue concentrations achieved two days following treatment. Fish metabolized pendimethalin and excreted a more polar metabolite. The maximum accumulation factor was 5,000, achieved by day 2. By day 10, the accumulation factor was 1,000, due in part to metabolism of the parent compound and in part to decreased concentrations in the water column as pendimathalin partitioned to the sediment. After three months some pendimethalin-derived residues remained in the fish. Accumulation factor at this point was 10, increasing to 20 at conclusion of the test. Authors attribute this to a metabolite rather than parent pendimethalin.

Results of this study are consistent with toxicity and fate information indicating pendimethalin partitions rapidly to sediment, and bioconcentrates in fish but does not bioaccumulate. The study summary lists a No Observable Effect Concentration for the zebrafish as >50 μg a.i./L based on the nominal concentration of the single applied dose. In practicality, the fish were only exposed to a brief pulse of pendimethalin at this concentration. By study day 28, concentrations of pendimethalin were <2 μg a.i./L. We did not time-average the measure concentrations, but these results are consistent with the endpoints derived from two available chronic tests in water-only systems. Guideline test data for fathead minnow provide a No Observed Adverse Effect Concentration (NOAEC) of 6.3 μg a.i./L and a Lowest Observed Adverse Effect Concentration (LOAEC) of 9.8 μg a.i./L ((EPA, 2009a), MRID 00037940). Tests on zebrafish embryos conducted by the Northwest Fisheries Science Center provide a No Observed Adverse Effect Concentration (NOAEC) of 15 μg a.i./L and a Lowest Observed Adverse Effect Concentration (LOAEC) of 150 μg a.i./L.

A second mesocosm study by Ebke (P. Ebke, et al., 2001) confirmed partitioning of pendimethalin in a water-sediment system and the bioconcentration and subsequent metabolism of pendimethlin by fish.
In this study 5.0 μg a.i./L pendimethalin technical was applied to ponds containing fish and naturalized biota. Concentrations of pendimethalin in the water column declined to below 50%

of applied within 7 days, with an estimated half-life in the system of ~3 days in pond C1 (pg 37). No treatment-related effects were observed on fish behavior, growth, or mortality. Based on radioactivity, there was rapid uptake of pendimethalin by all biota, with maximum concentrations of radioactivity achieved between day 3 and day 7 for various taxa. These results are consistent with existing acute and chronic toxicity data for pendimethalin. Authors also conclude there was no evidence of biomagnification of pendimethalin or pendimethalin metabolites through the food-chain. This conclusion is also consistent with existing fate data on bioaccumulation and physical properties such as K_{ow}.

In a study by Egeler (2001) bioaccumulation of pendimethalin from treated sediment was evaluated. Benthic oligochaetes were exposed to ^{14}C relabeled pendimethalin spiked sediment for 28 days and then moved to clean sediment for a depuration phase. Bioaccumulation factors (BAFs) were calculated for the beginning of the exposure phase and the end of the exposure phase. Residues at the end of the elimination phase were compared to residues at the end of the uptake phase. Pendimethalin was metabolized by the worms. BAFs ranged from 0.5 – 2.6 kg sediment/kg worm and at the end of the 10 day elimination phase, 50% of the accumulated pendimethalin had been eliminated. Authors concluded pendimethalin was not bioaccumulated by oligochaete worms. This conclusion is consistent with existing fate data on bioaccumulation and physical properties such as K_{ow}.

Summary of Toxicity Data

Assessment endpoints and associated concentrations are summarized in Table 101 for oryzalin, Table 102 for pendimethalin, and Table 103 for trifluralin. We have designated which of the endpoints are “standard,” that is, evaluated by data produced by guideline tests, and used by EPA as regulatoryy decision points and ones which are non-standard, such as information regarding sublethal effects on fish. These other endpoints are based on either salmon-specific risk hypotheses (*e.g*, effects on swimming and olfaction) or information located during our review of the literature for these a.i.s (*e.g*, endocrine disruption and vertebral deformities. For each assessment measure, there are references back to the table where the original data was summarized.

All of the a.i.s addressed in this opinion are herbicides, and as such, are expected to affect terrestrial vegetation near the stream to some extent. However, all are most effective as soil incorporated, pre-emergent applications, and work best on small-seeded herbaceous species. If the a.i.s are present in the soil, we anticipate they will affect streamside plants, especially grasses. However, we do not anticipate measureable effects on the biomass, species composition, or abundance of streamside vegetation due to drift from nearby applications.

Table 104 takes the information from the three previous tables, and provides a snapshot of anticipated adverse effects at various water concentrations for each of the a.i.s addressed in this opinion. This summary of expected effects is based on water concentration of the a.i. itself. Presence of other dinitroanilines, additional a.i.s having interactive effects with the a.i. evaluated, elevated water temperatures and other stressors could cause the same toxic effects at lower water concentrations.

Oryzalin is the least toxic of the three a.i. addressed in this opinion. It is more toxic to aquatic plants than to fish and other animals. We expect effects on aquatic plant communities to occur at water concentrations of 10 – 50 μg/L. Extent of damage will be greatly affected by repeated inputs, such as from multiple use sites in a watershed. Reductions in growth and reproduction for both fish and prey are expected to occur at water concentrations ranging from 220 – 608 μg/L. Mortality of fish and prey occurs at higher concentrations – between 1,000 μg/L and 3,500 μg/L.

Pendimethalin is more toxic than oryzalin to both aquatic plants and aquatic animals. Effects on aquatic plants and decrease in reproduction and growth of fish and prey species is expected to occur at concentrations of 5 – 17 μg/L. Mortality of fish and prey species is expected to occur at concentrations >100 μg/L.

Overall, trifluralin is the most toxic to fish and other animals of the three a.i.s considered, although it is the least toxic of the three to aquatic plants. Reproductive effects and vertebral deformities in fish are anticipated at water concentrations of 1 – 40 μg/L. Reductions in reproduction and growth for prey species is anticipated at similar concentrations. Aquatic plants are likely to be affected at concentrations of 22-81 μg/L. Mortality of fish and prey species is likely to occur at concentrations of 13 – 660 μg/L. NMFS believes concentrations of 1 – 250 μg/L are sufficient to cause damage to listed salmonids, their prey, and in-stream plants.

Table 101. Assessment Endpoints and Measures for Oryzalin

Assessment Endpoint			Assessment Measure	Median Concentration (µg ai/L)[1,2]	Range (µg ai/L)	n
Direct Effects on Salmonids	Standard endpoints	Survival	Fish 96h LC$_{50}$ (Table 89)	3,260	2,880-3,450	3
		Growth & Reproduction	Fish NOAEC Fish LOAEC (Table 91)	220 430	NA	1
	Sublethal endpoints	Swimming	No data located regarding this endpoint			
		Olfaction	No data located regarding this endpoint			
		Endocrine disruption	Induction of Cg Intersex lesions (Table 92)	3,300 NDD	NA 250 – 1,000	1 1
Effects on Prey (Aquatic Invertebrates)	Standard endpoints	Survival	Daphnia EC$_{50}$ (Table 97)	1,500	NA	1
		Growth & Reproduction	Daphnia NOAEC Daphnia LOAEC (Table 98)	358 608	NA	1
Effects on Primary Productivity, & Submerged and Emergent Vegetation	Standard endpoints	Biomass & Abundance	Aquatic plant EC$_{50}$ (Table 99)	47[3]	13-52	4
Effects on Riparian Vegetation	Standard endpoints	Biomass & Abundance	Terrestrial plant EC$_{25}$ Seedling emergence Vegetative vigor (Table 100)	0.12 (m) 0.65 (d) 0.16 (m) 2.3 (d)	0.08 - >6.0 (m) 0.03 – 6.0 (d) 0.014-0.16 (m) 0.05 - >6.0 (d)	3 6 4 6

[1] If more than one value was available. If only one value was available, the actual number given.
[2] Terrestrial plant endpoints given in lb a.i./A
[3] EC50 for blue-green algae is a statistical outlier compared to other aquatic plants, and was not included in calculation.
NA Not applicable, only one value available
NDD Not dose dependent, did not occur in dose response fashion
(m) – monocots, (d) – dicots

Table 102. Assessment Endpoints and Measures for Pendimethalin

Assessment Endpoint			Assessment Measure	Median Concentration (μg ai/L) [1,2]	Range (μg ai/L)	n
Direct Effects on Salmonids	Standard endpoints	Survival	Fish 96h LC_{50} (Table 89)	199	138-418	3
		Growth & Reproduction	Fish NOAEC Fish LOAEC (Table 91)	6.3 9.8	NA	1
	Sublethal endpoints	Swimming	No data located regarding this endpoint			
		Olfaction	No data located regarding this endpoint			
		No data located regarding additional sublethal endpoints				
Effects on Prey (Aquatic Invertebrates)	Standard endpoints	Survival	Daphnia EC_{50} (Table 97)	280	NA	1
		Growth & Reproduction	Daphnia NOAEC Daphnia LOAEC (Table 98)	14.5 17.2	NA	1
Effects on Primary Productivity, & Submerged and Emergent Vegetation	Standard endpoints	Biomass & Abundance	Aquatic plant EC_{50} (Table 99)	6.1[3]	5.2-12.5	4
Effects on Riparian Vegetation	Standard endpoints	Biomass & Abundance	Terrestrial plant EC_{25} Seedling emergence Vegetative vigor (Table 100)	0.38 (m) 0.65 (d) 0.67 (m) 2.3 (d)	0.08 - 1.0 (m) 0.09 – 4.7 (d) 0.03 – 2.8 (m) 0.10 – 4.8 (d)	4 6 4 6

[1] If more than one value was available. If only one value was available, the actual number is given.

[2] Terrestrial plant endpoints given in lb a.i./A

[3] EC50 for blue-green algae is a statistical outlier compared to other aquatic plants, and was not included in calculation.

NA Not applicable, only one value available

(m) – monocots, (d) – dicots

Table 103. Assessment Endpoints and Measures for Trifluralin

Assessment Endpoint			Assessment Measure	Median Concentration (µg ai/L) [1,2]	Range (µg ai/L)	n
Direct Effects on Salmonids	Standard endpoints	Survival	Fish 96h LC$_{50}$ No Mortality (Table 89, Table 90)	42.8[3] 13[3]	<5-660 <5-61	19 11
		Growth & Reproduction	Fish NOAEC Fish LOAEC (Table 91)	2.1[4] 5.0	1.3-15.2 4.2-49	4
	Sublethal endpoints	Swimming	No data located regarding this endpoint			
		Olfaction	No data located regarding this endpoint			
		Vertebral Deformities	Deformity NOAEC Deformity LOAEC (Table 94)	8 16	1.7-23 5-160	13
Effects on Prey (Aquatic Invertebrates)	Standard endpoints	Survival	Daphnia EC$_{50}$ (Table 97)	251	NA	1
		Growth & Reproduction	Daphnia NOAEC Daphnia LOAEC (Table 98)	2.4[5] 7.2	NA	1
Effects on Primary Productivity, & Submerged and Emergent Vegetation	Standard endpoints	Biomass & Abundance	Aquatic plant EC$_{50}$ (Table 99)	44[6]	22-81	4
Effects on Riparian Vegetation	Standard endpoints	Biomass & Abundance	Terrestrial plant EC$_{25}$ Seedling emergence Vegetative vigor (Table 100)	0.19 (m) 1.3 (d) 1.7 (m) 2.1 (d)	0.09 – 0.74 (m) 0.19 – 4.0 (d) 1.1 -2.7 (m) 0.8 – 2.6 (d)	4 6 4 5

[1] If more than one value was available. If only one value was available, the actual number given.
[2] Terrestrial plant endpoints given in lb a.i./A
[3] Some data includes "<"or ">" values from

Table 90. These were included in the calculation as the number given. Based on these data points, median LC_{50} and no mortality values may actually be lower than reported.

[4] One data point in this set was based on a sediment and water exposure. When this data point is not included in the calculation the NOAEC is 1.9 μg/L and LOAEC is 4.8 μg/L.

[5] Data from two studies are available, but one study did not determine a LOAEC and was not included in calculation. Data from study establishing both NOAEC and LOAEC is more consistent with other data for this chemical.

[6] EC50 for blue-green algae is a statistical outlier compared to other aquatic plants, and was not included in calculation.

NA Not applicable, only one value available

(m) – monocots, (d) – dicots

Table 104. Anticipated adverse effects from dinitroanilines at various water concentrations

Assessment Endpoint Range (μg/L)[1]	Approximate Water Concentration Range (μg/L)[2]	Anticipated Effects (Based on data from Table 101, Table 102, and Table 103)	Type of Adverse Effects
		Oryzalin	
<10	<10	Adverse effects from a.i. alone appear unlikely based on available data	None anticipated
10 - 50	10 - 100	From a short-term exposure, we anticipate reduction in biomass and abundance of in-stream plants. Longer exposure (days to weeks) or repeated short-term exposure may cause changes in plant community structure, initiating bottoms-up trophic cascades.	Habitat
220 - 608	100 – 1,000	Reduction in growth and reproductive capacity for both listed species and prey. Short duration exposures may not cause these effects. Effects expected to occur in conditions where exposure is longer-term, and or short-term exposure is repeated (*i.e.*, multiple sources). Also anticipate effects to in-stream plants noted at lower concentrations.	Direct Indirect Habitat
1,000 – 3,500	>1,000	Reduced survival for both listed fish and prey species even for short-term exposures. Also anticipate effects to in-stream plants, and potential growth and reproductive effects noted at lower concentrations.	Direct Indirect Habitat
		Pendimethalin	
<1	<1	Adverse effects from a.i. alone appear unlikely based on available data	None anticipated
5.2 – 9.8	1 - 10	From a short-term exposure, we anticipate reduction in biomass and abundance of in-stream plants. Longer exposure (days to weeks) or repeated short-term exposure may cause changes in plant community structure, initiating bottoms-up trophic cascades. Reduction in growth and reproductive capacity for listed species. Short duration exposures may not cause these effects. Effects expected to occur in conditions where exposure is longer-term, and or short-term exposure is repeated (*i.e.,* multiple sources).	Direct Indirect Habitat
14.5 – 17.2	10 - 100	From a short-term exposure, we anticipate reduction in biomass and abundance of in-stream plants. Longer exposure (days to weeks) or repeated short-term exposure may cause changes in plant community structure, initiating bottoms-up trophic cascades. Reduction in growth and reproductive capacity for both listed species and prey. Short duration exposures may not cause these effects. Effects expected to occur in conditions where exposure is longer-term, and or short-term exposure is repeated (*i.e.,* multiple sources).	Direct Indirect Habitat

Assessment Endpoint Range (µg/L)[1]	Approximate Water Concentration Range (µg/L)[2]	Anticipated Effects (Based on data from Table 101, Table 102, and Table 103)	Type of Adverse Effects
138 - 418	>100	Reduced survival for both listed fish and prey species even for short-term exposures. Also anticipate effects to in-stream plants, and potential growth and reproductive effects noted at lower concentrations.	Direct Indirect Habitat
Trifluralin			
<1	<1	Adverse effects from a.i. alone appear unlikely based on available data	None anticipated
2.1 - 8	1 - 10	Reduced reproduction, growth, and potential for vertebral deformities in listed fish even for short-term exposures. Reduced growth and reproduction for prey species.	Direct Indirect
13 - 44	10 -50	Reduced survival, reproduction, and potential for vertebral deformities in listed fish even for short-term exposures. Reduced growth and reproduction for prey species. Anticipated reduction in biomass and abundance of in-stream plant species, with the potential for changes in community structure and initiation of bottoms-up trophic cascades	Direct Indirect Habitat

1 Based on information on assessment measures and endpoints contained in Table 101, Table 102 and Table 103

2 Only a limited number of data points are available. The approximate water concentration range generalizes the types of effects expected at various concentrations to allow easier comparison with exposure concentrations.

Evaluation of Data Available for Response Analysis

We summarize the available toxicity information by assessment endpoint in Table 105. Data are considered in terms of availability, relevance, and quality, than we make an overall evaluation of the reliability of available data for making decisions about specific assessment endpoints. This evaluation is more specific than we have done in other opinions, which have just provided an overall qualitative ranking, but not specifically discussed the elements of data reliability.

We note that when data are not available regarding a certain endpoint, it does not mean that endpoint is unimportant for a particular chemical, but rather that it has not been evaluated or that those evaluations have not been published. Data availability is rated as "much data available", some data available, and "little or no data available." A lack of data increases the uncertainty associated with any decisions regarding that specific endpoint. Relevance is evaluated in a number of ways, including how closely related the test species are to the species of interest, how realistic the exposures are, and whether or not other interactions are included in the experiment. Because of the number of uncontrolled factors, data from relevant studies are often highly variable. We describe relevance as "highly relevant," "relevant," and "marginally or not relevant." Measurements of quality are factors such as analytical confirmation of test concentrations, well-documented procedures; complete reporting of data and statistical analysis, and repeatability of tests within a lab. We describe data quality as "high", "moderate", or "low". These three aspects are then combined to describe data reliability regarding a specific assessment endpoint as "high", "moderate", or "low".

Data for standard endpoints evaluated in guideline tests was generally available for all three a.i.s. Information regarding other assessment endpoints associated with completion of the salmon lifecycle and sublethal effects was significantly more variable.

Table 105. Evaluation of available toxicity data for oryzalin

Potential Adverse Effects	Assessment Endpoint	Data Evaluation			
		Availability	Relevance	Quality	Overall Reliability
Direct Effects on Listed Species					
Reduction in survival, growth, reproductive capacity, predator avoidance, swimming ability, migratory success	Survival	Some	Relevant	High	Moderate to high
	Growth & Reproduction	Some	Relevant	High	Moderate to high
	Swimming	No data available	NA	NA	NA
	Olfaction	No data available	NA	NA	NA
	Endocrine Disruption	Some	Relevant	Moderate	Low to moderate
	Vertebral Deformities	No data available	NA	NA	NA
Indirect Effects on Listed Species					
Reduction in abundance or prey or changes in type of prey available	Survival	Some	Relevant	High	Moderate to high
	Growth & Reproduction	Some	Relevant	High	Moderate to high
Changes in structure of in-stream community	Biomass & Abundance	Some	Relevant	High	Moderate to high
Modification of Designated Critical Habitat					
Reduction of water quality – inability to support type or abundance of prey necessary or the fish themselves	Survival	Some	Relevant	High	Moderate to high
	Growth & Reproduction	Some	Relevant	High	Moderate to high
Reduction in availability of cover, bottom-up modification of food web	Biomass & Abundance	Some	Relevant	High	Moderate to high
Reduction of shading, allochthonous input, and/or streambank stability	Biomass & Abundance	Some	Relevant	High	Moderate to high

NA not available

Table 106. Evaluation of available toxicity data for pendimethalin

Potential Adverse Effects	Assessment Endpoint	Data Evaluation			
		Availability	Relevance	Quality	Overall Reliability
Direct Effects on Listed Species					
Reduction in survival, growth, reproductive capacity, predator avoidance, swimming ability, migratory success	Survival	Some	Relevant	High	Moderate to high
	Growth & Reproduction	Some	Relevant	High	Moderate to high
	Swimming	No data available	NA	NA	NA
	Olfaction	No data available	NA	NA	NA
	Endocrine Disruption	No data available	NA	NA	NA
	Vertebral Deformities	No data available	NA	NA	NA
Indirect Effects on Listed Species					
Reduction in abundance or prey or changes in type of prey available	Survival	Some	Relevant	High	Moderate to high
	Growth & Reproduction	Some	Relevant	High	Moderate to high
Changes in structure of in-stream community	Biomass & Abundance	Some	Relevant	High	Moderate to high
Modification of Designated Critical Habitat					
Reduction of water quality – inability to support type or abundance of prey necessary or the fish themselves	Survival	Some	Relevant	High	Moderate to high
	Growth & Reproduction	Some	Relevant	High	Moderate to high
Reduction in availability of cover, bottom-up modification of food web	Biomass & Abundance	Some	Relevant	High	Moderate to high
Reduction of shading, allochthonous input, and/or streambank stability	Biomass & Abundance	Some	Relevant	High	Moderate to high

NA not available

Table 107. Evaluation of available toxicity data for trifluralin

Potential Adverse Effects	Assessment Endpoint	Data Evaluation			
		Availability	Relevance	Quality	Overall Reliability
Direct Effects on Listed Species					
Reduction in survival, growth, reproductive capacity, predator avoidance, swimming ability, migratory success	Survival	Much	Highly relevant	High	High
	Growth & Reproduction	Some	Relevant	High	Moderate to high
	Swimming	No data available	NA	NA	NA
	Olfaction	No data available	NA	NA	NA
	Endocrine Disruption	No data available	NA	NA	NA
	Vertebral Deformities	Much	Highly relevant	High	High
Indirect Effects on Listed Species					
Reduction in abundance or prey or changes in type of prey available	Survival	Some	Relevant	High	Moderate to high
	Growth & Reproduction	Some	Relevant	High	Moderate to high
Changes in structure of in-stream community	Biomass & Abundance	Some	Relevant	High	Moderate to high
Modification of Designated Critical Habitat					
Reduction of water quality – inability to support type or abundance of prey necessary or the fish themselves	Survival	Mome	Relevant	High	High
	Growth & Reproduction	Some	Relevant	High	Moderate to high
Reduction in availability of cover, bottom-up modification of food web	Biomass & Abundance	Some	Relevant	High	Moderate to high
Reduction of shading, allochthonous input, and/or streambank stability	Biomass & Abundance	Some	Relevant	High	Moderate to high

NA not available

Risk Characterization

In this section we integrate our exposure and response analyses to evaluate the likelihood of adverse effects to individuals and populations from stressors of the action (Figure 69). We evaluate the evidence presented in the exposure and response analyses to support or refute risk hypotheses. We evaluate the effects to specific ESUs and DPSs in the *Integration and Synthesis* section.

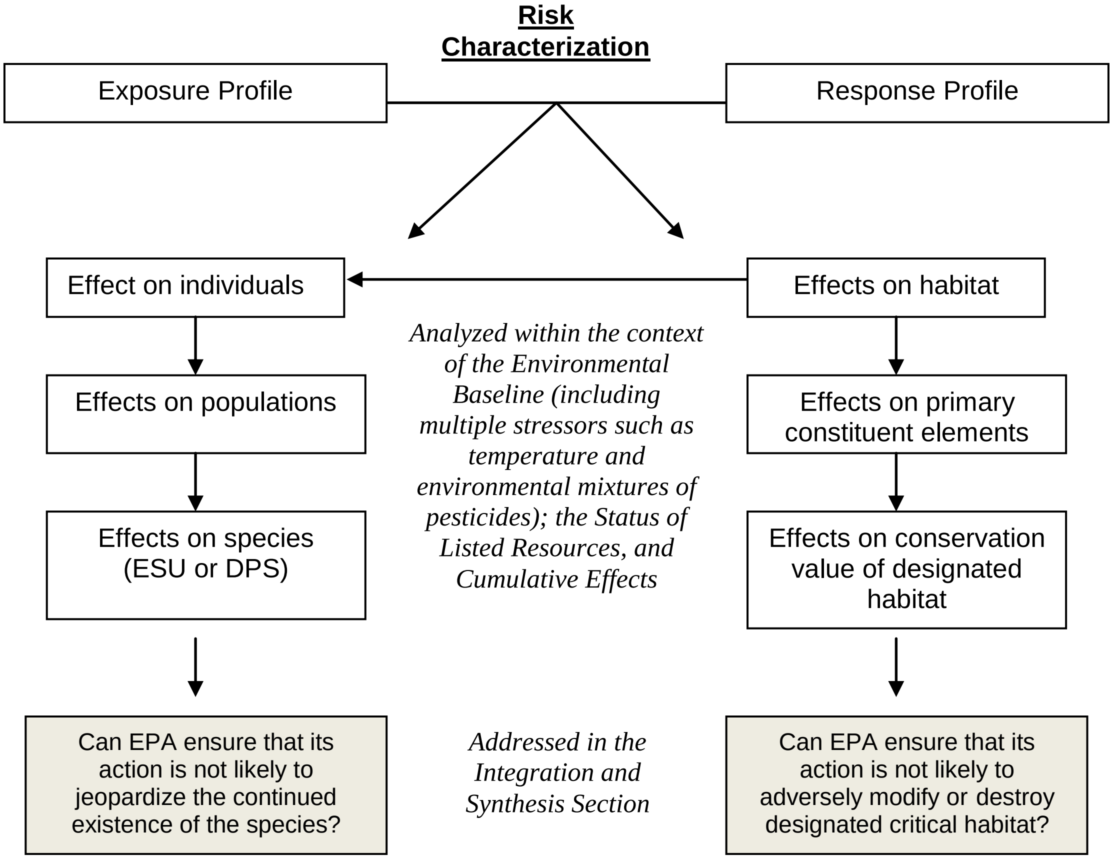

Figure 69. Schematic of the Risk Characterization Phase.

Integration of Exposure and Response

In Table 108, we compare the estimated environmental concentrations (EECs) and measured environmental concentrations (MECs) for the 3 a.i.s with approximate water concentrations determined to affect assessment endpoints, as detailed in (insert ref to response table). This portion of the analysis is based strictly on a.i., and does not take into account other stressors of the action that may contribute to toxicity, and/or that other a.i.s may be present, creating additive or synergistic toxicity. We discuss potential effects of mixtures in co-formulated products and recommended tank mixes in the following section.

The tables show the exposure concentration ranges (minimum–maximum values) gleaned from the three sources of exposure data we analyzed: EPA's estimates presented in the BEs, NMFS' modeling estimates for floodplain habitats; and surface water monitoring data from ambient monitoring programs and targeted monitoring. In addition to the salmonid BEs submitted to NMFS, we also considered the exposure estimates developed by EPA in the BEs for the California red-legged frog and California tiger salamander (oryzalin only). Some, although not all, of the red-legged frog BEs considered non-crop uses which were not included in the salmonid BEs submitted to NMFS. For some of the a.i.s evaluated in this Opinion, non-crop uses are an important market, however comparisons of EECs for the various landuse classes showed overlap and no specific differences. Evaluations for all landuses are presented together. The three dinitroanilines considered in this opinion are not registered for forestry uses, thus we consider the landuse categories of agriculture, urban/residential and rights-of-way.

The effect concentrations are based on the toxicity data reviewed in the *Response Analysis Section*. For the survival assessment endpoint, effect concentrations are generally LC_{50}s, the concentration at which 50% of the test organisms die. Individual fish may die at higher or lower concentrations, depending on individual sensitivity. When a 95% confidence interval (CI) or slope of the dose-response curve is provided, we can get a better estimate of what the range may be, or when an individual fish might be affected. However, the 95% CI and/or slope data are often not provided. The concentration at which death occurs for the first individual (*i.e*, the most sensitive individual in the group) often cannot be determined from the data provided in standard toxicity tests. Sometimes it can be estimated if the slope of the dose-response curve is included in the data, but because the tests are optimized to determine the $LC_{50,}$ estimations of individual effects (essentially an LC_{01}) may not be accurate. Typically, a sensitive life stage (young juvenile fish) is tested, but life stage sensitivity can vary depending on toxicant. Additionally, in the wild fish are often exposed to additional stressors which can influence response.

For some pesticides, lethal effects occur quickly, possibly within hours of introduction of the a.i. to the test system. For other chemicals, sub-lethal effects may not manifest for hours and/or lethal effects may not occur for the first 24 or 48 hours of the test. While NMFS considers the available range of LC_{50} data we also consider factors such as time-to-response, the correlation in sensitivities between the test organisms and the life stage being considered, and the potential for sensitive individuals to die at concentrations below the reported LC_{50}s. In addition to differences in individual and life stage sensitivities, there is some variation between species. For the a.i.s in this opinion, toxicity data regarding survival endpoints were available for one or more salmon species, thus we assume them to be relatively good predictors of response. However, other endpoints are often derived from less closely related species.

This analysis considers both spatial and temporal overlap of salmon and salmon habitat with pesticide applications, but we do not do a crop specific analysis[15]. In some cases, application rates, methods, or frequencies may vary for different landuse categories (*e.g*, agricultural uses, urban/residential uses, forestry uses, ROW uses), and we do take those differences into account where appropriate. For instance, we would not assume a high application rate for an ROW use would occur on agricultural land. In general, we do not see a difference in EECs between landuse classes for the dinitroanilines. Based on a run-timing analysis (*Appendix 5*) and an evaluation of landuse within the ESUs (*Appendix 4*) some sensitive life-stage of the relevant ESU/DPS may be present when the a.i.s are applied. This holds true for all ESUs/DPSs and all a.i.s, although not necessarily all use sites.

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[15] NMFS does not do a crop-specific analysis for several reasons. EPA's action continues for fifteen years, and federal agencies are in agreement that it is impossible to predict pesticide use that far in the future with any degree of certainty. Given changing climatic conditions and pest pressures, we can not assume that past crop patterns will continue over those 15 years either. Orchards and vineyards are an exception, as they take years to become established – we assume that they will remain fairly constant over the duration of the action. NMFS does not use the USDA CDL GIS layer as we are concerned about the completeness and quality of the data. The CDL only specifies certain crops and many have unacceptably high error rates. NMFS has discussed the utility of the CDL with EPA and the agencies are in agreement that it is more appropriate to use the NLCD dataset for these national-level consultations.

The analysis is predicated primarily on standard toxicity endpoints, as we located only a few studies with ecologically relevant sublethal information, and that information was not available for all a.i.s. This analysis does allow NMFS to systematically address which assessment endpoints are likely to be affected by exposure to the a.i.s. Where uncertainty arises, NMFS highlights the information and discusses its influence on our inferences and conclusions. Table 108 shows exposure concentrations, assessment endpoint ranges, and anticipated adverse effects.

Oryzalin

Oryzalin is registered for agricultural, urban/residential, and rights-of-way uses. Maximum authorized rates range from 0.2 – 6 lbs a.i./A, and it may be applied from 1-3 times a year. Rates and number of applications do not differ significantly between landuse classes. NASS usage data show typical application rates for crops surveyed are 1 – 3 lbs a.i./A, with applications once or twice a year (http://www.pestmanagement.info/nass/). Data are from 1990 – 2003 and only include agricultural uses. Based on this national data set, oryzalin is used mostly on orchard and berry crops, although other data from states within the range of Pacific salmonids show use on row crops. It is heavily used in California for orchard crops. Reported uses for non-agricultural crops include landscape maintenance and rights-of-way. Oryzalin is not authorized for aerial applications. Incorporation or watering-in is recommended but not required.

Like all of the dinitroanilines considered in this opinion, oryzalin partitions preferentially to soil rather than water. It degrades rapidly via aqueous photolysis ($t_{½}$ 0.06 d) and quickly via soil photolyisis ($t_{½}$ 3.8 d), although how applicable these pathways are following soil incorporation is debatable. Other degradation pathways are slower (weeks to months) and oryzalin maintains soil residual activity for 4-10 months following application (EPA, 2010b). Degradation products consist of a mixed group of benzene sulfonamides, which retain the characteristic dinitroaniline structure, and benzimidazole sulfonamides, where the $–NO_2$ sidechains have formed a conjoined ring structure. Measured concentrations of oryzalin range from 0.007 – 170 µg/L, with a median of 1.7 µg/L. The peak concentration of 170 µg/L was the highest reported in targeted monitoring. Peak EECs (acute exposures) from PRZM-EXAMS modeling range from 6.4 – 142 µg/L, and 21 d EECS (chronic exposures) range from 2.6 – 39 µg/L. Floodplain estimates range from 368 – 1,100 µg/L.

Oryzalin is the least toxic of the dinitroanilines considered in this opinion to fish and aquatic invertebrates, although its toxicity to terrestrial plants is comparable to the other dinitroanilines, and its toxicity to aquatic plants is less than pendimethalin but approximately equivalent to trifluralin. LC_{50}s for fish and aquatic invertebrates are in the 1,000 – 4,000 μg/L range. Effects on growth and reproduction (based on NOAECs/LOAECs) occur in the 250 – 750 μg/L range for fish and aquatic invertebrates. NMFS located some papers describing oryzalin as an endocrine disruptor for fish, but our evaluation of those papers showed the effects to occur at or near lethal concentrations. We located no information regarding the effects of oryzalin or any of the other dinitroanilines on salmon olfaction or swimming ability. Aquatic plants are more sensitive than fish or invertebrates, with EC_{50}s in the 13 – 52 μg/L range. Terrestrial plants are sensitive to oryzalin, with EC_{25}s in the 0.4 – 2.4 lbs a.i./A range. Monocots are more sensitive than dicots. Given the mode of action, terrestrial plants are unlikely to be affected by overspray on foliage, but very likely to be affected by concentrations in the soil. Dinitroanilines are active in soil for extended periods of time (months).

Table 108 shows how measured and estimated concentrations of oryzalin in the environment compare with concentrations demonstrated to adversely affect fish, their prey items, in-stream primary producers (phytoplankton, periphyton, vascular plants) and terrestrial vegetation. These are direct comparisons of the actual numbers, and do not include any type of safety margin or factor. Most concentrations in monitoring data are at a level below concentrations currently known to affect the most sensitive assessment endpoint for oryzalin, aquatic plants. Some PRZM-EXAMS EECs (both acute and chronic estimates) also are in this zone. However, most PRZM-EXAMS EECs fall within the range of 10 – 100 μg/L, which are concentrations known to affect aquatic plants. Short-term exposures are anticipated to cause reduction in biomass and abundance of in-stream plants. Longer exposure or repeated short-term exposures may cause changes in the in-stream plant community structure, initiating bottoms-up trophic cascades. Floodplain estimates and high monitoring concentrations are in the range of 100 – 1,000 μg/L. These concentrations are in the range known to cause reduction in growth and reproduction for both listed species and their prey in addition to effects on the plant community. Floodplain estimates at the highest application rates of 6 lb ai/A result in concentrations high enough to kill fish.

Pendimethalin

Pendimethalin is registered for agricultural, urban/residential, and rights-of-way uses. Maximum authorized rates range from 0.5 – 6 lbs a.i./A, and it may be applied from 1-2 times a year. Rates and number of applications do not differ significantly between landuse classes. NASS usage data show typical application rates for crops surveyed are 0.05 - 2 lbs a.i./A, with applications once or twice a year (http://www.pestmanagement.info/nass/). Data are from 1990 – 2003, and only include agricultural uses. Based on this national data set, pendimethalin is used heavily on soybeans, cotton, and peanuts. Soybeans and peanuts are not important crops in California and the Pacific Northwest, however, cotton is one of the primary uses in California. Data from states within the range of Pacific salmonids also show use on row crops, especially root crops like onions and potatoes. Reported uses for non-agricultural crops include landscape maintenance, ornamentals, and rights-of-way. Pendimethalin is authorized for aerial and ground applications. Incorporation or watering-in is recommended but not required.

Pendimethalin sorbs strongly to soil and degrades slowly via any pathway. The most rapid pathway of degradation is aqueous photolysis ($t_{½}$ 42 d), although given its tendency to sorb it will likely be in the particulate phase in natural waters and thus may not proceed through this reaction pathway. Other degradation pathways are slower (~ 6 months or longer). Of the known degradates, all retain both $–NO_2$ sidechains and a ring structure. Measured concentrations of pendimethalin range from 0.001 – 0.26 μg/L. Peak EECs (acute exposures) from PRZM-EXAMS modeling range from 1 – 12 μg/L, and 21 d EECS (chronic exposures) range from 0.2 – 2.9 μg/L. Floodplain estimates range from 184 – 375 μg/L).

Pendimethalin is more toxic to fish and aquatic invertebrates than oryzalin, but not quite as toxic as trifluralin. LC_{50}s for fish and aquatic invertebrates are in the 100 – 300 μg/L range. Effects on growth and reproduction (based on NOAECs/LOAECs) occur in the 5 – 20 μg/L range for fish and aquatic invertebrates. Few data are available for pendimethalin – most information is limited to guideline tests on standard endpoints, and there are a limited number of guideline studies. We located no information regarding the effects of pendimethalin or any of the other dinitroanilines on salmon olfaction or swimming ability. We located no information discussing any non-standard endpoints for animals or plants. Of the three a.i. considered in this opinion, pendimethalin is the most toxic to aquatic plants, with EC_{50}s in the 5- 13 μg/L range. Some terrestrial plants, especially some of the monocots, are very sensitive to pendimethalin, with EC_{25}s in the 0.08 – 4.8 lbs a.i./A range. Given the mode of action, terrestrial plants are unlikely to be affected by overspray on foliage, but very likely to be affected by concentrations in the soil. Dinitroanilines are active in soil for extended periods of time (months), and pendimethalin is particularly resistant to breakdown.

Table 108 shows how measured and estimated concentrations of pendimethalin in the environment compare with concentrations demonstrated to adversely affect fish, their prey items, in-stream primary producers (phytoplankton, periphyton, vascular plants) and terrestrial vegetation. These are direct comparisons of the actual numbers, and do not include any type of safety margin or factor. Most concentrations in monitoring data are at a level below concentrations currently know to affect the most sensitive assessment endpoints for pendimethalin, aquatic plants and reproductive endpoints for fish. Short-term exposures are anticipated to cause reduction in biomass and abundance of in-stream plants. Longer exposure or repeated short-term exposures may cause changes in the in-stream plant community structure, initiating bottoms-up trophic cascades. Reduced reproduction in fish affects population structure and abundance. All PRZM-EXAMS EECs (both acute and chronic estimates) fall within the range of 1 – 10 μg/L. At these concentrations, the aquatic plant community will be affected, and reproduction and growth of both fish and their prey items will be reduced. Existing data show lethal effect on fish and aquatic invertebrates occur at concentrations in the range of 100 – 500 μg/L, which is within the range of floodplain estimates (> 100 μg/L).

Trifluralin

Trifluralin is registered for agricultural, urban/residential, and rights-of-way uses. Maximum authorized rates range from 0.5 – 4 lbs a.i./A, and it may be applied from 1-2 times a year. There is also one registered use for preparation of bare ground for paving at 16 lbs a.i./A. Other than this use, rates and number of applications do not differ significantly between landuse classes.

NASS usage data show typical application rates for crops surveyed are 0.2 – 1.5 lbs a.i./A, with applications once or twice a year (http://www.pestmanagement.info/nass/). Highest use rates and/or more frequent applications appear common for asparagus, celery, and cucumbers. Data are from 1990 – 2003, and only include agricultural uses. Based on this national data set, trifluralin is used heavily on soybeans, cotton, and wheat. Trifluralin is used heavily in California, especially on alfalfa and tomatoes. Reported uses for non-agricultural crops include landscape maintenance, ornamentals, and rights-of-way. Trifluralin is authorized for aerial and ground applications. Incorporation or watering-in is required.

Trifluralin will partition preferentially to soil rather than water, more so than oryzalin, but slightly less so than pendimethalin. It degrades rapidly via aqueous photolysis ($t_{½}$ 0.37 d) and but much more slowly via soil photolyisis ($t_{½}$ 42 d), although how applicable these pathways are following soil incorporation is debatable. Other degradation pathways are slower (weeks to months). Trifluralin breaks down in two groups products, benzimidazoles, where the $–NO_2$ sidechains have formed a conjoined ring structure, and various benzene ring structures with carbon, nitro and amine sidechains. Two of the benzene ring structures which retain the characteristic dinitroaniline structure. In all cases the degradates retain the $–CF_3$ group. Measured concentrations of trifluralin range from 0.003 – 0.6 μg/L. Peak EECs (acute exposures) from PRZM-EXAMS modeling range from 0.4 – 5.8 μg/L, and 21 d EECS (chronic exposures) range from 0.01 – 0. 87μg/L. Floodplain estimates range from 92 – 300 μg/L.

Trifluralin is most toxic to fish and aquatic invertebrates of the three a.i.s considered in this opinon, and is significantly more toxic to aquatic animals than to aquatic plants, which is somewhat unusual given it is an herbicide. This toxicity is due in large part to the trifluoro group attached to the ring structure, and the fact it is hydrophobic and bioconcentrates rapidly in fish and (presumably) aquatic invertebrates. LC_{50}s for fish range from <5 μg/L to 660 μg/L, based on a number of data points (n=19). Only one aquatic invertebrate LC_{50} was available, a value of 250 μg/L for *Daphnia magna*. Typically *D. magna*, and aquatic invertebrates in general are more sensitive to toxicants than fish. The single data point falls within the range of fish sensitivities, thus we make the conservative assumption the range of aquatic invertebrates are the LC_{50}s are similar to fish. A significant body of literature shows trifluralin causes vertebral deformities in fish as a result of accumulating the parent molecule and subsequent fluorosis of the bone structure. These effects have been clearly shown to occur in the 1 – 10 μg/L range, which is also the effect concentrations for growth and reproductive effects for both fish and aquatic invertebrates in guideline tests. Even short-term exposures to these concentrations may result in a negative response due to the rapid uptake of trifluralin. We located no information regarding the effects of oryzalin or any of the other dinitroanilines on salmon olfaction or swimming ability. However, we believe it is likely vertebral deformities caused by trifluralin will result in impaired swimming ability. Trifluralin has a toxicity to aquatic plants similar to oryzalin, with EC_{50}s in the 22 - 81 μg/L range. Some terrestrial plants, especially some of the monocots, are very sensitive to pendimethalin, with EC_{25}s in the 0.2 – 2.1 lbs a.i./A range. Given the mode of action, terrestrial plants are unlikely to be affected by overspray on foliage, but very likely to be affected by concentrations in the soil. Dinitroanilines are active in soil for extended periods of time (months).

Table 108 shows how measured and estimated concentrations of trifluralin in the environment compare with concentrations demonstrated to adversely affect fish, their prey items, in-stream primary producers (phytoplankton, periphyton, vascular plants) and terrestrial vegetation. These are direct comparisons of the actual numbers, and do not include any type of safety margin or factor. Trifluralin is more toxic to fish and aquatic invertebrates (growth, reproduction, and vertebral deformity endpoints affected at 1 – 10 μg/L) than aquatic plants (affected at 10 – 100 μg/L). Concentrations in monitoring data and chronic PRZM-EXAMS EECs (both acute and chronic estimates) are below the concentrations known to affect fish. However, trifluralin bioconcentrates rapidly, and has been demonstrated to have a half-life in fish from 3 – 60 days. Thus exposures to low concentrations for extended periods of time or repeated short exposures to higher concentrations may cause fish to accumulate sufficient body burdens to cause vertebral deformities or reductions in reproduction and growth. Once vertebral deformities occur, they are not reversible. Peak PRZM-EXAMS EECs fall within the range of 1 – 10 μg/L. Exposure at these concentrations would cause vertebral deformities and reduce reproduction and growth. Floodplain estimates are all >> 50 μg/L, and would affect all endpoints, including causing death of fish and aquatic invertebrates.

Table 108 Comparison of Exposure Concentrations and Effect Concentrations

Measured and Estimated Concentrations (μg/L) (From Table 87)	Anticipated Effects Concentrations (μg/L) (From Table 104)	Anticipated Effects (From Table 104)	Type of Adverse Effect
Oryzalin			
Most monitoring data (0.007 – 170, med 1.7) Some acute and chronic PRZM-Exams EECs (6.4 – 142 acute, 2.6 – 39 chronic)	<10	Adverse effects from a.i. alone appear unlikely based on available data	None anticipated
Most acute and chronic PRZM-Exams EECs (6.4 – 142 acute, 2.6 – 39 chronic)	10 - 100	From a short-term exposure, we anticipate reduction in biomass and abundance of in-stream plants. Longer exposure (days to weeks) or repeated short-term exposure may cause changes in plant community structure, initiating bottoms-up trophic cascades.	Habitat
High monitoring values (170) Floodplain estimates (368 – 1,100)	100 – 1,000	Reduction in growth and reproductive capacity for both listed species and prey. Short duration exposures may not cause these effects. Effects expected to occur in conditions where exposure is longer-term, and or short-term exposure is repeated (*i.e.*, multiple sources). Also anticipate effects to in-stream plants noted at lower concentrations.	Direct Indirect Habitat
Highest floodplain estimates (1,100 for 6 lb ai/A)	>1,000	Reduced survival for both listed fish and prey species even for short-term exposures. Also anticipate effects to in-stream plants, and potential growth and reproductive effects noted at lower concentrations.	Direct Indirect Habitat
Pendimethalin			
Monitoring data (0.0013 – 0.26)	<1	Adverse effects from a.i. alone appear unlikely based on available data	None anticipated

Measured and Estimated Concentrations (μg/L) (From Table 87)	Anticipated Effects Concentrations (μg/L) (From Table 104)	Anticipated Effects (From Table 104)	Type of Adverse Effect
All acute and chronic PRZM-Exams EECs (1.0 – 11.8 acute, 0.2 – 2.9 chronic)	1 - 10	From a short-term exposure, we anticipate reduction in biomass and abundance of in-stream plants. Longer exposure (days to weeks) or repeated short-term exposure may cause changes in plant community structure, initiating bottoms-up trophic cascades. Reduction in growth and reproductive capacity for listed species. Short duration exposures may not cause these effects. Effects expected to occur in conditions where exposure is longer-term, and or short-term exposure is repeated (*i.e.,* multiple sources).	Direct Indirect Habitat
Some acute PRZM-Exams EECs (1.0 – 11.8 acute)	10 - 100	From a short-term exposure, we anticipate reduction in biomass and abundance of in-stream plants. Longer exposure (days to weeks) or repeated short-term exposure may cause changes in plant community structure, initiating bottoms-up trophic cascades. Reduction in growth and reproductive capacity for both listed species and prey. Short duration exposures may not cause these effects. Effects expected to occur in conditions where exposure is longer-term, and or short-term exposure is repeated (*i.e.,* multiple sources).	Direct Indirect Habitat
Floodplain estimates (184 – 375)	>100	Reduced survival for both listed fish and prey species even for short-term exposures. Also anticipate effects to in-stream plants, and potential growth and reproductive effects noted at lower concentrations.	Direct Indirect Habitat
Trifluralin			
Monitoring data (0.0003 – 0.5) Targeted study high (0.6) All chronic and some acute PRZM-Exams EECs (0.01 – 0.87 chronic, 0.04 – 5.8 acute)	<1	Adverse effects from a.i. alone appear unlikely based on available data	Direct
Some acute PRZM-Exams EECs (0.04 – 5.8 acute)	1 - 10	Reduced reproduction, growth, and potential for vertebral deformities in listed fish even for short-term exposures. Reduced growth and reproduction for prey species.	Direct Indirect

Measured and Estimated Concentrations (μg/L) (From Table 87)	Anticipated Effects Concentrations (μg/L) (From Table 104)	Anticipated Effects (From Table 104)	Type of Adverse Effect
No estimates or measured concentrations	10 - 50	Reduced survival, reproduction, and potential for vertebral deformities in listed fish even for short-term exposures. Reduced growth and reproduction for prey species. Anticipated reduction in biomass and abundance of in-stream plant species, with the potential for changes in community structure and initiation of bottoms-up trophic cascades	Direct Indirect Habitat
Floodplain estimates (92 – 300)	>50	Reduced survival, reproduction, and potential for vertebral deformities in listed fish even for short-term exposures. Reduced growth and reproduction for prey species. Anticipated reduction in biomass and abundance of in-stream plant species, with the potential for changes in community structure and initiation of bottoms-up trophic cascades	Direct Indirect Habitat

No significant difference between measured and estimated concentrations based on landuse class, agricultural and developed landuses essentially the same for oryzalin and pendimethalin

Single estimate of concentrations from trifluralin ROW use much higher than agricultural uses, however trifluralin does not appear to frequently be used for rights-of-way.

Table addresses direct overlap of range, does not include any type of safety margin.

Mixtures

Integration of Exposure and Response considers the potential effects of each of the dinitroanilines individually. However, it is highly likely that organisms in the environment will actually be exposed to more than one chemical at any given time. Some of these chemicals may be associated with the action considered in this consultation while others are associated with other activities in the watershed. The current state of the science in mixture analysis is not sufficient to permit a quantitative evaluation of most mixtures. In some cases, it may not even be mature enough to permit a positive qualitative statement such as a specific combination of chemicals causes an additive, synergestic, or antagonistic effect. In general, it is accepted that chemicals in the same class or with the same mode of action do cause additive effects. For some chemical classes which are well-studied, such as polychlorinated biphenyls and dioxins, a toxic equivalency (TEQ) approach is used. In a TEQ, the toxicities of various chemicals or chemical forms are normalized to a single chemical, allowing the toxicity of various components of a mixture to be added and expressed as a single value. Such an approach could be used for the three dinitroanilines considered in this opinion, however we do note this approach is typically used only for acute toxicity data. Monitoring data indicate there are several locations, mostly in heavily agricultural watersheds, where more than one of the chemicals is detected.

In general, it is also reasonable to presume combined exposure to multiple herbicide active ingredients, especially those targeted at different biochemical processes, will amplify these potentially harmful responses. Herbicides are frequently combined into pesticide product mixtures because such mixtures improve the spectrum of weeds controlled and/or increase their effectiveness against target weeds. We expect the same is true of non-target plants in the riparian area and aquatic habitats, thus we assume that mixtures of multiple herbicides will have a greater effect on these ecological receptors. However, for many herbicides, including the dinitroanilines addressed in this opinion, the toxic mode of action in animals is unknown or not well defined. It is reasonable to expect exposure to multiple toxicants will cause an increased or perhaps different response, but we know of virtually no way to quantify it, especially given the numbers of potential combinations.

Based on the label analysis, which showed a number of co-formulated products and recommended tank mixes with other a.i.s (Table 109), all of the dinitroanilines are extremely likely to be applied with one or more other ingredients.

Pesticide products also contain other ingredients in the formulations, and or that are added to the pesticide product at the time of application. These ingredients may include a wide range of substances approved under EPA's inert program. Generally these are added to improve the performance of the a.i. by in various ways, such as making it spread more easily, remain active in the environment longer, or penetrate the plant surface more effectively. A number of dinitroaniline, products especially those for pendimethalin, include or suggest addition of crop oil concentrates. Contents of the concentrate vary by manufacturer, but generally are a combination of paraffin-based petroleum hydrocarbons, and may include other polyethoxylated compounds and fatty acids. Some include non-ionic surfactants. (http://www.herbicide-adjuvants.com/adjprod-type.htm). These types of compounds may cause a general narcosis (disorientation and slowed response) for aquatic organisms. Other ingredients still on the approved list include xylene and toluene, which cause a similar response, and nonylphenols, which have been associated with endocrine disruption in the environment. Sometimes there are tests on aquatic organisms with end products, but these only address acute (survival) endpoints, and also do not include substances which might be added at the point of application. Clearly, environmental fate parameters for each of these substances are different, the exact combinations are unknown and may vary widely, and there is no current method available to predict the identity and concentration of all the chemicals entering the aquatic system and how they might disperse, partition, or degrade once they arrive. However, NMFS does believe it is reasonable to assume some of these chemicals are in the water coincident with the a.i. following application, and the additional chemicals are likely to cause some type of increased response beyond that observed in the laboratory tests for single a.i.s. Current toxicological literature generally indicates mixtures may cause effects even when substances in the mixture are at or below concentrations previously noted to cause effects. As far as we are aware, there is no way to quantitatively estimate the extent of enhancement, even to a rough order of magnitude.

Table 109. Additional a.i.s Listed on Labels as Co-formulants and/or Recommended Tank Mixes

Chemical Class	Active Ingredients	Mode of Action	Expected Interactions
		Oryzalin	
Benzamide herbicide	Isoxaben	Cellulose inhibitor	Increased response for plants due to inhibition of multiple pathways No information located indicating how interactions may affect animals
Dinitroaniline herbicide	Benfluralin (benefin)	Mitosis inhibitor	Additive for plants and animals
Nitrodiphenylether herbicide	Oxyflourfen	Protoporphyinogen oxidase (PPG oxidase) inhibitor	Increased response for plants due to inhibition of multiple pathways No information located indicating how interactions may affect animals
		Pendimethalin	
Aryl triazinone herbicide	Sulfentrazone	Protoporphyinogen oxidase (PPG oxidase) inhibitors	Increased response for plants due to inhibition of multiple pathways No information located indicating how interactions may affect animals
Aryloxyphenoxy propionic acid	fluazifop-P-butyl	Acetyl CoA (ACCase) carboxylase inhibitors	Increased response for plants due to inhibition of multiple pathways No information located indicating how interactions may affect animals
Benzamide herbicide	Isoxaben	Cellulose inhibitor	Increased response for plants due to inhibition of multiple pathways No information located indicating how interactions may affect animals
Dinitroaniline herbicide	Benfluralin (benefin)	Mitosis inhibitor	Additive for plants and animals
Imidazoline herbicide	Imazapyr Imazapic	Acetolactate synthase (ALS) or acetohydroxy acid synthase (AHAS) inhibitors	Increased response for plants due to inhibition of multiple pathways No information located indicating how interactions may affect animals
Organophophorus herbicide	Glyphosate	Enolpyruval shikimate-3-phosphate (EPSP) synthase inhibitor	Increased response for plants due to inhibition of multiple pathways No information located indicating how interactions may affect animals
Organophosphorus herbicide	Glufosinate	Glutamate synthetase inhibitors	Increased response for plants due to inhibition of multiple pathways No information located indicating how interactions may affect animals
Phenylurea herbicide	Diuron	Photosystem II inhibitors	Increased response for plants due to inhibition of multiple pathways No information located indicating how interactions may affect animals

Chemical Class	Active Ingredients	Mode of Action	Expected Interactions
Sulfonylurea herbicide	Sulfometuron-methyl	Acetolactate synthase (ALS) or acetohydroxy acid synthase (AHAS) inhibitors	Increased response for plants due to inhibition of multiple pathways No information located indicating how interactions may affect animals
Triazine herbicides	Atrazine Simizine	Photosystem II inhibitor	Increased response for plants due to inhibition of multiple pathways No information located indicating how interactions may affect animals
Trifluralin			
Benzamide herbicide	Isoxaben	Cellulose inhibitor	Increased response for plants due to inhibition of multiple pathways No information located indicating how interactions may affect animals
Benzoic acid herbicide	Chloramben	Synthetic auxin	Increased response for plants due to inhibition of multiple pathways No information located indicating how interactions may affect animals
Dinitroaniline herbicide	Benfluralin (benefin)	Mitosis inhibitor	Additive for plants and animals
Isoxazolidinone herbicide	Clomazone	Caretenoid biosynthesis inhibitors	Increased response for plants due to inhibition of multiple pathways No information located indicating how interactions may affect animals
Nitrodiphenylether herbicide	Oxyflourfen	Protoporphyinogen oxidase (PPG oxidase) inhibitor	Increased response for plants due to inhibition of multiple pathways No information located indicating how interactions may affect animals
Oxidaizole herbicide	Oxidiazone	Protoporphyinogen oxidase (PPG oxidase) inhibitor	Increased response for plants due to inhibition of multiple pathways No information located indicating how interactions may affect animals
Pyridine carboxyilic acid herbicid	Triclopyr TEA Clopyralid	Synthetic auxins	Increased response for plants due to inhibition of multiple pathways No information located indicating how interactions may affect animals
Thiocarbamate herbicide	EPTC Triallate Vernolate	Fatty acid and lipid biosynthesis inhibitors	Increased response for plants due to inhibition of multiple pathways No information located indicating how interactions may affect animals
Triazine herbicides	Atrazine	Photosystem II inhibitor	Increased response for plants due to inhibition of multiple pathways No information located indicating how interactions may affect animals

Field incidents reported in EPA incident database

Section 6 (a) of FIFRA requires registrants to report adverse information about registered pesticides to EPA, including reports of wildlife injured or killed by those pesticides. States, local governments, and other entities may also report incident information to EPA, although this is not required. EPA maintains a database of these incidents. Information contained in the reports is evaluated according to the following scale:

> Highly probable (4): Pesticide was confirmed as the cause through residue analysis or other reliable evidence, or the circumstances of the incident along with knowledge of the pesticides toxicity or history of previous incidents give strong support that this pesticide was the cause.
> Probable (3): Circumstances of the incident and properties of the pesticide indicate that this pesticide was the cause, but confirming evidence is lacking.
> Possible (2): The pesticide possibly could have caused the incident, but there are possible explanations that are at least as plausible. Often used when organisms were exposed to more than one pesticide.
> Unlikely (1): Evidence exists that a stressor other than exposure to this pesticide caused the incident, but that evidence is not conclusive.
> Unrelated (0): Conclusive evidence exists that a stressor other than exposure to the given pesticide caused the incident.

NMFS reviewed incident reports provided by EPA from OPP's incident database and also those reported in documents. The incident database is populated with reports received by EPA from registrants that are defined as reportable under FIFRA 6 (a) (2) and also includes other information received from registrants and other sources. Incidents associated with product misuses were not provided. NMFS uses incident information as a line of evidence regarding adverse effects of the a.i.s on fish, considering incidents which occur when the pesticides are used in accordance with label instructions[16]. Overall, the dinitroanilines were associated with very few reported incidents given the length of time they have been registered and the range of uses. We note that an absence of reported incidents does not mean that pesticides are not toxic, but rather that some toxic effects may be too subtle to be visually distinguished by a casual

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[16] Legal use, when pesticides are applied as authorized. Incidents knonw to result from the application of the pesticide at rates higher than authorized or on use sites for which the pesticide has not been authorized are placed in a "misuse" category by EPA. Misuse incident information is not provided to NMFS by EPA.

observer. Adverse effects such as death of organisms lower on the trophic chain (*i.e.*, aquatic plants, aquatic invertebrates), shifts in community composition, and/or reductions in reproduction or growth are unlikely to be reported.

No incidents were reported for oryzalin.

The effects determination for the California Red Legged Frog describes two aquatic incidents for pendimethalin. These reports were also submitted to NMFS by EPA for this consultation, but included little information. One incident occurred in Ohio in 1998. Both pendimethalin and Lorsban (chlorpyrifos) were applied to a corn field. Shortly afterwards one inch of rain fell and runoff from the corn field ran entered a pond. The distance from the field to the pond was between 14 and 70 feet. Approximately 300 bass and bluegill sunfish were later found dead. Fish and water samples were taken but findings were not submitted to EPA. EPA concluded pendimethalin would not be expected to kill fish outright from runoff from one inch of rain on a corn field based on EECs and toxicity. EPA noted chlorpyrifos is more toxic to aquatic animals than pendimethalin by three orders of magnitude as well as more soluble in water and concluded the chlorpyrifos was likely the cause of mortality (incident report I007677-001). The second report was a Minnesota Department of Natural Resources summary showing various spill incidents. This report included one incident involving pendimethalin (incident report IO02685). However, there is little information in the report, only a single line entry indicating that “250 - 300 gallons yellow weed killer, Prowl” contributed to the deaths of 996 minnows in Schwerin Creek.

Two incidents associated with trifluralin were identified in the database. One incident was classified with a certainty of probable (#I002215) and the other was classified with a certainty of unlikely (#I000254). The probable incident involved the use of a trifluralin-containing herbicide on an area prepared for paving. Bare ground uses often are at higher rates than standard vegetation control, and/or include multiple pesticides. A light rain, followed 24 hours later by a heavy thunderstorm, was believed to have washed the pesticide into a three acre pond, killing bass, bluegill and crappie but not carp or catfish. EPA did not provide the report for the incident categorized as unlikely to have been associated with trifluralin.

Available incident data do not indicate a strong probability of fish kills associated with the use of the 3 dinitroaniline herbicides considered in this opinion.

Evaluation of Risk Hypotheses:

In this phase of our analysis we examine the weight of evidence from the scientific and commercial data to determine whether it supports or refutes a given risk hypothesis. This is not a statistical analysis, but rather a qualitative weighing of the available lines of evidence. We also highlight general uncertainties and data gaps associated with the data. In some instances there may be no information specifically related to a given hypothesis. In some cases, if information on a similar endpoint or chemical is available, and it is reasonable to do so, we extrapolate from the available data to fill gaps, recognizing that this may introduce additional uncertainty in the analysis. Although three a.i.s are addressed in this Opinion, we recognize toxicities of these compounds vary widely, and have considered them separately throughout the analysis.

The available information to characterize pesticide exposure included surface water monitoring data and estimates from pesticide transport models. We combine this information with the distribution and life-history characteristics of listed Pacific salmonids. As discussed in the *Exposure Analysis* section, each source of information has inherent limitations and uncertainties. For example, the pesticide monitoring data were generally not designed to quantify peak exposure concentrations or distributions of exposure in listed Pacific salmonid habitats. Consequently, models were used to supplement monitoring data and together the information was used to describe the potential range of pesticide concentrations in salmonid habitats. The NMFS AgDrift model runs provided estimates for concentrations resulting from drift to a shallow and narrow body of water, such as those found in floodplain habitats used by listed Pacific salmonids. Small streams and many floodplain habitats are more susceptible to higher pesticide concentrations than larger, high flow systems as their physical characteristics provide less dilution.

We recognize that pesticide concentrations will vary greatly among habitats used by salmonids, and exposure durations will be reduced in flowing water systems where higher velocities occur.

There is uncertainty as to what the magnitude of response of fish and salmonid prey will be under different environmental dissipation patterns. Standardized toxicity tests for pesticide registration are poor predictors of real world aquatic ecosystems as fish and other test organisms are exposed to relatively constant pesticide concentrations for arbitrary durations (*e.g.* acute of 96 h and chronic of 21 d) that may poorly reflect field exposures, which tend to be repeated pulses. The response of fish and their prey to different durations of exposure, and exposure mimicking different environmentally relevant dissipation patterns of the three a.i.s, is a meaningful data gap. We generally did not average exposure concentrations over time, so called time-weighted averages, because adverse responses to short term exposures such as pulses would likely be masked.

Large spatial and temporal variability exists in the use of aquatic habitats by listed Pacific salmonids. These differences occur at multiple scales of biological organization (*i.e.,* individual, population, and species). Both an individual's lifestage and its life history are important considerations in its use of aquatic habitats. This natural variation is overlaid with the inherent variation of environmental factors including climate (*e.g.,* precipitation patterns), habitat stressors, and land use. Given this biological and environmental variability, it is difficult to predict the precise exposure to the stressors of the action for any one individual, let alone for a population or species.

Consequently, we used general life history information to evaluate potential exposure in the myriad aquatic habitats. For example, all listed Pacific salmon and steelhead occupy habitats which could contain high concentrations of these pesticides at one or more life stages. Use of those habitats varies temporally by species, by ESU/DPS, and even by different populations within the same ESU/DPS. Most species use shallow floodplain habitats and/or small streams during their freshwater and estuarine rearing period. These periods of development and growth can differ significantly between species and populations (details in *Appendix 5*). Coho, steelhead, sockeye, and stream-type Chinook spend much longer in freshwater systems prior to migrating to the ocean, while ocean-type Chinook and chum spend less time rearing in freshwater. Ocean-type Chinook migrate from their natal stream within 2-6 months of hatching and spend several months rearing in floodplain, estuary, nearshore habitats before continuing on to the open ocean. Chum spawn in side channels, tributary streams, and mainstem rivers. The egg and alevin life stages reside at these sites until they approach or reach the fry stage. Swim-up fry immediately migrate downstream to estuarine areas, where they typically reside near the shoreline for one or more weeks. Thus, a chum fry's freshwater residency period is only a few days, compared with more than a year for other species such as steelhead.

To account for the temporal and spatial variation of aquatic habitats across individuals, populations, and species, we evaluated the potential for individual fitness consequences, (*i.e.*, assessment endpoints) by comparing the range in expected exposure concentrations with adverse effect levels in the context of aquatic habitat utilization. We divided salmonid habitats into two basic groups.

The first group is composed of spawning and rearing habitats. These freshwater aquatic habitats range from first order streams to large mainstem rivers as well as lakes. They are essential for successful reproduction and for the development and growth of young fish.

The second habitat group is composed of migratory corridors, estuaries, and nearshore marine areas. Most salmonid species use some of these habitats to migrate and rear (feed, develop, shelter), prior to moving into open ocean areas. In general, pesticide exposure will likely be less intense in these areas compared to the other freshwater systems given their size, flow, and use by salmonids. Exceptions include estuaries and nearshore marine environments where juveniles are rearing for extended periods (weeks-months) proximate to high pesticide use areas such as rights-of-ways, agricultural operations near tidal areas and stormwater runoff from dense urban centers.

Although we recognize this as a simplification of the diversity in life histories as well as aquatic habitats used by listed Pacific salmonids, the framework allows us to evaluate risk hypotheses based on differences in habitats and their use by salmonids. We explicitly address species differences in the *Integration and Synthesis* section by evaluating the potential for the stressors of the action to jeopardize the continued existence of the species; or for the potential for stressors to adversely modify their designated critical habitat.

Risk Hypotheses

Here we evaluate the available evidence to determine whether each risk hypothesis is supported.

Risk hypothesis 1. Exposure to oryzalin, pedimethalin, or trifluralin is sufficient to:

A. Kill salmonids from direct, acute exposure

Species' life history information indicates that listed salmonids are at the greatest risk of exposure to acutely toxic concentrations of the three a.i.s during freshwater occupancy. Salmonids which rear in small streams and floodplain habitats are particularly vulnerable to the highest expected concentrations. We found limited survival data comparing the salmonid lifestages (*i.e.,* eggs, fry, smolts, returning jacks, and returning adults) for the three a.i.s. We identified no survival data for estuarine or marine salmonid life stages. The vast majority of lethality data are based on standard toxicity laboratory tests conducted with juvenile salmonids (predominantly rainbow trout) which determine the LC_{50}. These data show the three a.i.s have a wide range of LC_{50}s, and salmonid species tended to be among the most sensitive of the freshwater fish species tested. We relied on these data to evaluate whether expected concentrations of the three a.i.s are sufficient to kill individual salmonids.

Of the chemicals assessed, pendimethalin and trifluralin are significantly more toxic to fish than oryzalin. Oryzalin is classified as moderately toxic[17] based on an LC_{50} range of 2,880 – 3,450 μg/L (median 3,260 μg/L). Pendimethalin is classified as very highly toxic based on an LC_{50} range of 138 - 418 μg/L (median 199 μg/L). Trifluralin is classified as very highly toxic based on an LC_{50} range of 5 - 660 μg/L (median 42.8 μg/L).

Based on the monitoring data, EPA's modeling estimates, and NMFS modeling estimates, it appears unlikely oryzalin will kill salmonids. Only the floodplain estimates (1,100 μg/L) for the highest application rate (6 lb a.i./A) approaches the range of LC_{50}s. Floodplain estimates for lower application rates and the highest targeted monitoring concentration are less than half the range of LC_{50}s. PRZM-EXAMS EECs and monitoring MECs are 1-2 orders of magnitude lower

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[17] EPA uses a descriptive scale for acute aquatic effects: very highly toxic (LC50 <100 μg/L), highly toxic (LC50 100-1,000 μg/L), moderately toxic (LC50 >1,000-10,000 μg/L), slightly toxic (LC50 >10,000-100,000 μg/L), and practically non-toxic (LC50 >100,000 μg/L), as published in (Kamrin, 1997).

than LC_{50}s. Pendimethalin and trifluralin may sometimes kill juvenile fish. All floodplain estimates are higher (184 – 375 μg/L and 92 – 300 μg/L, respectively) than the range of LC_{50}s. For both a.i.s, PRZM-EXAMS EECs are 1 order of magnitude lower and monitoring MECs are 2 orders of magnitude lower than LC_{50}s.

Laboratory tests are conducted on young fish based on the presumption they are the most or one of the most susceptible lifestages. We know of no literature that compares LC_{50} values for young fish to LC_{50} values for adults migrating to spawn. However, this is a time of intense physiological stress for the migrating fish.

B. Reduce salmonid survival through impacts to growth or development.

Salmonid growth may be affected by pesticide exposure in two ways. The pesticide concentration may directly reduce the growth of the fish or it may reduce the amount of available, appropriately-sized prey. Effects due to reduction of prey are addressed in the following risk hypothesis. Salmonids are at the greatest risk of reduced growth from pesticide exposure during their fry to smolt lifestages, when they are growing rapidly. Smaller fish may be more susceptible to predation, and/or less able to compete with other organisms sharing their habitat. Larger smolt size has been correlated with better survival at sea. Post-yolksac larvae, which are just beginning to feed exogenously, are particularly susceptible to starvation when prey is not available as they have no energy reserves.

The longer salmonids remain in freshwater the greater the probability for pesticide exposure because the fish are closer to sources. Juveniles rearing in estuaries and nearshore environments are also susceptible. Although there is likely greater dilution for a specific source in the estuary, there also may be pesticide inputs from multiple streams. For most of the listed salmonid species, but especially stream-type Chinook and coho, extended periods of growth occur in shallow, low-flow habitats, including floodplain habitats and small streams.

For oryzalin, guideline tests submitted to EPA showed growth effects (reduction in weight) on fathead minnow occurred at concentrations of 430 μg/L. The corresponding NOAEC was 220 μg/L. We note test submitted for rainbow trout resulted in no adverse effects at a concentration of >460 µg/L. Giving the benefit of the doubt to the species, we use the definitive fathead minnow NOAEC and LOAEC in our assessment. All monitoring data and PRZM-EXAMS EECs are below the NOAEC. Floodplain EECs for all application rates are above the NOAEC, and for most application rates (≥3 lbs a.i./A) are above the LOAEC. With an estimated half-life in water of 60 days (Table 76), it is possible juvenile fish in small, low-flow habitats near application sites will suffer reduced growth.

EPA did not report reduced growth in fathead minnow due to pendimethalin, but did report a reduction in egg production at 9.8 µg/L. The corresponding NOAEC was 6.3 µg/L. We use these values as a proxy for reduced growth. Monitoring data are all an order of magnitude less than the NOAEC. Chronic PRZM-EXAMS EECs range from 0.03 to 0.5 of the NOAEC. Acute PRZM-EXAMS EECs (1.0 – 11.8) approach, equal and exceed the NOAEC and LOAEC. All floodplain EECs exceed the LOAEC by 1 to 2 orders of magnitude. Reduced growth of juvenile salmonids may sometimes be caused by pendimethalin, expecially in small, low-flow habitats near application sites, but also in larger waterbodies.

Trifluralin affects fish growth, survival, and fecundity of fish at concentrations between 1 µg/L and 5 µg/L (Table 103). Monitoring data ranges from several orders of magnitude lower to about half the NOAEC of 1 µg/L. PRZM-EXAMS chronic EECs range from 0.1 to 0.9 of the NOAEC, and PRZM-EXAMS acute EECs are within the 1 – 5 µg/L range. Flood plain EECs exceed the NOAEC and LOAEC by 2 to 3 orders of magnitude. There are a number of papers from different authors and organizations confirming effects at these concentrations. Fish bioconcentrate trifluralin rapidly, thus even short-term exposures to these concentrations are relevant. NMFS believes it is highly likely trifluralin will affect fish growth and cause vertebral deformities in a number of differenct exposure situations.

C. Reduce salmonid growth through impacts on the availability and quantity of salmonid prey

This hypothesis focuses on rearing juveniles and the amount of prey available to ensure adequate growth and ultimately, size. As mentioned previously, habitats most vulnerable to pesticide contamination are shallow, low flow habitats where salmonids congregate to feed on a variety of terrestrial and aquatic invertebrates. Other aquatic habitats used by rearing salmonids are also vulnerable to reductions in prey, including channel edges along larger streams, rivers, estuaries, and nearshore marine areas.

In previous opinions, NMFS has considered several lines of evidence in evaluating the likelihood of reduced salmonid growth from impacts to aquatic invertebrate prey. However, little beyond standard guideline test data were available to evaluate the effects of the dinitroaniline herbicides on aquatic invertebrates. In general, aquatic invertebrates tend to be more sensitive to toxicants than fish. However, based on data available, this does not appear to be the case for the a.i.s addressed in this opinion. The measurement of acute effects, the *Daphnia magna* EC_{50}, is slightly lower than the fish LC_{50}s for oryazalin (1,500 µg/L versus 2,880 – 3, 450 µg/L), but in the same order of magnitude. For pendimethalin the *D. magna* EC_{50} is in the same range as the fish LC_{50}s (280 µg/L versus 199 – 418 µg/L). In the case of trifluralin the *D. magna* EC_{50} is higher than the fish LC_{50}s by an order of magnitude (251 µg/L versus 18.5 – 43.6 µg/L). Assessment endpoints evaluating growth and reproduction follow the same pattern. We have no particular explanation or hypothesis for this. In general, it appears aquatic invertebrates will be affected at approximately the same water concentrations as fish.

D. Reduce survival, migration, and reproduction through impacts to olfactory-mediated behaviors.

Pacific salmonids rely on olfaction to sense environmental cues that facilitate success in mating, locating food, migration, homing, and avoiding predation. Several classes of pesticides, including herbicides and fungicides, are known to impair olfaction in fish and several studies have shown that pesticides and other contaminants can disrupt olfactory processes that are important for survival and reproduction (Tierney, Baldwin, Hara, Ross, & Scholz, 2010). We located no studies that evaluated Pacific salmon olfactory response to oryzalin, pendimethalin, or trifluralin. We did not locate any studies evaluating the effects of any dinitroaniline herbicides on salmon olfaction.

Risk hypothesis 2. Exposure to oryzalin, pendimethalin, and trifluralin is sufficient to:

A. Reduce aquatic primary producers thereby affecting salmonid prey communities and salmon

Pre-emergent herbicides such as oryzalin, pendimethalin, and trifluralin are used to prevent germination of terrestrial plants, essentially controlling them before they compete with desired plants. Control is achieved by interaction of the chemicals with the root surfaces. The dinitroanilines are not generally effective against established vegetation via contact with foliar surfaces. Aquatic plants and other primary producers are an essential component of productive salmonid habitats because they provide food resources to aquatic invertebrates and provide shelter for invertebrates and fish. Ecosystem studies show that herbicides have variable effects following reductions in primary producers. Reduced growth and survival of fish through trophic level interactions can occur, particularly in systems that are dominated by sensitive plants. Whether or not effects on fish occur or reach measurable levels depends on a number of factors, including frequency and intensity of inputs.

Of the three a.i.s, pendimethalin is the most toxic to aquatic plants, with EC_{50}s in the 5.2-12.5 µg/L range. Oryzalin and trifluralin are about equally toxic, EC_{50}s with ranging from 13 – 52 µg/L and 22 – 81 µg/L, respectively. For oryzalin, most monitoring data (0.007 – 170 µg/L, median 1.7 µg/L) are concentrations below where effects on plant are expected to occur. PRZM-EXAMS EECS are in the range (2.6 – 142 µg/L) where we anticipate reduction in biomass and abundance of plants, as well as potential shifts in community structure to more tolerant species. At these concentrations, changes in aquatic plants may or may not be sufficient to cause discernable effects on fish. At the highest measured concentration (170 µg/L) and at concentrations predicted by floodplain estimates (368 – 1,100 µg/L), we anticipate effects on plant communities will be sufficient to affect growth and survival of fish due to bottoms-up trophic effects.

Pendimethalin affects fish growth and reproduction endpoints at concentrations in the same range as it affects aquatic plants. Monitoring data (0.0013 – 0.26 µg/L) are concentrations below where effects on plant are expected to occur. PRZM-EXAMS EECS are in the range (0.2 – 11.8 μg/L) where we anticipate reduction in biomass and abundance of plants, as well as potential shifts in community structure to more tolerant species. At these concentrations, changes in aquatic plants may or may not be sufficient to cause discernable effects on fish, however we anticipate the fish may be suffering direct effects as well. At concentrations similar to floodplain estimates (182 – 375 μg/L), direct effects on fish will overwhelm effects on plant communities.

Trifluralin affects fish survival at concentrations in the same range as it affects aquatic plants, and fish growth, reproduction and deformity endpoints at concentrations below aquatic plant EC_{50}s. Monitoring data (0.0003 – 0.5 μg/L) are concentrations below where effects on plant are expected to occur, as are PRZM-EXAMS EECS (0.01 – 5.8 μg/L). Aquatic plants may be affected at concentrations predicted in the floodplain estimates (92 – 300 μg/L). However, at these concentrations we anticipate direct effects on fish will overwhelm effects on plant communities.

B. Reduce riparian vegetation to such an extent that stream temperatures are elevated, erosion increases, and reduction in inputs of woody debris and other organic matter occurs.

This risk hypothesis considers aquatic habitat changes due to potential herbicide impacts to riparian vegetation. Possible changes to salmonid habitat associated with modifications to the riparian zone include alterations in terrestrial input of organic matter (including leaf litter, woody debris, and terrestrial insects); increased input of contaminants due to decreased vegetative filtering; reduced maintenance of natural flow dynamics; decreased bank stability and associated increased erosion and sedimentation; and decreased shading and increased stream temperatures.

We are not aware of any studies that specifically evaluated aquatic habitat responses that may correspond with changes to the riparian habitat from these three herbicides. However, we do not expect use of these dinitroanilines will alter established riparian vegetation due to aerial transport of the herbicides to riparian habitats. It may have some effect on emerging herbaceous vegetation if deposited in or on riparian zone soils due to field runoff. It seems unlikely there will be a measurable, discernable effect on riparian vegetation due to use of any of these three herbicides unless one is applied directly in the riparian zone.

Risk hypothesis 3. Exposure to mixtures of oryzalin, pendimethalin, and trifluralin can act in combination to increase adverse effects on salmonids and salmonid habitat.

We are not aware of any data that directly assess mixtures of oryzalin, pendimethalin, and trifluralin. However, these compounds are structurally very similar, have a common mode of action, and produce several common degradates. Therefore, we reasonably assume they can act in combination to increase adverse effects to individual salmonids and salmonid habitat. We also note there are some registered products containing benfluralin in addition to a.i.s addressed in this opinion.

Risk hypothesis 4. Exposure to other stressors of the action including degradates, additional active ingredients, and inert/other ingredients in pesticide products and tank mixes cause adverse effects to salmonids and their habitat.

In addition to exposure to the a.i.s, salmonids and their habitat are likely exposed to other stressors of the action, including degradates and additional active ingredients in formulated products and tank mixes. Salmonid habitats may also be exposed to a number of the approximately 4,000 inert ingredients approved for use in end-use pesticide products by EPA, as well as adjuvants, such as surfactants and other products that are applied as tank mixtures. Once the mixture (formulated pesticide or tank mix) is introduced into the environment, physiochemical properties of the various compounds will cause them to move through the environment at different rates and partition into different compartments. We expect some percentage of these other stressors will be present in salmonid habitats from spray drift deposition, and from runoff events following application. Salmon and their habitats exposed to these multiple stressors are expected to show a greater response than laboratory animals exposed only to one a.i, thus available toxicity data generally underestimate the response in a field-applied pesticide mixture.

A. Exposure to degradates of oryzalin, pendimethalin, and trifluralin

The BEs identify degradates of oryzalin, pendimethalin, and trifluralin. Estimates quantifying potential exposure of listed salmonids and their habitat to these transformation products were not provided. Generally, all three of the a.i.s degrade slowly, and most of the degradates occur as less than 10% of the applied parent compound, thus EPA did not include them in the analysis. EPA noted there was little or no toxicological data on degradates of any of the a.i.s. NMFS did not locate any information on the degradates in our literature survey. Many of the degradates for all three a.i.s retain the characteristic dinitroaniline structure, and all known degradates of trifluralin still have the trifluro- sidechain. All degradates occur in relatively small amounts, but the total toxic residue of parent plus degradates is likely slightly higher than estimates for the parent alone. We believe exposure to degradates increases risk slightly. While we cannot specifically quantify this increased risk, total toxic residues are in the range of parent estimates plus approximately 10%.

B. Additional Active Ingredients

As discussed in the *Mixture Analysis* section above, pesticide products containing multiple a.i.s are common. While the a.i.s will move through the environment at different rates, it is reasonable to believe that all a.i.s in a given pesticide formulation will co-occur in receiving waters, especially from drift deposition and in the first runoff from the field following application. Some of the products containing oryzalin, pendimethalin, and trifluralin contain co-formulated a.i.s and many of them recommend tank mixes or co-application with other pesticides. Most of the pesticides recommended are herbicides with slightly different modes of action. Our presumption is a mixture of herbicides with different modes of action will cause more greater effects on aquatic and terrestrial plants than a single a.i. For instances when the additional a.i. is the same chemical class (*i.e.,* benfluralin) we assume the effects would be additive, with some adjustment for relative potencies.

Potential effects on fish and/or aquatic invertebrates are more difficult to predict. It is reasonable to assume co-applied a.i.s will occur in some combination in nearby aquatic habitats. Specific interactions between additional a.i.s in products and tank mixes and the a.i.s addressed in this Opinion are mostly unknown, but it is reasonable to assume toxicity of the a.i.s may be enhanced. In general, exposure to other active ingredients in pesticide products and tank mixes is expected to increase adverse effects to salmonids and their habitat.

C. Inert/other ingredients

In addition to a.i.s, pesticide products contain other ingredients which are sometimes referred to as the inert ingredients. Some of these ingredients are toxic to aquatic organisms or increase the toxicity of the active ingredients. As with tank mixes, the likelihood of these compounds co-occurring in the water column is difficult to determine with any specificity, but can reasonably be presumed to occur in spray drift deposition and runoff following applications. The other ingredients may make up the majority of the pesticide formulation, but few are required to be specifically identified by pesticide labels. Examples of these ingredients include various paraffin-based petroleum hydrocarbons used in crop oil concentrates. Other examples are nonylphenol polyethoxylates, which have been linked to endocrine disruption and were addressed at length in previous Opinions on EPA pesticide registrations (NMFS, 2008e, 2009c, 2010). There are a myriad of other ingredients, some of which may increase the toxicity of the a.i.s. The majority of a pesticide formulation is often composed of inert ingredients. Consequently, salmonid exposure to these ingredients may be greater than exposure to the assessed active ingredient. EPA currently has no specific method of accounting for this potential additional toxicity and risk, but must be considered in the analysis. NMFS has opted to address the uncertainty associated with these ingredients in a qualitative sense. Collectively, the available lines of evidence support the overall hypothesis that other stressors of the action cause adverse effects to salmonids and their habitat.

From our review of the available information it is not possible to accurately quantify the contribution of other stressors of the action. These stressors include the additional a.i.s and inert/other ingredients in pesticide formulations as well as tank mixes. These stressors of the action are an important consideration when assessing potential effects on listed salmonids and their habitat. Thus, to provide the benefit of the doubt to the species, we assume these stressors of the action will contribute additional, unquantifiable reductions in fitness to individuals beyond that of oryzalin, pendimethalin, and trifluralin.

Risk hypothesis 5. Exposure to other pesticides present in the action area can act in combination with the three a.i.s to increase effects on salmonids and their habitat.

Environmental mixtures of pesticides are common. We found no data evaluating the response of aquatic species to mixtures containing the three a.i.s. Toxicity investigations with pesticide mixtures reveal that responses of aquatic species are variable, and will depend on the composition of the mixture, concentrations of the a.i.s, modes of action and duration of exposure. Additionally, sequential exposures from other pesticides in the action area are reasonably expected to increase effects to salmonids and their habitats if and when they impact the same environmental receptors. For example, in addition to oryzalin, pendimethalin, and trifluralin there are many other herbicides used in the action area which may also reduce primary production. Therefore, based on the available toxicity and exposure data, we assume exposure to other pesticides present in the action area will act in combination with the three a.i.s to increase the effect on salmonids and their habitat.

Risk hypothesis 6. Exposure to elevated temperatures can enhance the toxicity of the stressors of the action.

We reviewed the available information to determine whether empirical data indicated enhanced toxicity at elevated temperatures for the a.i.s assessed in this opinion. We located one study specifically addressing temperature interactions with one of a.i.s and it did show an effect. No data were available for the other two, and we have assumed the effect noted applies to all the dinitroaniline considered in this opinion. Higher water temperatures can increase the metabolic rate for fish, thus increasing the rate at which they process the toxicant. Depending on the chemical, this may be either beneficial or detrimental. Water temperatures higher than optimum also increase general physiological stress for salmonids, making them more susceptible to other stressors.

Evaluation of Critical Habitat Risk Hypotheses

We use toxicity and exposure information presented in the *Effects of the Proposed Action* section to evaluate the scientific lines of evidence supporting or refuting risk hypotheses developed for critical habitats. The PCEs identified for salmon are freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, estuarine areas, and nearshore marine areas[18]. Each of the PCEs includes a number of essential physical and biological features. These features vary by PCE, but all include water quality. Water quality parameters are not specifically defined in most of the listing and critical habitat designation documents. For a chemical-based analysis such as this pesticide opinion, we define adequate water quality as having no concentrations of Federal action-related contaminants high enough to impair fitness of individual listed salmonids, decrease primary productivity, or reduce prey populations. Other water quality parameters which might interact with stressors of the action are temperature and suspended sediment, although they themselves are not stressors of the action. All PCEs other than the freshwater

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[18] Puget Sound is considered a nearshore marine area due to depth and hydrology.

spawning sites include natural cover and forage as additional essential physical and biological features. The freshwater spawning PCE also includes suitable substrate as a physical and biological feature. Natural cover includes in-stream vegetation.

Based on a co-occurrence analysis, we found use sites for all three a.i.s are near freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, estuarine areas, and nearshore marine areas[19] within designated critical habitats. Drift and/or runoff containing oryzalin, pendimethalin, and/or trifluralin from these use sites may enter these water bodies, thus the habitat is likely to be exposed to the stressors of the action over the 15-year registration duration.

Risk hypothesis 1. Exposure to the stressors of the action is sufficient to degrade water quality and substrates in freshwater spawning sites.

Freshwater spawning sites require water quality and substrate conditions that support spawning, incubation, and larval development. Salmon often, but not always spawn in small headwater streams, in an upwelling area where there is sufficient water flow to keep the redds oxygenated. Fry sometimes move to lower-flow rearing habitats soon after emergence. If they do feed following emergence, prey items are generally very small. The best estimators of water quality degradation for these habitats are fish sublethal endpoints, fish growth and reproduction endpoints, and prey growth and reproduction endpoints.

For oryzalin, sublethal endpoints, fish growth and reproduction endpoints, and prey growth and reproduction endpoints are likely to be affected at concentrations of 100 – 1,000 μg/L. These concentrations correspond with floodplain estimates and the high monitoring concentration, but are higher than PRZM-EXAMS EECs and most monitoring concentrations.

For pendimethalin, fish growth and reproduction endpoints, and prey growth and reproduction endpoints are likely to be affected at concentrations of 1 – 10 μg/L. We located no data regarding sublethal endpoints for pendimethalin. Concentrations of 1 – 10 μg/L correspond with

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[19] Puget Sound is considered a nearshore marine area due to depth and hydrology.

PRZM-EXAMS EECs, are higher than monitoring concentrations, and lower than floodplain estimates.

Trifluralin causes vertebral deformities in fish, fish growth and reproduction endpoints, and prey growth and reproduction endpoints at concentrations of 1 – 10 μg/L. These concentrations correspond with PRZM-EXAMS EECs, are higher than monitoring concentrations, and lower than floodplain estimates.

Based on allowable application timings of the pesticide products, we expect episodes of water quality degradation to coincide with spawning and emergence events within spawning habitats for some ESUs/DPSs. The levels of contamination expected are highly variable resulting from the diversity of species spawning habitats (small, shallow, first and second order streams to mainstem rivers with variable flow patterns) and year-to-year variation in climate and pesticide applications.

Based on a comparison of the endpoints with measured and estimated environmental concentrations, we believe it is possible but not likely water quality in spawning habitats will be degraded by oryzalin in some ESUs/DPSs where use sites are near the waterbody. We believe it is likely water quality will sometimes be degraded by pendimethalin and trifluralin in spawning habitats in some ESUs/DPSs where use sites are near the waterbody. Another factor to consider is whether concentrations of the a.i.s degrade the water quality sufficiently to kill spawning adults. For all three a.i.s, only the floodplain estimates indicated concentrations of the a.i. alone will reach this level. We believe it is possible but very unlikely spawning adults will be killed by any of the a.i.s.

Risk hypothesis 2. Exposure to the stressors of the action is sufficient to degrade water quality, natural cover, and/or reduce prey availability in freshwater rearing sites.

Freshwater rearing sites need to provide good water quality, abundant forage, and cover to support juvenile development. Reductions in any of these attributes can limit the existing and potential carrying capacity of rearing sites and subsequently reduce their conservation value. Recovery of listed salmonid populations is closely tied to the ability of juveniles to fully develop, mature, and grow during freshwater residency periods. All species of Pacific salmonids spend some amount of time in freshwater feeding and rearing areas. Chum salmon use fresh water for the shortest periods (generally a few days). Chinook, coho, steelhead, and sockeye salmon spend much longer periods rearing in freshwater systems, with steelhead trout spending up to several years before ocean migration. Freshwater rearing areas are diverse, extensive, and complex sites that can range from small, shallow, intermittent floodplain habitats to channel edges of large river systems. As such, expected concentrations range from some of the highest estimates (via spray drift into floodplain habitats) to some of the lowest estimates (monitoring results from large rivers). Many freshwater salmonid rearing sites are located in floodplains where shallow, low flow habitats are at high risk of pesticide drift and runoff. These habitats provide some of the most important foraging areas for developing juveniles.

The best estimators of water quality degradation for these habitats are fish sublethal endpoints, fish growth and reproduction endpoints, and prey growth and reproduction endpoints. Fish survival is also important in these habitats, but is affected at higher concentrations than fish sublethal, growth, and reproduction endpoints. Natural cover is an essential feature in this PCE, as is abundant forage. Thus, aquatic plant endpoints and invertebrate survival, growth, and reproduction endpoints are relevant.

For oryzalin, aquatic plants are the most sensitive endpoints, with EC_{50}s in the 10 – 100 μg/L. These concentrations correspond with PRZM-EXAMS EECs, but are higher than most monitoring concentrations, and would definitely be affected at concentrations predicted by floodplain estimates. Fish sublethal endpoints, fish growth and reproduction endpoints, and prey growth and reproduction endpoints are likely to be affected at concentrations of 100 – 1,000 μg/L. These concentrations correspond with floodplain estimates and the high monitoring concentration, but are higher than PRZM-EXAMS EECs and most monitoring concentrations. Fish and aquatic invertebrate survival endpoints are affected at concentrations >1,000 μg/L, which are lower than all but the highest floodplain estimates. We believe degradation of water quality sufficient to affect aquatic plant communities is highly likely in ESUs/DPSs where use sites are located near rearing sites. Water quality may be sufficiently degraded to affect fish and aquatic invertebrate growth and reproduction in some rearing sites, especially shallow, low-flow ones. We believe it is unlikely water quality will be degraded to such an extent fish would die from oryzalin use.

For pendimethalin, fish growth and reproduction endpoints, and prey growth and reproduction endpoints, and aquatic plants are likely to be affected at concentrations of 1 – 10 μg/L. We located no data regarding sublethal endpoints for pendimethalin. Concentrations of 1 – 10 μg/L correspond with PRZM-EXAMS EECs, are higher than monitoring concentrations, and lower than floodplain estimates. Fish and invertebrate survival endpoints are affected at concentrations of 10 – 100 μg/L. These concentrations are higher than higher than monitoring concentrations and PRZM-EXAMS EECs but lower than floodplain estimates. Fish and aquatic invertebrate survival is affected by pendimethalin at concentrations >100 μg/L. Only floodplain estimates are >100 μg/L. We believe degradation of water quality sufficient to affect aquatic plant communities, fish growth and reproduction, and aquatic invertebrate growth and reproduction is likely in ESUs/DPSs where use sites are located near rearing sites, especially shallow, low-flow ones. We believe it is unlikely water quality will be degraded to such an extent fish and/or aquatic invertebrates will die from pendimethalin use.

Trifluralin causes vertebral deformities in fish, decreases fish growth and reproduction endpoints, and decreases prey growth and reproduction at concentrations of 1 – 10 μg/L. These concentrations correspond with PRZM-EXAMS EECs, are higher than monitoring concentrations, and lower than floodplain estimates. We are particularly concerned about the potential for vertebral deformities in juvenile fish. Fish survival is affected at concentrations of 10 – 50 μg/L. We believe degradation of water quality sufficient to affect aquatic plant communities, fish growth and reproduction, and aquatic invertebrate growth and reproduction is likely in ESUs/DPSs where use sites are located near rearing sites, especially shallow, low-flow ones. We believe it is unlikely, but possible water quality will be degraded to such an extent fish and/or aquatic invertebrates will die from trifluralin use.

Based on allowable application timings of the pesticide products, we expect episodes of water quality degradation to coincide with rearing in most ESUs/DPSs. The levels of contamination expected are highly variable due to the diversity of habitats.

Risk hypothesis 3. Exposure to the stressors of the action is sufficient to degrade water quality, natural cover, and/or reduce prey availability in freshwater migration corridors.

Essential physical and biological features defined for freshwater migration corridors include good water quality, natural cover, and sufficient forage to support both juveniles (ocean migration) and adults (spawning migration). Species vary widely in how much time they spend in migration corridors during in-migration and out-migration. In most cases, designated critical habitat classified as a migratory corridor is a large river, such as the Columbia and the Snake or estuaries connecting the upland rivers with the ocean. Salmon also migrate through a variety of smaller stream networks. Based on allowable application timings of the pesticide products, we expect inputs of the a.i.s and other stressors of the action will sometimes coincide with salmon migrations. For some ESUs/DPSs, salmon may experience multiple input events during the migration. Available natural cover, including vegetation, and adequate forage during the migration are important to avoid predation and maintain body condition.

The best estimators of water quality degradation for these habitats are fish sublethal endpoints, aquatic plant endpoints and fish and invertebrate survival endpoints. Fish and aquatic invertebrate growth and reproduction endpoints are also important.

For oryzalin, aquatic plants are the most sensitive endpoints, with EC_{50}s in the 10 – 100 μg/L. These concentrations correspond with PRZM-EXAMS EECs, but are higher than most monitoring concentrations, and would definitely be affected at concentrations predicted by floodplain estimates. Fish sublethal endpoints, fish growth and reproduction endpoints, and prey growth and reproduction endpoints are likely to be affected at concentrations of 100 – 1,000 μg/L. These concentrations correspond with floodplain estimates, but are higher than PRZM-EXAMS EECs and most monitoring concentrations. Fish and aquatic invertebrate survival endpoints are affected at concentrations >1,000 μg/L, which are lower than all but the highest floodplain estimates. We believe degradation of water quality sufficient to affect aquatic plant communities is highly likely in ESUs/DPSs where use sites are located near migratory corridors.

Water quality may be sufficiently degraded to affect fish and aquatic invertebrate growth and reproduction in some locations, especially shallow, low-flow ones. We believe it is unlikely water quality will be degraded to such an extent fish would die from oryzalin use.

For pendimethalin, fish growth and reproduction endpoints, and prey growth and reproduction endpoints, and aquatic plants are likely to be affected at concentrations of 1 – 10 μg/L. We located no data regarding other sublethal endpoints for pendimethalin. Concentrations of 1 – 10 μg/L correspond with PRZM-EXAMS EECs, are higher than monitoring concentrations, and lower than floodplain estimates. Fish and invertebrate survival endpoints are affected at concentrations of 10 – 100 μg/L. These concentrations are higher than monitoring concentrations and PRZM-EXAMS EECs but lower than floodplain estimates. Fish and aquatic invertebrate survival is affected by pendimethalin at concentrations >100 μg/L. Only floodplain estimates are >100 μg/L. We believe degradation of water quality sufficient to affect aquatic plant communities, fish growth and reproduction, and aquatic invertebrate growth and reproduction is likely in ESUs/DPSs where use sites are located near migratory corridors, especially shallow, or low-flow ones. We believe it is unlikely water quality will be degraded to such an extent fish and/or aquatic invertebrates will die from pendimethalin use.

Trifluralin causes vertebral deformities in fish, decreases fish growth and reproduction endpoints, and decreases prey growth and reproduction at concentrations of 1 – 10 μg/L. These concentrations correspond with PRZM-EXAMS EECs, are higher than monitoring concentrations, and lower than floodplain estimates. We are particularly concerned about the potential for vertebral deformities in juvenile fish. Fish survival is affected at concentrations of 10 – 50 μg/L. These concentrations are higher than PRZM-EXAMS EECs and monitoring concentrations. We believe degradation of water quality sufficient to affect aquatic plant communities, fish growth and reproduction, and aquatic invertebrate growth and reproduction is likely in ESUs/DPSs where use sites are located near migratory corridors. We believe it is unlikely, but possible water quality will be degraded to such an extent fish and/or aquatic invertebrates will die from trifluralin use.

Risk hypothesis 4. Exposure to the stressors of the action is sufficient to degrade water quality, natural cover, and/or reduce prey availability in estuarine areas.

Essential physical and biological features in estuarine areas also include water quality, natural cover and forage. Some species, especially chum, use estuarine areas for rearing. Others species use the estuary as a portion of their migratory route. Some species undergo the physiological transition (smoltification) necessary to live in saltwater while resident in the estuary. In some ESUs/DPSs the immediate watershed includes heavily agricultural land. Others have highly developed areas on sections of the shoreline. As estuaries frequently receive inflow from more than one river, or from large rivers draining multiple tributaries, the water often contains complex chemical mixtures. Unfortunately, many monitoring programs are focused above head-of-tide, so these mixtures are not well characterized. Due to tidal action, residence time of water and consequent exposure to waterborne contaminants is typically longer than in free-flowing streams. There is a higher volume of water in many estuarine habitats then some other habitat areas. In general, exposure to the three a.i.s and other stressors of the action is probably best characterized as long term exposure at lower concentrations than habitats immediately next to use sites.

The best estimators of water quality degradation for these habitats are fish sublethal endpoints, fish and aquatic invertebrate growth and reproduction endpoints, aquatic plant endpoints and fish and invertebrate survival endpoints. Monitoring concentrations and PRZM-EXAMS EECs are probably more reflective of exposure conditions in most estuarine areas than floodplain estimates. All of the dinitroanilines addressed in this opinion will partition to suspended sediment or bed sediment to an extent. Dissolved phase oryzalin and trifluralin will be affected by photolytic reactions in shallow and/or clear waters. However, total half-life in aquatic systems is sufficiently long that some portion of the a.i.s entering upstream will end up in the estuaries.

Aquatic plants are the most sensitive of the assessment endpoints to the effects of oryzalin, with EC_{50}s in the 10 – 100 μg/L. These concentrations correspond with PRZM-EXAMS EECs, but are higher than most monitoring concentrations. Fish sublethal endpoints, fish growth and reproduction endpoints, and prey growth and reproduction endpoints are likely to be affected at concentrations of 100 – 1,000 μg/L. These concentrations correspond with the high monitoring concentration, but are higher than PRZM-EXAMS EECs and most monitoring concentrations. Fish and aquatic invertebrate survival endpoints are affected at concentrations >1,000 μg/L, which are lower than all but the highest floodplain estimates. We believe degradation of water quality sufficient to affect aquatic plant communities is likely in ESUs/DPSs where use sites are located near the estuary, and/or with extensive use sites upstream. Water quality may be sufficiently degraded to affect fish and aquatic invertebrate growth and reproduction in some locations. We believe it is unlikely water quality in estuarine habitats will be degraded to such an extent fish would die from oryzalin use.

For pendimethalin, fish growth and reproduction endpoints, and prey growth and reproduction endpoints, and aquatic plants are likely to be affected at concentrations of 1 – 10 μg/L. We located no data regarding other sublethal endpoints for pendimethalin. Concentrations of 1 – 10 μg/L correspond with PRZM-EXAMS EECs, but are higher than monitoring concentration. Fish and invertebrate survival endpoints are affected at concentrations of 10 – 100 μg/L. These concentrations are higher than monitoring concentrations and PRZM-EXAMS EECs. Fish and aquatic invertebrate survival is affected by pendimethalin at concentrations >100 μg/L. Only floodplain estimates are >100 μg/L. We believe degradation of water quality sufficient to affect aquatic plant communities, fish growth and reproduction, and aquatic invertebrate growth and reproduction is likely in ESUs/DPSs where use sites are located near the estuary. Given pendimethalin's strong tendency to sorb to soil and sediment, we believe it is unlikely to be transported to the estuary from upstream use sites. We believe it is unlikely water quality in estuaries will be degraded to such an extent fish and/or aquatic invertebrates will die from pendimethalin use.

Trifluralin causes vertebral deformities in fish, decreases fish growth and reproduction endpoints, and decreases prey growth and reproduction at concentrations of 1 – 10 μg/L. These concentrations correspond with PRZM-EXAMS EECs and are higher than monitoring concentrations. We are particularly concerned about the potential for vertebral deformities in juvenile fish. Fish survival is affected at concentrations of 10 – 50 μg/L. These concentrations are higher than PRZM-EXAMS EECs and monitoring concentrations. We believe degradation of water quality sufficient to affect aquatic plant communities, fish growth and reproduction, and aquatic invertebrate growth and reproduction is likely in ESUs/DPSs where use sites are located near the estuary and/or there are use sites upstream. We believe it is unlikely, but possible estuarine water quality will be degraded to such an extent fish and/or aquatic invertebrates will die from trifluralin use.

Risk hypothesis 5. Exposure to the stressors of the action is sufficient to degrade water quality, natural cover, and/or reduce prey availability in nearshore marine areas.

Essential physical and biological features in estuarine areas also include water quality, natural cover and forage. Nearshore marine areas include the Puget Sound, and areas along the California, Oregon, and Washington coasts. Puget Sound is included in this group rather than in estuarine habitat because of its depth and hydrology. The bottom contour of Puget Sound is fjord-like rather than being a drowned river valley. There is a rock sill at the entrance, and water in the Sound has a long residence time. Functionally, the salmon species in ESUs/DPSs which include Puget Sound use it in the same way other ESUs/DPSs use estuaries. They pass through it during migration, and undergo smoltification in the estuary. Some species reside in the Sound as part of rearing.

In some ESUs/DPSs watershed (s) adjacent to the nearshore marine habitat includes agricultural land or highly developed areas on sections of the shoreline. As these areas frequently receive water input from both the open ocean and rivers, contaminant composition is difficult to predict and may vary widely both spatially and temporally. There is a higher volume of water in these habitats then some other habitat areas. In general, exposure to the three a.i.s addressed in this opinion and other stressors of the action is probably best characterized as lower concentrations than habitats immediately next to or downstream of use sites.

The best estimators of water quality degradation for these habitats are fish sublethal endpoints, fish and aquatic invertebrate growth and reproduction endpoints, aquatic plant endpoints and fish and invertebrate survival endpoints. Monitoring concentrations and PRZM-EXAMS EECs are probably more reflective of exposure conditions in most estuarine areas than floodplain estimates. All of the dinitroanilines addressed in this opinion will partition to suspended sediment or bed sediment to an extent. Dissolved phase oryzalin and trifluralin will be affected by photolytic reactions in shallow and/or clear waters. However, total half-life in aquatic systems is sufficiently long that some portion of the a.i.s entering upstream will end up in the nearshore marine zone.

Aquatic plants are the most sensitive of the assessment endpoints to the effects of oryzalin, with EC_{50}s in the 10 – 100 μg/L. These concentrations correspond with PRZM-EXAMS EECs, but are higher than most monitoring concentrations. Fish sublethal endpoints, fish growth and reproduction endpoints, and prey growth and reproduction endpoints are likely to be affected at concentrations of 100 – 1,000 μg/L. These concentrations correspond with one high monitoring concentration and floodplain estimates, but are higher than PRZM-EXAMS EECs and most monitoring concentrations. Fish and aquatic invertebrate survival endpoints are affected at concentrations >1,000 μg/L, which are lower than all but the highest floodplain estimates. We believe degradation of water quality sufficient to affect aquatic plant communities may occur in ESUs/DPSs where use sites are located adjacent to the nearshore marine area. Water quality may be sufficiently degraded to affect fish and aquatic invertebrate growth and reproduction in some locations. We believe it is unlikely water quality in nearshore marine habitats will be degraded to such an extent fish would die from oryzalin use.

For pendimethalin, fish growth and reproduction endpoints, and prey growth and reproduction endpoints, and aquatic plants are likely to be affected at concentrations of 1 – 10 μg/L. We located no data regarding other sublethal endpoints for pendimethalin. Concentrations of 1 – 10 μg/L correspond with PRZM-EXAMS EECs, but are higher than monitoring concentrations. Fish and invertebrate survival endpoints are affected at concentrations of 10 – 100 μg/L. These concentrations are higher than monitoring concentrations and PRZM-EXAMS EECs. Fish and aquatic invertebrate survival is affected by pendimethalin at concentrations >100 μg/L. We believe degradation of water quality sufficient to affect aquatic plant communities, fish growth and reproduction, and aquatic invertebrate growth and reproduction may occur in ESUs/DPSs where use sites are located adjacent the nearshore marine. Given pendimethalin’s strong tendency to sorb to soil and sediment, we believe it is unlikely to be transported to the estuary from upstream use sites. We believe it is unlikely water quality in nearshore marine habitats will be degraded to such an extent fish and/or aquatic invertebrates will die from pendimethalin use.

Trifluralin causes vertebral deformities in fish, decreases fish growth and reproduction endpoints, and decreases prey growth and reproduction at concentrations of 1 – 10 μg/L. These concentrations correspond with PRZM-EXAMS EECs and are higher than monitoring concentrations. We are particularly concerned about the potential for vertebral deformities in juvenile fish. Fish survival is affected at concentrations of 10 – 50 μg/L. These concentrations are higher than PRZM-EXAMS EECs and monitoring concentrations. We believe degradation of water quality sufficient to affect aquatic plant communities, fish growth and reproduction, and aquatic invertebrate growth and reproduction may occur in ESUs/DPSs where use sites are located adjacent to nearshore marine habitat. We believe it is unlikely water quality in nearshore marine habitats will be degraded to such an extent fish and/or aquatic invertebrates will die from trifluralin use.

Summary of Risk Hypotheses Evaluations for Individual Salmonids and Designated Critical Habitat.

In our evaluation the individual salmon and designated critical habitat risk hypotheses, we determine if there is sufficient information to support each of the risk hypotheses. This is a binary yes-no decision as to whether we consider that risk hypothesis in the next level of our analysis. The *Effects* section of the opinion is specific to each a.i., but does not evaluate the unique characteristics of each ESU/DPS and its associated designated critical habitat

In general, we found support for most individual-based risk hypotheses. The exception was degradation of riparian vegetation (risk hypothesis 2B). We located no information on the effects of the dinitroanilines on salmon olfaction. We found support for all risk hypotheses for designated critical habitat and those will be carried forward in the analysis as appropriate for each ESU/DPS. Not all ESU/DPS have all types of designated critical habitat considered, and two ESUs/DPSs do not have designated critical habitat. Individual-based risk hypotheses are summarized in Table 110 and designated critical habitat risk hypotheses are summarized in Table 111.

Table 110. Summary of individual-based risk hypotheses

Risk Hypotheses	Is fitness of individual salmon potentially affected?		
	Oryzalin	Pendimethalin	Trifluralin
1.A. Kill salmonids from direct, acute exposure	Yes	Yes	Yes
1. B. Reduce salmonid survival through impacts to growth or development	Yes	Yes	Yes
1. C. Reduce salmonid growth through impacts on the availability and quantity of salmonid prey	Yes	Yes	Yes
1. D. Reduce survival, migration, and reproduction through impacts to olfactory-mediated behaviors	No data	No data	No data
2.A. Reduce aquatic primary producers, thereby affecting salmonid prey communities and salmonids	Yes	Yes	Yes
2.B. Reduce riparian vegetation to such an extent that stream temperatures are elevated, erosion increases, and reduction in inputs of woody debris and other organic matter occurs	No	No	No
3. Exposure to mixtures of oryzalin, pendimethalin, and trifluralin concurrently increases adverse effects on assessment endpoints	Yes	Yes	Yes
4. Exposure to other stressors of the action including degradates, additional a.i.s and inert/other ingredients in formulations and tank mixes cause adverse effects to salmonids and their habitat	Yes	Yes	Yes
5. Exposure to other pesticides present in the action area can act in combination with the three a.i.s to increase effects to salmonids and their habitat	Yes	Yes	Yes
6. Exposure to elevated temperatures can enhance the toxicity of the stressors of the action	Yes	Yes	Yes

Table 111. Summary of individual-based risk hypotheses

Risk Hypotheses	Are PCEs potentially degraded?		
	Oryzalin	Pendimethalin	Trifluralin
1. Degradation of water quality and substrates in freshwater spawning sites	Yes	Yes	Yes
2. Degradation of water quality, natural cover, and/or prey reduction in freshwater rearing sites	Yes	Yes	Yes
3. Degradation of water quality, natural cover, and/or prey reduction in freshwater migration corridors	Yes	Yes	Yes
4.. Degradation of water quality, natural cover, and/or prey reduction in estuarine areas.	Yes	Yes	Yes
5. Degradation of water quality, natural cover, and/or prey reduction in nearshore marine areas.	Yes	Yes	Yes

Considering Various Elements of Uncertainty

Given the range of elements affecting the outcome of a fish or other organism exposed to a specific concentration of a pesticide or other toxicant, it is not enough to simply compare the laboratory generated assessment endpoint for a single a.i. to a measured or estimated concentration of that a.i. This fails to account for other factors, influencing the outcome. However, it is also difficult to quantify the effect of these other stressors in a simple fashion. One potential method of accounting for the other stressors is the use of a safety factor. For ecotoxicology, “standard” safety factors are problematic, as environmental stressors may interact very differently with different chemical classes. Additionally, some types of interactions are well-documented, others are only hypothesized, and some likely are as of yet undiscovered.

OPP deals with the uncertainties by using pre-established levels of concern (LOCs) compared to risk quotients (RQs) generated by comparing the highest EECs to the most sensitive endpoint for several generic taxa (EPA, 2004a). For listed aquatic species, the LOC used for acute effects is 0.05 (essentially 1/20th of the LC_{50}) and the LOC for chronic effects is 1 (compared to the NOAEC). For prey items the acute LOC is 0.5 (1/2 of the EC_{50}) and the LOC for chronic effects is 1 (compared to the NOAEC). For non-listed plants the LOC is 1, and the endpoints used are the EC_{50} for aquatic plants and EC_{25} for terrestrial plants. OPP does not have an LOC to address any sublethal effects other than impairments in reproduction or growth.

In general, NMFS does not concur that the 0.05 LOC used by OPP is adequately protective of listed aquatic species as it does not fully account for potential sublethal effects. While use of the NOAEC will in most cases be more protective, OPP compares this value to EECs averaged over 21 d (aquatic invertebrates) or 60 d (fish) periods. Thus, it also does not account for quick onset sublethal effects such as the rapid bioconcentration of trifluralin and subsequent vertebral deformities, or the disorientation caused by acetylcholinesterase inhibitors. Table 112 shows concentrations of concern calculated by applying OPP's protocol. In our survey of the open literature, we located information on sublethal effects for both oryzalin and trifluralin. We located nothing regarding sublethal effects caused by pendimethalin. We note there was little literature on the effects of pendimethalin in general, thus no identification of sublethal effects more likely reflects the lack of research rather than the absence of effects. Oryzalin was found to induce intersex lesions in fish at concentrations of 250 – 1,000 μg/L. The NOAECs for vertebral deformities caused by trifluralin range from 1.7 – 23 μg/L.

Table 112. Concentrations of concern for oryzalin, pendimethalin, and trifluralin based on OPP's pre-established LOCs

OPP Standard Assessment Endpoint	Concentration of Concern (μg/L)[1]		
	Oryzalin	Pendimethalin	Trifluralin
Fish LC_{50}	144	6.9	2.1
Fish NOAEC	220	6.3	2.1
Aquatic invertebrate EC_{50}	750	140	126
Aquatic invertebrate NOAEC	358	14.5	2.4
Aquatic plant EC_{50}	13	5.2	22
Terrestrial plant EC_{25}	0.12 lb a.i./A	0.38 lb a.i./A	0.19 lb a.i./A

1 Except concentrations of concern for terrestrial plants, which are given in lb a.i./A

Based on what information we have located regarding these a.i.s and what we know about additional chemicals, the status of these ESU/DPS, the many other stressors chemical and otherwise in the environmental baseline it is our best professional judgement there should be a margin of one to two orders of magnitude (10 – 100X) between laboratory generated a.i.-specific endpoints and environmental concentrations deemed likely to cause risk.

Chemical-specific Risk Conclusions

Based on all lines of evidence, and considering the effects of other environmental stressors our best professional judgement is that:

- Based on effects from the a.i. alone, oryzalin is likely to cause modifications in aquatic plant community structure at water concentrations of ≥ 10 μg/L, and adverse effects on aquatic invertebrates and fish at water concentrations of ≥ 100 μg/L
- Based on effects from the a.i. alone, pendimethalin is likely to cause modifications in aquatic plant community structure, adverse effects on aquatic invertebrates, and adverse effects on fish at water concentrations of ≥ 1 μg/L
- Based on effects from the a.i. alone, trifluralin is likely to cause modifications in aquatic plant community structure, adverse effects on aquatic invertebrates, and adverse effects on fish at water concentrations of ≥ 1 μg/L

The degree to which the a.i.s will affect each specific ESU/DPS is in large part dependent on the extent of use sites and spatial distribution of use sites in the relevant watershed(s). ESU/DPS specific determinations are made in the *Integration and Synthesis* section.

Cumulative Effects

Cumulative effects include the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the action area considered by this Opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

During this consultation, NMFS searched for information on future state, tribal, local, or private actions that were reasonably certain to occur in the action area. NMFS conducted electronic searches of business journals, trade journals, and newspapers using Google and other electronic search engines. Those searches produced reports on projected population growth, commercial and industrial growth, and global warming. Trends described below highlight the effects of population growth on existing populations and habitats for all 28 ESUs/DPSs. Changes in the near-term (five-years; 2017) are more likely to occur than longer-term projects (10-years; 2022). Projections are based upon recognized organizations producing best available information and reasonable rough-trend estimates of change stemming from these data. NMFS analysis provides a snapshot of the effects from these future trends on listed ESUs.

The states of the west coast region, which contribute water to and withdraw water from major river systems, are projected to have the most rapid growth of any area in the U.S. within the next few decades. California, Idaho, Oregon, and Washington are forecasted to have double digit increases in population for each decade from 2000 to 2030 (USCB, 2005). Overall, the west coast region has a projected population of 72.2 million people in 2010. The U.S. Census Bureau predicts this figure will grow to 76.8 million in 2015 and 81.6 million in 2020.

Although general population growth stems from development of metropolitan areas, growth in the western states is projected from the enlargement of smaller cities rather than from major metropolitan areas. Of the 46 western state metropolitan areas that experienced a 10% growth or greater between 2000 and 2008, only seven have populations greater than one million people. Of these major cities, one and two cities are from Oregon and California, respectively. They include

Portland-Vancouver-Beaverton, OR (1.81% per year), Riverside-San Bernadino-Ontario, CA (3.31% per year), and Sacramento-Arden-Arcade-Roseville, CA (2.18% per year) (USCB, 2009).

As these cities border coastal or riverine systems, diffuse and extensive growth will increase overall volume of contaminant loading from wastewater treatment plants and sediments from sprawling urban and suburban development into riverine, estuarine, and marine habitats. Urban runoff from impervious surfaces and existing and additional roadways may also contain oil, heavy metals, PAHs, and other chemical pollutants and flow into state surface waters. Inputs of these point and non-point pollution sources into numerous rivers and their tributaries will affect water quality in available spawning and rearing habitat for salmon. Based on the increase in human population growth, we expect an associated increase in the number of NPDES permits issued and the potential listing of more 303(d) waters with high pollutant concentrations in state surface waters. Continued growth into forested and other natural areas will continue the cycle of altering landscapes to the detriment of salmon habitat. Altered landscapes adversely affect the delivery of sediment and gravel and significantly alter stream hydrology and water quality.

Mining has historically been a major component of western state economies. With national output for metals projected to increase by 4.3% annually, output of western mines should increase markedly (Figueroa & Woods, 2007). Increases in mining activity will add to existing significant levels of mining contaminants entering river basins. Given this trend, we expect existing water degradation in many western streams that feed into or provide spawning habitat for threatened and endangered salmonid populations will be exacerbated.

As the western states have large tracts of irrigated agriculture, a 2.2% rise in agricultural output is anticipated (Figueroa & Woods, 2007). Impacts from heightened agricultural production will likely result in two negative impacts on listed Pacific salmonids. The first impact is the greater use and application of pesticide, fertilizers, and herbicides and their increased concentrations and entry into freshwater systems. Oryzalin, pendimethatlin, and trifluralin and other pollutants from agricultural runoff may further degrade existing salmonid habitats. Second, increased output and water diversions for agriculture may also place greater demands upon limited water resources. Water diversions will reduce flow rates and alter habitat throughout freshwater systems. As water is drawn off, contaminants will become more concentrated in these systems, exacerbating contamination issues in habitats for protected species.

The western states are widely known for scenic and natural beauty, and are used recreationally by residents and tourists. Increases in use could place additional strain on the natural state of park and nature areas that are also occupied by protected species. However, hiking, camping, and recreational fishing in these natural areas is unlikely to have any extensive effects on water quality.

The above non-federal actions are likely to pose continuous unquantifiable negative effects on listed salmonids addressed in this Opinion. Each activity has negative effects on water quality. They include increases in sedimentation, increased point and non-point pollution discharges, decreased infiltration of rainwater (leading to decreases in shallow groundwater recharge, decreases in hyporrheic flow, and decreases in summer low flows).

Non-federal actions likely to occur in or near surface waters in the action area may also have beneficial effects on the 28 ESUs. They include implementation of riparian improvement measures, fish habitat restoration projects, and best management practices (*e.g.*, associated with timber harvest, grazing, agricultural activities, urban development, road building, recreational activities, and other non-point source pollution controls).

Considering the status of these ESU/DPS, all of which are listed as endangered or threatened and remain at risk, and their degraded designated critical habitat, the effects from the actions in the Environmental Baseline, including EPA's registration of the a.i.s of the past four recent Opinions,[20] the effects from anthropogenic growth on the natural environment will continue to affect and influence the overall distribution, survival, and recovery of Pacific salmonids in California, Idaho, Oregon, and Washington.

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[20] Opinion 1: chlorpyrifos, malathion, and diazinon; Opinion 2: carbaryl, carbofuran, and methomyl; Opinion 3: azinphos-methyl, dimethoate, phorate, methidathion, naled, methyl parathion, disulfoton, fenamiphos, methamidophos, phosmet, ethoprop, and bensulide; and Opinion 4: 2,4-D, triclopyr BEE, diuron, linuron, captan, and chlorothalonil.

Integration and Synthesis

Analysis for Listed Species

The *Integration and Synthesis* section describes NMFS' assessment of the potential for EPA's registration of oryazalin, pendimethalin, and trifluralin to reduce the reproduction, numbers or distribution of listed Pacific salmonids. This assessment is not made in isolation, but takes into account the status of the species, the many stressors present in the environmental baseline, and that are anticipated to occur as a result of the activities evaluated in the cumulative effects section

In the *Effects* section we described the effects we anticipate for individual salmon themselves due to direct toxicity from the active ingredients. We described anticipated direct effects due to exposure to other stressors of the action and interactions of multiple stressors of the action. We also discussed indirect effects to salmonids via effects on prey, primary productivity, and other habitat constituents. Summaries of effects expected based on our analysis of the a.i.s and other stressors of the action are presented below.

In this section we analyze the likelihood that effects of the a.i.s and other stressors of the action will reduce the reproduction, numbers, or distribution of listed Pacfic salmon within the context of the species-specific considerations discussed in the *Status of Listed Resources, Environmental Baseline*, and *Cumulative Effects* sections. We evaluate ESU/DPS-specific life history characteristics and distribution of pesticide use sites within their watersheds to determine the likelihood of exposure and probable effects on populations. This is accomplished by considering co-occurrence in both space (detailed in *Appendix 4*) and time (detailed in *Appendix 5*) of use sites. The full range of application rates for use sites within a landuse category are considered.

Based on our analysis, we evaluate whether use of the a.i. as registered will likely reduce the reproduction, numbers, or distribution of populations within each ESU/DPS. This likelihood is expressed qualitatively as low, medium, or high for each of the a.i.-ESU/DPS combinations.

Evaluating the Likelihood of Effects on Populations

Our exposure analysis begins at the organism (individual) level of biological organization. We consider the life stage and life histories of the individuals likely to be exposed. This scale of assessment is essential as adverse effects to individuals may result in population-level consequences, particularly for populations of extremely low abundance, (*i.e.* threatened and endangered species). Characterization of impacts to an individual's fitness is necessary to assess potential impacts to populations, and ultimately to the species.

We link the assessment endpoints and risk hypotheses we considered in the *Effects* section to reduction in the reproduction, numbers, or distribution of populations in the following way. Reductions in reproduction are caused by physiological or behavioral impairments which decrease the number of fish reaching spawning grounds, cause fish to mate unsuccessfully or not at all, or reduce the number or viability of eggs or young produced. Reductions in numbers are caused by direct lethality at any life stage, increased mortality due to predation or interaction with other stressors, or inability of the habitat to support normal growth and development of the fish (*e.g.*, decreased prey availability, lack of cover, reduced primary productivity). Unlike a dam or other physical barrier which can clearly be linked to a reduction in distribution because it blocks access, reductions in distribution caused by chemical stressors are more subtle. Reductions in distribution are typically the result of reductions in reproduction, numbers, or some combination thereof to the point the population no longer uses the affected waterbody and/or cannot recolonize it.

We considered the likelihood for appreciable reduction in the reproduction, numbers, or distribution of a population to be low if we expected that the a.i. and other stressors of the action would: rarely or never kill fish; would have minor or transient effects on physiological functions, would be unlikely to reduce reproduction, and would cause little or no reduction in prey availability, primary productivity, or cover.

We considered the likelihood for appreciable reduction in the reproduction, numbers, or distribution of a population medium if we expected: that the a.i and other stressors of the action might kill fish, but mortality would occur infrequently; they will have effects on other physiological functions, but not to the extent the fish are unable to complete life functions; they will cause minor reductions in reproduction; or they will cause some reduction in prey availability, primary productivity or cover. If we expected an a.i. whose effects meet the criteria for medium would not often reach salmon-bearing waters in certain ESU/DPSs based on landuse category, authorized use sites within that landuse category, and/or other restrictions the likelihood of appreciable reduction in the reproduction, numbers, or distribution of a population was considered low.

We considered the likelihood for appreciable reduction in the reproduction, numbers, or distribution of a population high if we expected that the a.i and other stressors of the action were expected to frequently kill fish; cause impairments of physiological functions to the extent that fish die or are unable to perform necessary life functions such as predator avoidance, foraging, and migration; to be likely to reduce reproduction, or to cause significant reduction in prey availability, primary productivity, or cover. If we expected an a.i. whose effects meet the criteria for high would not often reach salmon-bearing waters in certain ESU/DPSs, based onlanduse category, authorized use sites within that landuse category, and/or other restrictions, the likelihood of appreciable reduction in the reproduction, numbers, or distribution of a population may be considered medium or low.

Evaluating the Likelihood of Effects on Species

ESUs/DPSs are made up of discrete population(s) of salmon or steelhead. Each of these populations support the survival and recovery of the species, but may not all be equally affected by the use of an a.i.(s). Some ESUs/DPSs have been reduced to only one or two populations, others have more. However, in some cases, although there are a number of populations, one or two of these populations are particularly important to the species. Taking into account both the potential use of the various a.i.s, across the landscape, and the relative importance of various populations to the ESU/DPS, we determine the potential for appreciable reduction in the reproduction, numbers, or distribution of the species. This also is expressed qualitatively as low, medium, or high and summarized inTable 113.

The potential for appreciable reduction in reproduction, numbers, or distribution of the species was considered low in cases where the likelihood for appreciable reduction in reproduction, numbers, or distribution at the population level was low for all populations.

The potential for an appreciable reduction in reproduction, numbers, or distribution of the species was considered medium in cases where the likelihood for an appreciable reduction in reproduction, numbers, or distribution at the population level was medium for all or most populations. If the likelihood for an appreciable reduction in reproduction, numbers, or distribution at the population level was low for some populations, but medium for one or more populations particularly important to the ESU/DPS, likelihood for reductions at the species level was considered medium.

The potential for appreciable reduction in reproduction, numbers, or distribution of the species was considered high in cases where the likelihood for appreciable reduction in reproduction, numbers, or distribution at the population level was high for all or most populations. If the likelihood for appreciable reduction in reproduction, numbers, or distribution at the population level was low or medium for some populations, but high for one or more populations particularly important to the ESU/DPS, likelihood for reductions at the species level was considered high.

Determining Jeopardy

We present jeopardy and no jeopardy determinations (Table 115) based on consideration of the status of the species, the environmental baseline and cumulative effects. We believe high potential for reduction in the reproduction, numbers, or distribution of the species will jeopardize the ESU/DPS. We believe a low potential for reduction in the reproduction, numbers, or distribution of the species will not jeopardize the ESU/DPS. A medium potential for reduction in the reproduction, numbers, or distribution of the species sometimes may jeopardize and sometimes may not jeopardize the ESU/DPS, depending on circumstances associated with population(s) at risk, the relative importance of those populations to the ESU/DPS, and the characteristics and types and amount of use of the a.i under consideration, as well as the status of the species, the environmental baseline and cumulative effects.

Analysis for Critical Habitat

This section describes NMFS' assessment of the likelihood that EPA's registration of oryzalin, pendimethalin, and trifluralin will destroy or adversely modify designated critical habitat for the 26 ESUs/DPSs that have designated critical habitat covered in this Opinion. Critical habitat has not been designated for the LCR coho salmon and Puget Sound steelhead.

All species addressed in this Opinion have similar PCEs. These PCEs are sites supporting one or more life stages and include

1. freshwater rearing sites,
2. freshwater migration corridors,
3. estuarine areas,
4. nearshore marine areas, and
5. offshore marine areas.

These designated areas contain physical or biological features essential to the conservation of the ESU/DPS.

Essential physical and biological features include water quality, substrate, prey availability, and natural cover. Within this section we evaluate whether these adverse changes to PCEs affect the conservation value of designated critical habitat. Destruction or adverse modification of designated critical habitat is evaluated in this Opinion based on whether the stressors of the action are expected to cause reductions or community-level modifications in the in- and near-stream plant communities or reductions in water quality that may cause fish to have impaired health or greater susceptibility to other stressors.

As noted in the salmonid recovery plans and critical habitat designations, during all freshwater life stages, salmonids require cool water, free of contaminants. Water free of contaminants promotes normal fish behavior for successful migration, spawning, and juvenile rearing. In the juvenile life stage, salmonids also require stream habitat providing adequate cover and forage. Sufficient forage is necessary for juveniles to maintain growth, which subsequently reduces freshwater predation mortality, increases overwintering success, initiates smoltification, and improves their survival at sea. Natural cover, such as over-hanging vegetation and aquatic plants, provides juveniles protective shelters from predation and substrates for prey.

We start with the analyses presented in the *Effects* chapter. Modeling EECs and monitoring data are not ESU/DPS specific. Inherent in the modeling used to determine both PRZM-EXAMS and AgDrift EECs is the assumption that the pesticide is applied in a location next to or draining directly into designated critical habitat. Monitoring data may reflect pesticide applications proximate to the waterbody, or resulting from more distant uses in the watershed or airshed. In the *Exposure* NMFS used a GIS overlay containing landuse categories and salmon distributions to determine overlap of the landuse categories and designated critical habitat for each ESU/DPS. During the fifteen year period covered by this Opinion, market or environmental changes, including climate change, could result in shifting or rotation of crops. Therefore landuse categories (agricultural, forestry, urban/developed) are used to determine potential overlap rather than specific crops. Details of the GIS analysis and the maps are provided in *Appendix 4*.

In the *Response* section we described the anticipated effects on water quality, primary productivity, riparian vegetation, prey availability and other habitat constituents. Summaries of effects expected based on our analysis of the a.i.s and other stressors of the action are presented below in *Summary of Individual a.i.s*.

In this section we analyze the likelihood that effects of the a.i.s and other stressors of the action will cause appreciable reduction in the designated critical habitat PCEs for listed Pacific salmon within the context of ESU/DPS- specific considerations discussed in the *Environmental Baseline* and *Status of Listed Resources* sections. We also consider the impact of site specific restrictions such as federal land management plans and state regulations. Although these restrictions are not part of the federal action under consultation, they do affect how the a.i.s are used in the ecosystems supporting listed Pacific salmonids.

Evaluating the Likelihood of Adverse Effects on PCEs

The likelihood of adverse effects on PCEs was considered low in cases where we did not anticipate reductions or community-level modifications in the in- and near-stream plant communities or reductions in water quality that might impair fish health, decrease reproduction, or cause greater susceptibility to other stressors.

The likelihood of adverse effects on PCEs was considered medium in cases where we anticipate reductions or community-level modifications in the in- and near-stream plant communities or reductions in water quality which might impair fish health or cause greater susceptibility to other stressors. Conditions warranting a medium classification included reductions or community-level modifications to in-stream plant communities where the affected plant communities are less diverse and abundant, but still provide sufficient cover and energy base for the system. A medium classification is also applied when changes in riparian vegetation affect the amount or type of allochthonous input or reduce shading. Degradation of water quality is considered medium when chemical concentrations are high enough to affect fish health and susceptibility to other stressors, but not to cause death or visually obvious behavioral modifications.

The likelihood of adverse effects on PCEs was considered high in cases where we anticipate reductions or community-level modifications in the in- and near-stream plant communities or reductions in water quality that might impair fish health or cause greater susceptibility to other stressors. Conditions warranting a high classification included reductions or community-level modifications to in-stream plant communities where affected plant communities are less diverse and abundant, and no longer provide sufficient cover and energy base for the system. A high classification is also applied when changes in riparian vegetation significantly affect amount or type of allochthonous input, significantly reduce shading, increase sedimentation, or destabilize streambanks. Degradation of water quality is considered high when chemical concentrations are high enough to affect fish health and susceptibility to other stressors, and/or causes death or visually obvious behavioral modifications.

Determining Destruction or Adverse Modification of Critical Habitat

In the *Conclusion* section, we present our conclusions regarding whether the proposed action is likely to destroy or adversely modify critical habitat (Table 116). Taking into account the potential unevenness in use of the a.i.s, and the conservation value of the various watersheds, we determined if the proposed action would appreciably reduce conservation value of the critical habitat. We considered the conservation value appreciably reduced if effects were sufficient to cause long-term or permanent shifts in the plant communities, or were anticipated to be temporally persistent due to chemical properties of the a.i. or frequent inputs and occurred in a significant number of watersheds in the ESU/DPS. We considered the conservation value appreciably reduced if degradation of water quality affects fish health or prey availability. Our conclusions regarding destruction or adverse modification of critical habitat are presented in

Table 114. In that table, yes indicates we consider the proposed action likely to result in the destruction or adverse modification of designated critical habitat, while no indicates we do not consider the proposed action likely to result in the destruction or adverse modification of designated critical habitat.

Summary of Individual a.i.s and Risk to a Generic Salmon Population

Following are generic conclusions for each a.i., based on the criteria described earlier in this section. ESU/DPS specific discussions describe whether and how applicable the generic conclusion is to that ESU/DPS for the listed species, and also for the designated critical habitat.

Oyzalin

Oryzalin agricultural registrations include orchard and vineyard crops, but no row crops. It is also registered for residential turf and garden uses, general turf uses, and rights-of-way. No forestry uses are authorized. Oryzalin cannot be applied aerially, only by ground methods. Soil incorporation is recommended but not required. Washington has placed some restrictions on oryzalin use for roadside rights-of-way. As far as NMFS is aware, there are no other state restrictions on oryzalin.

Oryzalin tends to partition to soil, but is more soluble than the other two dinitroanilines considered in this opinion. It degrades slowly, but degradates are likely not more toxic than the parent. Of the pesticides considered in this opinion, oryzalin is the least acutely toxic to fish (LC_{50}s 2,880 – 3,450 μg/L). Growth and reproductive NOAECs for fish and aquatic invertebrates range from 220 – 358 μg/L. Based on our review of data, we have no specific concerns about other sublethal effects. Aquatic plants are affected at much lower concentrations, from 13 – 52 μg/L. Taking into account uncertainties, we anticipate effects on aquatic plants at concentrations in the 1 – 10 μg/L range, effects on aquatic invertebrates and fish reproduction in the 10 – 100 μg/L range, and reduction in survival for aquatic invertebrates and fish at concentrations > 100 μg/L. Most monitoring data measures oryzalin at concentrations <10 μg/L, although there are occasional reports of higher concentrations. PRZM-EXAMS EECs range from 6 – 142 μg/L for peak values, and 3 – 39 μg/L for longer durations. AgDrift EECs for floodplain habitats, based solely on drift and application rate, range from 368 – 1,100 μg/L.

Considering overlap between the various exposure estimates and the effects concentrations, we believe oryzalin will cause some reduction in primary productivity, some reduction in prey availability due to reduced reproduction and food availability for prey, and minor reductions in reproduction for fish. In watersheds where oryzalin is commonly used, we believe effects on individual fish are sufficient to cause an effect at the population level. Overall, the likelihood oryzalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium.

Oryzalin is anticipated to affect critical habitat by causing plant communities to be less diverse and abundant, but not to the point of being unable to provide cover and energy base for the system. We do not anticipate changes in established riparian vegetation, primarily due to the fact oryzalin inhibits germination, and overspray is not anticipated to affect established vegetation. Some riparian grasses may not germinate if oryzalin is present in the soil. Overall, the likelihood oryzalin will cause adverse effects on critical habitat PCEs is medium.

Pendimethalin

Pendimethalin is registered for use on a wide range of agricultural uses, including both row and orchard crops. It is also registered for residential turf and garden uses, general turf uses, and rights-of-way. No forestry uses are authorized. Pendimethalin can be applied aerially and by ground methods. Soil incorporation is recommended but not required. Labels currently include a 170 – 200 ft no spray zone for applications in proximity to listed plants. Washington has placed some restrictions on pendimethalin use for roadside rights-of-way. As far as NMFS is aware, there are no other state restrictions on pendimethalin

Pendimethalin binds tightly to soil, and degrades extremely slowly (months). Toxic effects to fish reproduction, aquatic invertebrate reproduction, and aquatic plants occur in the same concentration ranges. LC_{50}s for fish are in the 138 – 418 μg/L range. Growth and reproductive NOAECs for fish and aquatic invertebrates range from 6 – 17 μg/L. Aquatic plants are affected at concentrations ranging from 5 – 12 μg/L. Based on our review of data, we have no specific concerns about other sublethal effects. Taking in account uncertainties, we anticipate effects on aquatic plants, fish reproduction, and aquatic invertebrate reproduction at concentrations in the 0.1 – 1.0 μg/L range. Reduction in survival for aquatic invertebrates and fish is expected when concentrations are > 10 μg/L. Most monitoring data measures pendimethalin at concentrations <1 μg/L. PRZM-EXAMS EECs range from 1 – 12 μg/L for peak values, and 0.2 – 2.9 μg/L for longer durations. AgDrift EECs for floodplain habitat, based solely on drift and application rate, range from 184 – 1,912 μg/L.

Considering overlap between the various exposure estimates and the effects concentrations, we believe pendimethalin will cause some reduction in primary productivity, some reduction in prey availability due to reduced reproduction and food availability for prey, and minor reductions in reproduction for fish. In watersheds where pendimethalin is commonly used, we believe effects on individual fish are sufficient to cause an effect at the population level. Overall, the likelihood pendimethalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium.

Pendimethalin is anticipated to affect critical habitat by causing plant communities to be less diverse and abundant, but not to the point of being unable to provide cover and energy base for the system. We do not anticipate changes in established riparian vegetation, primarily due to the fact pendimethalin inhibits germination, and overspray is not anticipated to affect established vegetation. Some riparian grasses may not germinate if pendimethalin is present in the soil. Pendimethalin is expected to cause reductions in water quality, resulting in decreased fish reproduction. Overall, the likelihood pendimethalin will cause adverse effects on critical habitat PCEs is medium.

Trifluralin

Trifluralin is registered for use on a wide range of agricultural uses, including both row and orchard crops. It is also registered for residential turf and garden uses, general turf uses, and rights-of-way. No forestry uses are authorized. Trifluralin can be applied aerially and by ground methods. Soil incorporation is required. Washington does not permit trifluralin to be used on roadside rights-of-way. As far as NMFS is aware, there are no other state restrictions on trifluralin.

Trifluralin tends to partition to soil. Fish bioconcentrate it rapidly when it is in water in the dissolved phase. It degrades slowly, and most degradates retain the trifluoromethyl sidechain. Of the pesticides considered in this opinion, triflualin is the most acutely toxic to fish (LC_{50}s 5 – 660 μg/L). It has been documented to cause vertebral deformities in fish at low concentrations (NOAECs 1.7 – 23 μg/L), even for short exposure durations. Growth and reproductive NOAECs for fish and aquatic invertebrates range from 1.3 – 49 μg/L. Aquatic plants are affected at slightly higher concentrations, from 22 – 81 μg/L. Taking into account uncertainties, we anticipate vertebral deformities in fish, and reduced reproduction in fish and aquatic invertebrates at concentrations <0.1 μg/L, and reduced survival of aquatic invertebrates and fish and effects on aquatic plants at concentrations in the 0.1 – 1.0 μg/L range. Most monitoring data measures trifluralin at concentrations <1 μg/L, although there are occasional reports of much higher concentrations. PRZM-EXAMS EECs range from 0.04 – 5.8 μg/L for peak values, and 0.01 – 0.87 μg/L for longer durations. AgDrift EECs for floodplain habitat, based solely on drift and application rate, range from 92 – 2,940 μg/L.

Considering overlap between the various exposure estimates and the effects concentrations, we believe trifluralin may sometimes kill fish; will cause vertebral deformities which impair physiological functions to the extent that fish die or are unable to perform necessary life functions such as predator avoidance, foraging, and migration; will reduce reproduction of both fish and aquatic invertebrates, and may cause a reduction in in-stream primary productivity. In watersheds where trifluralin is commonly used, we believe effects on individual fish are sufficient to cause an effect at the population level. Overall, the likelihood trifluralin will reduce the reproduction, numbers, or distribution of listed salmonid populations is high.

Trifluralin is anticipated to affect critical habitat by degrading of water quality to the point fish suffer vertebral deformities, reduced reproduction, and sometimes death. It may also cause plant communities to be less diverse and abundant, but not to the point of being unable to provide cover and energy base for the system. We do not anticipate changes in established riparian vegetation, primarily due to the fact pendimethalin inhibits germination, and overspray is not anticipated to affect established vegetation. Some riparian grasses may not germinate if trifluralin is present in the soil. Overall, the likelihood trifluralin will cause adverse effects on critical habitat PCEs is high.

ESU/DPS Specific Evaluations for Threatened and Endangered Pacific Salmonids

Below, we summarize the current status of each species, including baseline stressors. VSP parameters (abundance, growth rate, genetic variability, and spatial structure) are presented as a measure of the ESU/DPS's relative health. As exposure to a.i.s during the juvenile life stage is of particular concern, we highlight the length of time juveniles are found in shallow, more vulnerable habitats. The number of extant populations that co-occur with agricultural and urban areas is also given.

Puget Sound Chinook Salmon (Threatened Species)

The Puget Sound ESU is comprised of 22 extant populations. Eleven of these populations have declining productivity; the remaining populations are at replacement value. Current spawner abundance is significantly lower than historical estimates. The spatial structure for this species is compromised by extinct and weak populations that are disproportionately distributed in the mid- to southern Puget Sound and the Strait of Juan de Fuca. The genetic diversity of this ESU has been reduced due to a disproportionate loss of populations exhibiting the early-run life history and past hatchery practices.

More than 50 percent of the ESU is composed of evergreen, deciduous, or mixed forests. Landuse categories on which dinitroaniline use is authorized include urban/residential development (18%) and agricultural uses (5%), and rights-of-way (100%). The developed areas of this ESU likely have higher concentrations of rights-of-way uses. Cultivated crops, inlcuding hay crops and pastures are primarily distributed on the floodplain and other lowland habitats. The majority of urban/residential land use also occurs within river and stream valleys in lowland areas, and much of the nearshore marine habitat is bordered by also consists of urban/residential.

These areas serve as spawning, rearing, and migration habitat for Puget Sound Chinook. Juveniles generally migrate to marine waters within 6 months of emergence, though some have longer freshwater residences of one or more years. Given their long residency period and use of freshwater, estuarine, and nearshore areas, juveniles and migrating adults have a high probability of exposure to pesticides that are applied near their habitats.

Oryzalin: Overall, the likelihood oryzalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Only a few watersheds in the ESU/DPS have much agriculture and it is not typically orchards and vineyards. We anticipate some input from urban/developed areas and from rights-of-way. However, we believe most populations will be minimally affected due to limited use of oryzalin in the ESU/DPS. Likelihood for appreciable reductions at the species level is low. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Pendimethalin: Overall, the likelihood pendimethalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all populations will be affected. Likelihood for appreciable reductions at the species level is medium. We anticipate fish will be exposed to pendimethalin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Trifluralin: Overall, the likelihood trifluralin will reduce the reproduction, numbers, or distribution of listed salmonid populations is high. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all populations will be affected. Likelihood for appreciable reductions at the species level is high. We anticipate fish will be exposed to trifluralin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Lower Columbia River (LCR) Chinook Salmon (Threatened Species)

The LCR Chinook salmon ESU includes 20 fall- and 2 late-fall runs and 9 spring-run populations. The majority of spring-run LCR Chinook salmon populations are nearly extirpated. Total returns for all runs are substantially depressed, and only one population is considered self-sustaining. The spatial structure for this ESU is relatively intact despite a 35% reduction in habitat. The genetic diversity of all populations (except the late fall-runs) has been eroded by large hatchery influences and low effective population size.

The percentage of agriculture lands that overlap with LCR Chinook salmon ESU is about 6 %, with 2% as cultivated crop crops and 4% as hay/pasture. 82% of the ESU is composed of evergreen, deciduous forest, and mixed forests. Urban/residential development (12 %) is a fairly substantial portion of this ESU. Most of the highly developed land and agricultural areas in this ESU's range are adjacent to salmonid habitat.

Populations located near the Portland area are expected to have increased exposure to urban uses, while the more Northern populations experience inputs from agricultural and forestry uses. Turf uses, including use on golf courses, are spread throughout the ESU with a higher concentration near Portland and along the mainstem Columbia. We expect that salmonids near Portland will have significant exposure from rights-of-way uses. This area has a high concentration of rights-of-way from rail, road, and utilities. These uses are of greater concern as they tend to be higher use rates with greater probability of runoff. This concern is mediated somewhat by the wide distribution of populations throughout the basin, and the fact that exposure will likely occur in higher volume, higher flow habitats, such as the Columbia River. Given their long juvenile residency period, use of river mainstem and upstream tributaries for spawning, juveniles and migrating adults have a high probability of exposure to pesticides that are applied near their habitats.

Oryzalin: Overall, the likelihood oryzalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Use sites are distributed throughout the ESU/DPS, but we anticipate only some populations will be affected. Likelihood for appreciable reductions at the species level is medium. However, we do not believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Pendimethalin: Overall, the likelihood pendimethalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all populations will be affected. Likelihood for appreciable reductions at the species level is medium. We anticipate fish will be exposed to pendimethalin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Trifluralin: Overall, the likelihood trifluralin will reduce the reproduction, numbers, or distribution of listed salmonid populations is high. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all populations will be affected. Likelihood for appreciable reductions at the species level is high. We anticipate fish will be exposed to trifluralin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Upper Columbia River (UCR) Spring run Chinook Salmon (Endangered Species)

The UCR Spring-run Chinook salmon ESU is comprised of three extant populations. These populations are affected by low abundances and failing recruitment. The long-term trend for abundance and lambda for all three populations indicate a decline. The ESU's genetic integrity is compromised by periods of low effective population size and a low proportion of natural-origin fish. Spatial structure of this ESU is fairly intact but has been compromised by low summer flows.

While this ESU has very few populations left, we do not expect that there will be much exposure to any of the a.i.s. There is very little agriculture and urban development within the ESU, and correspondingly less right-of-way. The percentage of agricultural and developed lands that overlap with UCR Chinook salmon habitat is about 5% and 5%, respectively. Forested lands make up about 90% of the ESU. Much of the forested land is federally owned; and any program involving the use of pesticides would be covered under its own ESA consultation. Therefore, we are considering exposure to be minimal in these areas as well. Most exposure will occur during migration along the Columbia River. This exposure is of less concern as it is a high volume, high flow system.

Oryzalin: Overall, the likelihood oryzalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Only a few watersheds in the ESU/DPS have much agriculture and it is not typically orchards and vineyards. We anticipate some input from urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe most populations will be minimally affected. Likelihood for appreciable reductions at the species level is low. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Pendimethalin: Overall, the likelihood pendimethalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe most populations will be minimally affected. Likelihood for appreciable reductions at the species level is low. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Trifluralin: Overall, the likelihood trifluralin will reduce the reproduction, numbers, or distribution of listed salmonid populations is high. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe most populations will be minimally affected. Likelihood for appreciable reductions at the species level is medium. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Snake River (SR) Fall-run Chinook Salmon (Threatened Species)

The SR Fall-run Chinook salmon ESU consists of one population that spawns in the lower mainstem Snake River. Its spatial distribution has been reduced to 10 to 15% of the historical range. The annual population growth rate for the population is just over replacement, and the ESU remains highly vulnerable due to low abundance. Genetic diversity has been reduced with the loss of additional populations and influx of hatchery raised spawners.

Pesticide use areas for the 3 a.i.s within this ESU include forests (79%), cultivated crops (19%), and developed lands (2%). The one population remaining in this ESU may experience some exposure to the three a.i.s. There is some developed and some agricultural area in the spawning and rearing areas, though they are generally set back from the river. Exposure would occur in a high flow, high volume habitat decreasing the likelihood of experiencing a high concentration. Given the uses of these a.i.s, there may be adverse effects to some individuals, but we do not expect that population-level impacts will occur. As there is only one population, we do not make separate population and species level calls in the following a.i. summaries.

Oryzalin: Overall, the likelihood oryzalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Only a few watersheds in the ESU/DPS have much agriculture and it is not typically orchards and vineyards. We anticipate some input from urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. Likelihood for appreciable reductions at the species level is low.

Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Pendimethalin: Overall, the likelihood pendimethalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. Likelihood for appreciable reductions at the species level is low. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Trifluralin: Overall, the likelihood trifluralin will reduce the reproduction, numbers, or distribution of listed salmonid populations is high. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. Likelihood for appreciable reductions at the species level is medium. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Snake River (SR) Spring/Summer-run Chinook Salmon (Threatened Species)

This ESU includes 31 historical populations. Productivity trends are approaching replacement levels, though most populations are far below their respective interim recovery targets. Many individual populations have highly variable abundance and no positive long-term growth. The genetic diversity and spatial distribution of this ESU are intact.

The percentage of cultivated croplands and developed lands that overlap with SR Spring/Summer-run Chinook salmon habitat are 7% and 2%, respectively. Juvenile fish mature in fresh water for one year and may migrate from natal reaches into alternative summer-rearing or overwintering areas.

Exposure of the Snake River Spring-Summer Run populations to the a.i.s is likely to be fairly low. As many spawn and rear in U.S. Forest Service lands, any pesticide use would be authorized under additional ESA consultations. Given these conditions, we do not believe that populations in these areas will experience adverse effects from any of the a.i.s. Agricultural and urban areas are not common in the watersheds comprising the ESU, and those that are present are clustered mostly around the mainstem Snake and Columbia Rivers. Some populations may experience exposure from agricultural or urban uses, particularly during migration. Since these exposures will occur in a high volume high flow system, we expect population effects to be minimal.

Oryzalin: Overall, the likelihood oryzalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. However, there is little or no agriculture or urban/developed areas near the spawning and rearing habitat. Likelihood of exposure to the a.i. is low, except during migration through the Snake River, which is a high volume, high flow water body. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Pendimethalin: Overall, the likelihood pendimethalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. However, there is little or no agriculture or urban/developed areas near the spawning and rearing habitat. Likelihood of exposure to the a.i. is low, except during migration through the Snake River, which is a high volume, high flow water body. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Trifluralin: Overall, the likelihood trifluralin will reduce the reproduction, numbers, or distribution of listed salmonid populations is high. However, there is little or no agriculture or urban/developed areas near the spawning and rearing habitat. Likelihood of exposure to the a.i. is low, except during migration through the Snake River, which is a high volume, high flow water body. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Upper Willamette River (UWR) Chinook Salmon (Threatened Species)

The UWR Chinook salmon ESU is composed of seven populations. Of these, only the McKenzie population is producing naturally. Abundance is low for all populations, and growth rates are negative. The spatial distribution of this ESU has been dramatically reduced, with 30 to 40% of the total historic habitat blocked by dams. The genetic diversity of this ESU has been compromised by hatchery stocks and mixing between populations.

The percentage of cultivated and developed lands that overlap with UWR Chinook salmon habitat are 27% and 9%, respectively. Our GIS analysis indicates all populations in this ESU may be exposed to pesticides applied in agriculture and urban areas. Juveniles rear in the mainstem Willamette River and floodplain wetlands during the inundation period. Residence periods range from 6 months to over a year, with three distinct emigration runs.

We expect that populations within this ESU will be exposed to the a.i.s due to the high degree of agricultural and developed land classes. The valley is also heavily used by railroads, roads, and electrical transmission lines, increasing the likelihood of rights-of-way applications. We also expect that environmental mixtures will compound the effects of these chemicals. Given their residency period and habitat preference, juveniles and migrating adults have a high probability of exposure to pesticides that are applied near their habitat.

Oryzalin: Overall, the likelihood oryzalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all populations will be affected. Likelihood for appreciable reductions at the species level is medium. We anticipate fish will be exposed to oryzalin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Pendimethalin: Overall, the likelihood pendimethalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all populations will be affected. Likelihood for appreciable reductions at the species level is medium. We anticipate fish will be exposed to pendimethalin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Trifluralin: Overall, the likelihood trifluralin will reduce the reproduction, numbers, or distribution of listed salmonid populations is high. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all populations will be affected. Likelihood for appreciable reductions at the species level is high. We anticipate fish will be exposed to trifluralin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

California Coastal (CC) Chinook Salmon (Threatened Species)

The CC Chinook salmon ESU's spatial structure has been drastically altered through the loss of several historic populations. Genetic diversity has been significantly reduced by the loss of the spring-run and coastal populations. Current population structure is uncertain, though fish are concentrated in 15 geographic locations. Populations in the Eel River and Russian River are larger than some of the others, and are important to the ESU. Overall ESU productivity is low and all populations have low abundance.

The percentage of cultivated croplands and developed lands that overlap with CC Chinook salmon habitat are 2% and 6%, respectively. The most abundant populations are in the Eel River and tributaries, and in the Russian River watershed. While there is little overlap of use sites with the habitat of the Eel River populations, there is substantial overlap in the Russian River watershed. Due to the importance of this population to the ESU, likelihood of negative effects were based primarily on the overlap in this watershed. Juveniles rear in freshwater streams for a few months, and may reside in the estuary for an extended period before entering the ocean.

In general, we expect the populations to have limited exposure to the a.i.s. There is a low amount of development, agriculture, and rights-of-way uses within the range of the ESU. We expect the population in the Russian River will have a much higher degree of exposure due to the distribution of land uses. This is particularly important for oryzalin exposure, as grapes are an important crop in the Russian River valley.

Oryzalin: Overall, the likelihood oryzalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. We anticipate a key population will be affected. Likelihood for appreciable reductions at the species level is medium. We anticipate fish will be exposed to oryzalin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Pendimethalin: Overall, the likelihood pendimethalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. We anticipate a key population will be affected. Likelihood for appreciable reductions at the species level is medium. We anticipate fish will be exposed to pendimethalin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Trifluralin: Overall, the likelihood trifluralin will reduce the reproduction, numbers, or distribution of listed salmonid populations is high. We anticipate a key population will be affected. Likelihood for appreciable reductions at the species level is high. We anticipate fish will be exposed to trifluralin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Central Valley (CV) Spring-run Chinook Salmon (Threatened Species)

The CV Spring-run Chinook salmon ESU includes four populations in the upper Sacramento River and three of its tributaries. The spatial distribution has been greatly reduced through extirpation of populations and dams blocking fish passage. Genetic diversity was similarly reduced, with the extirpation of all San Joaquin runs. Abundance levels are all severely depressed from historic estimates, though time series data show that all three tributary populations have growth rates just above replacement.

Juvenile emigration in the Sacramento River is highly variable; individuals may migrate as fry or as yearlings. Floodplain habitats are particularly important for CV Spring-run Chinook salmon juveniles during rearing and migration (Sommer, Harrell, & Nobriga, 2005; Sommer, et al., 2001). Given the residency period and use of non-natal tributaries, intermittent streams, and floodplain habitats for rearing and migration, juveniles and adults have a high probability of exposure to pesticides that are applied near their habitat.

We expect that individuals within this population will be exposed to the a.i.s. Their range is heavily developed, for both agricultural and urban purposes. The percentage of cultivated croplands and developed lands that overlap with CV Chinook salmon habitat are 25% and 12%, respectively. The valley also has a high concentration of power and transportation lines, indicating that rights-of-way applications will also occur. Most spawning occurs in the upper waters of three Northern watersheds which are largely undeveloped, thus lowering the likelihood of exposure to some life stages. Much of the rearing and migration of these populations occurs along the Sacramento River, where exposure to the a.i.s is likely to occur. As this area is highly developed, we expect that fish will be exposed to a variety of environmental mixtures. They are also likely to experience pesticide inputs from multiple sources, increasing the likelihood of exposure to each a.i. at intervals shorter than the labeled application interval. We expect that all populations may be exposed to the a.i.s during the rearing period, and may experience adverse effects from this exposure.

Oryzalin: Overall, the likelihood oryzalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all populations will be affected. Likelihood for appreciable reductions at the species level is medium. We anticipate fish will be exposed to oryzalin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Pendimethalin: Overall, the likelihood pendimethalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all populations will be affected. Likelihood for appreciable reductions at the species level is medium. We anticipate fish will be exposed to pendimethalin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Trifluralin: Overall, the likelihood trifluralin will reduce the reproduction, numbers, or distribution of listed salmonid populations is high. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all populations will be affected. Likelihood for appreciable reductions at the species level is high. We anticipate fish will be exposed to trifluralin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Sacramento River Winter-run Chinook Salmon (Endangered Species)

The Sacramento River Winter-run Chinook salmon ESU is now comprised of a single population. This population rears in the mainstem of the Sacramento River below Keswick

Dam. Abundance and productivity have fluctuated greatly over the past two decades. The genetic diversity of this population has been reduced through small population sizes and the influence of hatchery fish. The large fluctuations in productivity and abundance indicate that the species is highly vulnerable to extinction.

We expect the one population in this ESU may be exposed to the a.i.s, as its range is restricted to the mainstem Sacramento River. The Central Valley has significant agricultural and urban development, and is a main corridor for many utilities which may use the a.i.s on rights-of-way. The percentage of cultivated croplands and developed lands that overlap with Sacramento River Winter-run Chinook salmon are 25% and 12%, respectively. As this area is highly developed, we expect that fish will be exposed to a variety of environmental mixtures. They are also likely to experience pesticide inputs from multiple sources, increasing the likelihood of exposure to each a.i. at intervals shorter than the labeled application interval. Juvenile winter-run fish are found in the Delta primarily from November through early May, though some spend up to 10 months in the river system. We expect that some individuals from this ESU will experience adverse chronic effects from exposure to the a.i.s. As there is only one population, we do not make separate population and species level calls in the following a.i. summaries.

Oryzalin: Overall, the likelihood oryzalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Likelihood for appreciable reductions at the species level is medium. We anticipate fish will be exposed to oryzalin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Pendimethalin: Overall, the likelihood pendimethalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Likelihood for appreciable reductions at the species level is medium. We anticipate fish will be exposed to pendimethalin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i.

We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Trifluralin: Overall, the likelihood trifluralin will reduce the reproduction, numbers, or distribution of listed salmonid populations is high. Likelihood for appreciable reductions at the species level is high. We anticipate fish will be exposed to trifluralin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Hood Canal Summer-run Chum Salmon (Threatened Species)

This ESU has two remaining independent populations made up of multiple spawning aggregations. Much of the historical spatial structure has been lost; with the exception of the Union River, populations on the eastern side of the canal are extirpated. Despite being low, the genetic diversity of the ESU has increased from the low values seen in the 1990s. The two populations have long-term trends above replacement, and while they have increased since the time of listing, abundance is still considered low. The life history of this ESU strongly influences the potential for exposure. Following emergence, fish typically migrate quickly to nearshore marine areas in Hood Canal and Discovery Bay to rear and grow. Average rearing time for juveniles is around 23 days before emigration to the outer Strait of Juan de Fuca and Pacific Ocean.

The area occupied by this ESU is largely undeveloped; roughly 50% of the land is federally owned within the Olympic National Forest. The Forest Service has already consulted on the use of herbicides for invasive plant control within the Olympic Forest, so we are not concerned about forestry use in those areas. Exposure from urban and agricultural lands is likely to be low, as there is a small amount of development. Correspondingly, we expect a low amount of rights-of-way uses. The percentage of cultivated croplands and developed lands that overlap with HC Summer-run chum salmon habitat is about 0.04% and 8.9%, respectively.

Oryzalin: Overall, the likelihood oryzalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Only a few watersheds in the ESU/DPS have much agriculture and it is not typically orchards and vineyards. We anticipate some input from urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe most populations will be minimally affected. Likelihood for appreciable reductions at the species level is low. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Pendimethalin: Overall, the likelihood pendimethalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe most populations will be minimally affected. Likelihood for appreciable reductions at the species level is low. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Trifluralin: Overall, the likelihood trifluralin will reduce the reproduction, numbers, or distribution of listed salmonid populations is high. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe most populations will be minimally affected. Likelihood for appreciable reductions at the species level is medium. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Columbia River (CR) Chum Salmon (Threatened Species)

This ESU has been reduced to two populations: the Lower Gorge tributaries and Grays River. The population abundances for the Grays River and Lower Gorge are significantly depressed. Short- and long-term productivity trends for these populations are at or below replacement. Much of the genetic diversity of this population has been lost due to the extirpation of 15 populations.

The percentage of cultivated croplands, hay/pasture, and developed lands that overlap with CR chum salmon habitat is about 2%, 5%, and 15%, respectively. More than 50% of the ESU is covered by deciduous, evergreen, or mixed forests. Within the ESU, agriculture and development are predominantly distributed in the low-lying areas near the Columbia River and its tributaries. The Grays River population is largely in undeveloped areas, thus lowering the likelihood of exposure to the a.i.s. The Upper Gorge population is more likely to be exposed, as individuals must migrate past the Portland area, which includes the upstream contributions from the Willamette basin.

Adult chum salmon spawning occurs in the late fall, from mid-October to December. The fry emerge between March and May and emigrate shortly thereafter to nearshore estuarine environments (Salo, 1991). Juveniles spend around 24 days feeding in the estuary. This relatively short residence period in fresh water results in chum having a lower likelihood of exposure than other salmonids.

Oryzalin: Overall, the likelihood oryzalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Only a few watersheds in the ESU/DPS have much agriculture and it is not typically orchards and vineyards. We anticipate some input from urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe most populations will be minimally affected. Likelihood for appreciable reductions at the species level is low. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Pendimethalin: Overall, the likelihood pendimethalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe most populations will be minimally affected. Likelihood for appreciable reductions at the species level is low. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Trifluralin: Overall, the likelihood trifluralin will reduce the reproduction, numbers, or distribution of listed salmonid populations is high. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe most populations will be minimally affected. Likelihood for appreciable reductions at the species level is medium. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Lower Columbia River Coho Salmon (Threatened Species)

The LCR coho salmon ESU now consists of two populations found in the Sandy and Clackamas Rivers. Both populations have low levels of abundance. The diversity of populations has been eroded by large hatchery influences and low effective population sizes. The spatial structure for this ESU has also been drastically reduced compared to historical levels. Additionally, coho have the most sensitive life history of the salmonids, as they have three distinct cohorts.

The percentage of cultivated crop lands overlap with LCR coho ESU is about 6 %, 4% as hay/pasture land and 2% as cultivated crop land. More than 76% of the ESU is composed of evergreen, deciduous forest, and mixed forests. Urban/residential development lands (12%) make up a fairly substantial portion of this ESU. The percentage of cultivated croplands and developed lands that overlap with LCR chum salmon habitat are 2% and 11.7%, respectively.

The forested areas are largely private, rather than federally controlled. While the spawning areas are in tributaries located in lower-use areas, we expect that these individuals will be exposed to the a.i.s during rearing and migration. The two populations in this ESU must both navigate the waters around Portland, where there is an abundance of rights-of-way in addition to urban and agricultural development. We expect that these populations will have significant exposure from rights-of-way uses. This area has a high concentration of rights-of-way from rail, road, and utilities. These uses are of greater concern as they tend to be higher use rates with greater probability of runoff. This concern is mediated somewhat by the wide distribution of populations throughout the basin, and the fact that exposure will likely occur in higher volume, higher flow habitats, such as the Columbia River. Given the higher likelihood of exposure based on geographic distribution and the higher sensitivity of the species, there is a greater likelihood that the populations, and the ESU as a whole, will be negatively affected by the use of these a.i.s. The likelihood of negative effects is further influenced by the properties of the chemicals themselves.

Oryzalin: Overall, the likelihood oryzalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Use sites are distributed throughout the ESU/DPS, but we anticipate only some populations will be affected. Likelihood for appreciable reductions at the species level is medium. However, we do not believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Pendimethalin: Overall, the likelihood pendimethalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all populations will be affected. Likelihood for appreciable reductions at the species level is medium. We anticipate fish will be exposed to pendimethalin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Trifluralin: Overall, the likelihood trifluralin will reduce the reproduction, numbers, or distribution of listed salmonid populations is high. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all populations will be affected. Likelihood for appreciable reductions at the species level is high. We anticipate fish will be exposed to trifluralin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Oregon Coast (OC) Coho Salmon (Threatened Species)

The OC coho salmon ESU includes 13 functionally independent populations. Current abundance levels are less than 10% of historic populations. Long-term trends in ESU productivity remain strong however, populations within the ESU experience recruitment failure and long-term negative growth (Good, Waples et al. 2005). Spatial distribution is relatively intact. As with other coho, there is a 3 year brood cycle, and depletion of a specific brood year may reduce the resiliency of the ESU.

The percentage of cultivated croplands and developed lands that overlap with OC coho salmon habitat are 0.23% and 6.6%, respectively. Most of the cropland is hay/pasture, and is primarily located in the Umpqua watersheds. While this is an important population for this ESU, there are a number of other functionally independent populations in other watersheds with less overlap. Juvenile coho salmon are often found in small streams less than five feet wide and rear in fresh water for 18 months.

A large portion of this ESU’s range is Forest Service land. As any pesticide applications would undergo a separate consultation, we are less concerned with uses within these areas. The low amounts of urban and agricultural lands also indicate a lower likelihood of exposure. While there is the possibility of exposure and subsequent negative effects to individuals, we believe that the potential for negative population level effects is low. The spatial distribution of the populations combined with the distribution of use sites, and relatively low expected use, we do not believe that most a.i.s will have a large enough impact to negatively affect the ESU.

Oryzalin: Overall, the likelihood oryzalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Only a few watersheds in the ESU/DPS have much agriculture and it is not typically orchards and vineyards. We anticipate some input from urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe most populations will be minimally affected. Likelihood for appreciable reductions at the species level is low. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Pendimethalin: Overall, the likelihood pendimethalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe most populations will be minimally affected. Likelihood for appreciable reductions at the species level is low. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Trifluralin: Overall, the likelihood trifluralin will reduce the reproduction, numbers, or distribution of listed salmonid populations is high. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe most populations will be minimally affected. Likelihood for appreciable reductions at the species level is medium. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Southern Oregon/Northern California Coast (SONCC) Coho Salmon (Threatened Species)

The SONCC coho salmon ESU includes coho salmon in streams between Cape Blanco, Oregon, and Punta Gorda, California. The disproportionate loss of southern populations has decreased the spatial structure and genetic diversity of this ESU. Distribution within individual watersheds has been reduced throughout the entire range. There is very limited information on population growth rates for this ESU. Available data indicates that the Eel River and southern populations have critically low abundances. Coho have a 3 year brood cycle, and depletion of a specific brood year may reduce the resiliency of the ESU.

The percentage of cultivated croplands and developed lands that overlap with SONCC coho salmon habitat are 2.5% and 4.3%, respectively. As little population data were available for this ESU, we were not able to determine if agricultural and developed areas, which cluster in certain watersheds, co-occur with important populations. Areas with more cropland include the Scott and Shasta watersheds in the Klamath basin, and the Upper and Middle Rough River[21] watersheds. Of the development in this ESU, much is in the Rough River basin, with most of the rest distributed along the coastline and estuaries. The fry rear in backwater, side channels, and shallow channel edges for up to 18 months.

We expect that this ESU will have fairly low exposure to the a.i.s, due to the low agricultural and urban development within its range. Rights-of-way uses are also expected to be low. Roughly 36% of the land is federally owned, including parts of the Redwood forest. While the spatial structure of the population is not well understood, salmon are present throughout the range. Individuals may be exposed to the a.i.s and experience adverse effects. However, given the

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[21] The Rough River is also referred to as the Rouge or Rouge River in other publications, maps, or websites.

distribution of land uses, it is unlikely that a large portion of the ESU would experience a high exposure event for any chemical. Therefore, we believe that there is a low likelihood of an ESU-level effect for most a.i.s.

Oryzalin: Overall, the likelihood oryzalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Only a few watersheds in the ESU/DPS have much agriculture and it is not typically orchards and vineyards. We anticipate some input from urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe most populations will be minimally affected. Likelihood for appreciable reductions at the species level is low. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Pendimethalin: Overall, the likelihood pendimethalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe most populations will be minimally affected. Likelihood for appreciable reductions at the species level is low. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Trifluralin: Overall, the likelihood trifluralin will reduce the reproduction, numbers, or distribution of listed salmonid populations is high. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe most populations will be minimally affected. Likelihood for appreciable reductions at the species level is medium. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Central California Coast (CCC) Coho Salmon (Endangered Species)

The CCC coho salmon ESU includes 11 independent populations. The spatial structure for CCC coho salmon has been substantially modified due to lack of viable source populations and loss of dependent populations. All populations have very low abundances making it difficult to determine long-term population trends. Returns suggest that all three year classes are faring poorly across the species' range. Loss of a specific year class may decrease the overall resiliency of the population. The life histories of this ESU strongly influence the potential for exposure to these a.i.s. Juveniles rear for 18 months, spending two winters in fresh water.

The percentage of cultivated croplands and developed lands that overlap with CCC coho salmon habitat are 2.3% and 9.4%, respectively. Much of the development is centered on San Francisco Bay, and there are also developed areas and agriculture in the Russian River watershed. Coho in the San Francisco Bay are considered effectively extirpated, and the Russian River, which was once a source population for this ESU, is in serious decline (Brian C. Spence, et al., 2008). Highly contaminated runoff into the Russian River, San Francisco Bay, and into rivers south of the Golden Gate Bridge is expected during the first fall storms. The majority of the salmon remaining is in the northern, undeveloped watersheds around the Navarro and Big Rivers.

The populations within this ESU have very different potential for exposure to the a.i.s. We expect that the populations in the Russian River and southern areas will have a higher likelihood of exposure than the more Northern populations. There is some development in the Northern watersheds, as well as potential rights-of-way uses on electric transmission lines. Therefore we expect that all populations may have some degree of exposure. The likelihood of species-level effects is strongly tied to the Russian River population, as it is one of the more important populations. This is particularly important for oryzalin exposure, as grapes are an important crop in the Russian River valley.

Oryzalin: Overall, the likelihood oryzalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate some populations will be affected. Likelihood for appreciable reductions at the species level is medium. However, we do not believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Pendimethalin: Overall, the likelihood pendimethalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all populations will be affected. Likelihood for appreciable reductions at the species level is medium. We anticipate fish will be exposed to pendimethalin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Trifluralin: Overall, the likelihood trifluralin will reduce the reproduction, numbers, or distribution of listed salmonid populations is high. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all populations will be affected. Likelihood for appreciable reductions at the species level is high. We anticipate fish will be exposed to trifluralin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Ozette Lake Sockeye Salmon (Threatened Species)

The Ozette Lake sockeye salmon ESU consists of a single population made up of five spawning aggregations. Uncertainty remains on the growth rate and productivity of the natural component of the ESU. While genetic differences occur between age cohorts and different age groups do not spawn with each other, genetic diversity within the ESU is low. Spatial structure of the population has been altered, as only two beaches are known to be used for spawning (Haggerty, Ritchie, Shellberg, Crewson, & Jolonen, 2007). Overall abundance is also significantly depressed.

Ozette Lake is in a sparsely populated area, with less than 1% of land developed within the range of this ESU. Similarly, there is no cultivated cropland. Roughly 77% of the land in Ozette Basin is managed for timber production (Jacobs, Larson, Meyer, Currence, & Hinton, 1996). Land use of this ESU is primarily forest with private, state, and federal ownership (86% forested, 13% open water, 1% developed land, 0% agriculture). The entire circumference of the lake is within Olympic National Park.

The life histories of this ESU strongly influence the potential for exposure to the a.i.s. Adult spawners enter Ozette River from April to early August and may remain in Ozette Lake for extended periods before spawning (October- February). Spawning occurs along the lakeshore and historically in some of the lakes' tributaries. Fry migrate immediately to the lake where they rear for a year or so before entering the ocean. The predominant pesticide use sites (*i.e.,* urban/residential and forestry uses) overlap with the Lake's freshwater tributaries. As such, the greatest risk of exposure is to sockeye using freshwater tributary habitats. Direct effects to fish remain a concern within tributaries.

Oryzalin: Overall, the likelihood oryzalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. However, there is little or no agriculture or urban/developed areas near the spawning, rearing or migratory habitat. Likelihood of exposure to the a.i. is low. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Pendimethalin: Overall, the likelihood pendimethalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. However, there is little or no agriculture or urban/developed areas near the spawning, rearing or migratory habitat. Likelihood of exposure to the a.i. is low. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Trifluralin: Overall, the likelihood trifluralin will reduce the reproduction, numbers, or distribution of listed salmonid populations is high. However, there is little or no agriculture or urban/developed areas near the spawning, rearing or migratory habitat. Likelihood of exposure to the a.i. is low. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Snake River Sockeye Salmon (Endangered Species)

The SR sockeye salmon ESU is comprised of one remaining population in Redfish Lake, Idaho. Abundance and productivity are highly variable; around 30 fish of hatchery origin return to spawn each year (NMFS, 2008d). However, this figure has increased to adults numbering in the hundreds over the last four years. The ESU's genetic diversity has been reduced based on low population abundance and a high proportion of hatchery-origin fish.

About 1% of the land surrounding Redfish Lake has been developed, and another 1% is used for agriculture, primarily hay and pasture. More than 50% of the ESUs is composed of evergreen forests. Consequently, forestry uses are the major source of pesticide exposure during spawning and rearing activities. However, Redfish Lake is located in a watershed that is 92% federal land. Therefore, any forestry uses of the chemicals would fall under a separate section 7 consultation. We expect that exposure to the a.i.s will occur during migration to and from Redfish Lake. Juvenile sockeye remain in the lake for one to three years before migrating through the Snake and Columbia Rivers for several hundred miles to the ocean.

Oryzalin: Overall, the likelihood oryzalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. However, there is little or no agriculture or urban/developed areas near the spawning and rearing habitat. Likelihood of exposure to the a.i. is low, except during migration through the Snake River, which is a high volume, high flow water body. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Pendimethalin: Overall, the likelihood pendimethalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. However, there is little or no agriculture or urban/developed areas near the spawning and rearing habitat. Likelihood of exposure to the a.i. is low, except during migration through the Snake River, which is a high volume, high flow water body. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Trifluralin: Overall, the likelihood trifluralin will reduce the reproduction, numbers, or distribution of listed salmonid populations is high. However, there is little or no agriculture or urban/developed areas near the spawning and rearing habitat. Likelihood of exposure to the a.i. is low, except during migration through the Snake River, which is a high volume, high flow water body. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Puget Sound Steelhead (Threatened Species)

The Puget Sound steelhead is comprised of 53 populations (37 winter-run and 16 summer-run). Summer-run populations are concentrated in northern Puget Sound and Hood Canal. The WDFW 2002 stock assessment categorized 5 populations as healthy, 19 as depressed, 1 as critical, and 27 of unknown status (Washington Department of Fish and Wildlife (WDFW), 2002). Median population growth rates indicate declining population growth for nearly all populations in the DPS (NMFS, 2005d). Overall, the DPS experiences declining abundance, reduced genetic diversity, and abbreviated spatial complexity.

More than 75 percent of the DPS is composed of evergreen, deciduous, or mixed forests. Other pesticide use areas include urban/residential development (18%) and agricultural uses (5%). Cultivated crops, including hay crops and pastures are primarily distributed on the floodplain and other lowland habitats. The majority of urban/residential also occurs within river and stream valleys in lowland areas, and much of the nearshore marine area habtat is near urban/residential development. These areas serve as rearing and migration areas for juveniles. Spawning generally occurs in the forested upper portions of the watersheds. Fry usually inhabit shallow water along banks of stream or aquatic habitats on stream margins. Juveniles rear in a wide variety of freshwater habitats, generally for two years with a minority migrating to the marine waters as one or three-year olds.

Oryzalin: Overall, the likelihood oryzalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Use sites are distributed throughout the ESU/DPS, but we anticipate only some populations will be affected. Likelihood for appreciable reductions at the species level is medium. However, we do not believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Pendimethalin: Overall, the likelihood pendimethalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all populations will be affected. Likelihood for appreciable reductions at the species level is medium. We anticipate fish will be exposed to pendimethalin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Trifluralin: Overall, the likelihood trifluralin will reduce the reproduction, numbers, or distribution of listed salmonid populations is high. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all populations will be affected. Likelihood for appreciable reductions at the species level is high. We anticipate fish will be exposed to trifluralin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Lower Columbia River Steelhead (Threatened Species)

The LCR steelhead DPS includes 23 extant populations. Spatial structure within the DPS, especially in Washington, has been substantially reduced by the loss of access to the upper portions of some basins from tributary hydropower development. Many of the populations in this DPS are small, and the long- and short-term trends in abundance of all individual populations are negative. The genetic diversity of this DPS has also been substantially reduced.

The percentage of cultivated crop lands overlap with LCR Steelhead DPS is about 7%. Approximately 81% of the DPS is composed of evergreen, deciduous forest, and mixed forests. Urban/residential development lands (13%) are a fairly substantial portion of this DPS. Juveniles typically rear in floodplain habitats associated with their natal rivers and streams for more than a year, and remain in fresh water systems for at least two years.

Populations located near the Portland area are expected to have increased exposure to urban uses, while the more northern populations experience inputs from agricultural and forestry uses. Turf uses, including use on golf courses, are spread throughout the ESU with a higher concentration near Portland and along the mainstem Columbia. We expect that salmonids near Portland will have significant exposure from rights-of-way uses. This area has a high concentration of rights-of-way from rail, road, and utilities. These uses are of greater concern as they tend to be higher use rates with greater probability of runoff. This concern is mediated somewhat by the wide distribution of populations throughout the basin, and the fact that exposure will likely occur in higher volume, higher flow habitats, such as the Columbia River. Given their long juvenile residency period, use of river mainstem and upstream tributaries for spawning, juveniles and migrating adults have a high probability of exposure to pesticides that are applied near their habitats.

Oryzalin: Overall, the likelihood oryzalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Use sites are distributed throughout the ESU/DPS, but we anticipate only some populations will be affected. Likelihood for appreciable reductions at the species level is medium. However, we do not believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Pendimethalin: Overall, the likelihood pendimethalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all populations will be affected. Likelihood for appreciable reductions at the species level is medium. We anticipate fish will be exposed to pendimethalin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Trifluralin: Overall, the likelihood trifluralin will reduce the reproduction, numbers, or distribution of listed salmonid populations is high. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all populations will be affected. Likelihood for appreciable reductions at the species level is high. We anticipate fish will be exposed to trifluralin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Upper Willamette River Steelhead (Threatened Species)

The UWR steelhead DPS is comprised of four extant populations that occupy tributaries draining the east side of the UWR basin. Populations within this DPS have been declining and have exhibited large fluctuations in abundance. Abundance is moderately depressed for the entire DPS. The DPS's spatial distribution and genetic diversity are moderately intact.

The major threats to the survival and recovery of this DPS include habitat loss due to blockages, lost or degraded floodplain connectivity, and degraded water quality within the Willamette mainstem and the lower reaches of its tributaries. Fifty pesticides were detected in streams that drain both agricultural and urban areas. Forty-nine pesticides were detected in streams draining agricultural land, while 25 pesticides were detected in streams draining urban areas. Ten of these pesticides exceeded EPA criteria for the protection of freshwater aquatic life.

The percentage of cultivated crop lands and developed lands overlapping with this DPS are 34% and 10%, respectively. After emergence, steelhead fry typically rear in floodplain habitats associated with their natal rivers and streams for two years.

We expect that populations within this ESU will be exposed to the a.i.s due to the high amount of agricultural and developed land. Further, while some of the spawning and rearing streams are in forested areas, they are not necessarily in Federal lands. As such, we cannot assume any additional protections from other ESA consultations. The valley is also heavily used by railroads, roads, and electrical transmission lines, increasing the likelihood of rights-of-way applications. We also expect that environmental mixtures will compound the effects of these chemicals. Given their residency period and habitat preference, juveniles and migrating adults have a high probability of exposure to pesticides that are applied near their habitat.

Oryzalin: Overall, the likelihood oryzalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all populations will be affected. Likelihood for appreciable reductions at the species level is medium. We anticipate fish will be exposed to oryzalin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Pendimethalin: Overall, the likelihood pendimethalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all populations will be affected. Likelihood for appreciable reductions at the species level is medium. We anticipate fish will be exposed to pendimethalin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Trifluralin: Overall, the likelihood trifluralin will reduce the reproduction, numbers, or distribution of listed salmonid populations is high. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all populations will be affected. Likelihood for appreciable reductions at the species level is high. We anticipate fish will be exposed to trifluralin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Middle Columbia River Steelhead (Threatened Status)

The MCR steelhead DPS includes 16 extant populations in Oregon and Washington. The spatial structure of this population is relatively intact. The genetic diversity has been compromised by interbreeding with resident and hatchery fish. Population growth rates are near replacement, though abundances are depressed in relation to historic levels.

The percentage of cultivated crop lands and developed lands within the range of this DPS are 17% and 3%, respectively. Orchards are common in this area, and often located in close proximity to rivers. There are few urban centers, but low levels of development are distributed throughout the range. Due to the relatively low levels of development, we do not expect that rights-of-way uses will be a major exposure route, aside from areas directly along the Columbia River. Swim–up fry usually inhabit shallow water along banks of streams or aquatic habitats on stream margins. Juveniles rear in a variety of freshwater habitat for two years.

Oryzalin: Overall, the likelihood oryzalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all populations will be affected. Likelihood for appreciable reductions at the species level is medium. We anticipate fish will be exposed to oryzalin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Pendimethalin: Overall, the likelihood pendimethalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all populations will be affected. Likelihood for appreciable reductions at the species level is medium. We anticipate fish will be exposed to pendimethalin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Trifluralin: Overall, the likelihood trifluralin will reduce the reproduction, numbers, or distribution of listed salmonid populations is high. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all populations will be affected. Likelihood for appreciable reductions at the species level is high. We anticipate fish will be exposed to trifluralin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Upper Columbia River Steelhead (Threatened Species)

The UCR steelhead DPS consists of four extant populations in Washington State. Abundance data indicate that these populations are below the minimum threshold for recovery and have negative growth rates. Adult returns are dominated by hatchery fish and experience reduced genetic diversity from homogenization of populations. The spatial structure of this DPS has been severely altered, with 50% of its habitat cutoff by the Grand Coulee Dam.

Newly emerged fry move about considerably and seek suitable rearing habitat, such as stream margins or cascades. The majority of juveniles smolt as two-year olds, though some individuals may rear for as long as seven years in these fresh water systems.

While this ESU has very few populations left, we do not expect that there will be much exposure to any of the a.i.s. There is very little agriculture and urban development within the ESU, and correspondingly less right-of-way. The percentage of cultivated crop lands and developed lands within the range of the ESU are 15% and 5%, respectively. There is some agriculture in the spawning and rearing areas in the Wenatchee, Methow, and Okenogan watersheds. In the Entiat, there is intense agriculture the Upper Columbia Irrigation District. However, the water is heavily used and re-used in irrigation. Forested lands make up about 80% of the ESU. Much of the forested land is federally owned; any program involving the use of pesticides would be covered under its own ESA consultation. Therefore, we are considering exposure to be minimal in these areas as well. Most exposure will occur during migration along the Columbia River. This exposure is of less concern as it is a high volume, high flow system.

Oryzalin: Overall, the likelihood oryzalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Only a few watersheds in the ESU/DPS have much agriculture and it is not typically orchards and vineyards. We anticipate some input from urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. Likelihood for appreciable reductions at the species level is low. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Pendimethalin: Overall, the likelihood pendimethalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. Likelihood for appreciable reductions at the species level is low. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Trifluralin: Overall, the likelihood trifluralin will reduce the reproduction, numbers, or distribution of listed salmonid populations is high. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. Likelihood for appreciable reductions at the species level is medium. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Snake River Basin Steelhead (Threatened Species)

The SR basin steelhead DPS includes 23 populations that are spatially distributed in each of the six major geographic areas in the Snake River basin (T. P. Good, et al., 2005). The historic spatial structure is relatively unaltered. While population growth rates show mixed long- and short-term trends in productivity, overall abundances remain well below their interim recovery criteria. Genetic diversity has been reduced, particularly for the B-run steelhead, those whose life history pattern includes spending two or more years in freshwater, and two or more years in the ocean before their upriver migration. A-run steelhead are smaller, and have a shorter freshwater and ocean residence. Juveniles typically rear in floodplain habitats associated with their natal rivers and streams for more than a year. SR basin steelhead typically smolt after two or three years.

Exposure of the Snake River Steelhead populations to the a.i.s to is likely to be fairly low. Potential exposure from use within the DPS includes agricultural lands (90%), and use in urban/residential or other developed areas (2%). As many spawn and rear in U.S. Forest Service lands, any pesticide use would be authorized under additional ESA consultations. Given these conditions, we do not believe that populations in these areas will experience adverse effects from any of the a.i.s. Some populations may experience exposure from agricultural or urban uses, particularly during migration. Since these exposures will occur in a high volume high flow system, we expect population effects to be minimal.

Oryzalin: Overall, the likelihood oryzalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Only a few watersheds in the ESU/DPS have much agriculture and it is not typically orchards and vineyards. We anticipate some input from urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. Likelihood for appreciable reductions at the species level is low. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Pendimethalin: Overall, the likelihood pendimethalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. Likelihood for appreciable reductions at the species level is low. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Trifluralin: Overall, the likelihood trifluralin will reduce the reproduction, numbers, or distribution of listed salmonid populations is high. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. Likelihood for appreciable reductions at the species level is medium. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Northern California Steelhead (Threatened Species)

The NC steelhead DPS includes 15 historically independent populations of winter steelhead and 4 extant populations of summer steelhead. The loss of summer-run steelhead populations has significantly reduced the genetic diversity. Most populations are in decline and have low abundances and production. Although the DPS spatial structure is relatively intact, the distribution within most watersheds has been restricted by physical and temperature barriers. Juvenile steelhead remain in fresh water for two or more years, rearing in streams and lagoons.

In general, we expect the populations to have limited exposure to the a.i.s. There is a low amount of development, agriculture, and rights-of-way uses within the range of the ESU. The percentage of cultivated crop lands and developed lands overlapping with NC steelhead habitat are less than 1% and 4%, and there are few areas of concentrated agriculture. Most appears to hay/pasture, concentrated in the Lower Eel watershed and some of the other coastal valleys. Development is concentrated primarily near Eureka, on the coast in the Mad River and Redwood Creek watersheds. Much of the land area in this DPS is heavily forested, and there are a number of state and national parks.

Oryzalin: Overall, the likelihood oryzalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Only a few watersheds in the ESU/DPS have much agriculture and it is not typically orchards and vineyards. We anticipate some input from urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. Likelihood for appreciable reductions at the species level is low. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Pendimethalin: Overall, the likelihood pendimethalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. Likelihood for appreciable reductions at the species level is low. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Trifluralin: Overall, the likelihood trifluralin will reduce the reproduction, numbers, or distribution of listed salmonid populations is high. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. Likelihood for appreciable reductions at the species level is medium. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Central California Coast (CCC) Steelhead (Threatened Species)

The CCC steelhead DPS includes nine historic independent populations, all of which are nearly extirpated. Data on abundance and population growth rates are scarce, but available information strongly suggests that no population is viable. The loss of spatial structure and hatchery influences have likely reduced the genetic diversity for this DPS. Juvenile steelhead remain in fresh water for one or more years rearing in small tributaries and floodplain habitats. Age to smoltificaton for this DPS is typically 1 to 4 years. Steelhead have a more adaptive life history than some of the other salmon species, including overlapping generations and iteropary.

High densities of crop farming occur throughout the San Joaquin Basin, the Delta, and along the lower Sacramento River. There is also agriculture in the Russian River valley. The Russian River population is one of the largest runs. Southern portions of DPS include the heavily developed areas around San Francisco Bay. The percentage of cultivated croplands and developed lands that overlap with CCC steelhead habitat are 4% and 24%, respectively. The most abundant populations are in the Eel River and tributaries, and in the Russian River watershed. While there is little overlap of use sites with the habitat of the Eel River populations, there is substantial overlap in the Russian River watershed. Due to the importance of this population to the ESU, likelihood of negative effects was based primarily on the overlap in this watershed. Juveniles rear in freshwater streams for a few months, and may reside in the estuary for an extended period before entering the ocean.

In general, we expect the populations to have limited exposure to the a.i.s. There is a low amount of development, agriculture, and rights-of-way uses within the range of the ESU. We expect the population in the Russian River will have a much higher degree of exposure due to the distribution of land uses. This is particularly important for oryzalin exposure, as grapes are an important crop in the Russian River valley. Given these factors and the long residency period of steelhead, we expect that the populations will be exposed to all a.i.s to some extent.

Oryzalin: Overall, the likelihood oryzalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. We anticipate a key population will be affected. Likelihood for appreciable reductions at the species level is medium. We anticipate fish will be exposed to oryzalin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Pendimethalin: Overall, the likelihood pendimethalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. We anticipate a key population will be affected. Likelihood for appreciable reductions at the species level is medium. We anticipate fish will be exposed to pendimethalin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Trifluralin: Overall, the likelihood trifluralin will reduce the reproduction, numbers, or distribution of listed salmonid populations is high. We anticipate a key population will be affected. Likelihood for appreciable reductions at the species level is high. We anticipate fish will be exposed to trifluralin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

California Central Valley (CCV) Steelhead (Threatened Species)

The CCV steelhead DPS consisted of 81 historical and independent populations. The spatial structure of the CCV steelhead has been greatly reduced by loss of habitat diversity and tributary access from dams. Available information shows a significant long-term downward trend in abundance for this DPS (NMFS, 2009a). Population losses and reduction in abundance have reduced the genetic diversity that existed within the DPS.

We expect that individuals within this population will be exposed to the a.i.s. Their range is heavily developed, for both agricultural and urban purposes. The percentage of agriculture, developed, and forested lands that overlap with CCV steelhead habitat are 32%, 11%, and 58%, respectively. Heavy use of agricultural pesticides and the high probability of mixtures increase likelihood of negative effects for this species. They are also likely to experience pesticide inputs from multiple sources, increasing the likelihood of exposure to each a.i. at intervals shorter than the labeled application interval. The valley also has a high concentration of power and transportation lines, indicating that rights-of-way applications will also occur. Juveniles typically rear for multiple years in fresh water. Juveniles also feed and rear in a variety of habitats, including the Sacramento River, the Delta, non-natal intermittent tributaries, tidal marshes, non-tidal freshwater marshes, and other shallow areas in the Delta as rearing areas for short periods during out-migration to the sea.

Oryzalin: Overall, the likelihood oryzalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all populations will be affected. Likelihood for appreciable reductions at the species level is medium. We anticipate fish will be exposed to oryzalin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Pendimethalin: Overall, the likelihood pendimethalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Use sites are distributed throughout the

ESU/DPS, and we anticipate most or all populations will be affected. Likelihood for appreciable reductions at the species level is medium. We anticipate fish will be exposed to pendimethalin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Trifluralin: Overall, the likelihood trifluralin will reduce the reproduction, numbers, or distribution of listed salmonid populations is high. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all populations will be affected. Likelihood for appreciable reductions at the species level is high. We anticipate fish will be exposed to trifluralin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

South-Central California Coast (S-CCC) Steelhead (Threatened Species)

The S-CCC steelhead DPS includes all naturally spawned steelhead in streams from the Pajaro River to the Santa Maria River. Population growth rates are unknown, though abundances are very depressed. Generally, juvenile steelhead remain in fresh water for one or more years before migrating downstream to smolt. Steelhead have a more adaptive life history than some of the other species, including overlapping generations, and iteropary. Following emergence, fry rear in smaller tributaries and floodplain habitats

Little information is available on the spatial structure or genetic diversity of this DPS. Because of the lack of information as to which populations are more important to the DPS, we have given the benefit of doubt to the species, and assumed that the populations in the mainstem of the Salinas and Pajaro Rivers, both of which have areas of intensive agriculture and development, are important.

The percentage of cultivated crop lands and developed lands that overlap with this DPS' range are 8% and 10%, respectively. Because of the degree of development in the system, we also expect that there will be a moderate to high amount of land which may have right-of-way applications. Agriculturally, the area is known for lettuces, strawberries, cut flowers, and vineyards. The volume of berries and grapes grown in the area makes it more likely that fungicides will be used within the basin. Agriculture is the dominant land use in the Salinas River valley, and there are areas of intense agriculture in the Pajaro watershed as well. Areas higher in the Salinas and Pajaro watersheds and along some of the coastal areas are much less developed, so are less affected.

Oryzalin: Overall, the likelihood oryzalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Use sites are distributed throughout the ESU/DPS, but we anticipate only some populations will be affected. Likelihood for appreciable reductions at the species level is medium. However, we do not believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Pendimethalin: Overall, the likelihood pendimethalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all populations will be affected. Likelihood for appreciable reductions at the species level is medium. We anticipate fish will be exposed to pendimethalin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Trifluralin: Overall, the likelihood trifluralin will reduce the reproduction, numbers, or distribution of listed salmonid populations is high. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all populations will be affected. Likelihood for appreciable reductions at the species level is high. We anticipate fish will be exposed to trifluralin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i.

We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Southern California (SC) Steelhead (Endangered Species)

The SC steelhead DPS includes populations in five major and several small coastal river basins in California from the Santa Maria River to the U.S.–Mexican border. Long-term estimates and population trends are lacking for the streams within the DPS. The DPS experiences reduced and fragmented distribution, and large variations in annual spawner runs. Abundance is extremely low. SC steelhead juveniles may rear in fresh water or at the upper end of coastal lagoons for the first or second summer before migrating downstream to smolt.

This area is highly developed, so we expect exposure to uses in urban, residential, and industrial areas. There is also a high concentration of roads, railroads and power lines resulting in multiple pathways for exposure to rights-of-way uses. The percentage of cultivated crop lands and developed lands within SC steelhead habitat are about 5% and 35%, respectively. The agricultural areas are mostly along the coast of the more northern portion of the DPS. Some of the spawning and rearing areas are in the upper portions of these watersheds, away from the areas heavy development. Additionally, some populations overlap with portions of the Los Padres National Forest.

Oryzalin: Overall, the likelihood oryzalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Only a few watersheds in the ESU/DPS have much agriculture and it is not typically orchards and vineyards. We anticipate some input from urban/developed areas and from rights-of-way. We believe most populations will be minimally affected. Likelihood for appreciable reductions at the species level is low. Use of this a.i. as currently registered does not appear likely to jeopardize the continued existence and recovery of the species.

Pendimethalin: Overall, the likelihood pendimethalin will reduce the reproduction, numbers, or distribution of listed salmonid populations is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all populations will be affected. Likelihood for appreciable reductions at the species level is medium. We anticipate fish will be exposed to pendimethalin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Trifluralin: Overall, the likelihood trifluralin will reduce the reproduction, numbers, or distribution of listed salmonid populations is high. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all populations will be affected. Likelihood for appreciable reductions at the species level is high. We anticipate fish will be exposed to trifluralin multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We do believe reductions will rise to the level where they jeopardize the continued existence and recovery of the species.

Table 113. Potential for reduction in reproduction, abundance, or distribution of ESU/DPSs

Species	ESU/DPS	Oryzalin	Pendimethalin	Trifluralin
Chinook	Puget Sound	Low	Medium	High
	Lower Columbia River	Medium	Medium	High
	Upper Columbia River Spring - Run	Low	Low	Medium
	Snake River Fall - Run	Low	Low	Medium
	Snake River Spring/Summer - Run	Low	Low	Medium
	Upper Willamette River	Medium	Medium	High
	California Coastal	Medium	Medium	High
	Central Valley Spring - Run	Medium	Medium	High
	Sacramento River Winter - Run	Medium	Medium	High
Chum	Hood Canal Summer - Run	Low	Low	Medium
	Columbia River	Low	Low	Medium
Coho	Lower Columbia River	Medium	Medium	High
	Oregon Coast	Low	Low	Medium
	Southern Oregon and Northern California Coast	Low	Low	Medium
	Central California Coast	Medium	Medium	High
Sockeye	Ozette Lake	Low	Low	Low
	Snake River	Low	Low	Low
Steelhead	Puget Sound	Low	Medium	High
	Lower Columbia River	Medium	Medium	High
	Upper Willamette River	Medium	Medium	High
	Middle Columbia River	Medium	Medium	High
	Upper Columbia River	Low	Low	Medium
	Snake River	Low	Low	Medium
	Northern California	Low	Low	Medium
	Central California Coast	Medium	Medium	High
	California Central Valley	Medium	Medium	High
	South-Central California Coast	Medium	Medium	High
	Southern California	Medium	Medium	High

Designated Critical Habitat Specific Evaluations for Each a.i.

Below, we summarize the current status of high and medium conservation value watersheds for each species, including baseline stressors. As exposure to the stressors of the action in salmonid spawning, rearing, and migration habitat is of concern, we highlight exposure from the stressors in shallow, more vulnerable habitats. The number of exposed watersheds that co-occur with agricultural and urban areas is also given. Using both chemical and species habitat information, we determine whether the stressors associated with each a.i. will co-occur and have negative effects on PCEs and if those effects will cause an appreciable decline in the conservation value of that habitat.

Puget Sound Chinook Salmon

Of 61 assessed watersheds (HUC 5), 40 and 9 are of high and medium conservation value, respectively. Nineteen nearshore marine areas are also of high conservation value. Of the high value conservation watersheds, 32 and 40 are exposed to pesticides from agriculture and urban land uses, respectively. Among the medium value watersheds, six and nine are exposed to pesticides from agriculture and urban land uses, respectively. All low value areas are exposed to both agricultural and urban land uses. These areas serve as spawning, rearing, and migration habitat for Puget Sound Chinook salmon.

Migration, spawning, and rearing PCEs in upper watersheds of most river systems, and in the lower alluvial valleys of mid- to southern Puget Sound and the Strait of Juan de Fuca have been heavily altered by forestry, agriculture, and urban land uses. These activities have resulted in the loss of floodplain habitat, reduced substrate conditions for spawning and incubation, and degraded water quality. Estuary PCEs in the northwest Puget Sound are also degraded from impaired water quality (*e.g.*, contaminants), altered salinity conditions, lack of natural cover, and modification of and lack of access to tidal marshes and their channels. As elevated water temperature prevents this ESU from inhabiting about 374 km of streams within its range, suitable PCE conditions in remaining available species habitat become important for ensuring long-term species conservation.

Cultivated crops, including hay and pastures (5%) are primarily distributed on the floodplain and other lowland habitats. The majority of urban/residential land use also occurs within river and stream valleys in lowland areas, much of the nearshore marine area also consists of urban/residential.

Oryzalin: Overall, the likelihood oryzalin will cause adverse effects on critical habitat PCEs is medium. Only a few watersheds in the ESU/DPS have much agriculture and it is not typically orchards and vineyards. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe designated critical habitat will be minimally affected. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Pendimethalin: Overall, the likelihood pendimethalin will cause adverse effects on critical habitat PCEs is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate pendimethalin input to habitat will occur multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Trifluralin: Overall, the likelihood trifluralin will cause adverse effects on critical habitat PCEs is high. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate trifluralin input to habitat will occur multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Lower Columbia River (LCR) Chinook Salmon

Thirty-one and 13 watersheds are of high and medium conservation value, respectively. Four additional unoccupied watersheds received a "possibly high" rating for species conservation as well. Our GIS analysis indicates 26 of 31 high conservation value watersheds are exposed to pesticide applications from agriculture and urban land uses, respectively. All 13 medium and 4 low conservation watersheds are also exposed to pesticide applications from both land uses.

Spawning and rearing PCEs for LCR Chinook salmon have been degraded by timber harvests, agriculture, and urbanization. These land uses have reduced floodplain connectivity and water quality, and removed natural cover in several rivers. Hydropower development projects have also reduced the timing and magnitude of water flows, thereby altering required water quantity to form and maintain physical habitat conditions for juvenile fish growth and mobility. Migration PCEs are also affected by several dams along the migration route used by adult and juvenile fish. The survival of yearlings in the ocean is also affected by habitat conditions in the estuary, such as changes in food availability and the presence of contaminants.

Spawning and migration PCEs in these exposed watersheds, as well as the river mainstem, and upstream tributaries likely experience reductions in water quality and prey abundance during allowable pesticide applications adjacent to these systems. As elevated water temperature prevents LCR Chinook salmon from inhabiting about 275 km of streams within its range, suitable PCE conditions in available species habitat are important for ensuring long-term species conservation.

Oryzalin: Overall, the likelihood oryzalin will cause adverse effects on critical habitat PCEs is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate some designated critical habitat will be affected. However, the effects are not anticipated to appreciably reduce the conservation value of the designated critical habitat.

Pendimethalin: Overall, the likelihood pendimethalin will cause adverse effects on critical habitat PCEs is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate pendimethalin input to habitat will occur multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Trifluralin: Overall, the likelihood trifluralin will cause adverse effects on critical habitat PCEs is high. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate trifluralin input to habitat will occur multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Upper Columbia River (UCR) Spring-run Chinook Salmon

Twenty-six and five watersheds are of high and medium conservation value, respectively. Our GIS analysis indicates 23 and 26 high conservation watersheds are exposed to pesticide applications from agriculture and urban land uses, respectively. All medium conservation value watersheds are also exposed to pesticides from both land uses.

Fish spawn and rear in the major tributaries leading to the Columbia River between Rock Island and Chief Joseph dams. Urbanization in lower reaches, irrigation and diversion in the major upper drainages, and grazing in the middle reaches have degraded spawning and rearing PCEs in tributary systems. Migration PCEs for adult and juvenile fish are heavily degraded by Columbia River federal dam projects and a number of mid-Columbia River Public Utility District dam projects.

Oryzalin: Overall, the likelihood oryzalin will cause adverse effects on critical habitat PCEs is medium. Only a few watersheds in the ESU/DPS have much agriculture and it is not typically orchards and vineyards. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe designated critical habitat will be minimally affected. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Pendimethalin: Overall, the likelihood pendimethalin will cause adverse effects on critical habitat PCEs is medium. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe designated critical habitat will be minimally affected. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Trifluralin: Overall, the likelihood trifluralin will cause adverse effects on critical habitat PCEs is high. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe most populations will be minimally affected. We believe designated critical habitat will be minimally affected. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Snake River (SR) Fall-run Chinook Salmon

Individual watersheds within the range of SR Fall-run Chinook salmon have not been evaluated by the CHART team for their conservation value. However, the Lower Columbia River corridor is of high conservation value as it connects several populations with the ocean and is used by rearing/migrating juveniles and migrating adults. The Columbia River estuary is also a unique and essential area for juveniles and adults making the physiological transition between life in freshwater and marine habitats. In lieu of CHART data on the conservation value ratings of salmonid watersheds, we recognize that all watersheds within the range of SR Fall-run Chinook salmon are of high conservation value. We used GIS data to assess the overlap between spawning and migration PCEs and use sites and their exposure in the Columbia River estuary and migratory corridor.

Baseline conditions for this ESU include reduced spawning habitat and impaired stream flows and barriers to fish passage in tributaries from hydroelectric dams. Stream water quality and biological communities in the downstream portion of the upper Snake River basin are also degraded. We note that elevated water temperature currently prevents SR Fall-run Chinook salmon from inhabiting 2,401 km of streams within its range.

Oryzalin: Overall, the likelihood oryzalin will cause adverse effects on critical habitat PCEs is medium. Only a few watersheds in the ESU/DPS have much agriculture and it is not typically orchards and vineyards. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe designated critical habitat will be minimally affected. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Pendimethalin: Overall, the likelihood pendimethalin will cause adverse effects on critical habitat PCEs is medium. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe designated critical habitat will be minimally affected. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Trifluralin: Overall, the likelihood trifluralin will cause adverse effects on critical habitat PCEs is high. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe most populations will be minimally affected. We believe designated critical habitat will be minimally affected. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Snake River (SR) Spring/Summer-run Chinook Salmon

Watersheds within the range of SR Spring/Summer-run Chinook salmon were not evaluated by the CHART team for their conservation value. However, the Lower Columbia River is of high conservation value as it connects every population with the ocean and is used by rearing/migrating juveniles and migrating adults. Juveniles of this ESU rely on adequate fresh water quality and prey abundance for migrating and rearing in freshwater habitats including migratory routes from natal reaches leading to alternative summer-rearing or overwintering areas.

Spawning and juvenile rearing PCEs are regionally degraded by changes in flow quantity, water quality, and loss of cover. Juvenile and adult migrations are obstructed by reduced access stemming from altered flow regimes from hydroelectric dams. As elevated water temperature prevents SR Spring/Summer-run Chinook salmon from inhabiting 1,596.3 km of streams within its range, suitable PCE conditions in remaining species habitat become important for ensuring the long-term conservation for this species.

This ESU spawns and rears primarily in the smaller tributaries, many of which are located on U.S. Forest Service lands. Agricultural and urban areas are not common in the watersheds comprising the ESU, and those that are present are clustered mostly around the mainstem Snake and Columbia Rivers. The Snake River is a high-volume, high-flow system, and salmon use it primarily as a migratory corridor.

Oryzalin: Overall, the likelihood oryzalin will cause adverse effects on critical habitat PCEs is medium. Only a few watersheds in the ESU/DPS have much agriculture and it is not typically orchards and vineyards. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe designated critical habitat will be minimally affected. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Pendimethalin: Overall, the likelihood pendimethalin will cause adverse effects on critical habitat PCEs is medium. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe designated critical habitat will be minimally affected. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Trifluralin: Overall, the likelihood trifluralin will cause adverse effects on critical habitat PCEs is high. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe most populations will be minimally affected. We believe designated critical habitat will be minimally affected. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Upper Willamette River (UWR) Chinook Salmon

Of 59 assessed watersheds, 22 are of high, 18 are medium and 19 are low conservation value. The lower Willamette/Columbia River rearing/migration corridor downstream of the spawning range is also of high conservation value. Our GIS analysis indicates 15 and 19 high conservation watersheds are exposed to pesticide applications from agriculture and urban land uses, respectively. Of the medium conservation watersheds, 13 and 12 are also exposed to pesticide applications from the above respective land uses. All 19 low value habitats are exposed to urban and developed uses. The percentage of cultivated and develop lands that overlap with UWR Chinook salmon habitat are 27% and 9%, respectively. Spawning, rearing, and migration freshwater PCEs in these exposed watersheds (including mainstem and floodplain wetlands) likely experience reductions in water quality and prey abundance.

Migration and rearing PCEs have been degraded by dams altering migration timing and water management. Migration, rearing, and estuary PCEs are also degraded by the loss of riparian vegetation and instream cover. Water quality is also degraded in floodplain rearing habitat along the lower Willamette River. As elevated water temperature prevents UWR Chinook salmon from inhabiting 2,468 km of waters within its range, PCE conditions in remaining species habitat are important for ensuring long-term conservation for this species.

Oryzalin: Overall, the likelihood oryzalin will cause adverse effects on critical habitat PCEs is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate oryzalin input to habitat will occur multiple times due to repeated applications, and/or from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Pendimethalin: Overall, the likelihood pendimethalin will cause adverse effects on critical habitat PCEs is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate pendimethalin input to habitat will occur multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Trifluralin: Overall, the likelihood trifluralin will cause adverse effects on critical habitat PCEs is high. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate trifluralin input to habitat will occur multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

California Coastal (CC) Chinook Salmon

Of 45 occupied watersheds, 27 and 10 are of high and medium conservation value, respectively. The remaining 8 are of low conservation value. Our GIS analysis indicates 8 and 27 high conservation watersheds are exposed to pesticides from agriculture and urban land uses, respectively. Of the medium conservation watersheds, 4 and 10 are exposed to pesticide applications from the above respective land uses. All 8 low are exposed to urban land uses, while 2 are exposed to agriculture land uses.

The spawning PCE in coastal streams have been degraded from timber harvests. Rearing and migration PCEs in the Russian River have also been impacted by agriculture and urban areas. Water management for dams within the Russian and Eel River watersheds maintain high flows and warm water during summer which indirectly benefits the introduced Sacramento pikeminnow, a predatory fish on CC Chinook salmon along migration corridors. The estuary PCE has also been degraded from breaches of the sandbar at the mouth of the Russian River causing periodic mixing of salt water. This condition alters the water quality and salinity conditions for the juvenile physiological transitions between fresh and salt water. Current PCE conditions likely maintain a low population abundance across the ESU.

Oryzalin: Overall, the likelihood oryzalin will cause adverse effects on critical habitat PCEs is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate oryzalin input to habitat will occur multiple times due to repeated applications, and/or from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Pendimethalin: Overall, the likelihood pendimethalin will cause adverse effects on critical habitat PCEs is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate pendimethalin input to habitat will occur multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Trifluralin: Overall, the likelihood trifluralin will cause adverse effects on critical habitat PCEs is high. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate trifluralin input to habitat will occur multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Central Valley (CV) Spring-run Chinook Salmon

Of 38 occupied watersheds, 28 and 3 are of high and medium conservation value, respectively. Four of these watersheds comprise portions of the San Francisco-San Pablo-Suisun Bay estuarine complex which provides rearing and migratory habitat for CV Spring-run Chinook salmon. Our GIS analysis indicates 17 and 28 high conservation value watersheds are exposed to pesticides from agriculture and urban land uses, respectively. Of the medium conservation watersheds, two and three watersheds are exposed to from the above land uses as well. All low value watersheds are exposed to pesticide applications from urban land uses, while only 2 are exposed to agricultural applications.

Spawning and rearing PCEs are currently degraded by elevated water temperature and lost access to historic spawning areas in upper watersheds with cool and clean water throughout the summer. The rearing PCE is degraded and is affected by loss of floodplain habitat connectivity from the mainstem of larger rivers through the Sacramento River watershed, thereby reducing effective foraging. The migration PCE is degraded by lack of natural cover along the migration corridors. Juvenile migration is further obstructed by water diversions along the Sacramento River and by two large state and federal water-export facilities in the Sacramento-San Joaquin Delta. Agriculture and urban runoff containing a suite of pollutants further impair water quality of receiving systems used by this species.

Intensive agricultural development occurs in the California Central Valley and may degrade waters draining into the Sacramento River. We further expect rearing and migration PCEs in non-natal tributaries, intermittent streams, and floodplain habitats may also experience likely reductions in water quality and prey abundance. Migration PCEs in the San Francisco-San Pablo-Suisan Bay estuaries complex, which are heavily influenced by input from California's Central Valley likely experience reductions in water quality and prey abundance.

Oryzalin: Overall, the likelihood oryzalin will cause adverse effects on critical habitat PCEs is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate oryzalin input to habitat will occur multiple times due to repeated applications, and/or from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Pendimethalin: Overall, the likelihood pendimethalin will cause adverse effects on critical habitat PCEs is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate pendimethalin input to habitat will occur multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Trifluralin: Overall, the likelihood trifluralin will cause adverse effects on critical habitat PCEs is high. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate trifluralin input to habitat will occur multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Sacramento River Winter-run Chinook Salmon

Individual subbasins or river sections were not evaluated for their conservation value. However, the entire Sacramento River and the Delta are considered of high conservation value for spawning, rearing, and migration.

Spawning and rearing PCEs are currently degraded by elevated water temperature and lost access to historic spawning areas in upper watersheds with cool and clean water throughout the summer. The rearing PCE is degraded and is affected by loss of floodplain habitat connection from the mainstem of larger rivers through the Sacramento River watershed, thereby reducing effective foraging. The migration PCE is degraded by lack of natural cover along the migration corridors. Juvenile migration is further obstructed by water diversions along the Sacramento River and by two large state and federal water-export facilities in the Sacramento-San Joaquin Delta. As agriculture and urban land uses occur in the Sacramento River watershed and in the Sacramento-San Joaquin Delta, we expect rearing and spawning PCEs in floodplain habitat and the Sacramento River may experience reductions in water quality and prey abundance.

Oryzalin: Overall, the likelihood oryzalin will cause adverse effects on critical habitat PCEs is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate oryzalin input to habitat will occur multiple times due to repeated applications, and/or from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Pendimethalin: Overall, the likelihood pendimethalin will cause adverse effects on critical habitat PCEs is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate pendimethalin input to habitat will occur multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Trifluralin: Overall, the likelihood trifluralin will cause adverse effects on critical habitat PCEs is high. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate trifluralin input to habitat will occur multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Hood Canal Summer-run Chum Salmon

Of 12 assessed watersheds, nine and three are of high and medium conservation value, respectively. Five nearshore marine areas were also rated as high conservation value. Many of the watersheds have less than four miles of spawning habitat and none are greater than 8.5 miles in length. Our GIS analysis indicates seven and nine high conservation value watersheds are exposed to pesticides from agriculture and urban land uses, respectively. All three medium conservation watersheds are exposed to both land uses as well.

The spawning PCE is degraded by excessive fine sediment in gravel. The rearing PCE is degraded by loss of access to sloughs in the estuary and nearshore areas and excessive predation. Migration and rearing PCEs in estuaries are impaired by the loss of functional floodplain areas. These degraded conditions likely maintain low population abundance across the ESU.

Most of the agriculture and urban/residential uses occur within rivers and stream valleys in lowland areas. Nearshore marine areas are frequently adjacent to urban/residential areas. Given these uses, spawning and migration PCEs in streams, estuaries, and nearshore marine areas may experience reductions in water quality and prey abundance during allowable pesticide applications adjacent to these systems.

Oryzalin: Overall, the likelihood oryzalin will cause adverse effects on critical habitat PCEs is medium. Only a few watersheds in the ESU/DPS have much agriculture and it is not typically orchards and vineyards. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe designated critical habitat will be minimally affected. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Pendimethalin: Overall, the likelihood pendimethalin will cause adverse effects on critical habitat PCEs is medium. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe designated critical habitat will be minimally affected. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Trifluralin: Overall, the likelihood trifluralin will cause adverse effects on critical habitat PCEs is high. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe most populations will be minimally affected. We believe designated critical habitat will be minimally affected. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Columbia River (CR) Chum Salmon

Of 19 assessed watersheds, 16 and 3 are of high and medium conservation value, respectively. Our GIS analysis indicates all high and medium conservation value watersheds are exposed to pesticide applications from agriculture, developed areas, and forestry adjacent to CR chum salmon habitat.

The migration PCE for this species has been significantly impacted by dams obstructing adult migration and access to historic spawning sites. Water quality and cover for estuary and rearing PCEs have decreased and are not likely to maintain their intended function to conserve the species. Elevated water temperature further prevents CR chum salmon from inhabiting 272.8 km of waters within its range.

More than 50% of the range of the ESU is covered by deciduous, evergreen, or mixed forests. Within the ESU, agricultural and development are predominantly distributed in the low-lying areas near the Columbia River and its tributaries. Given these uses the rearing and migration PCEs along the edges of the mainstem or in tributaries and side channels of freshwater and estuarine systems may experience reductions in water quality and prey abundance during allowable pesticide applications adjacent to these systems.

Oryzalin: Overall, the likelihood oryzalin will cause adverse effects on critical habitat PCEs is medium. Only a few watersheds in the ESU/DPS have much agriculture and it is not typically orchards and vineyards. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe designated critical habitat will be minimally affected. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Pendimethalin: Overall, the likelihood pendimethalin will cause adverse effects on critical habitat PCEs is medium. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe designated critical habitat will be minimally affected. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Trifluralin: Overall, the likelihood trifluralin will cause adverse effects on critical habitat PCEs is high. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe most populations will be minimally affected. We believe designated critical habitat will be minimally affected. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Oregon Coast (OC) Coho Salmon

Of 80 watersheds, 45 and 27 are of high and medium conservation value, respectively. Our GIS analysis indicates 39 and 44 high conservation watersheds are exposed to pesticides from agriculture and urban areas, respectively. Of the medium conservation watersheds, 18 and 23 are exposed to pesticide applications from the above respective land uses. Of the 8 low conservation value watersheds, 2 are exposed to pesticide applications from agricultural and 4 are exposed to pesticide applications from urban land uses.

The rearing PCE has been degraded by elevated water temperature in 29 of the 80 HUC 5 watersheds. Elevated temperature further prevents OC coho salmon from inhabiting 3,716 km of waters within its range. Twelve watersheds have reduced water quality from contaminants and excessive nutrition. Most of the cropland is hay/pasture and is primarily located in the Umpqua watersheds. Given these uses, we expect a low likelihood of freshwater rearing PCE in small streams to experience reductions in water quality and prey abundance.

Oryzalin: Overall, the likelihood oryzalin will cause adverse effects on critical habitat PCEs is medium. Only a few watersheds in the ESU/DPS have much agriculture and it is not typically orchards and vineyards. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe designated critical habitat will be minimally affected. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Pendimethalin: Overall, the likelihood pendimethalin will cause adverse effects on critical habitat PCEs is medium. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe designated critical habitat will be minimally affected. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Trifluralin: Overall, the likelihood trifluralin will cause adverse effects on critical habitat PCEs is high. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe most populations will be minimally affected. We believe designated critical habitat will be minimally affected. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Southern Oregon/Northern California Coast (SONCC) Coho Salmon

Although watersheds within this ESU were not evaluated for their conservation value, the northern coastal streams that are designated as critical habitat are of good quality. Throughout this ESU's range, the spawning PCE has been degraded by fines in spawning gravel from logging. The rearing PCE has been considerably degraded in many inland watersheds by the loss of riparian vegetation, resulting in unsuitable high temperatures. Rearing and migration PCEs have been reduced by the disconnection of floodplain and off-channel habitats in low gradient reaches of streams. Elevated water temperature further prevents SONCC coho salmon from inhabiting 3,249.2 km of waters within its range.

Areas with more cropland include the Scott and Shasta watersheds in the Klamath basin and the Upper and Middle rough River watersheds. Of the development in this ESU, much is in the rough River basin, with remaining development distributed along the coastline and estuaries.

Oryzalin: Overall, the likelihood oryzalin will cause adverse effects on critical habitat PCEs is medium. Only a few watersheds in the ESU/DPS have much agriculture and it is not typically orchards and vineyards. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe designated critical habitat will be minimally affected. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Pendimethalin: Overall, the likelihood pendimethalin will cause adverse effects on critical habitat PCEs is medium. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe designated critical habitat will be minimally affected. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Trifluralin: Overall, the likelihood trifluralin will cause adverse effects on critical habitat PCEs is high. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe most populations will be minimally affected. We believe designated critical habitat will be minimally affected. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Central California Coast (CCC) Coho Salmon

Individual watersheds have not been evaluated for their conservation value. Nevertheless, there is a distinct trend of increasing degradation in quality and quantity of all PCEs as the habitat progresses south through the species range along the Lost Coast to Navarro Point and the Santa Cruz Mountains. Spawning and incubation substrate and juvenile rearing habitat are generally degraded.

Much of the development is centered around San Francisco Bay, and developed and agricultural areas also occur in the Russian River watershed. The northern, undeveloped watersheds around the Navarro and Big Rivers are used by the majority of this species. Given these land uses, we expect the freshwater rearing PCE may experience reductions in water quality and prey abundance during allowable pesticide applications adjacent to freshwater systems.

Oryzalin: Overall, the likelihood oryzalin will cause adverse effects on critical habitat PCEs is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate oryzalin input to habitat will occur multiple times due to repeated applications, and/or from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Pendimethalin: Overall, the likelihood pendimethalin will cause adverse effects on critical habitat PCEs is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate pendimethalin input to habitat will occur multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Trifluralin: Overall, the likelihood trifluralin will cause adverse effects on critical habitat PCEs is high. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate trifluralin input to habitat will occur multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Ozette Lake Sockeye Salmon

The Ozette Lake watershed is of high conservation value. The entire circumference of the lake is within Olympic National Park. Ozette Lake and portions of three tributaries support spawning and rearing PCEs. Ozette River supports rearing and migration PCEs; its river mouth also provides estuarine habitat. Migration habitat is also affected by low water flow in summer and elevated water temperature which pose as a thermal barrier for migration.

Spawning habitat has been affected by the loss of tributary spawning areas, low water levels in summer, and vegetation and sediment that have reduced the quantity and suitability of beaches for spawning. The rearing PCE is degraded by excessive predation, competition with non-native species, and loss of rearing habitat. Migration habitat is affected by high water temperatures and low water flows in summer.

Ozette Lake is in a sparsely populated area, with less than 1% of land developed within the range of this ESU. Similarly, there is no cultivated cropland. Land use is primarily forest with private, state, and federal ownership (86% forested, 13% open water, 1% developed land, 0% agriculture). The predominant pesticide use sites (*i.e.*, urban/residential and forestry) overlap with the Lake's freshwater tributaries. Thus, the greatest risk of exposure to freshwater PCEs are in tributary habitats. However, we do not expect a reduction in prey abundance within these tributaries. Although private residences along tributaries may have small, non-commercial crops for pesticide applications, it is unlikely that restricted use pesticides would be applied.

Oryzalin: Overall, the likelihood oryzalin will cause adverse effects on critical habitat PCEs is medium. However, there is little or no agriculture or urban/developed areas near the spawning, rearing or migratory habitat. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Pendimethalin: Overall, the likelihood pendimethalin will cause adverse effects on critical habitat PCEs is medium. However, there is little or no agriculture or urban/developed areas near the spawning, rearing or migratory habitat. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Trifluralin: Overall, the likelihood trifluralin will cause adverse effects on critical habitat PCEs is high. However, there is little or no agriculture or urban/developed areas near the spawning, rearing or migratory habitat. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Snake River Sockeye Salmon

Conservation values of individual watersheds have not been reported. Nevertheless, all areas occupied and used by migrating SR sockeye are considered of high conservation value as this species is limited to a single lake within the SR basin.

The quality and quantity of rearing and migration PCEs have been reduced by land uses that disrupt access to foraging areas, increase the amount of fines in the stream substrate, and reduce instream cover. Water quality is impaired by a suite of anthropogenic pollutants which enter surface waters and riverine sediments from the headwaters of the Salmon River to the Columbia

River estuary. The migration PCE is also affected by four dams in the SR basins that obstructs migration and increases mortality of downstream migrating juveniles. Given the migration distance traveled by this species, adequate passage conditions (water quality and quantity available at specific times) is critical.

About 1% of the land surrounding Red Fish Lake has been developed, and another 1% is used for agriculture, primarily hay and pasture. More than 50% of range of this ESU is in evergreen forests. Consequently, forestry uses are the major source of exposure in spawning and rearing habitats.

Oryzalin: Overall, the likelihood oryzalin will cause adverse effects on critical habitat PCEs is medium. However, there is little or no agriculture or urban/developed areas near the spawning and rearing habitat. Likelihood of exposure to the a.i. is low, except during migration through the Snake River, which is a high volume, high flow water body. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Pendimethalin: Overall, the likelihood pendimethalin will cause adverse effects on critical habitat PCEs is medium. However, there is little or no agriculture or urban/developed areas near the spawning and rearing habitat. Likelihood of exposure to the a.i. is low, except during migration through the Snake River, which is a high volume, high flow water body. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Trifluralin: Overall, the likelihood trifluralin will cause adverse effects on critical habitat PCEs is high. However, there is little or no agriculture or urban/developed areas near the spawning and rearing habitat. Likelihood of exposure to the a.i. is low, except during migration through the Snake River, which is a high volume, high flow water body. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Lower Columbia River Steelhead

Of 41 watersheds listed as critical habitat for LCR steelhead, 28 and 11 are of high and medium conservation value, respectively. Our GIS analysis indicates 21 and 26 high conservation watersheds are exposed to pesticides from agriculture and urban/residential land uses, respectively. Of the medium conservation watersheds, 11 and 10 are also exposed to pesticide applications from the above respective land uses. The two low conservation value watersheds are exposed to pesticides applied in both agricultural and urban settings.

The water quality of the rearing PCE within the lower portion and alluvial valleys of many watersheds has been degraded by agricultural runoff into tributaries reaches and the mainstem Columbia River. Consequently, invertebrate production in these aquatic systems is also affected. Elevated water temperature further prevents LCR steelhead from inhabiting 341.5 km of waters within its range.

Oryzalin: Overall, the likelihood oryzalin will cause adverse effects on critical habitat PCEs is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate some designated critical habitat will be affected. However, the effects are not anticipated to appreciably reduce the conservation value of the designated critical habitat.

Pendimethalin: Overall, the likelihood pendimethalin will cause adverse effects on critical habitat PCEs is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate pendimethalin input to habitat will occur multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Trifluralin: Overall, the likelihood trifluralin will cause adverse effects on critical habitat PCEs is high. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate trifluralin input to habitat will occur multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Upper Willamette River Steelhead

Of the watersheds assessed, 14 and 6 are of high and medium conservation value, respectively. Our GIS analysis indicates all high and medium conservation value watersheds are exposed to pesticide applications from agriculture and urban areas adjacent to UWR steelhead critical habitat. All 17 of the low conservation value watersheds are at risk of exposure to pesticides applied in agricultural and urban areas.

Existing water quality necessary for juvenile rearing within many watersheds have been impaired by pollutants in agricultural runoff. Consequently, invertebrate production for salmonids in several watersheds and in the mainstem Columbia River is affected. As several dams obstruct migrating fish along the migratory corridor, the migration PCE is also reduced by these features. Elevated water temperature further prevents UWR steelhead from inhabiting 1,668 km of waters within its range.

Given these uses, we expect the freshwater rearing PCE in floodplain habitats, rivers, and streams may experience reductions in water quality and prey abundance during allowable pesticide applications adjacent to these systems.

Oryzalin: Overall, the likelihood oryzalin will cause adverse effects on critical habitat PCEs is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate oryzalin input to habitat will occur multiple times due to repeated applications, and/or from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Pendimethalin: Overall, the likelihood pendimethalin will cause adverse effects on critical habitat PCEs is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate pendimethalin input to habitat will occur multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Trifluralin: Overall, the likelihood trifluralin will cause adverse effects on critical habitat PCEs is high. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate trifluralin input to habitat will occur multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Middle Columbia River Steelhead

Of the 106 assessed watersheds, 73 and 24 are of high and medium conservation value, respectively. The lower Columbia River rearing/migration corridor downstream of the spawning range is also of high conservation value. Our GIS analysis indicates 67 and 68 high conservation watersheds are exposed to pesticides from agriculture and urban areas, respectively. Of the medium conservation watersheds, 23 and 24 watersheds are also exposed to pesticide applications from the above respective land uses. All 9 of the low conservation value watersheds are at risk of exposure to pesticides applied in agricultural and urban areas.

The current condition of critical habitat for MCR steelhead is moderately degraded. The water quality attribute for the rearing PCE within many watersheds is reduced. Consequently, invertebrate production in these watersheds and in the mainstem Columbia River is also reduced. Loss of riparian vegetation to grazing has resulted in elevated water temperature in the John Day Basin. Elevated water temperature prevents MCR steelhead from inhabiting 3,727.9 km of waters within its range. In the Yakima River, 72 streams and river segments are also listed as impaired waters and 83% exceed temperature standards. As several dams obstruct fish along their migratory corridor, these features further degrade the migration PCE.

Oryzalin: Overall, the likelihood oryzalin will cause adverse effects on critical habitat PCEs is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate oryzalin input to habitat will occur multiple times due to repeated applications, and/or from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Pendimethalin: Overall, the likelihood pendimethalin will cause adverse effects on critical habitat PCEs is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate pendimethalin input to habitat will occur multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Trifluralin: Overall, the likelihood trifluralin will cause adverse effects on critical habitat PCEs is high. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate trifluralin input to habitat will occur multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Upper Columbia River Steelhead

Of the 41 watersheds occupied by UCR steelhead, 31 and 7 are of high and medium conservation value, respectively. The lower Columbia River rearing/migration corridor downstream of the species' spawning range is also of high conservation value. Our GIS analysis indicates 28 and 31 high conservation watersheds are exposed to pesticides from agriculture and urban areas, respectively. All seven medium and all three low conservation value watersheds are exposed to pesticide applications from the above land uses.

The current condition of UCR steelhead critical habitat is moderately degraded. Habitat quality in tributary streams range from excellent to poor. Water quality for the rearing PCEs within many watersheds has been reduced from agriculture runoff. Consequently, invertebrate production in several watersheds and in the mainstem Columbia River is also reduced. Several dams obstruct fish migrating through the migratory corridor and further impact the migration PCEs. There is some agriculture in the spawning and rearing areas in the Wenatchee, Methow, and Okenogan watersheds. Intense agriculture occurs in the Upper Columbia Irrigation District within the Entiat watershed. The water is heavily used and re-used for irrigation.

Oryzalin: Overall, the likelihood oryzalin will cause adverse effects on critical habitat PCEs is medium. Only a few watersheds in the ESU/DPS have much agriculture and it is not typically orchards and vineyards. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe designated critical habitat will be minimally affected. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Pendimethalin: Overall, the likelihood pendimethalin will cause adverse effects on critical habitat PCEs is medium. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe designated critical habitat will be minimally affected. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Trifluralin: Overall, the likelihood trifluralin will cause adverse effects on critical habitat PCEs is high. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe most populations will be minimally affected. We believe designated critical habitat will be minimally affected. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Snake River Basin Steelhead

Of the watersheds assessed, 229 and 41 are of high and medium conservation value, respectively. The Columbia River migration corridor is also of high conservation value. Our GIS analysis indicates 163 and 99 high conservation watersheds are exposed to pesticides from agriculture and urban areas, respectively. Of the medium conservation watersheds, 34 and 28 are also exposed to pesticide applications from the above land uses. Of the low conservation value watersheds, 12 are exposed to pesticides applied in agricultural areas, while 9 are exposed to those applied in urban areas.

The current condition of SR basin steelhead critical habitat is moderately degraded. Water quality conditions for rearing PCEs within many watersheds have been degraded from contaminants in agricultural runoff. Consequently, invertebrate communities in several watersheds and in the mainstem Columbia River are negatively impacted. These conditions have reduced the rearing PCE. As several dams obstruct adult fish migrating along the migratory corridor, the migration PCE is also negatively impacted. Elevated water temperature further prevents SR basin steelhead from inhabiting 3,282 km of waters within its range.

Oryzalin: Overall, the likelihood oryzalin will cause adverse effects on critical habitat PCEs is medium. Only a few watersheds in the ESU/DPS have much agriculture and it is not typically orchards and vineyards. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe designated critical habitat will be minimally affected. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Pendimethalin: Overall, the likelihood pendimethalin will cause adverse effects on critical habitat PCEs is medium. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe designated critical habitat will be minimally affected. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Trifluralin: Overall, the likelihood trifluralin will cause adverse effects on critical habitat PCEs is high. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe most populations will be minimally affected. We believe designated critical habitat will be minimally affected. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Northern California Steelhead

Of the 50 assessed watersheds, 27 and 14 are of high and medium conservation value, respectively. Two estuarine habitat areas used for rearing and migration (Humboldt Bay and the Eel River Estuary) are also of high conservation value. Our GIS analysis indicates 10 and 27 high conservation watersheds are exposed to agriculture and urban areas, respectively. Of the medium conservation watersheds, 2 and 14 are also exposed to pesticide applications from the same above land uses, respectively. Of the low watersheds, all nine may be exposed to pesticides applied in urban areas, while only one is at risk of exposure to pesticides applied in agricultural areas.

The current condition of critical habitat for NC steelhead is moderately degraded. Removal of riparian vegetation within portions of its range promotes elevated water temperature and consequently affects the rearing PCE in freshwater and estuaries. Spawning PCE attributes such as the quality of substrate supporting spawning, incubation, and larval development are degraded by silt and sediment fines in the spawning gravel. Access to tributaries in many watersheds is affected by bridges, culverts, and forest road construction. Consequently, these uses reduce the function of the migration PCE for adults.

There are few areas of concentrated agriculture and most appear to be hay/pasture and are concentrated in the Lower Eel watershed and some of the other coastal valleys. Development is concentrated primarily near Eureka, on the coast in the Mad River and Redwood Creek watersheds. Much of the land area in this DPS is heavily forested, and there is a number of state and national parks.

Oryzalin: Overall, the likelihood oryzalin will cause adverse effects on critical habitat PCEs is medium. Only a few watersheds in the ESU/DPS have much agriculture and it is not typically orchards and vineyards. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe designated critical habitat will be minimally affected. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Pendimethalin: Overall, the likelihood pendimethalin will cause adverse effects on critical habitat PCEs is medium. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe designated critical habitat will be minimally affected. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Trifluralin: Overall, the likelihood trifluralin will cause adverse effects on critical habitat PCEs is high. There is minimal agriculture in most of the watersheds in the ESU/DPS and/or it is not located adjacent to salmon-bearing waters, or it is located near high-volume, high-flow waters where we expect concentrations will be lower. We anticipate some input in urban/developed areas and from rights-of-way, but these are not located adjacent to salmon-bearing waters, or are located near high-volume, high-flow waters where we expect concentrations will be lower. We believe most populations will be minimally affected. We believe designated critical habitat will be minimally affected. We do not believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Central California Coast (CCC) Steelhead

Of 47 occupied watersheds, 19 and 15 are of high and medium conservation value, respectively. Our GIS analysis indicates 12 and 15 high conservation watersheds are exposed to pesticide applications from agriculture and urban areas, respectively. Of the medium conservation watersheds, 8 and 13 are also exposed to the above land uses areas, respectively. Of the low conservation watersheds, 9 are exposed to agricultural applications, while 15 are exposed to applications in urban areas. Throughout the species' range, habitat conditions and quality have been degraded by a lack of channel complexity, eroded banks, turbid and contaminated water, low summer flow and high water temperatures, multiple contaminants found at toxic levels, and restricted access to cooler head waters from migration barriers.

The current condition of designated critical habitat for CCC steelhead is poor. The spawning PCE is impacted by sediment fines in the spawning gravel, which limits the production of aquatic stream insects adapted to running water. Elevated water temperature and impaired water quality have further reduced the quality, quantity, and function of the rearing PCE within most streams.

High densities of crop farming occur throughout the San Joaquin Basin, the Delta, and along the lower Sacramento River. Agriculture also occurs in the Russian River valley. Most of the watersheds in this DPS are heavily developed, and/or have intensive agriculture in the river valley. Given these land uses, rearing and migration PCEs in small freshwater tributaries and floodplains and the San Francisco-San Pablo-Suisan Bay estuarine complex may experience reductions in water quality and prey abundance during allowable pesticide applications adjacent to these systems.

Oryzalin: Overall, the likelihood oryzalin will cause adverse effects on critical habitat PCEs is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate oryzalin input to habitat will occur multiple times due to repeated applications, and/or from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Pendimethalin: Overall, the likelihood pendimethalin will cause adverse effects on critical habitat PCEs is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate pendimethalin input to habitat will occur multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Trifluralin: Overall, the likelihood trifluralin will cause adverse effects on critical habitat PCEs is high. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate trifluralin input to habitat will occur multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

California Central Valley (CCV) Steelhead

Of 67 occupied watersheds, 37 and 18 are of high and medium conservation value, respectively. Our GIS analysis indicates 24 and 37 high conservation watersheds are exposed to pesticide applications from agriculture and urban areas, respectively. Of the medium conservation watersheds, 14 and 17 watersheds are exposed to pesticide applications from the above land uses, respectively. Of the low conservation watersheds, 12 are exposed to applications in urban areas, while 5 are exposed to urban applications.

The current condition of CCV steelhead critical habitat is degraded and does not function well for ensuring species recovery. The Sacramento-San Joaquin River Delta serves little function for juvenile CCV steelhead rearing and their physiological transition to salt water. Water flow and temperature, especially during the summer months affect the condition of the spawning PCE in floodplains and flood bypasses. The rearing PCE is degraded by channelized, leveed, and riprapped river reaches and sloughs in the Sacramento-San Joaquin system. Stream channels commonly have elevated water temperature. The current condition of migration corridors is poor. Both migration and rearing PCEs are affected by dense urbanization and agriculture along the mainstems and in the Delta which contribute to reduced water quality from contaminants in runoff. The RBDD gates obstruct migrating juveniles and adults. State and federal government pumps and associated fish facilities alter flow in the Delta and consequently obstruct migrations along the migratory corridor.

Heavy uses of agricultural pesticides and the high probably of mixtures increase the likelihood of negative effects on PCEs and critical habitat. As there is a continuous run of steelhead throughout the year, the conditions of the rearing PCE in a variety of habitat are important for this DPS. Given these land uses, freshwater rearing and migration PCEs in the Sacramento River, the Delta, tributaries, tidal and non-tidal marshes, and other shallow areas in the Delta may experience reductions in water quality and prey abundance during allowable pesticide applications adjacent to these systems.

Oryzalin: Overall, the likelihood oryzalin will cause adverse effects on critical habitat PCEs is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate oryzalin input to habitat will occur multiple times due to repeated applications, and/or from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Pendimethalin: Overall, the likelihood pendimethalin will cause adverse effects on critical habitat PCEs is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate pendimethalin input to habitat will occur multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Trifluralin: Overall, the likelihood trifluralin will cause adverse effects on critical habitat PCEs is high. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate trifluralin input to habitat will occur multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

South-Central California Coast (S-CCC) Steelhead

Of 29 occupied watersheds, 12 and 11 are of high and medium conservation value, respectively. Our GIS analysis indicates all high conservation watersheds are exposed to pesticide applications from agriculture and urban areas. Of the medium conservation watersheds, 9 and 11 watersheds are exposed to pesticide applications from agriculture and urban areas, respectively. All 6 of the low conservation value watersheds are at risk of exposure to pesticides applied in agricultural and urban areas.

Migration and rearing PCEs are degraded throughout critical habitat by elevated water temperature and contaminants from urban and agricultural runoff. The estuarine PCE is further affected when estuaries are breached and receive contaminant inputs from runoff.

Agriculture is the dominant land use in the Salinas River valley, and there are areas of intense agriculture in the Pajaro watershed as well. Areas higher in the Salinas and Pajaro watersheds and along some of the coastal areas are less affected.

Oryzalin: Overall, the likelihood oryzalin will cause adverse effects on critical habitat PCEs is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate oryzalin input to habitat will occur multiple times due to repeated applications, and/or from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Pendimethalin: Overall, the likelihood pendimethalin will cause adverse effects on critical habitat PCEs is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate pendimethalin input to habitat will occur multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Trifluralin: Overall, the likelihood trifluralin will cause adverse effects on critical habitat PCEs is high. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate trifluralin input to habitat will occur multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Southern California (SC) Steelhead

Of 29 freshwater and estuarine watersheds, 21 and 5 are of high and medium conservation value, respectively. Our GIS analysis indicates 15 and 21 high conservation watersheds are exposed to pesticide applications from agriculture and urban areas, respectively. Of the medium conservation watersheds, all five watersheds are exposed to pesticide applications from the same above land uses. All three low conservation value watersheds are exposed to pesticides used in urban areas, and two are exposed to those applied in agricultural areas.

All PCEs are affected by degraded water quality from pollutants in urban and agricultural runoff. Elevated water temperature and low water flow impact rearing and migration PCEs. The spawning PCE is affected by erosive geology and land use activities that result in an excessive amount of fines in the spawning gravel of most rivers.

Oryzalin: Overall, the likelihood oryzalin will cause adverse effects on critical habitat PCEs is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate some designated critical habitat will be affected. However, the effects are not anticipated to appreciably reduce the conservation value of the designated critical habitat.

Pendimethalin: Overall, the likelihood pendimethalin will cause adverse effects on critical habitat PCEs is medium. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate pendimethalin input to habitat will occur multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Trifluralin: Overall, the likelihood trifluralin will cause adverse effects on critical habitat PCEs is high. Use sites are distributed throughout the ESU/DPS, and we anticipate most or all designated critical habitat will be affected. We anticipate trifluralin input to habitat will occur multiple times due to repeated applications, and/or input from multiple sources. Given landuse within the ESU/DPS, we also anticipate exposure to other stressors which exacerbate the effects of the a.i. We believe the proposed action will appreciably reduce the conservation value of the designated critical habitat.

Table 114. Appreciable reduction in conservation value of critical habitat.

Species	ESU/DPS	Oryzalin	Pendimethalin	Trifluralin
Chinook	Puget Sound	Low	Medium	High
	Lower Columbia River	Medium	Medium	High
	Upper Columbia River Spring - Run	Low	Low	Medium
	Snake River Fall - Run	Low	Low	Medium
	Snake River Spring/Summer - Run	Low	Low	Medium
	Upper Willamette River	Medium	Medium	High
	California Coastal	Medium	Medium	High
	Central Valley Spring - Run	Medium	Medium	High
	Sacramento River Winter - Run	Medium	Medium	High
Chum	Hood Canal Summer - Run	Low	Low	Medium
	Columbia River	Low	Low	Medium
Coho	Lower Columbia River	*not applicable*	*not applicable*	*not applicable*
	Oregon Coast	Low	Low	Medium
	Southern Oregon and Northern California Coast	Low	Low	Medium
	Central California Coast	Medium	Medium	High
Sockeye	Ozette Lake	Low	Low	Low
	Snake River	Low	Low	Low
Steelhead	Puget Sound	*not applicable*	*not applicable*	*not applicable*
	Lower Columbia River	Medium	Medium	High
	Upper Willamette River	Medium	Medium	High
	Middle Columbia River	Medium	Medium	High
	Upper Columbia River	Low	Low	Medium
	Snake River	Low	Low	Medium
	Northern California	Low	Low	Medium
	Central California Coast	Medium	Medium	High
	California Central Valley	Medium	Medium	High
	South-Central California Coast	Medium	Medium	High
	Southern California	Medium	Medium	High

Conclusion

In the *Integration and Synthesis of Effects to Listed Species* section, we described NMFS' assessment of the likelihood of negative effects posed to the survival and recovery of listed Pacific salmonids as a result of EPA's registration of oryzalin, pendimethalin, and trifluralin.
The likelihood of effects assigned to each ESU/DPS for each a.i. reflects NMFS' evaluation of the likelihood that a compound will cause reductions in species' viability.

We expect oryzalin, pendimethalin, and trifluralin will have an adverse effect on most listed salmonids. For some ESUs/DPSs, the effects may be extensive enough to rise to the level of jeopardy, and for other ESUs/DPSs the effects may not. This is primarily of function of the extent of registered use sites in the watershed. Final determinations for jeopardy are presented in Table 115.

We expect oryzalin, pendimethalin, and trifluralin will have an adverse effect on most listed salmonids. For some ESUs/DPSs, the effects may be extensive to constitute adverse modification or destruction of designated critical habitat and in other cases it may not. This is primarily of function of the extent of registered use sites in the watershed. Final determinations for adverse modification are presented in Table 116

Table 115. Jeopardy determinations for a.i.s.

Species	ESU/DPS	Oryzalin	Pendimethalin	Trifluralin
Chinook	Puget Sound	No	**Jeopardy**	**Jeopardy**
	Lower Columbia River	No	**Jeopardy**	**Jeopardy**
	Upper Columbia River Spring - Run	No	No	No
	Snake River Fall - Run	No	No	No
	Snake River Spring/Summer - Run	No	No	No
	Upper Willamette River	**Jeopardy**	**Jeopardy**	**Jeopardy**
	California Coastal	**Jeopardy**	**Jeopardy**	**Jeopardy**
	Central Valley Spring - Run	**Jeopardy**	**Jeopardy**	**Jeopardy**
	Sacramento River Winter - Run	**Jeopardy**	**Jeopardy**	**Jeopardy**
Chum	Hood Canal Summer - Run	No	No	No
	Columbia River	No	No	No
Coho	Lower Columbia River	No	**Jeopardy**	**Jeopardy**
	Oregon Coast	No	No	No
	Southern Oregon and Northern California Coast	No	No	No
	Central California Coast	**Jeopardy**	**Jeopardy**	**Jeopardy**
Sockeye	Ozette Lake	No	No	No
	Snake River	No	No	No
Steelhead	Puget Sound	No	**Jeopardy**	**Jeopardy**
	Lower Columbia River	No	**Jeopardy**	**Jeopardy**
	Upper Willamette River	**Jeopardy**	**Jeopardy**	**Jeopardy**
	Middle Columbia River	**Jeopardy**	**Jeopardy**	**Jeopardy**
	Upper Columbia River	No	No	No
	Snake River	No	No	No
	Northern California	No	No	No
	Central California Coast	**Jeopardy**	**Jeopardy**	**Jeopardy**
	California Central Valley	**Jeopardy**	**Jeopardy**	**Jeopardy**
	South-Central California Coast	**Jeopardy**	**Jeopardy**	**Jeopardy**
	Southern California	No	**Jeopardy**	**Jeopardy**

Table 116. Adverse modification determinations

Species	ESU/DPS	Oryzalin	Pendimethalin	Trifluralin
Chinook	Puget Sound	No	**Ad Mod**	**Ad Mod**
	Lower Columbia River	No	**Ad Mod**	**Ad Mod**
	Upper Columbia River Spring - Run	No	No	No
	Snake River Fall - Run	No	No	No
	Snake River Spring/Summer - Run	No	No	No
	Upper Willamette River	**Ad Mod**	**Ad Mod**	**Ad Mod**
	California Coastal	**Ad Mod**	**Ad Mod**	**Ad Mod**
	Central Valley Spring - Run	**Ad Mod**	**Ad Mod**	**Ad Mod**
	Sacramento River Winter - Run	**Ad Mod**	**Ad Mod**	**Ad Mod**
Chum	Hood Canal Summer - Run	No	No	No
	Columbia River	No	No	No
Coho	Lower Columbia River	*not applicable*	*not applicable*	*not applicable*
	Oregon Coast	No	No	No
	Southern Oregon and Northern California Coast	No	No	No
	Central California Coast	**Ad Mod**	**Ad Mod**	**Ad Mod**
Sockeye	Ozette Lake	No	No	No
	Snake River	No	No	No
Steelhead	Puget Sound	*not applicable*	*not applicable*	*not applicable*
	Lower Columbia River	No	**Ad Mod**	**Ad Mod**
	Upper Willamette River	**Ad Mod**	**Ad Mod**	**Ad Mod**
	Middle Columbia River	**Ad Mod**	**Ad Mod**	**Ad Mod**
	Upper Columbia River	No	No	No
	Snake River	No	No	No
	Northern California	No	No	No
	Central California Coast	**Ad Mod**	**Ad Mod**	**Ad Mod**
	California Central Valley	**Ad Mod**	**Ad Mod**	**Ad Mod**
	South-Central California Coast	**Ad Mod**	**Ad Mod**	**Ad Mod**
	Southern California	No	**Ad Mod**	**Ad Mod**

Reasonable and Prudent Alternatives

Regulations (50 CFR §402.02) implementing section 7 of the ESA define reasonable and prudent alternatives as alternative actions, identified during formal consultation, that: (1) can be implemented in a manner consistent with the intended purpose of the action; (2) can be implemented consistent with the scope of the action agency's legal authority and jurisdiction; (3) are economically and technologically feasible; and (4) NMFS believes will alleviate the likelihood of jeopardizing the continued existence of listed species or resulting in the destruction or adverse modification of critical habitat.

This Opinion has concluded EPA’s registration of oryzalin is likely to jeopardize the continued existence of 10 of the 28 ESUs/DPSs of listed Pacific salmonids. This Opinion has also concluded EPA’s registration of oryzalin is likely to adversely modify or destroy designated critical habitat for 10 of the 26 ESUs/DPSs for which critical habitat has been designated. This Opinion has concluded EPA’s registrations of pendimethalin and trifluralin are likely to jeopardize the continued existence of 16 of the 28 ESUs/DPSs of listed Pacific salmonids. This Opinion has also concluded EPA’s registrations of pendimethalin and trifluralin are likely to adversely modify or destroy designated critical habitat for 14 of the 26 ESUs/DPSs for which critical habitat has been designated. Critical habitat has not been designated for Lower Columbia River coho and Puget Sound steelhead. NMFS reached these conclusions because predicted concentrations of these a.i.s in salmonid habitats are likely to adversely affect Pacific salmonids, water quality, salmonid prey, natural cover, and/or substrate in freshwater rearing, spawning, and migratory habitats.

NMFS’ Reasonable and Prudent Alternative (RPA) accounts for the following issues:

1. The action will result in exposure to other chemical stressors in addition to the a.i., including unspecified inert ingredients, adjuvants, and tank mixes; which may increase the risk of the action to listed species,
2. The action will likely result in exposure to chemical mixtures containing multiple a.i.s, which may have additive or synergistic effects; and,
3. Exposure to other chemicals and physical stressors present in the habitat, but derived from other actions which may intensify response to the a.i.s.

The action as implemented under the NMFS recommended RPA will alleviate the likelihood of jeopardy and adverse modification by reducing the concentrations of each of these a.i.s and associated stressors of the action within the designated critical habitat. In the RPA, NMFS does not attempt to ensure there is no take of listed species. NMFS believes take will occur, and has provided an incidental take statement exempting that take from the take prohibitions. Avoiding take altogether would most likely entail canceling registration, or prohibiting use in watersheds inhabited by salmonids. The goal of the RPA is to reduce exposure, thus ensuring the action is not likely to jeopardize listed species, or destroy or adversely modify critical habitat.

The RPA is comprised of two required elements which must be implemented in its entirety within one year of the EPA's receipt of this Opinion to ensure the registration of these pesticides is not likely to jeopardize listed Pacific salmonids or destroy or adversely modify critical habitat designated for these species. For each a.i., the elements of the RPA apply only to those ESUs/DPSs where NMFS has determined that registration of that a.i. is likely to jeopardize listed species and/or destroy or adversely modify designated critical habitat (Table 115 and Table 116). These sub-elements rely upon recognized practices for reducing the loading of pesticide products into aquatic habitats. Specific elements 1a,b, and c address pesticide loading via spray drift, runoff in the dissolved phase, and entrainment on soil particles. In addition, NMFS has tailored the recommended sub-Elements to each a.i. The recommendation in Element 1a does not apply to oryzalin. The recommendation in Element 1b does not apply to trifluralin. Table 117details which sub elements apply to which ESUs/DPSs.

Because this Opinion has found jeopardy and destruction or adverse modification to designated critical habitat, the EPA is required to notify NMFS of its final decision on the implementation of the reasonable and prudent alternatives (50 CFR §402.15(b)).

Specific Elements of the Reasonable and Prudent Alternative

Elements 1, including any implemented sub-elements or other measures to implement Element 1, and 2 shall be either specified directly on FIFRA labels of all pesticide products containing oryzalin, pendimethalin, or trifluralin or those labels shall direct pesticide users to the EPA's Endangered

Species Protection Program (ESPP) county bulletins which list Elements 1, including any implemented sub-elements or other measures to implement Element 1, and 2. These elements apply when pesticide products containing oryzalin, pendimethalin, or trifluralin are used within an ESU/DPS for which jeopardy or adverse modification of designated critical habitat has been determined. Table 117 shows ESUs/DPSs to which reasonable and prudent alternatives apply.

Salmon-bearing waters are defined as fresh, brackish, and marine waters accessible to salmonids. These waters are defined in the *Federal Register* notice published when the species are listed or their listing status is modified. A list of these waters has been provided to EPA in *Appendix 7*, along with the counties in which they occur. Distances for various restrictions are measured from the ordinary high-water line or bankfull elevation for free-flowing streams and from extreme high water line high water for tidal waters (50 CFR §226.212). “Bankfull elevation is the level at which water begins to leave the channel and move into the floodplain and is reached at a discharge which generally has a recurrence interval of 1 to 2 years on the annual flood series.” (50 CFR §226.212).

*Element 1***.** Based on PRZM-EXAMs EECs, concentrations of a.i. in salmon-bearing waters shall at no time exceed the following thresholds:

- Oryzalin 10 μg/L
- Pendimathlin 1 μg/L
- Trifluralin 1 μg/L

Concentration limits are derived from the analysis in the *Effects* chapter and are set at a level where we anticipate no adverse effects from the a.i. alone (Table 108). We believe setting thresholds at this level accounts for uncertainties associated with the status of the species, stressors of the action other than the a.i., other stressors identified in the environmental baseline, and cumulative effects.

Given NMFS’ understanding of agricultural practices associated with these a.i., we recommend Sub-elements 1a, 1b, and 1c, as applicable to each a.i., as the most practical ways to reduce spray drift, dissolved phase runoff, and sediment bound runoff of these a.i.s into salmonid habitat.

Sub-Element 1a. Pesticide products containing pendimethalin or trifluralin shall not be applied aerially within 300 ft of salmon-bearing waters.

Rationale: At approximately 300 ft away from the flight line of aerially applied pesticides, deposition is ~ 1% of applied (Bird, et al., 2002). This Sub-Element reduces spray drift.

This restriction does not apply to granular products, which are not subject to spray drift. However, applicator must control any off-target deposition of granular product to ensure it does not enter salmon-bearing waters. Oryzalin is currently not registered for aerial uses. Aerial uses of oryzalin are not considered part of this action.

Sub-Element 1b. Pesticide products containing oryzalin or pendimethalin shall be watered-in or soil incorporated when applied to the ground within 300 ft of salmon-bearing waters. Application of these products in anticipation of rainfall meets the watering-in requirement. This element does not apply to trifluralin, as existing labels already require watering-in or soil incorporation of trifluralin.

Rationale: Pesticides which are soil incorporated are less available for runoff. This Sub-Element reduces contamination by pesticides in the dissolved phase.

Sub-Element 1c. Either a 10 ft vegetated filter strip which cannot be treated with these a.i.s or a 20 ft no-treatment zone shall be maintained between salmon-bearing waters and use sites where oryzalin, pendimethalin, or trifluralin are applied. This restriction applies to ground applications, as aerial applications are already restricted within this proximity to salmon-bearing waters by Sub-Element 1a.

Rationale: Even relatively narrow filter strips (~20ft) can reduce input of highly adsorbed pesticides (USDA, 2000). This Sub-Element reduces contamination by pesticides sorbed to eroded soil particles.

Element 2. All incidents of fish mortality occurring within the vicinity of the treatment area in the four days following application of any pesticide products containing oryzalin, pendimethalin or trifluralin, shall be reported to EPA's Office of Pesticide Programs. "Vicinity" includes areas adjacent to, downwind of, or downstream of the application area which might reasonably be affected by the application. Given environmental transport properties of these a.i.s, NMFS considers areas >1 mile from the application sites are outside of application vicinity.

Should EPA modify FIFRA 6(a)2 to require registrants to report all fish kills immediately, regardless of incident classification (*i.e.* both minor and major incidents), reporting through the FIFRA 6(a)2 process will meet this reporting requirement. EPA shall submit an annual report to NMFS OPR identifying the total number of fish affected, the incident locations, and details regarding incidents.

Table 117. Sub-elements of RPA elements 1 applicable to each ESU/DPS. Element 2 applies to all ESU/DPSs where a sub element of 1 applies. Neither Element 1 or Element 2 is applicable to those ESUs marked NA.

Species	ESU	Sub-elements that apply		
		Oryzalin	Pendimethalin	Trifluralin
Chinook	Puget Sound	NA	A, B, C	A, C
	Lower Columbia River	NA	A, B, C	A, C
	Upper Columbia River Spring - Run	NA	NA	NA
	Snake River Fall - Run	NA	NA	NA
	Snake River Spring/Summer - Run	NA	NA	NA
	Upper Willamette River	B, C	A, B, C	A, C
	California Coastal	B, C	A, B, C	A, C
	Central Valley Spring - Run	B, C	A, B, C	A, C
	Sacramento River Winter - Run	B, C	A, B, C	A, C
Chum	Hood Canal Summer - Run	NA	NA	NA
	Columbia River	NA	NA	NA
Coho	Lower Columbia River	NA	NA	A, C
	Oregon Coast	NA	NA	NA
	Southern Oregon and Northern California Coast	NA	NA	NA
	Central California Coast	B, C	A, B, C	A, C
Sockeye	Ozette Lake	NA	NA	NA
	Snake River	NA	NA	NA
Steelhead	Puget Sound	NA	A, B, C	A, C
	Lower Columbia River	NA	A, B, C	A, C
	Upper Willamette River	B, C	A, B, C	A, C
	Middle Columbia River	B, C	A, B, C	A, C
	Upper Columbia River	NA	NA	NA
	Snake River	NA	NA	NA
	Northern California	NA	NA	NA
	Central California Coast	B, C	A, B, C	A, C
	California Central Valley	B, C	A, B, C	A, C
	South-Central California Coast	B, C	A, B, C	A, C
	Southern California	NA	A, B, C	A, C

NA Not applicable, no jeopardy or adverse modification for this ESU/DPS or designated critical habitat

Incidental Take Statement

Section 9(a)(1) of the ESA prohibits the taking of endangered species without a specific permit or exemption. Protective regulations adopted pursuant to section 4(d) of the ESA extend the prohibition to threatened species. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct (50 CFR 222.102). Harm is further defined by NMFS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action, whether implemented as proposed or as modified by reasonable and prudent alternatives, is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

Amount or Extent of Take

As described earlier in this Opinion, this is a consultation on the EPA's registration of pesticide products containing oryzalin, pendimethalin, trifluralin, and their formulations as they are used in the Pacific Northwest and California and the effects of these applications on listed ESUs/DPSs of Pacific salmonids. The EPA authorizes use of these pesticide products for pest control purposes across multiple landscapes as described in the *Description of the Proposed Action* and elsewhere in the document. The goal of this Opinion is to evaluate the impacts to NMFS' listed resources from the EPA's broad authorization of applied pesticide products. This Opinion is a partial consultation because pursuant to the court's order, EPA sought consultation on only 26 listed Pacific salmonids under NMFS' jurisdiction. However, even though the court's order did not address the two more recently listed ESUs and DPSs, NMFS analyzed the impacts of EPA's actions to them because they belong to the same taxon and the analysis requires consideration of the same information. Consultation with NMFS will be completed when EPA makes effect determinations on all remaining species under NMFS' jurisdiction and consults with NMFS as necessary.

For this Opinion, NMFS anticipates the general direct and indirect effects that would occur from EPA's registration of pesticide products across the states of California, Idaho, Oregon, and Washington to 28 listed Pacific salmonids under NMFS' jurisdiction during the 15-year duration of the proposed action. Recent and historical surveys indicate listed salmonids occur in the action area, in places where they will be exposed to the stressors of the action. The RPA and RPMs provided in this Opinion are designed to reduce this exposure but not eliminate it. Pesticide runoff and drift of oryzalin, pendimethalin, and trifluralin are most likely to reach streams and other aquatic sites when they are applied to crops and other land use settings located adjacent to riparian areas, wetlands, ditches, off-channel habitats, perennial, intermittent, and ephemeral streams. Inputs into aquatic habitats are especially high when rainfall immediately follows applications particularly on impervious surfaces or when there is a high amount of rainfall. The effects of pesticides and other contaminants found in rights-of-ways and urban runoff, especially from areas with a high degree of impervious surfaces, may also exacerbate degraded water quality conditions in receiving waters. Urban runoff is also generally warmer in temperature, and elevated water temperature negatively affects certain life history phases for salmon.

The range of effects caused by the three a.i.s includes direct and indirect toxicological effects. Within this range, effects can include impairments of physiological functions to the extent that fish die or are unable to perform necessary life functions (such as predator avoidance, foraging, migration and reductions in reproductive success). More often, effects are anticipated to include reduced growth and developmental effects for fish. Effects on aquatic vegetation may decrease available energy base for the system, shift in-stream plant communities, reduce natural cover, or reduce the prey base, thereby affecting growth of fish. Incidental take of listed salmonids is reasonably certain to occur over the 15-year duration of the proposed action.

Given the variability of real-life conditions, the broad nature and scope of the proposed action, and the migratory nature of salmon, the best scientific and commercial data available are not sufficient to enable NMFS to estimate a specific amount of incidental take associated with the proposed action. The *Description of the Proposed Action* and the *Effects of the Proposed Action* sections describe multiple uncertainties associated with the proposed action and the analysis thereof. Areas of uncertainty include:

1. Inability to quantify the effect of herbicides on salmon habitat due to variability in plant susceptibility to the herbicides and variability in species composition and density in the various locations;
2. Incomplete information on the proposed action (*i.e.*, no master labels summarizing all stressors of the action and all authorized uses of pesticide products);
3. Limited use and exposure data on stressors of the action for non-agricultural uses of these pesticides;
4. Minimal information on exposure and toxicity for pesticide formulations, adjuvants, and other/inert ingredients within registered formulations;
5. Minimal information on permitted tank mixtures and associated exposure estimates;
6. Limited data on toxicity of environmental mixtures;
7. Inability to quantify responses due to exposure to combinations of the three a.i.s and other stressors in the baseline;
8. Variability in annual land use, crop cover, and pest pressure;
9. Temporal and spatial variability within each ESU/DPS, especially at the population level; and
10. Size and flow variations of water bodies in which salmonids live.

NMFS therefore identifies, as a surrogate for the allowable extent of take, the ability of this action to proceed without any fish kills attributed to the legal use of oryzalin, pendimethalin, trifluralin, or any compounds, degradates, or mixtures in aquatic habitats containing individuals from any ESU/DPS. Because of the difficulty of detecting salmonid deaths, fishes killed do not have to be listed salmonids. In general, salmonids tend to be more sensitive to chemical stressors than many other species of fish, so that if there are kills of other freshwater fishes attributed to use of these pesticides, it is likely that salmonids have also died, even if no dead salmonids can be located. Additionally, if stream conditions due to pesticide use kill less sensitive fishes in certain areas, the potential for lethal and non-lethal takes in downstream areas increases. A fish kill is considered attributable to one of these three a.i.s, its metabolites, or degradates, if the a.i is known to have been applied in the vicinity, may reasonably be supposed to have run off or drifted into the affected area, and if surface water samples, or pathology indicate lethal levels of the a.i.(s).

NMFS notes that with increased monitoring and study of the impact of these pesticides on water quality, particularly water quality in off-channel habitats, NMFS may be able to refine this incidental take statement, and future incidental take statements, to allow other measures of the extent of take.

Reasonable and Prudent Measures

The measures described below are non-discretionary measures to avoid or minimize take that must be undertaken by the EPA so they become binding conditions of any grant or permit, in this case the registration and label authorizing use of an a.i., issued to the applicant(s), as appropriate, for the exemption in section 7(o)(2) to apply. The EPA has a continuing duty to regulate the activity covered by this incidental take statement. If the EPA (1) fails to assume and implement the terms and conditions implementing these measures or (2) fails to require the applicant(s) to adhere to the terms and conditions of the incidental take statement through enforceable terms added to the registration labe, the protective coverage of section 7(o)(2) lapses. In order to monitor the impact of incidental take, the EPA must report the progress of the action and its impact on the species to NMFS OPR as specified in the incidental take statement [50 CFR§402.14(i)(3)].

To satisfy its obligations pursuant to section 7(a)(2) of the ESA, the EPA must monitor (a) the direct, indirect, and cumulative impacts of its long-term registration of pesticide products containing oryzalin, pendimethalin, and trifluralin; and (b) the consequences of those effects on listed Pacific salmonids under NMFS' jurisdiction. For oryzalin, pendimethalin, and trifluralin, this monitoring consists of documenting adverse effects associated with use of these a.i.s and promptly reporting those adverse effects to NMFS. The purpose of the monitoring program is for the EPA to use the results of the monitoring data and modify the registration process in order to reduce exposure and minimize the effects of exposure when pesticides are used near salmonid habitat. NMFS believes all measures described as part of the proposed action, together with use of the Reasonable and Prudent Measures and Terms and Conditions described below, are necessary and appropriate to minimize the likelihood of incidental take of listed species due to implementation of the proposed action.

The EPA shall:

1. Minimize the amount and extent of incidental take from use of pesticide products containing oryzalin, pendimethalin, and trifluralin by reducing the potential of those chemicals to reach salmon-bearing waters;
2. Monitor any incidental take or surrogate measure of take that occurs from the action; and
3. Report annually to NMFS OPR on the take monitoring results from the previous year.

Terms and Conditions

To be exempt from the prohibitions of section 9 of the ESA, within one year following the date of issuance of this Opinion, the EPA must comply with the following terms and conditions. These terms and conditions implement the reasonable and prudent measures described above. These terms and conditions are non-discretionary. Terms and conditions 1 - 2 shall be either specified directly on FIFRA labels of all pesticide products containing oryzalin, pendimethalin, or trifluralin or those labels shall direct pesticide users to the EPA's Endangered Species Protection Program (ESPP) county bulletins which list Terms and Conditions 1 - 2

For all products containing oryzalin, pendimethalin, and trifluralin:

1. EPA shall use accepted pesticide risk reduction measures including but not limited to no spray zones, limitations on application methods, rates, and timing or other types of buffers to minimize pesticide loading into salmon-bearing waters.
2. EPA shall include a statement on requiring all incidents of fish mortality occurring within the vicinity of the treatment area in the four days following application of any pesticide products containing oryzalin, pendimethalin or trifluralin, be reported to EPA's Office of Pesticide Programs. "Vicinity" includes areas adjacent to, downwind of, or downstream of the application area which might reasonably be affected by the application. Given environmental transport properties of these a.i.s, NMFS considers areas >1 mile from the application sites are outside of application vicinity.

3. EPA shall report to NMFS OPR any incidences regarding oryzalin, pendimethalin, or trifluralin effects on aquatic ecosystems added to its incident database which EPA has classified as “probable” or “highly probable.” within one month of receiving the incident report.

Conservation Recommendations

Section 7(a) (1) of the ESA directs federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

The following conservation recommendations would provide information for future consultations involving future authorizations of pesticide a.i.s that may affect listed species:

1. Collaborate with States to develop accurate and consistent methods for pesticide incident detection, reporting, and verification.
2. Conduct mixture toxicity analysis in screening-level and endangered species biological evaluations;
3. Develop models to estimate pesticide concentrations in shallow, low-flow habitats;
4. Develop models to estimate pesticide concentrations in aquatic habitats associated with non-agricultural applications, particularly in residential and industrial environments; and
5. Develop and implement a program to educate users of pesticide about the potential adverse effects on salmonids and their designated critical habitat. Educational materials should discuss measures and techniques appropriate for reducing input of pesticides to aquatic habitats.

In order for NMFS to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the EPA should notify NMFS OPR of any conservation recommendations implemented in the final action.

Reinitiation Notice

This concludes formal consultation on the EPA’s proposed registration of pesticide products containing oryzalin, pendimethalin, and trifluralin and their formulations to ESA-listed Pacific salmonids under the jurisdiction of the NMFS. As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the extent of take specified in the *Incidental Take Statement* is exceeded; (2) new information reveals effects of this action that may affect listed species or designated critical habitat in a manner or to an extent not previously considered in this biological opinion; (3) the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this Opinion; or (4) a new species is listed or critical habitat designated that may be affected by the identified action. If reinitiation of consultation appears warranted due to one or more of the above circumstances, EPA must contact NMFS OPR. In the event reinitiation conditions (1), (2), or (3) is met, reinitiation will be only for the a.i.(s) which meet that condition, not for all a.i.s considered in the Opinion. If none of these reinitiation triggers are met within the next 15 years, then reinitiation on this partial consultation will be required because the Opinion only covers the action for 15 years.

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Appendix 1: Species and Population Annual Rates of Growth

Chinook Salmon

ESU	Population	λ - H=0	95% CI -lower	95% CI - upper
California Coastal	Eel River	N/A	N/A	N/A
	Redwood Creek	N/A	N/A	N/A
	Mad River	N/A	N/A	N/A
	Humboldt Bay tributaries	N/A	N/A	N/A
	Bear River	N/A	N/A	N/A
	Mattole River	N/A	N/A	N/A
	Tenmile to Gualala	N/A	N/A	N/A
	Russain River	N/A	N/A	N/A
Central Valley Spring - Run (Good et al., 2005 - 90% CI)	Butte Creek - spring run	1.300	1.060	1.600
	Deer Creek - spring run	1.170	1.040	1.350
	Mill Creek - spring run	1.190	1.000	1.470
Lower Columbia River (Good et al., 2005) (# = McElhany et al., 2007)	Youngs Bay	N/A	N/A	N/A
	Grays River - fall run	0.944	0.739	1.204
	Big Creek	N/A	N/A	N/A
	Elochoman River - fall run	1.037	0.813	1.323
	Clatskanie River #	0.990	0.824	1.189
	Mill, Abernathy, Germany Creeks - fall run	0.981	0.769	1.252
	Scappose Creek	N/A	N/A	N/A
	Coweeman River - fall run	1.092	0.855	1.393
	Lower Cowlitz River - fall run	0.998	0.776	1.282
	Upper Cowlitz River - fall run	N/A	N/A	N/A
	Toutle River - fall run	N/A	N/A	N/A
	Kalamaha River - fall run	0.937	0.763	1.242
	Salmon Creek / Lewis River - fall run	0.984	0.771	1.256
	Clackamas River - fall run	N/A	N/A	N/A
	Washougal River - fall run	1.025	0.803	1.308
	Sandy River - fall run	N/A	N/A	N/A
	Lower Gorge tributaries	N/A	N/A	N/A
	Upper Gorge tributaries - fall run	0.959	0.751	1.224
	Hood River - fall run	N/A	N/A	N/A
	Big White Salmon River - fall run	0.963	0.755	1.229
	Sandy River - late fall run	0.943	0.715	1.243
	North Fork Lewis River - late fall run	0.968	0.756	1.204
	Upper Cowlitz River - spring run	N/A	N/A	N/A
	Cispus River	N/A	N/A	N/A
	Tilton River	N/A	N/A	N/A
	Toutle River - spring run	N/A	N/A	N/A
	Kalamaha River - spring run	N/A	N/A	N/A
	Lewis River - spring run	N/A	N/A	N/A
	Sandy River - spring run #	0.961	0.853	1.083
	Big White Salmon River - spring run	N/A	N/A	N/A
	Hood River - spring run	N/A	N/A	N/A

Chinook Salmon (continued)

ESU	Population	λ - H=0	95% CI -lower	95% CI - upper
Upper Columbia River Spring - Run (FCRPS)	Methow River	1.100	N/A	N/A
	Twisp River	N/A	N/A	N/A
	Chewuch River	N/A	N/A	N/A
	Lost / Early River	N/A	N/A	N/A
	Entiat River	0.990	N/A	N/A
	Wenatchee River	1.010	N/A	N/A
	Chiawawa River	N/A	N/A	N/A
	Nason River	N/A	N/A	N/A
	Upper Wenatchee River	N/A	N/A	N/A
	White River	N/A	N/A	N/A
	Little Wenatchee River	N/A	N/A	N/A
Puget Sound (only have λ where hatchery fish = native fish), (Good et al., 2005)	Nooksack - North Fork	0.750	0.680	0.820
	Nooksack - South Fork	0.940	0.880	0.990
	Lower Skagit	1.050	0.960	1.140
	Upper Skagit	1.050	0.990	1.110
	Upper Cascade	1.060	1.010	1.110
	Lower Sauk	1.010	0.890	1.130
	Upper Sauk	0.960	0.900	1.020
	Suiattle	0.990	0.930	1.050
	Stillaguamish - North Fork	0.920	0.880	0.960
	Stillaguamish - South Fork	0.990	0.970	1.010
	Skykomish	0.870	0.840	0.900
	Snoqualmie	1.000	0.960	1.040
	North Lake Washington	1.070	1.000	1.140
	Cedar	0.990	0.920	1.060
	Green	0.670	0.610	0.730
	White	1.160	1.100	1.220
	Puyallup	0.950	0.890	1.010
	Nisqually	1.040	0.970	1.110
	Skokomish	1.040	1.000	1.080
	Dosewallips	1.170	1.070	1.270
	Duckabush	N/A	N/A	N/A
	Hamma Hamma	N/A	N/A	N/A
	Mid Hood Canal	N/A	N/A	N/A
	Dungeness	1.090	0.980	1.200
	Elwha	0.950	0.840	1.060
Sacramento River Winter - Run (Good, 2005 - 90% CI))	Sacramento River - winter run	0.970	0.870	1.090

Chinook Salmon (continued)

ESU	Population	λ - H=0	95% CI -lower	95% CI - upper
Snake River Fall - Run (Good, 2005)	Lower Snake River	1.024	N/A	N/A
Snake River Spring/Summer - Run (FCRPS)	Tucannon River	1.000	N/A	N/A
	Wenaha River	1.100	N/A	N/A
	Wallowa River	N/A	N/A	N/A
	Lostine River	1.050	N/A	N/A
	Minam River	1.050	N/A	N/A
	Catherine Creek	0.970	N/A	N/A
	Upper Grande Ronde River	N/A	N/A	N/A
	South Fork Salmon River	1.110	N/A	N/A
	Secesh River	1.070	N/A	N/A
	Johnson Creek	N/A	N/A	N/A
	Big Creek Spring Run	1.090	N/A	N/A
	Big Creek Summer Run	1.090	N/A	N/A
	Loon Creek	N/A	N/A	N/A
	Marsh Creek	1.080	N/A	N/A
	Bear Valley / Elk Creek	1.100	N/A	N/A
	North Fork Salmon River	N/A	N/A	N/A
	Lemhi River	1.020	N/A	N/A
	Pahsimeroi River	1.080	N/A	N/A
	East Fork Salmon Spring Run	1.040	N/A	N/A
	East Fork Salmon Summer Run	1.040	N/A	N/A
	Yankee Fork Spring Run	N/A	N/A	N/A
	Yankee Fork Summer Run	N/A	N/A	N/A
	Valley Creek Spring Run	N/A	N/A	N/A
	Valley Creek Summer Run	N/A	N/A	N/A
	Upper Salmon Spring Run	1.060	N/A	N/A
	Upper Salmon Summer Run	1.060	N/A	N/A
	Alturas Lake Creek	N/A	N/A	N/A
	Imnaha River	1.050	N/A	N/A
	Big Sheep Creek	N/A	N/A	N/A
	Lick Creek	N/A	N/A	N/A
Upper Williamette River (McElhany et al., 2007)	Clackamas River	0.967	0.849	1.102
	Molalla River	N/A	N/A	N/A
	North Santiam River	N/A	N/A	N/A
	South Santiam River	N/A	N/A	N/A
	Calapooia River	N/A	N/A	N/A
	McKenzie River	0.927	0.761	1.129
	Middle Fork Williamette River	N/A	N/A	N/A
	Upper Fork Williamette River	N/A	N/A	N/A

Chum Salmon

ESU	Population	λ - H=0	95% CI -lower	95% CI - upper
Columbia River	Youngs Bay	N/A	N/A	N/A
	Grays River	0.954	0.855	1.064
	Big Creek	N/A	N/A	N/A
	Elochoman River	N/A	N/A	N/A
	Clatskanie River	N/A	N/A	N/A
	Mill, Abernathy and German Creeks	N/A	N/A	N/A
	Scappose Creek	N/A	N/A	N/A
	Cowlitz River	N/A	N/A	N/A
	Kalama River	N/A	N/A	N/A
	Lewis River	N/A	N/A	N/A
	Salmon Creek	N/A	N/A	N/A
	Clackamus River	N/A	N/A	N/A
	Sandy River	N/A	N/A	N/A
	Washougal River	N/A	N/A	N/A
	Lower Gorge tributaries	0.984	0.883	1.096
	Upper Gorge tributaries	N/A	N/A	N/A
Hood Canal Summer - Run (only have λ where hatchery fish reproductive potential = native fish; Good et. al., 2005)	Jimmycomelately Creek	0.850	0.690	1.010
	Salmon / Snow Creeks	1.230	1.130	1.330
	Big / Little Quilcene rivers	1.390	1.170	1.610
	Lilliwaup Creek	1.190	0.750	1.630
	Hamma Hamma River	1.300	1.110	1.490
	Duckabush River	1.100	0.930	1.270
	Dosewallips River	1.170	0.930	1.410
	Union River	1.150	1.050	1.250
	Chimacum Creek	N/A	N/A	N/A
	Big Beef Creek	N/A	N/A	N/A
	Dewetto Creek	N/A	N/A	N/A

Coho Salmon

ESU	Population	λ - H=0	95% CI -lower	95% CI - upper
Central California Coast	Ten Mile River	N/A	N/A	N/A
	Noyo River	N/A	N/A	N/A
	Big River	N/A	N/A	N/A
	Navarro River	N/A	N/A	N/A
	Garcia River	N/A	N/A	N/A
	Other Mendacino County Rivers	N/A	N/A	N/A
	Gualala River	N/A	N/A	N/A
	Russain River	N/A	N/A	N/A
	Other Sonoma County Rivers	N/A	N/A	N/A
	Martin County	N/A	N/A	N/A
	San Mateo County	N/A	N/A	N/A
	Santa Cruz County	N/A	N/A	N/A
	San Lorenzo River	N/A	N/A	N/A
Lower Columbia River (Good et al., 2005)	Youngs Bay	N/A	N/A	N/A
	Grays River	N/A	N/A	N/A
	Elochoman River	N/A	N/A	N/A
	Clatskanie River	N/A	N/A	N/A
	Mill, Abernathy, Germany Creeks	N/A	N/A	N/A
	Scappose Creek	N/A	N/A	N/A
	Cispus River	N/A	N/A	N/A
	Tilton River	N/A	N/A	N/A
	Upper Cowlitz River	N/A	N/A	N/A
	Lower Cowlitz River	N/A	N/A	N/A
	North Fork Toutle River	N/A	N/A	N/A
	South Fork Toutle River	N/A	N/A	N/A
	Coweeman River	N/A	N/A	N/A
	Kalama River	N/A	N/A	N/A
	North Fork Lewis River	N/A	N/A	N/A
	East Fork Lewis River	N/A	N/A	N/A
	Upper Clackamas River	1.028	0.898	1.177
	Lower Clackamas River	N/A	N/A	N/A
	Salmon Creek	N/A	N/A	N/A
	Upper Sandy River	1.102	0.874	1.172
	Lower Sandy River	N/A	N/A	N/A
	Washougal River	N/A	N/A	N/A
	Lower Columbia River gorge tributaries	N/A	N/A	N/A
	White Salmon	N/A	N/A	N/A
	Upper Columbia River gorge tributaries	N/A	N/A	N/A
	Hood River	N/A	N/A	N/A

Coho Salmon (continued)

ESU	Population	λ - H=0	95% CI -lower	95% CI - upper
Southern Oregon and Northern California Coast	Southern Oregon and Northern California Coast	N/A	N/A	N/A
Oregon Coast	Necanicum	N/A	N/A	N/A
	Nehalem	N/A	N/A	N/A
	Tillamook	N/A	N/A	N/A
	Nestucca	N/A	N/A	N/A
	Siletz	N/A	N/A	N/A
	Yaquima	N/A	N/A	N/A
	Alsea	N/A	N/A	N/A
	Siuslaw	N/A	N/A	N/A
	Umpqua	N/A	N/A	N/A
	Coos	N/A	N/A	N/A
	Coquille	N/A	N/A	N/A

Sockeye Salmon

ESU	Population	λ - H=0	95% CI -lower	95% CI - upper
Ozette Lake	Ozette Lake	N/A	N/A	N/A
Snake River	Snake River	N/A	N/A	N/A

Steelhead

DPS	Population	λ - H=0	95% CI -lower	95% CI - upper
Central California Coast (Good et al., 2005)	Russain River	N/A	N/A	N/A
	Lagunitas	N/A	N/A	N/A
	San Gregorio	N/A	N/A	N/A
	Waddell Creek	N/A	N/A	N/A
	Scott Creek	N/A	N/A	N/A
	San Vincente Creek	N/A	N/A	N/A
	San Lorenzo River	N/A	N/A	N/A
	Soquel Creek	N/A	N/A	N/A
	Aptos Creek	N/A	N/A	N/A
California Central Valley (Good et al., 2005)	Sacramento River	0.950	0.900	1.020
Lower Columbia River (Good et al., 2005)	Cispus River	N/A	N/A	N/A
	Tilton River	N/A	N/A	N/A
	Upper Cowlitz River	N/A	N/A	N/A
	Lower Cowlitz River	N/A	N/A	N/A
	Coweeman River	0.908	0.792	1.041
	South Fork Toutle River	0.938	0.830	1.059
	North Fork Toutle River	1.062	0.915	1.233
	Kalama River - winter run	1.010	9.130	1.117
	Kalama River - summer run	0.981	0.889	1.083
	North Fork Lewis River - winter run	N/A	N/A	N/A
	North Fork Lewis River - summer run	N/A	N/A	N/A
	East Fork Lewis River - winter run	N/A	N/A	N/A
	East Fork Lewis River - summer run	N/A	N/A	N/A
	Salmon Creek	N/A	N/A	N/A
	Washougal River - winter run	N/A	N/A	N/A
	Washougal River - summer run	1.003	0.884	1.138
	Clackamas River	0.971	0.901	1.047
	Sandy River	0.945	0.850	1.051
	Lower Columbia gorge tributaries	N/A	N/A	N/A
	Upper Columbia gorge tributaries	N/A	N/A	N/A

Steelhead (continued)

DPS	Population	λ - H=0	95% CI -lower	95% CI - upper
Middle Columbia River (Good et al., 2005)	Klickitat River	N/A	N/A	N/A
	Yakima River	1.009	N/A	N/A
	Fifteenmile Creek	0.981	N/A	N/A
	Deschutes River	1.022	N/A	N/A
	John Day - upper main stream	0.975	N/A	N/A
	John Day - lower main stream	0.981	N/A	N/A
	John Day - upper north fork	1.011	N/A	N/A
	John Day - lower north fork	1.013	N/A	N/A
	John Day - middle fork	0.966	N/A	N/A
	John Day - south fork	0.967	N/A	N/A
	Umatilla River	1.007	N/A	N/A
	Touchet River	0.961	N/A	N/A
Northern California (Good et al., 2005)	Redwood Creek	N/A	N/A	N/A
	Mad River - winter run	1.000	0.930	1.050
	Eel River - summer run	0.980	0.930	1.040
	Mattole River	N/A	N/A	N/A
	Ten Mile river	N/A	N/A	N/A
	Noyo River	N/A	N/A	N/A
	Big River	N/A	N/A	N/A
	Navarro River	N/A	N/A	N/A
	Garcia River	N/A	N/A	N/A
	Gualala River	N/A	N/A	N/A
	Other Humboldt County streams	N/A	N/A	N/A
	Other Mendocino County streams	N/A	N/A	N/A
Puget Sound*	Puget Sound	N/A	N/A	N/A
Snake River (Good et al., 2005)	Tucannon River	0.886	N/A	N/A
	Lower Granite run	0.994	N/A	N/A
	Snake A run	0.998	N/A	N/A
	Snake B run	0.927	N/A	N/A
	Asotin Creek	N/A	N/A	N/A
	Upper Grande Ronde River	0.967	N/A	N/A
	Joseph Creek	1.069	N/A	N/A
	Imnaha River	1.045	N/A	N/A
	Camp Creek	1.077	N/A	N/A
South-Central California Coast	South-Central California Coast	N/A	N/A	N/A
Southern California	Santa Ynez River	N/A	N/A	N/A
	Ventura River	N/A	N/A	N/A
	Matilija River	N/A	N/A	N/A
	Creek River	N/A	N/A	N/A
	Santa Clara River	N/A	N/A	N/A

Steelhead (continued)

DPS	Population	λ - H=0	95% CI -lower	95% CI - upper
Upper Columbia River (Good et al., 2005)	Wenatchee / Entiat Rivers	1.067	N/A	N/A
	Methow / Okanogan Rivers	1.086	N/A	N/A
Upper Williamette River (McElhany et al., 2007)	Molalla River	0.988	0.790	1.235
	North Santiam River	0.983	0.789	1.231
	South Santiam River	0.976	0.855	1.114
	Calapooia River	1.023	0.743	1.409

Appendix 2: Abbreviations / Acronyms

7-DADMax	7-day average of the daily maximum
ACA	Alternative Conservation Agreement
AChE	acetylcholinesterase
a.i.	active ingredient
APEs	alkylphenol ethoxylates
APHIS	U.S. Department of Agriculture Animal Plant and Health Inspection Service
BE	Biological Evaluation
BEAD	Biological and Economic Analysis Divsion
BLM	Bureau of Land Management
BMP	Best Management Practices
BOR	Bureau of Reclaimation
BOR	Bureau of Reclamation
BPA	Bonneville Power Administration
BRT	Biological Review Team (NOAA Fisheries)
BY	Brood Years
CAISMP	California Aquatic Invasive Species Management Plan
CALFED	CALFED Bay-Delta Program (California Resource Agency)
CBFWA	Columbia Basin Fish and Wildlife Authority
CBI	Confidential Business Information
CC	California Coastal
CCC	Central California Coast
CCV	Central California Valley
CDPR	California Department of Pesticide Regulation
CHART	Critical Habitat Assessment Review Team
CIDMP	Comprehensive Irrigation District Management Plan
CFR	Code of Federal Regulations
cfs	cubic feet per second
CDFG	California Department of Fish and Game
Corps	U.S. Department of the Army Corps of Engineers

CSOs	combined sewer/stormwater overflows
CSWP	California State Water Project
CURES	Coalition for Urban/Rural Environmental Stewardship
CVP	Central Valley Projects
CVRWQCB	Central Valley Regional Water Quality Control Board
CWA	Clean Water Act
d	day
DCI	Date Call-Ins
DDD	*Dichloro* Diphenyl Dichloroethane
DDE	Diphenyl Dichlorethylene
DDT	*Dichloro Diphenyl Trichloroethane*
DER	*Data Evaluation Review*
DEQ	Oregon Department of Environmental Quality
DIP	Demographically Independent Population
DOE	Washington State Department of Ecology
DPS	Distinct Population Segment
EC	Emulsifiable Concentrate Pesticide Formulation
EC_{50}	Median Effect Concentration
EEC	Estimated Environmental Concentration
EFED	Environmental Fate and Effects Division
EIM	Environmental Information Management
EPA	U.S. Environmental Protection Agency
ESPP	Endangered Species Protection Program
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
EU	European Union
EXAMS	Tier II Surface Water Computer Model
FERC	Federal Energy Regulatory Commission
FCRPS	Federal Columbia River Power System
FFDCA	Federal Food and Drug Cosmetic Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act

FQPA	Food Quality Protection Act
ft	feet
GENEEC	Generic Estimated Exposure Concentration
GESTF	Generic Endangered Species Task Force
h	hour
HCP	Habitat Conservation Plan
HSRG	Hatchery Scientific Review Group
HUC	Hydrological Unit Code
IBI	Indices of Biological Integrity
ICTRT	Interior Columbia Technical Recovery Team
ILWP	Irrigated Lands Waiver Program
IPCC	Intergovernmental Panel on Climate Change
IRED	Interim Re-registration Decision
LCFRB	Lower Columbia Fish Recovery Board
ISG	Independent Science Group
ITS	Incidental Take Statement
km	kilometer
Lbs	Pounds
LC_{50}	Median Lethal Concentration.
LCR	Lower Columbia River
LOAEC	Lowest Observed Adverse Effect Concentration.
LOEL	Lowest Observed Adverse Effect level
LOC	Level of Concern
LOEC	Lowest Observed Effect Concentration
LOQ	Limit of Quantification
LRL	Laboratory Reporting Level
LWD	Large Woody Debris
m	meter
MCR	Middle Columbia River
mg/L	milligrams per liter
MOA	Memorandum of Agreement

MPG	Major Population Group
MRID	Master Record Identification Number
MTBE	Methyl tert-butyl ether
NASA	National Aeronautics and Space Administration
NAWQA	U.S. Geological Survey National Water-Quality Assessment
NC	Northern California
NEPA	National Environmental Protection Agency
NLCD	Natural Land Cover Data
NP	Nonylphenol
NPDES	National Pollutant Discharge Elimination System
NPS	National Parks Services
NRCS	Natural Resources Conservation Service
NWS	National Weather Service
NEPA	National Environmental Policy Act
NMA	National Mining Association
NMC	*N*-methyl carbamates
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOAEC	No Observed Adverse Effect Concentration
NPDES	National Pollution Discharge Eliminating System
NPIRS	National Pesticide Information Retrieval System
NRC	National Research Council
OC	Oregon Coast
ODFW	Oregon Division of Fish and Wildlife
OP	Organophosphates
Opinion	Biological Opinion
OPP	EPA Office of Pesticide Program
PAH	polyaromatic hydrocarbons
PBDEs	polybrominated diphenyl ethers
PCBs	polychlorinated biphenyls
PCEs	primary constituent elements

POP	Persistent Organic Pollutants
ppb	Parts Per Billion
PPE	Personal Protection Equipment
PSP	Pesticide Stewardship Partnerships
PSAMP	Puget Sound Assessment and Monitoring Program
PSAT	Puget Sound Action Team
PRIA	Pesticide Registration Improvement Act
PRZM	Pesticide Root Zone Model
PUR	Pesticide Use Reporting
QA/QC	Quality Assurance/Quality Control
RED	Re-registration Eligibility Decision
REI	Restricted Entry Interval
RPA	Reasonable and Prudent Alternatives
RPM	reasonable and prudent measures
RQ	Risk Quotient
SAP	Scientific Advisory Panel
SAR	smolt-to-adult return rate
SASSI	Salmon and Steelhead Stock Inventory
SC	Southern California
S-CCC	South-Central California Coast
SONCC	Southern Oregon Northern California Coast
SLN	Special Local Need (Registrations under Section 24(c) of FIFRA)
SR	Snake River
TCE	Trichloroethylene
TCP	3,5,6-trichloro-2-pyridinal
TGAI	Technical Grade Active Ingredient
TIE	Toxicity Identification Evaluation
TMDL	Total Maximum Daily Load
TRT	Technical Recovery Team
UCR	Upper Columbia River
USFS	United States Forest Service

USC	United States Code
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UWR	Upper Willamette River
VOC	Volatile Organic Compounds
VSP	Viable Salmonid Population
WDFW	Washington Department of Fish and Wildlife
WLCRTRT	Willamette/Lower Columbia River Technical Review Team
WQS	Water Quality Standards
WWTIT	Western Washington Treaty Indian Tribes
WWTP	Wastewater Treatment Plant

Appendix 3: Glossary

303(d) waters	Section 303 of the federal Clean Water Act requires states to prepare a list of all surface waters in the state for which beneficial uses – such as drinking, recreation, aquatic habitat, and industrial use - are impaired by pollutants. These are water quality limited estuaries, lakes, and streams that do not meet the state's surface water quality standards and are not expected to improve within the next two years. After water bodies are put on the 303(d) list they enter into a Total Maximum Daily Load Clean Up Plan.
Active ingredient	The component(s) that kills or otherwise affects the pest. A.i.s are always listed on the label (FIFRA 2(a)).
Adulticide	A compound that kills the adult life stage of the pest insect.
Anadromous Fish	Species that are hatched in freshwater migrate to and mature in salt water and return to freshwater to spawn.
Adjuvant	A compound that aides the operation or improves the effectiveness of a pesticide.
Alevin	Life history stage of a salmonid immediately after hatching and before the yolk-sac is absorbed. Alevins usually remain buried in the gravel in or near the egg nest (redd) until their yolk sac is absorbed then they swim up and enter the water column.
Allochthonous	Originating in a place other that where it is found. In stream ecology it refers to leaves, insects, branches, etc. that originate in the riparian zone and fall into the stream, providing an additional source of nutrients.

Anadromy	The life history pattern that features egg incubation and early juvenile development in freshwater migration to sea water for adult development, and a return to freshwater for spawning.
Assessment Endpoint	Explicit expression of the actual ecological value that is to be protected (*e.g.*, growth of juvenile salmonids).
Bankfull	The level at which water begins to leave the channel and move into the floodplain and is reached at a discharge which generally has a reccurence of 1 to 2 years on the annual flood series.
Bioaccumulation	Accumulation through the food chain (*i.e.*, consumption of food, water/sediment) or direct water and/or sediment exposure.
Bioconcentration	Uptake of a chemical across membranes, generally used in reference to waterborne exposures.
Biomagnification	Transfer of chemicals via the food chain through two or more trophic levels as a result of bioconcentration and bioaccumulation.
Degradates	New compounds formed by the transformation of a pesticide by chemical or biological reactions.
Distinct Population Segment	A listable entity under the ESA that meets tests of discreteness and significance according to USFWS and NMFS policy. A population is considered distinct (and hence a “species” for purposes of conservation under the ESA) if it is discrete from and significant to the remainder of its species based on factors such as physical, behavioral, or genetic characteristics, it occupies an unusual or unique ecological setting, or its loss would represent a significant gap in the species’ range.

Escapement	The number of fish that survive to reach the spawning grounds or hatcheries. The escapement plus the number of fish removed by harvest form the total run size.
Evolutionarily Significant Unit	A group of Pacific salmon or steelhead trout that is (1) substantially reproductively isolated from other conspecific units and (2) represent an important component of the evolutionary legacy of the species.
Fall Chinook Salmon	This salmon stock returns from the ocean in late summer and early fall to head upriver to its spawning grounds, distinguishing it from other stocks which migrate in different seasons.
Fate	Dispersal of a material in various environmental compartments (sediment, water air, biota) as a result of transport, transformation, and degradation.
Flowable	A pesticide formulation that can be mixed with water to form a suspension in a spray tank.
Fry	Stage in salmonid life history when the juvenile has absorbed its yolk sac and leaves the gravel of the redd to swim up into the water column. The fry stage follows the alevin stage and in most salmonid species is followed by the parr, fingerling, and smolt stages. However, chum salmon juveniles share characteristics of both the fry and smolt stages and can enter sea water almost immediately after becoming fry.
Half-pounder	A life history trait of steelhead exhibited in the Rogue, Klamath, Mad, and Eel Rivers of southern Oregon and northern California. Following smoltification, half-pounders spend only 2-4 months in the ocean, then return to fresh water. They overwinter in fresh water and emigrate to salt water

	again the following spring. This is often termed a false spawning migration, as few half-pounders are sexually mature.
Hatchery	Salmon hatcheries use artificial procedures to spawn adults and raise the resulting progeny in fresh water for release into the natural environment, either directly from the hatchery or by transfer into another area. In some cases, fertilized eggs are outplanted (usually in “hatch-boxes”), but it is more common to release fry or smolts.
Inert ingredients	“an ingredient which is not active” (FIFRA 2(m)). It may be toxic or enhance the toxicity of the active ingredient.
Iteroparous	Capable of spawning more than once before death
Jacks	Male salmon that return from the ocean to spawn one or more years before full-sized adults return. For coho salmon in California, Oregon, Washington, and southern British Columbia, jacks are 2 years old, having spent only 6 months in the ocean, in contrast to adults, which are 3 years old after spending 1 ½ years in the ocean.
Jills	Female salmon that return from the ocean to spawn one or more years before full-sized adult returns. For sockeye salmon in Oregon, Washington, and southern British Columbia, jills are 3 years old (age 1.1), having spent only one winter in the ocean in contrast to more typical sockeye salmon that are age 1.2, 1.32.2, or 2.3 on return.
Kokanee	The self-perpetuating, non-anadromous form of *O. nerka* that occurs in balanced sex ration populations and whose parents, for several generations back, have spent their whole lives in freshwater.

Lambda	Also known as Population growth rate, or the rate at which the abundance of fish in a population increases or decreases.
LRL	Laboratory Reporting Level (USGS NAWQA data) - Generally equal to twice the yearly determined LT-MDL. The LRL controls false negative error. The probability of falsely reporting a non-detection for a sample that contained an analyte at a concentration equal to or greater than the LRL is predicted to be less than or equal to 1 percent.
Major Population Group (MPG)	A group of salmonid populations that are geographically and genetically cohesive. The MPG is a level of organization between demographically independent populations and the ESU.
Main channel	The stream channel that includes the thalweg (longitudinal continuous deepest portion of the channel).
Metabolite	A transformation product resulting from metabolism.
Mode of Action	A series of key processes that begins with the interaction of a pesticide with a receptor site and proceeds through operational and anatomical changes in an organism that result in sublethal or lethal effects.
Natural fish	A fish that is produced by parents spawning in a stream or lake bed, as opposed to a controlled environment such as a hatchery.
Nonylphenols	A type of APE and is an example of an adjuvant that may be present as an ingredient of a formulated product or added to a tank mix prior to application.
Off-channel habitat	Water bodies and/or inundated areas that are connected (accessible to salmonid juveniles) seasonally or annually to the main channel of a stream

	including but not limited to features such as side channels, alcoves, ox bows, ditches, and floodplains.
Parr	The stage in anadromous salmonid development between absorption of the yolk sac and transformation to smolt before migration seaward.
Persistence	The tendency of a compound to remain in its original chemical form in the environment.
Pesticide	Any substance or mixture of substances intended for preventing, destroying, repelling or mitigating any pest.
Reasonable and Prudent Alternative (RPA)	Recommended alternative actions identified during formal consultation that can be implemented in a manner consistent with the scope of the Federal agency's legal authority and jurisdiction, that are economically and technologically feasible, and that the Services believes would avoid the likelihood of jeopardizing the continued existence of the listed species or the destruction or adverse modification of designated critical habitat.
Redd	A nest constructed by female salmonids in streambed gravels where eggs are deposited and fertilization occurs.
Riparian area	Riparian habitats are the transitional zones between terrestrial and aquatic ecosystems and are distinguished by gradients in biological and physical conditions, ecological processes, and biota. They are areas through which surface and subsurface hydrology connect waterbodies with their adjacent uplands. They include those portions of terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems (*i.e.*, zone of influence). Riparian areas are the products of water

	and material interactions in three dimensions – longitudinal, lateral, and vertical. They include portions of the channel system and associated features (*e.g.*, gravel bars, islands, woody debris); a vegetated zone of varying successional states influenced by floods, sediment deposition, soil-formation processes, and water availability; and a transitional zone to the uplands of the valley wall – all underlain by an alluvial aquifer. Riparian areas are adjacent to rivers, and perennial, intermittent, and ephemeral streams, and lakes, and estuarine-marine shorelines.
Risk	The probability of harm from actual or predicted concentrations of a chemical in the aquatic environment – a scientific judgment.
Salmon-bearing Waters	Fresh, brackish and marine waters accessible to salmonids.
Salmonid	Fish of the family *Salmonidae*, including salmon, trout, chars, grayling, and whitefish. In general usage, the term usually refers to salmon, trout, and chars.
SASSI	A cooperative program by WDFW and WWTIT to inventory and evaluate the status of Pacific salmonids in Washington State. The SASSI report is a series of publications from this program.
Semelparous	The condition in an individual organism of reproducing only once in a lifetime.
Smolt	A juvenile salmon or steelhead migrating to the ocean and undergoing physiological changes to adapt from freshwater to a saltwater environment.
Sublethal	Below the concentration that directly causes death. Exposure to sublethal concentrations of a material may produce less obvious effect on behavior,

	biochemical, and/or physiological function of the organism often leading to indirect death.
Surfactant	A substance that reduces the interfacial or surface tension of a system or a surface-active substance.
Synergism	A phenomenon in which the toxicity of a mixture of chemicals is greater than that which would be expected from a simple summation of the toxicities of the individual chemicals present in the mixture.
Technical Grade Active Ingredient (TGAI)	Pure or almost pure active ingredient. Available to formulators. Most toxicology data are developed with the TGAI. The percent AI is listed on all labels.
Technical Recovery Teams (TRT)	Teams convened by NOAA Fisheries to develop technical products related to recovery planning. TRTs are complemented by planning forums unique to specific states, tribes, or reigns, which use TRT and other technical products to identify recovery actions.
Teratogenic	Effects produced during gestation that evidence themselves as altered structural or functional processes in offspring.
Total Maximum Daily Load (TMDL)	defines how much of a pollutant a water body can tolerate (absorb) daily and remain compliant with applicable water quality standards. All pollutant sources in the watershed combined, including non-point sources, are limited to discharging no more than the TMDL.
Unique Mixture	A specific combination of 2 or more compounds, regardless of the presence of other compounds.
Viable Salmonid	An independent population of Pacific salmon or steelhead trout

Population	that has a negligible risk of extinction over a 100-year time frame. Viability at the independent population scale is evaluated based on the parameters of abundance, productivity, spatial structure, and diversity.
VSP Parameters	Abundance, productivity, spatial structure, and diversity. These describe characteristics of salmonid populations that are useful in evaluating population viability. See NOAA Technical Memorandum NMFS-NWFSC-, “Viable salmonid populations and the recovery of evolutionarily significant units,” McElhany *et al.,* June 2000.
WDFW	Washington Department of Fish and Wildlife is a co-manager of salmonids and salmonid fisheries in Washington State with WWTIT and other fisheries groups. The agency was formed in the early 1990s by the combination of the Washington Department of Fisheries and the Washington Department of Wildlife.
WWTIT	Western Washington Treaty Indian Tribes is an organization of Native American tribes with treaty fishing rights recognized by the U.S. government. WWTIT is a co-manager of salmonids and salmonid fisheries in western Washington in cooperation with the WDFW and other fisheries groups.
WQS	“A water quality standard defines the water quality goals of a waterbody, or portion thereof, by designating the use or uses to be made of the water and by setting criteria necessary to protect public health or welfare, enhance the quality of water and serve the purposes of the Clean Water

Appendix 4: Co-occurrence Analysis for Integration and Synthesis

Our species viability assessment considers the spatial, temporal, and biological overlap of ESA-listed species with the stressors of the action. Where there is co-occurrence, salmonids may be exposed to and affected by the a.i. and its associated stressors.

Because pesticides are registered for specific uses, we determine where specific portions of the proposed action may be carried out based on the type of use. National Land Cover Database (NLCD) land use categories were used as a surrogate for use sites: cultivated crops or hay/pasture for a specific crop or crops; developed areas for residential and urban uses, pest control, and disease vector control; and managed forests for forestry applications. While cropping patterns may shift or lands may become fallow over a longer period of time, the NLCD dataset is the most relevant method of estimating exposure. As we cannot determine where a certain crop will be cultivated, we assume that any pesticide registered for use on an agricultural crop could be applied in an area defined as agricultural land use. We did consider differences in state regulations and SLN registrations, as well as general cropping trends for different basins.

However, we cannot determine where rights-of-way uses will occur based on land use information. We assume that rights-of-way will be concentrated in urban areas, but will also be present in rural areas as well. In more remote areas, roads and railroads are often situated along river valleys, sometimes in close proximity to the stream or river.

We used the GIS program ArcView to overlay the NLCD data on ESUs/DPSs range and distribution shapefiles to determine areas of potential co-occurrence of pesticide use and ESA-listed salmon. Species range shapefiles were developed by NMFS Northwest Regional Office. These files exist for every ESU and consist of polygons encompassing the hydrologic units where that species can be found. In some cases, these polygons include areas that are not currently occupied, but are accessible and are part of the historic range of the species. We also assessed distribution data for each ESU/DPS. Distribution files were developed by the Northwest and Southwest regional offices in the process of identifying and designating critical habitat for 19 species in 2005.

The remaining ESUs/DPSs did not have existing distribution layers. They were created for this consultation by overlaying datasets from other sources with the NMFS range polygons. The data is largely presence/absence data collected by governmental agencies and university researchers. Information on Idaho, Oregon, and Washington species was compiled and presented by Streamnet (www.streamnet.org) while California data came from CalFish (www.calfish.org). Streams where fish were present within the range polygon were exported to a new distribution file. This method was used to create files for Snake River Fall-run Chinook salmon, Snake River Spring-run Chinook salmon, Sacramento River Winter-run Chinook salmon, Snake River sockeye salmon, Ozette Lake Sockeye salmon, Lower Columbia River Coho salmon, Southern Oregon Northern California Coho salmon, Central California Coast Coho salmon, and Puget Sound Steelhead salmon.

For all ESUs/DPSs, a 2.5 km "buffer" was created on each side of salmonid aquatic habitat. This distance was selected by the team as it is large enough to account for discrepancies between GIS layers due to channel alteration / migration, but not so large that it would encompass the entire range of an ESU. We expect pesticide applications in these areas are most relevant to concentrations experienced by salmonids via pesticide runoff and drift. If land in any of the relevant NLCD categories was within the buffer we determined that salmon and the a.i. could co-occur. Over the 15-year duration of the proposed action, we expect some individuals within each of the listed ESUs/DPSs in the action area will be exposed to these a.i.s during their life cycle. Given that these pesticides can be used across the landscape, and that temporal and spatial distribution of listed salmonids are both highly variable, we expect exposure is also highly variable among both individuals and populations of listed salmon.

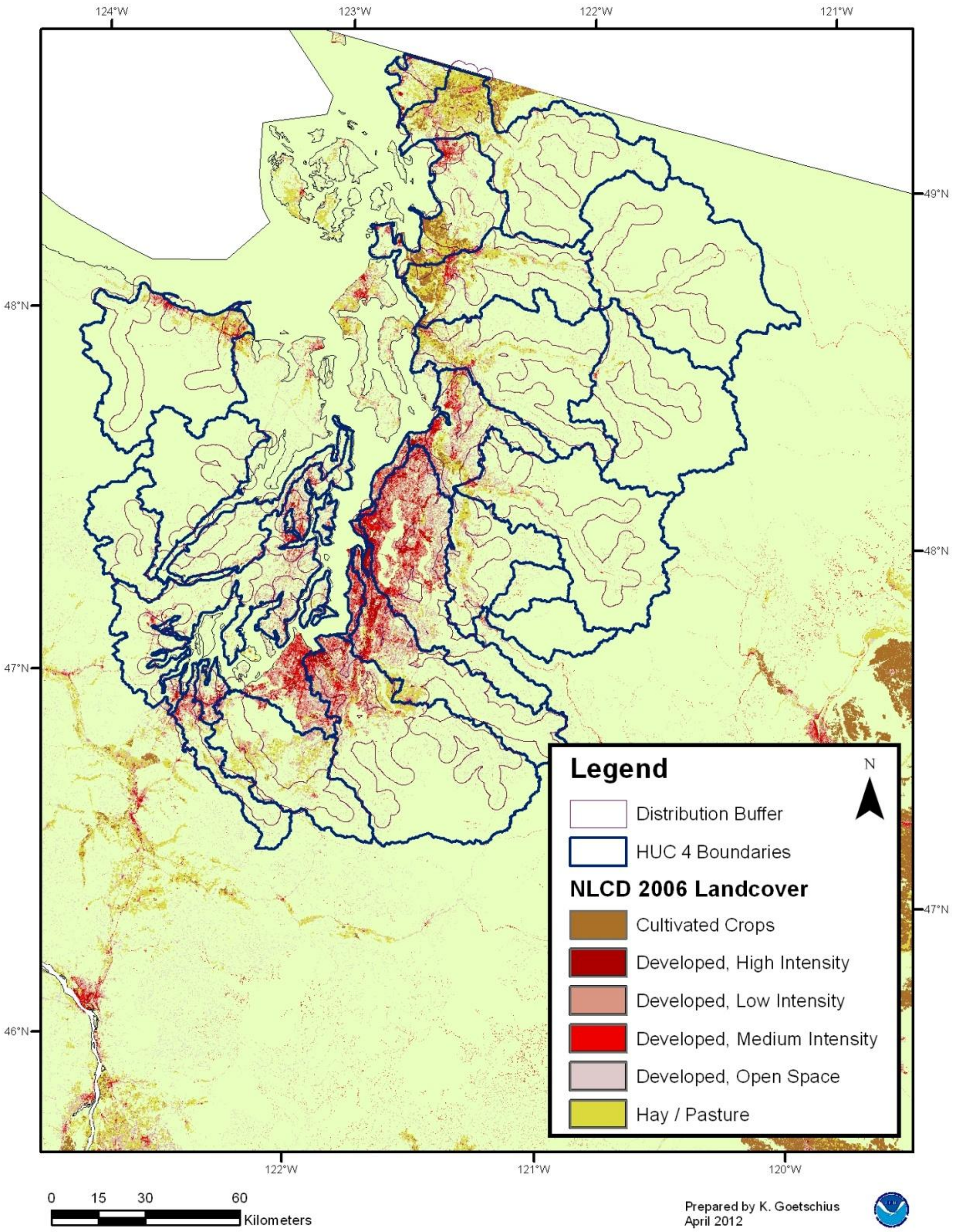
Once co-occurrence is determined via GIS for each a.i., we evaluated the spatial and temporal extent of potential exposure for the ESU/DPS, given the life history of the species. In many cases, fish may be in the system for prolonged periods of time, and there is generally no specific seasonal restriction on application of pesticides. Additionally, species are made up of "runs" which spawn at different times of the year. Thus, the spatial and biological overlap is of greater importance in analyzing this action than the temporal component.

We further considered the existing environmental mixtures, seasonally elevated water temperatures, and other factors which influence the survival of the species, such as loss of habitat features, hydropower and water management conditions, and invasive species or predators. Other important factors that were taken into consideration include location of federal land, railroad lines, and electrical transmission lines.

To illustrate the co-occurrence analysis process, this appendix includes two maps for each ESU/DPS. The first map shows the range of the ESU with each HUC 4 outlined in blue, the 2.5 km buffer in burgundy and relevant categories from the 2006 NLCD land use layer. This map aided in the Species analyses. The second map was used in the critical habitat analysis. For 19 of the species, conservation values have been assigned to the HUC 5 level units. In Idaho, Oregon, and Washington, these units are referred to as watersheds, while California uses the term “hydrological sub-area” or HSA. The Critical Habitat maps show either, (a) all designated HUC5s and their conservation values, or (b) the species map with the buffer removed. The exceptions to this are Snake River Fall-Run Chinook and Ozette Lake Sockeye, as they cover such small areas, and the two species for which critical habitat has not been designated (Columbia River Coho and Puget Sound Steelhead). These four species each only have one map. The following species have conservation values assigned by HUC5:

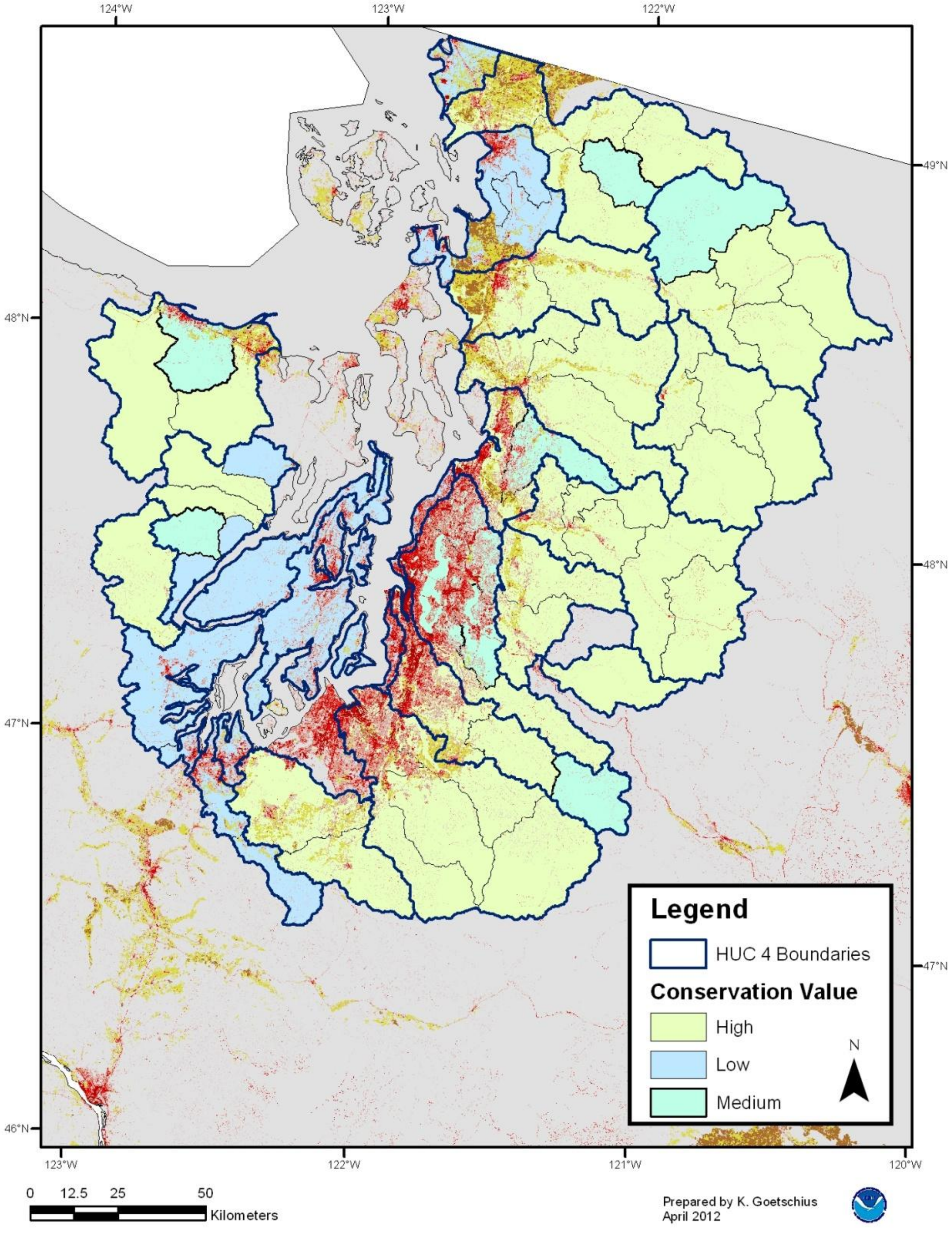
1. Puget Sound Chinook
2. Lower Columbia River Chinook
3. Upper Columbia River Spring Run Chinook
4. Upper Willamette River Chinook
5. California Coastal Chinook
6. Central Valley Spring Run Chinook
7. Columbia River Chum
8. Hood Canal Chum
9. Oregon Coast Coho
10. Lower Columbia River Steelhead
11. Middle Columbia River Steelhead
12. Upper Columbia River Steelhead
13. Upper Willamette River Steelhead
14. Snake River Steelhead
15. Northern California Steelhead
16. Central California Coast Steelhead
17. California Central Valley Steelhead
18. South-Central California Coast Steelhead
19. Southern California Steelhead

Puget Sound Chinook ESU

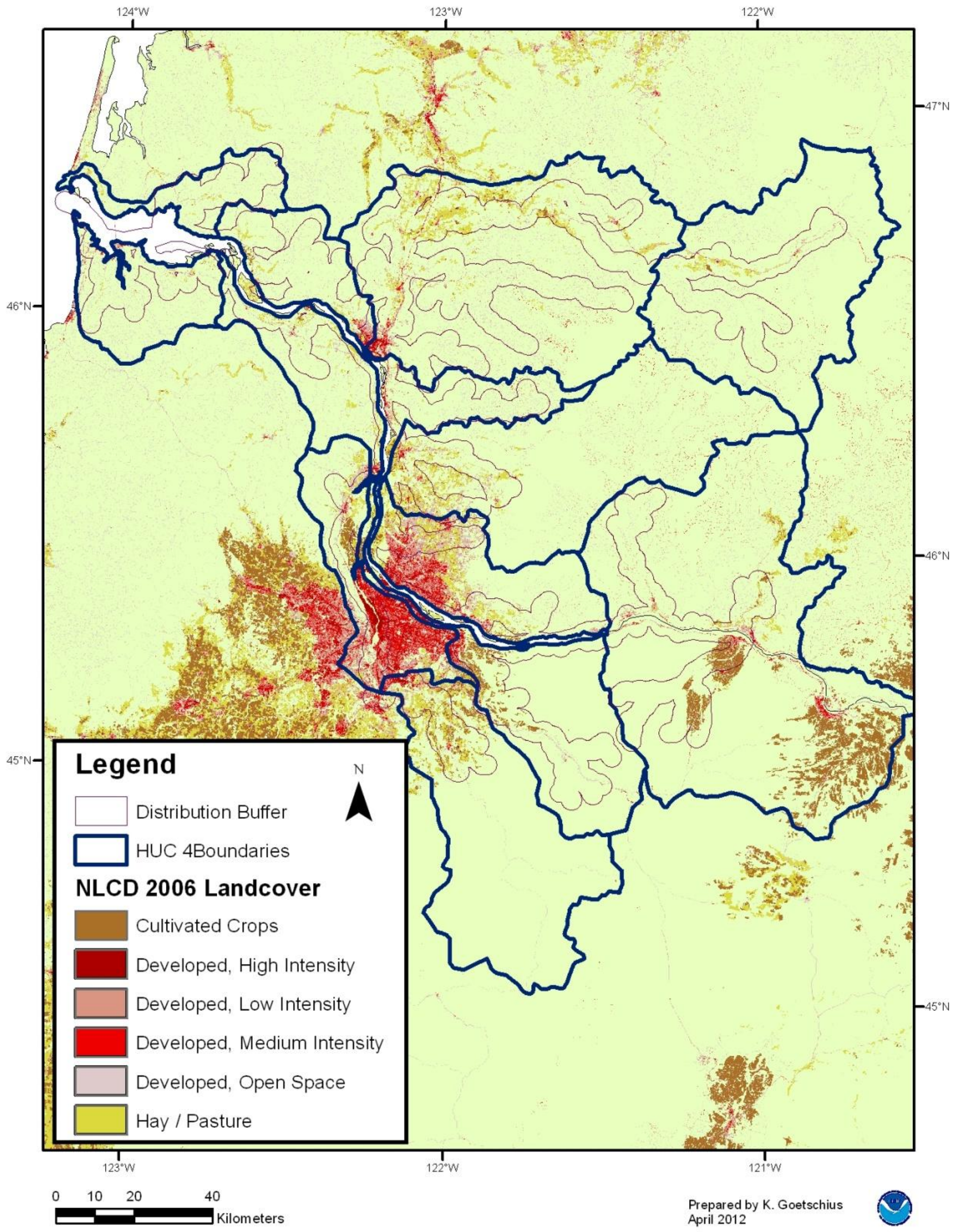


Prepared by K. Goetschius
April 2012

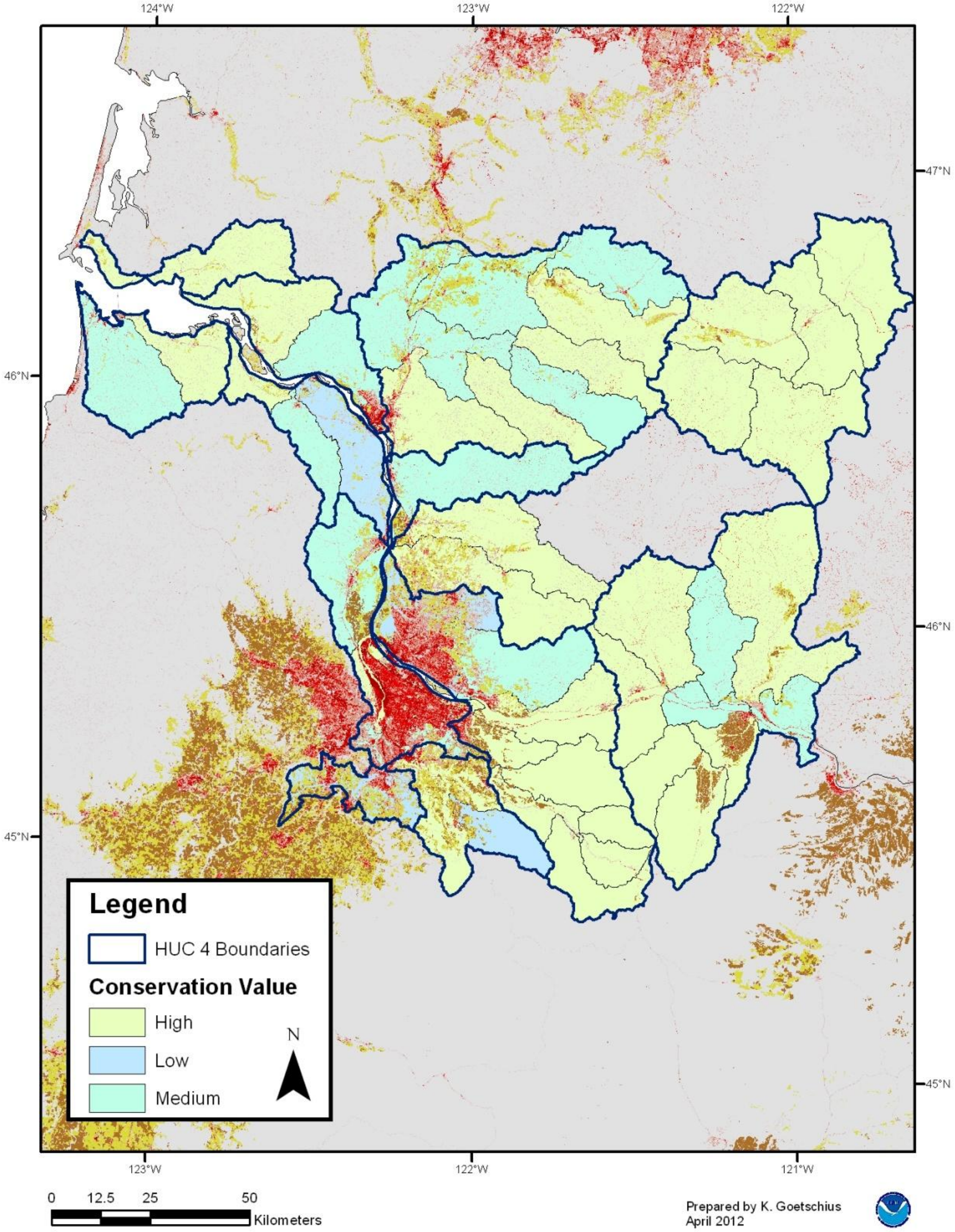
Puget Sound Chinook ESU
Critical Habbitat



Lower Columbia River Chinook ESU

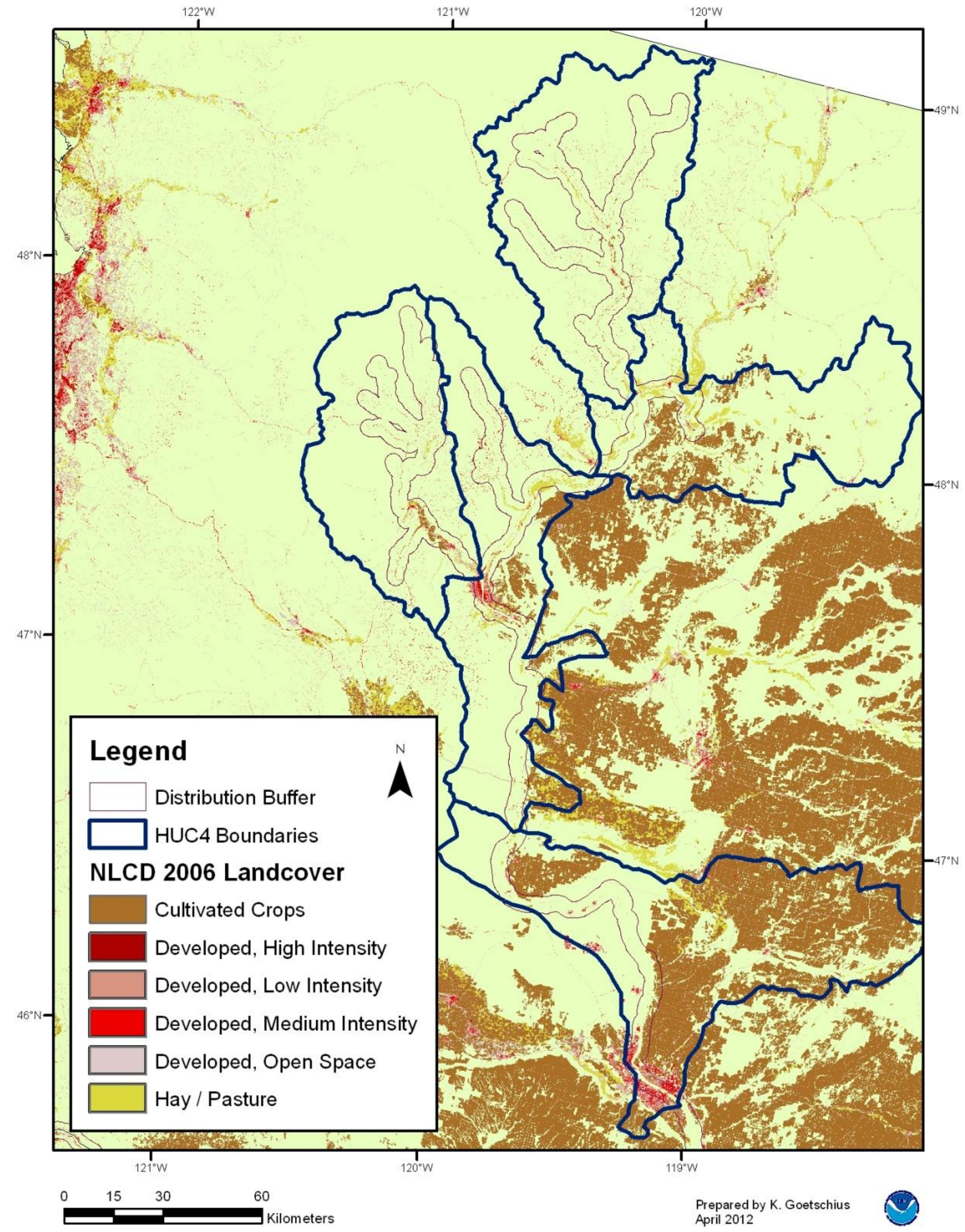


Lower Columbia River Chinook ESU Critical Habitat

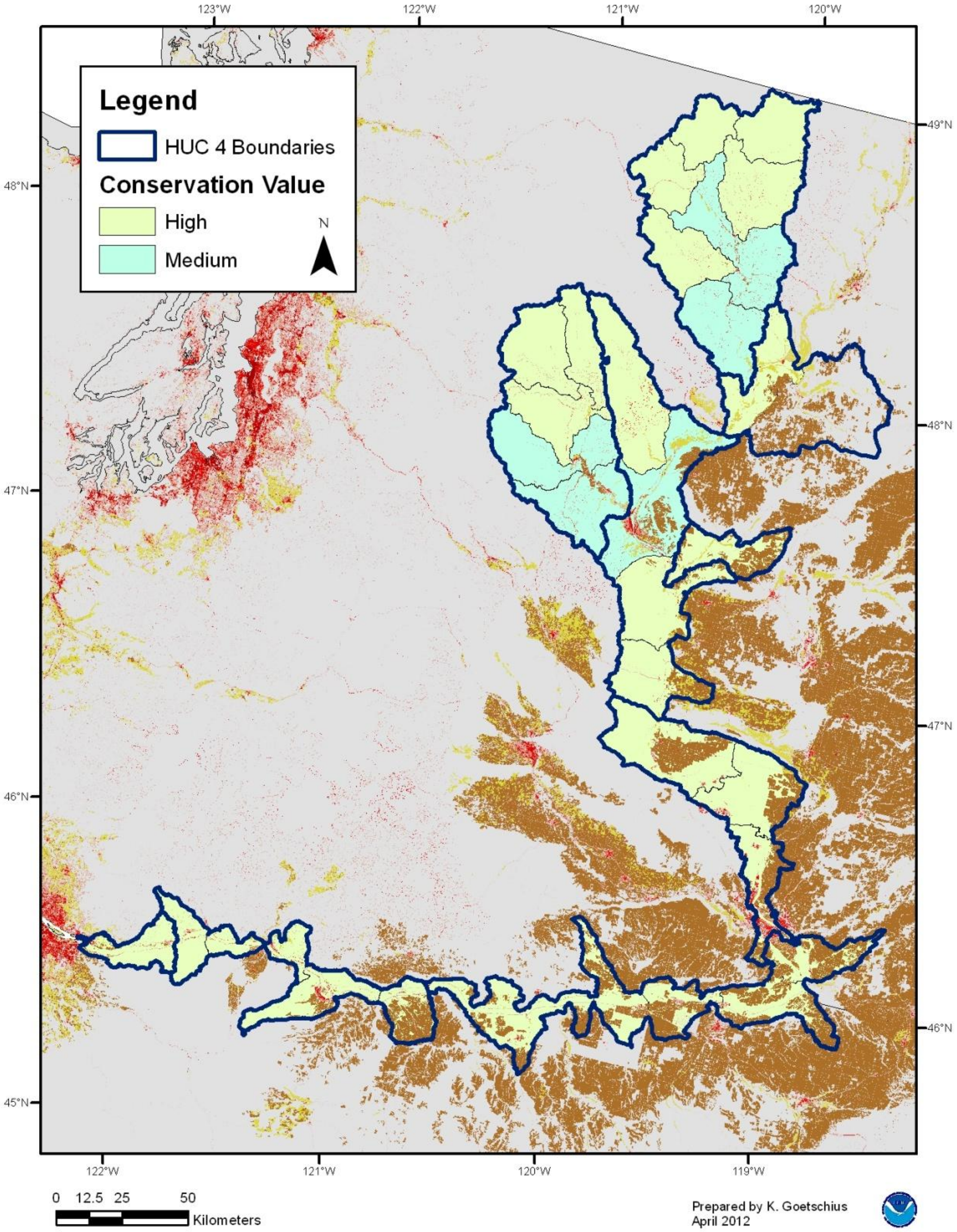


Prepared by K. Goetschius
April 2012

Upper Columbia Spring-Run Chinook ESU

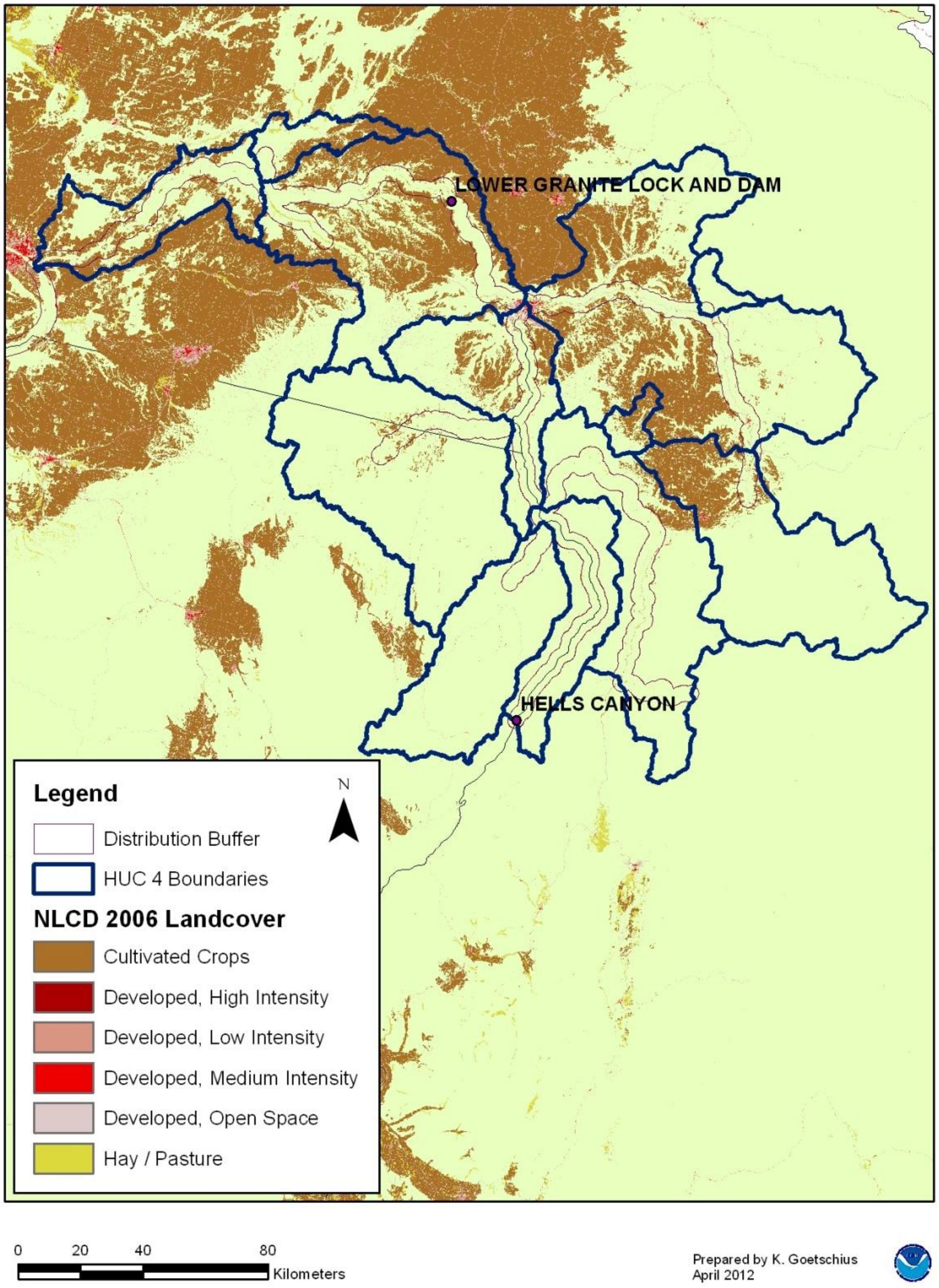


Upper Coulmbia River Chinook ESU Critical Habitat

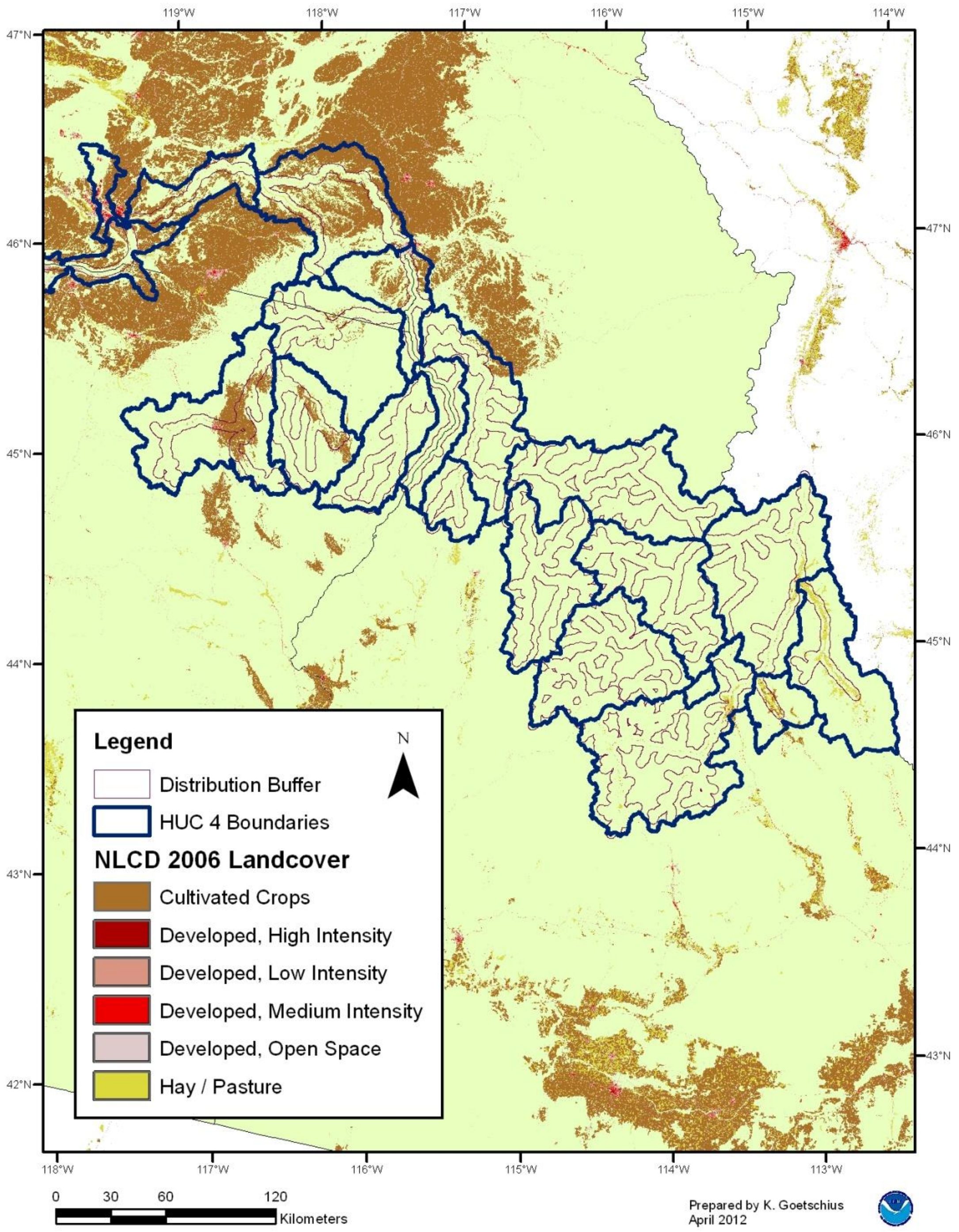


Prepared by K. Goetschius
April 2012

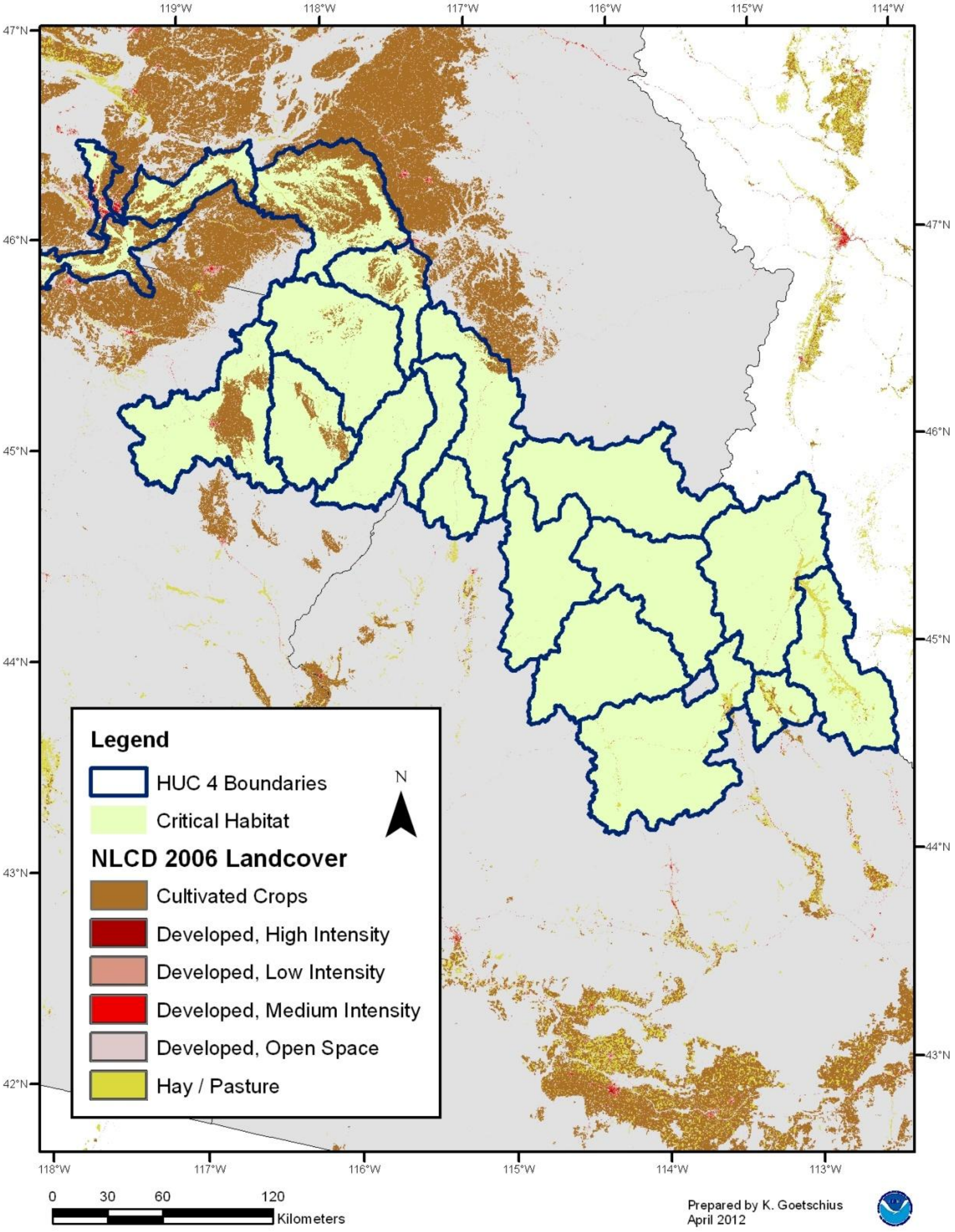
Snake River Fall Run Chinook ESU



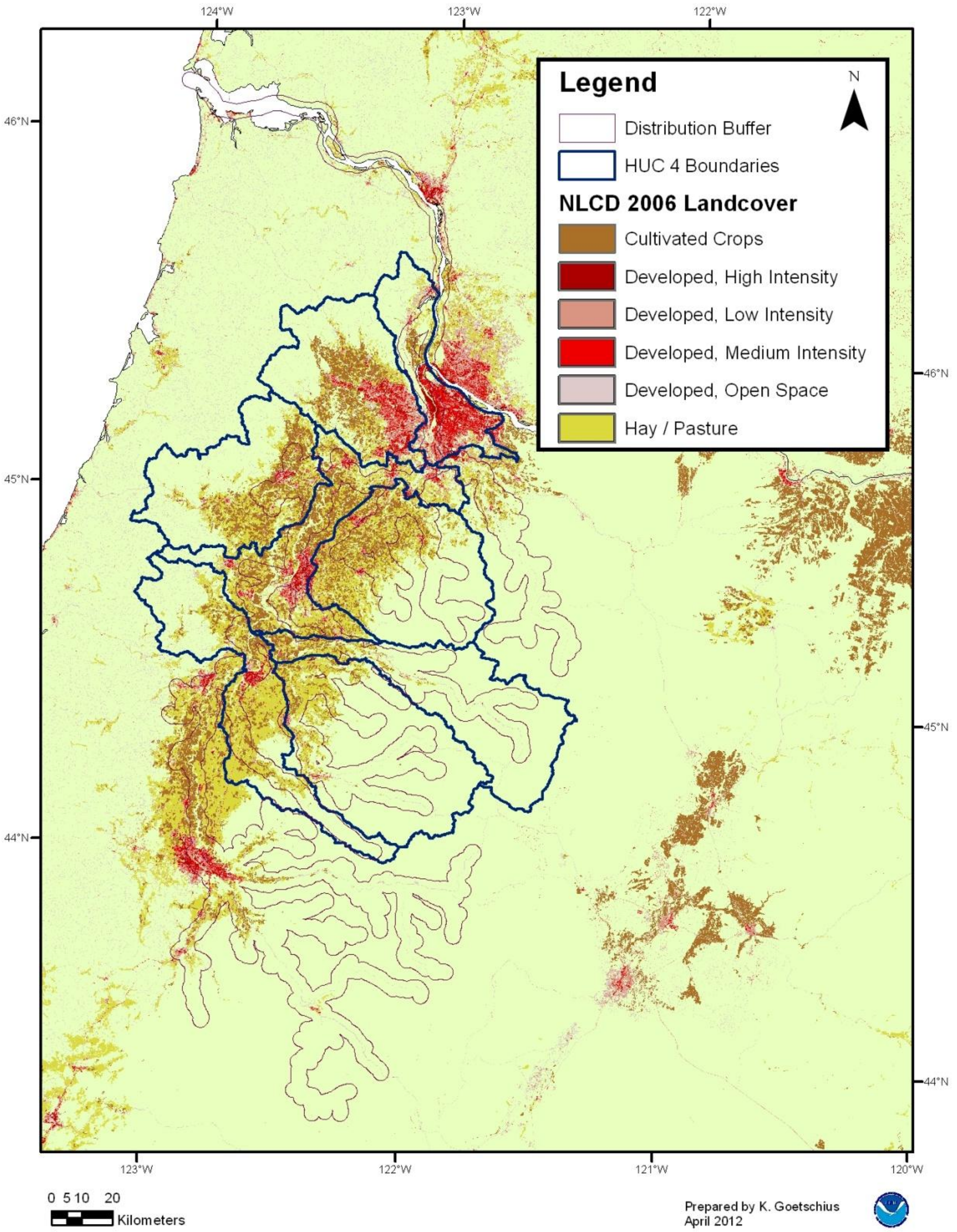
Snake River Spring-Summer Run Chinook



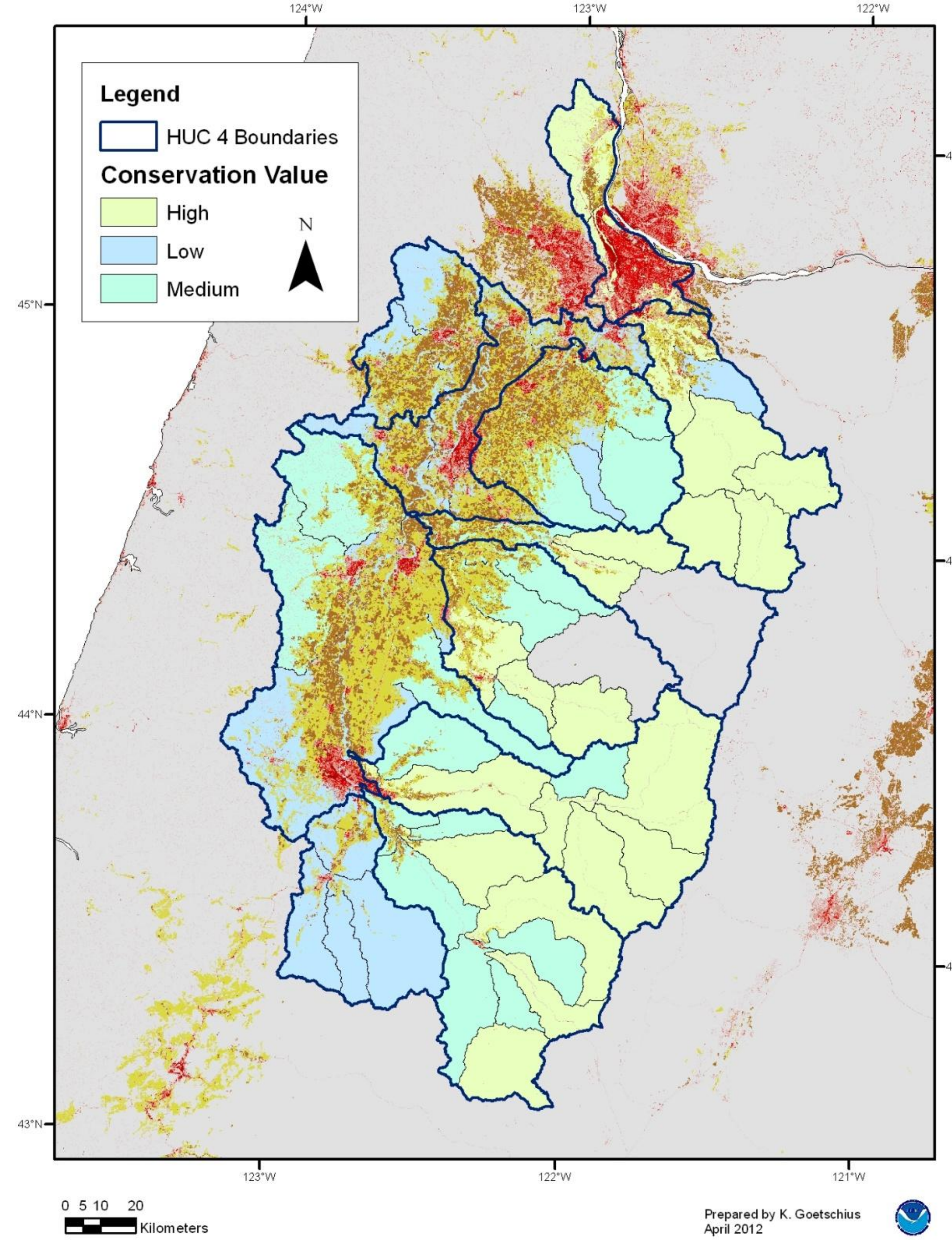
Snake River Spring-Summer Run Chinook Critical Habitat



Upper Willamette River Chinook ESU

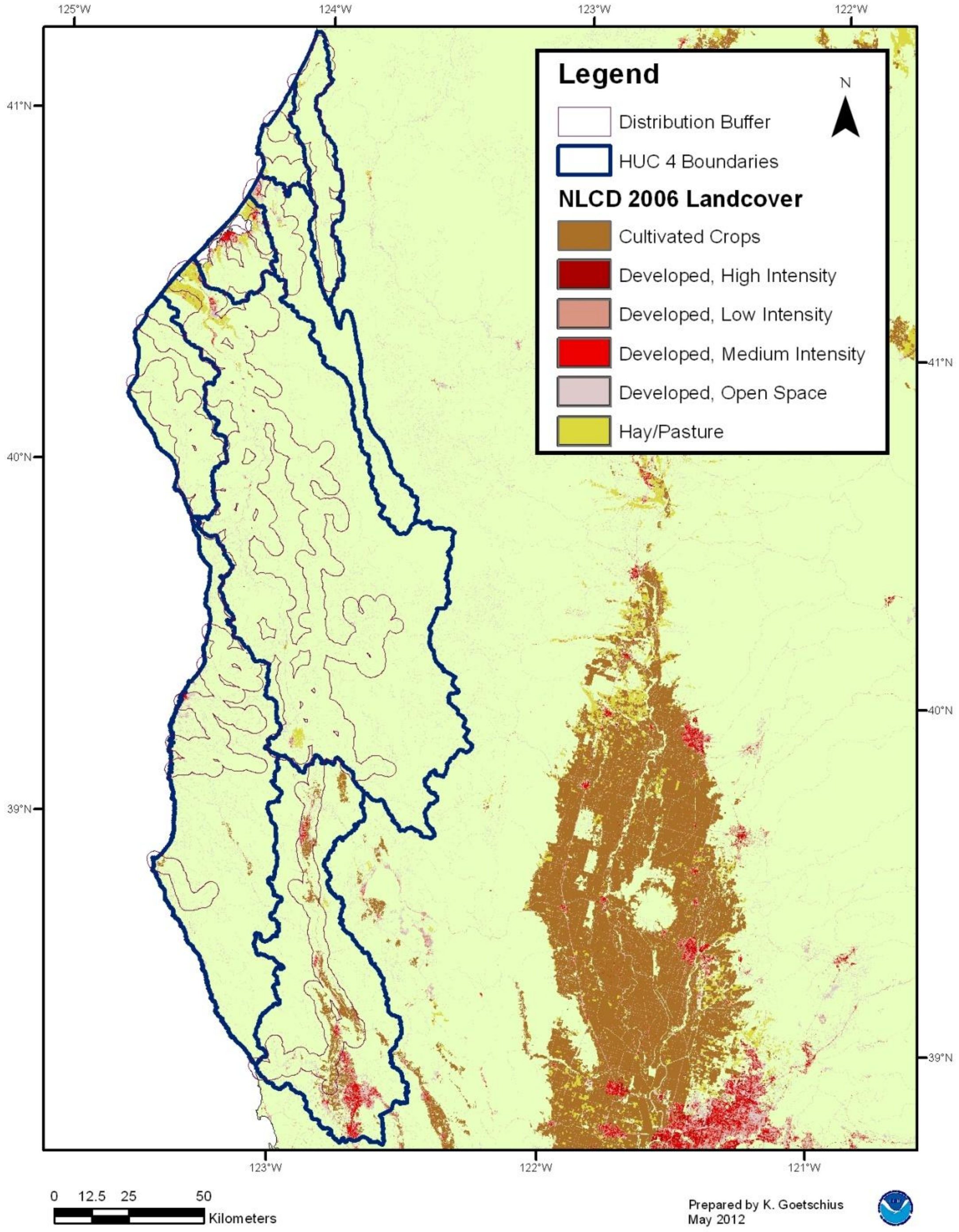


Upper Willamette River Chinook ESU Critical Habitat

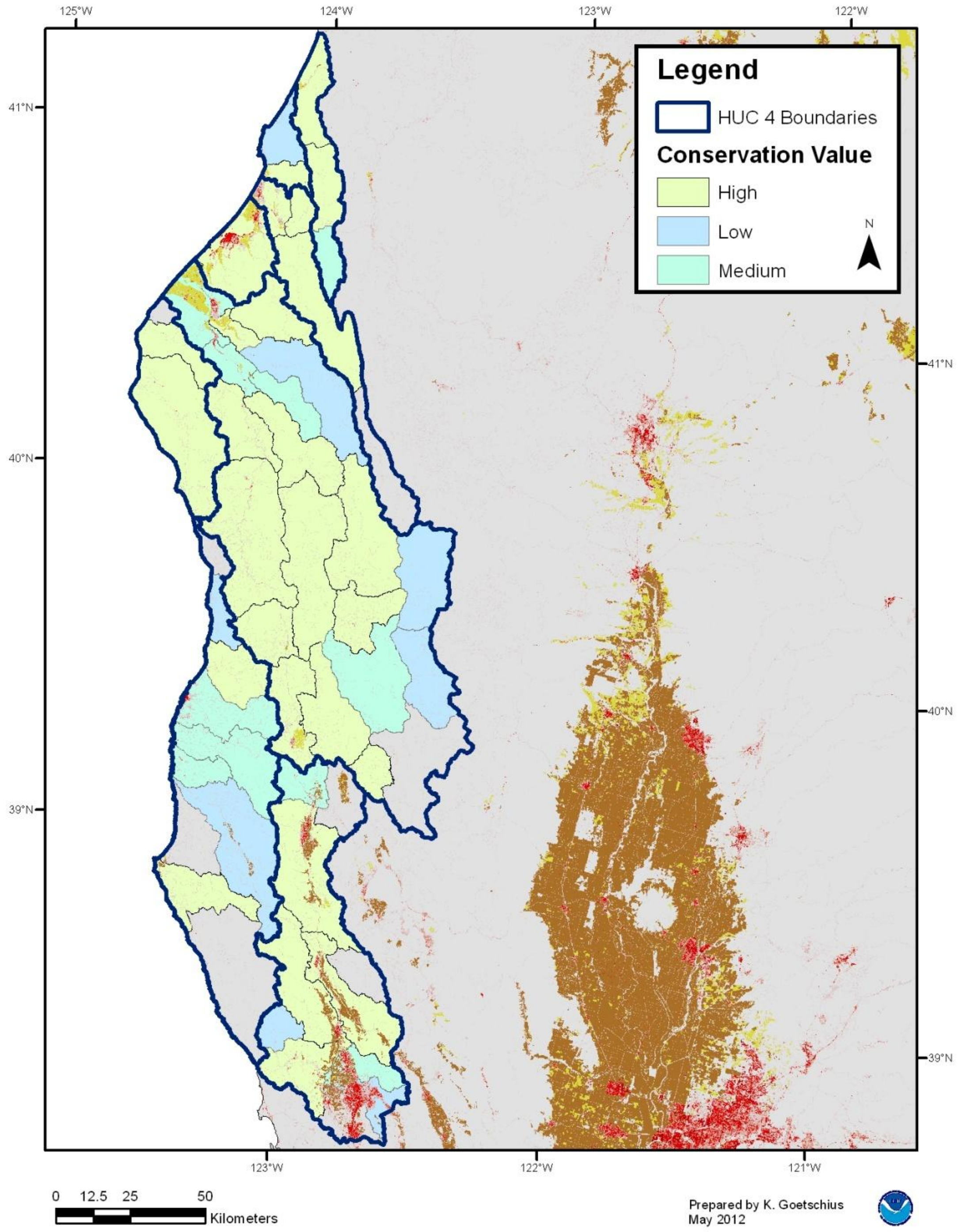


Prepared by K. Goetschius
April 2012

California Coastal Chinook ESU

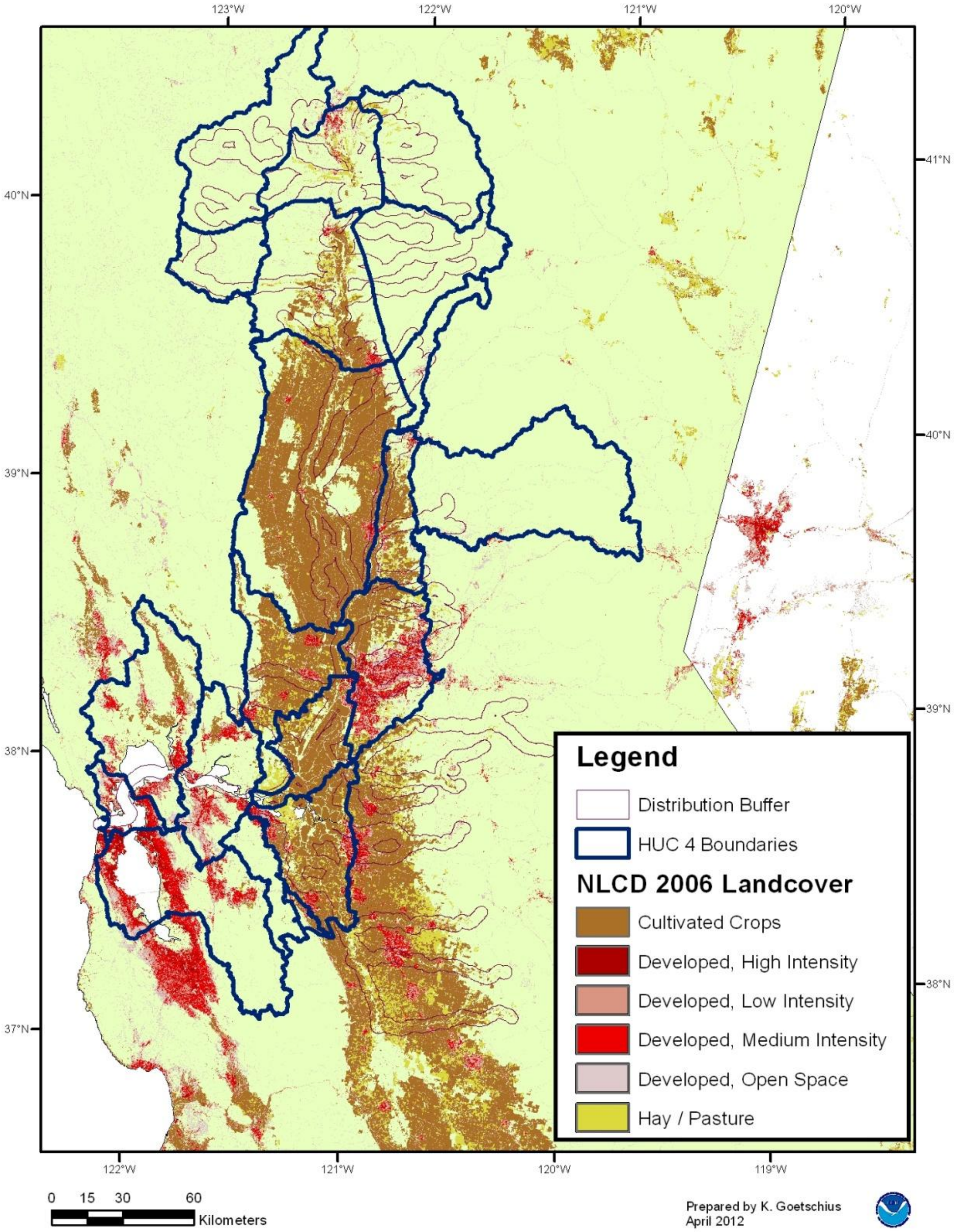


California Coastal Chinook ESU Critical Habitat



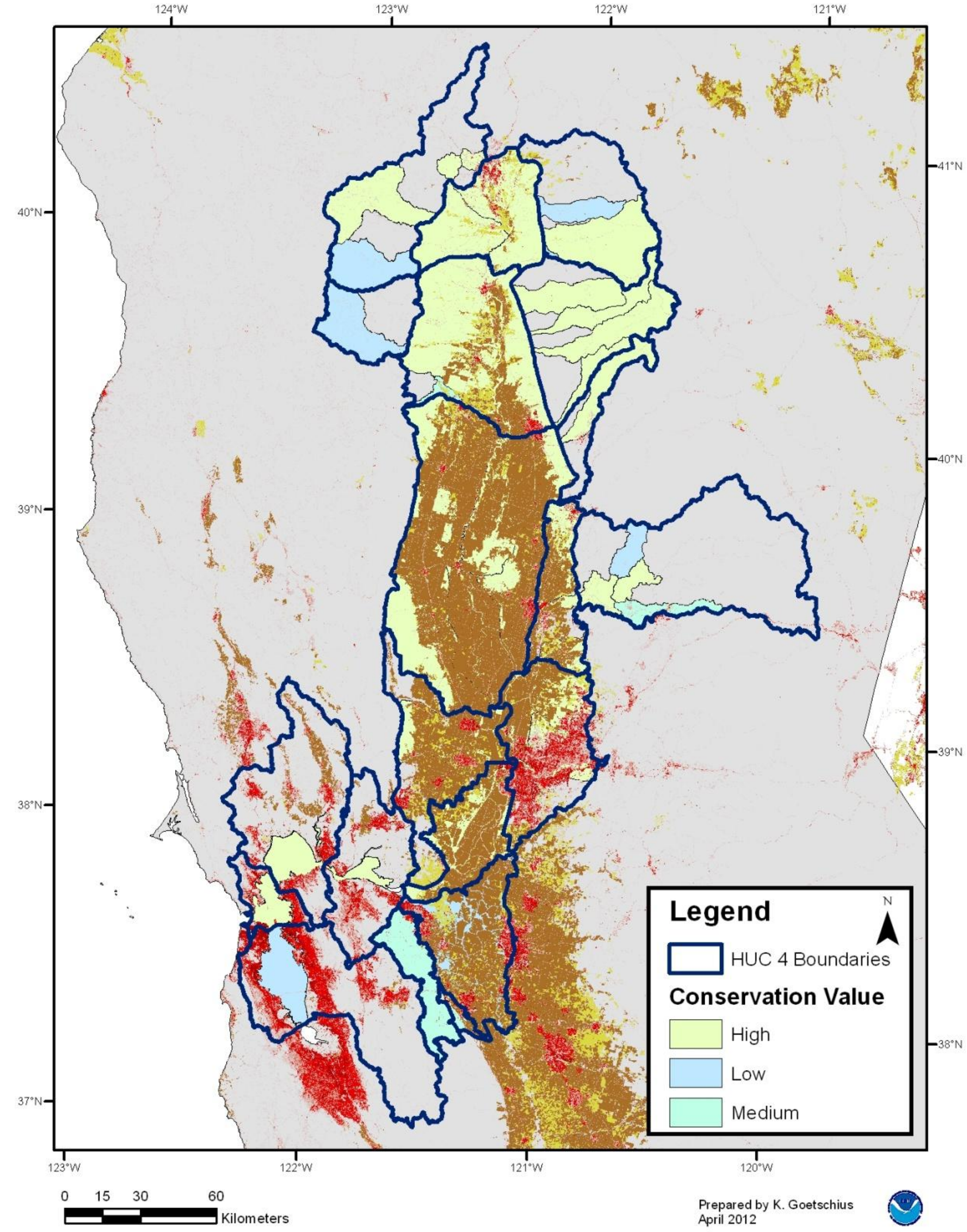
Prepared by K. Goetschius
May 2012

Central Valley Spring-Run Chinook ESU



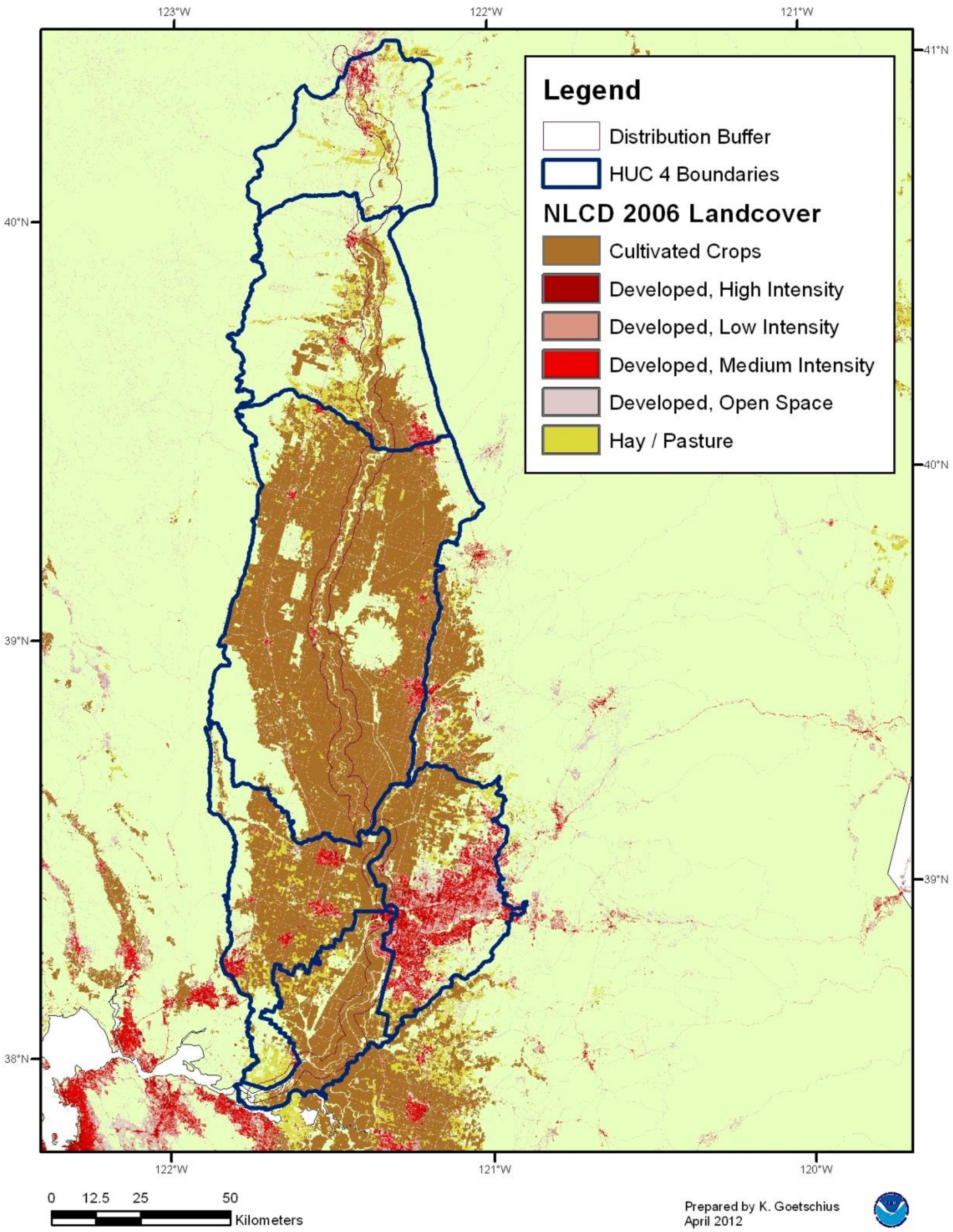
Prepared by K. Goetschius
April 2012

Central Valley Spring-Run Chinook ESU Critical Habitat



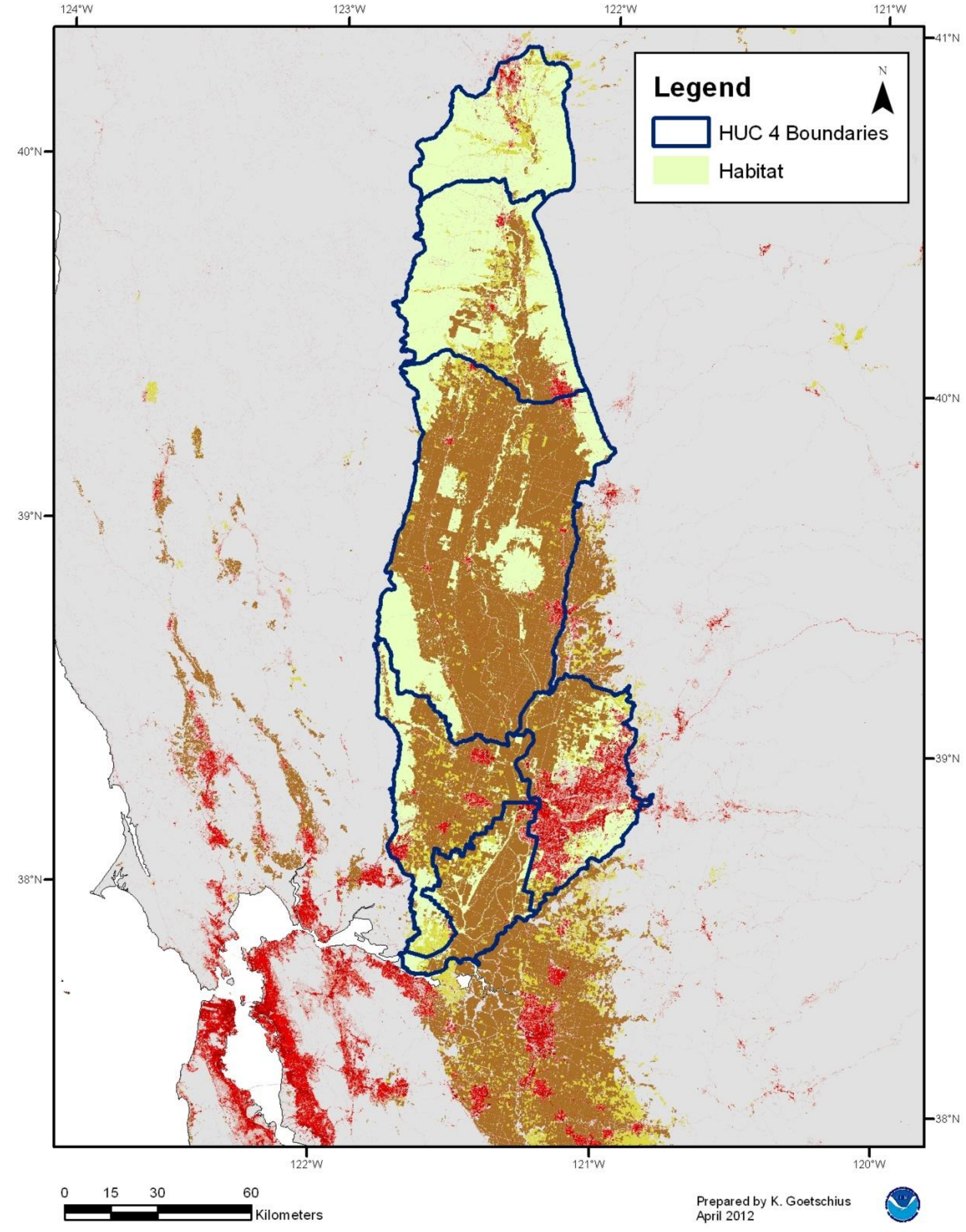
Prepared by K. Goetschius
April 2012

Sacramento River Winter Run Chinook ESU



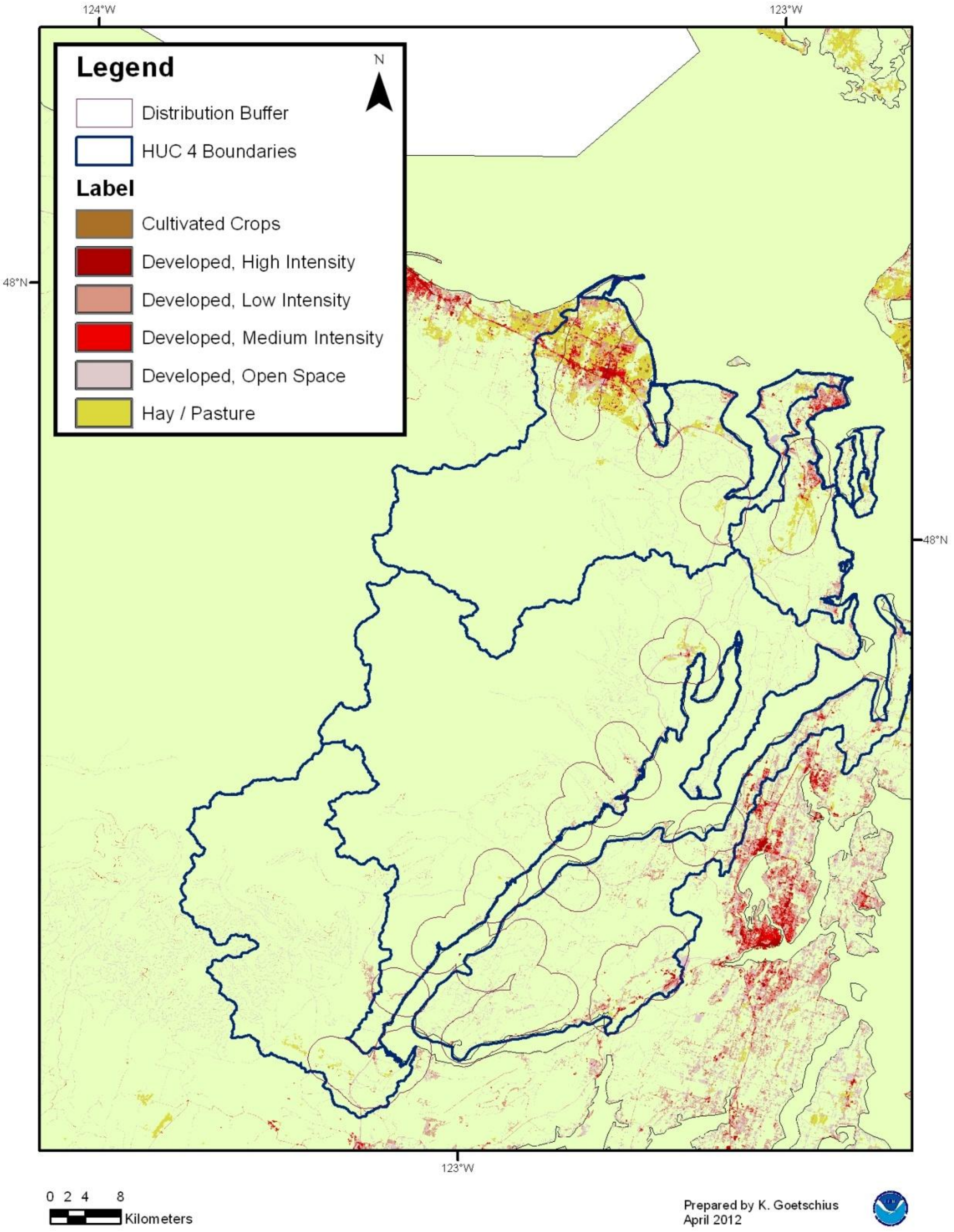
Prepared by K. Goetschius
April 2012

Sacramento River Winter Run Chinook ESU Critical Habitat

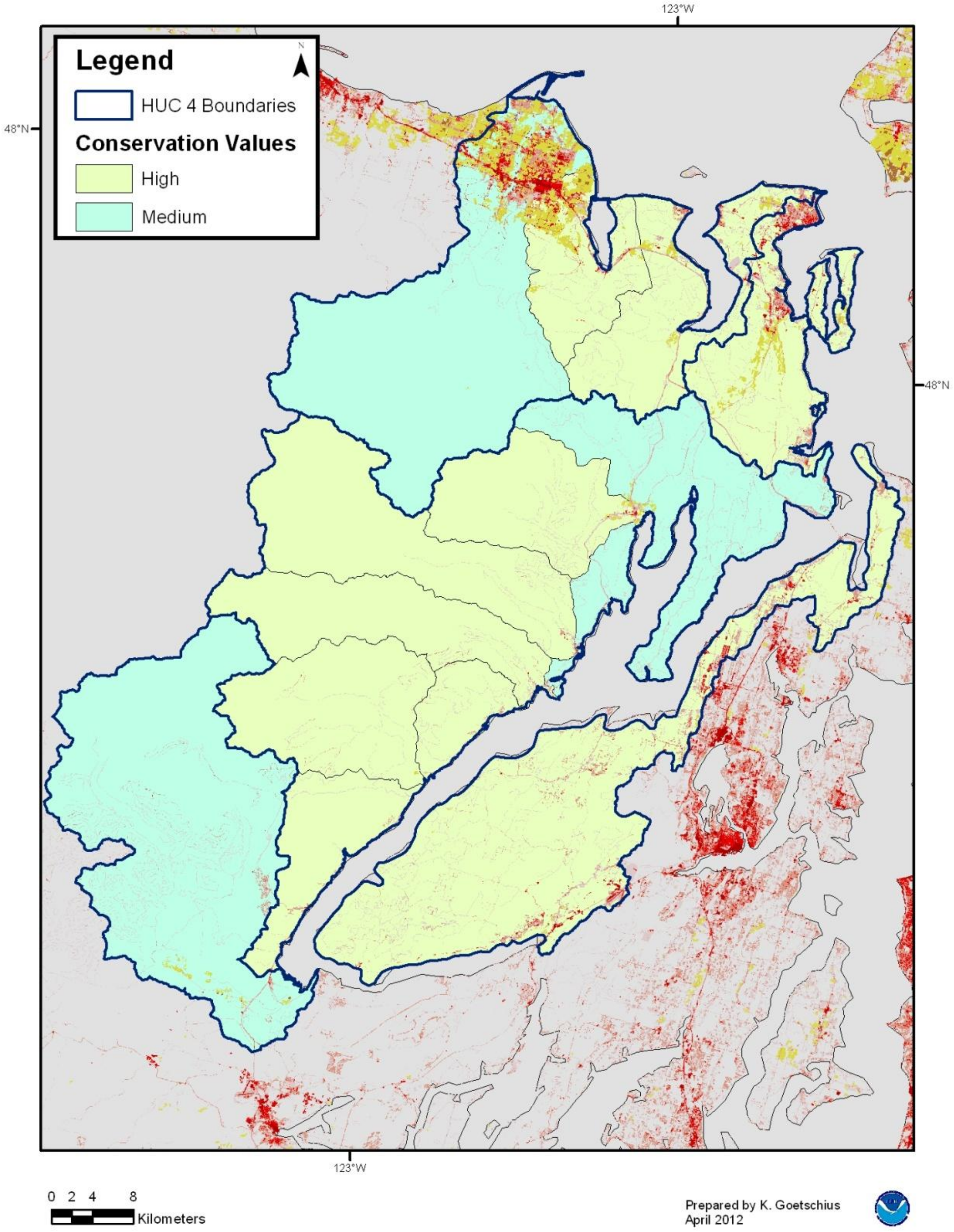


Prepared by K. Goetschius
April 2012

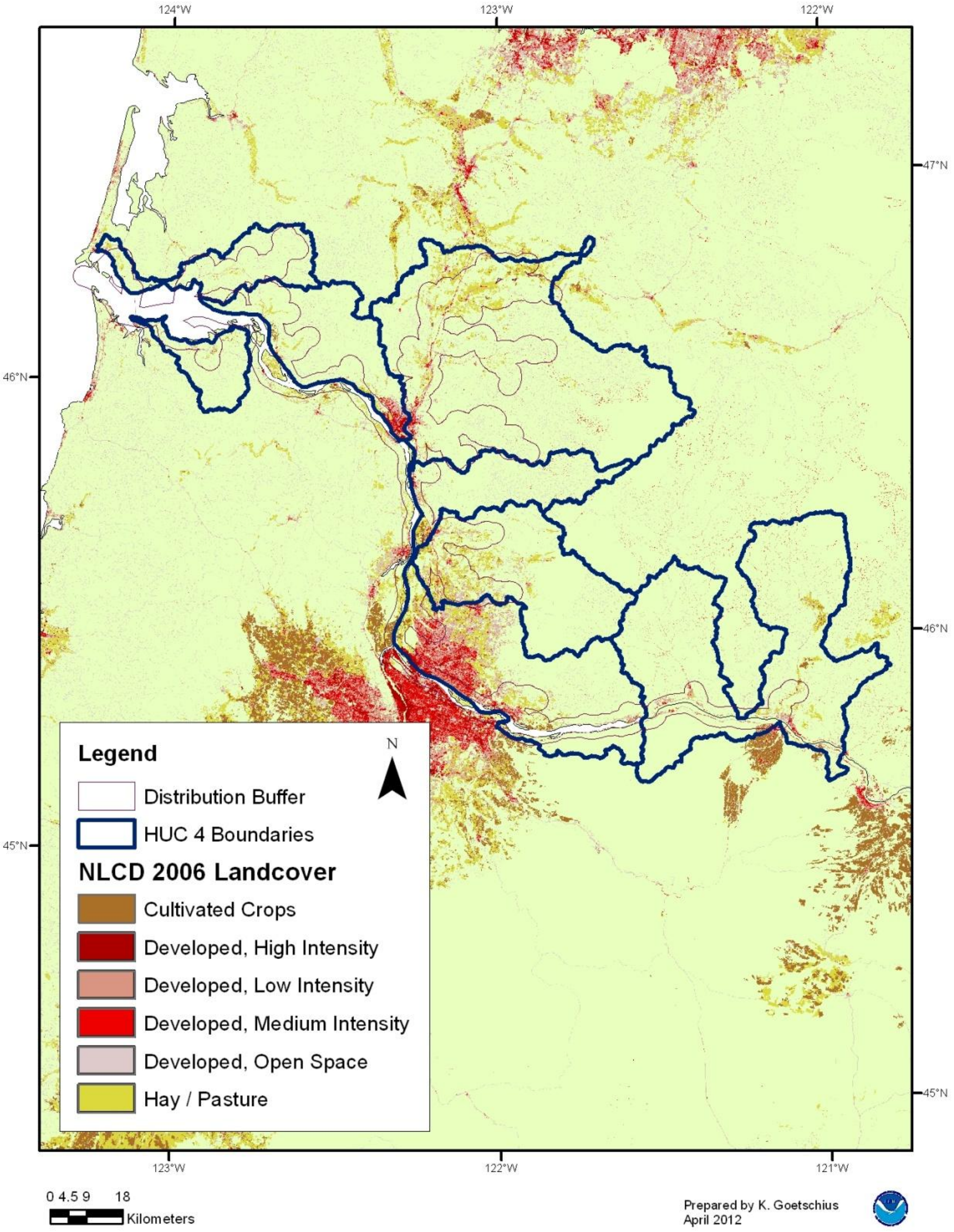
Hood Canal Summer-Run Chum ESU



Hood Canal Summer-Run Chum ESU Critical Habitat

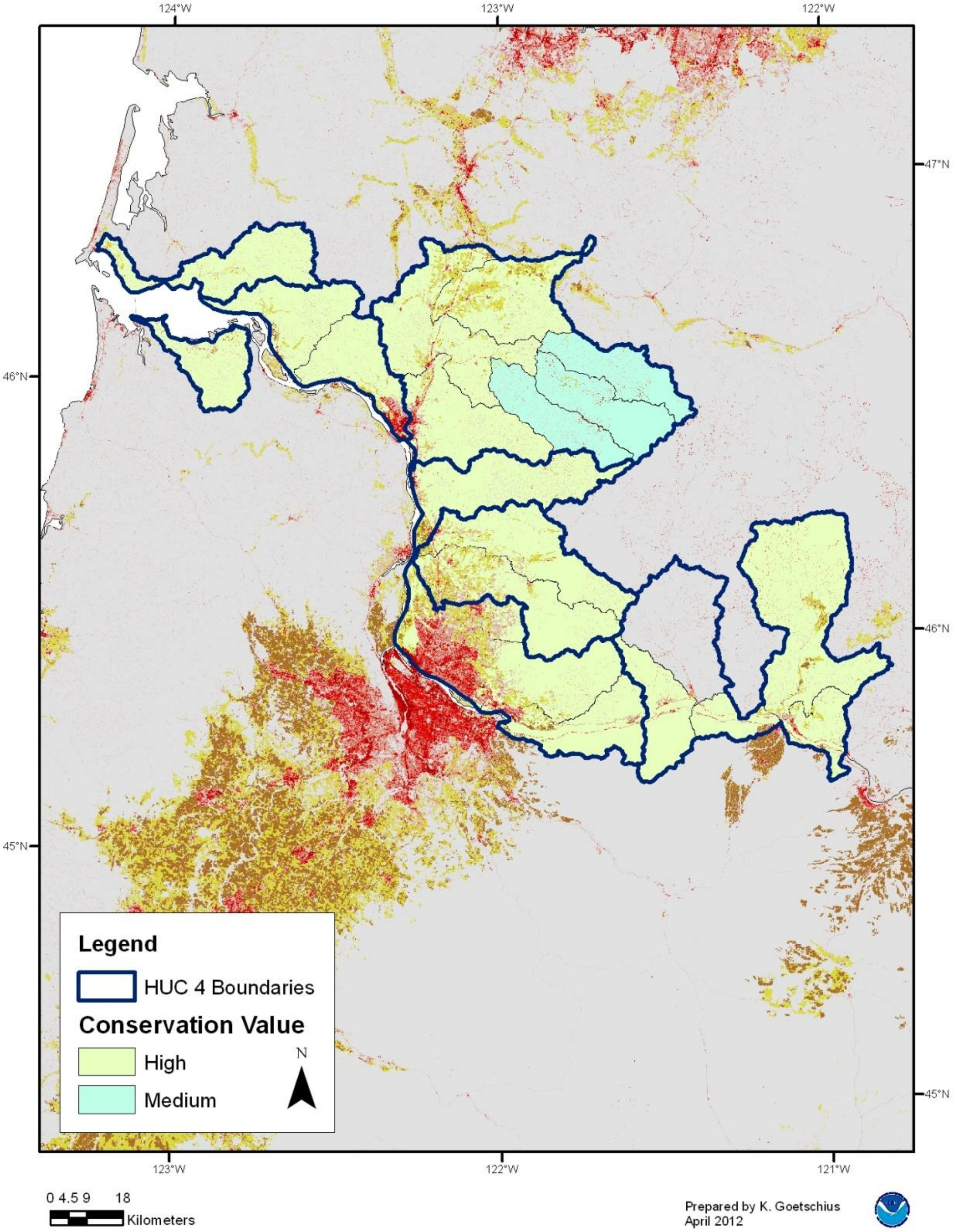


Columbia River Chum ESU



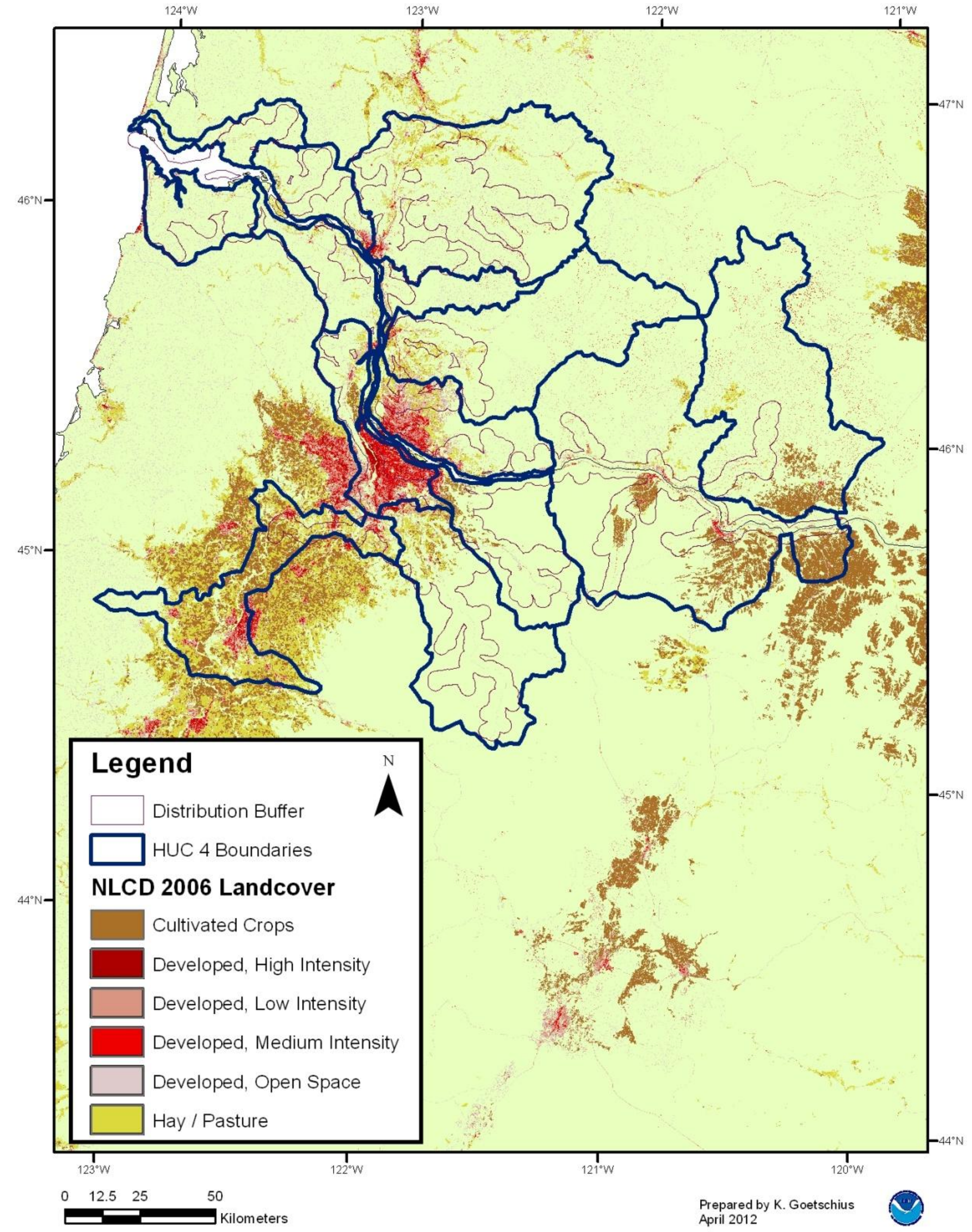
Prepared by K. Goetschius
April 2012

Columbia River Chum ESU
Critical Habitat

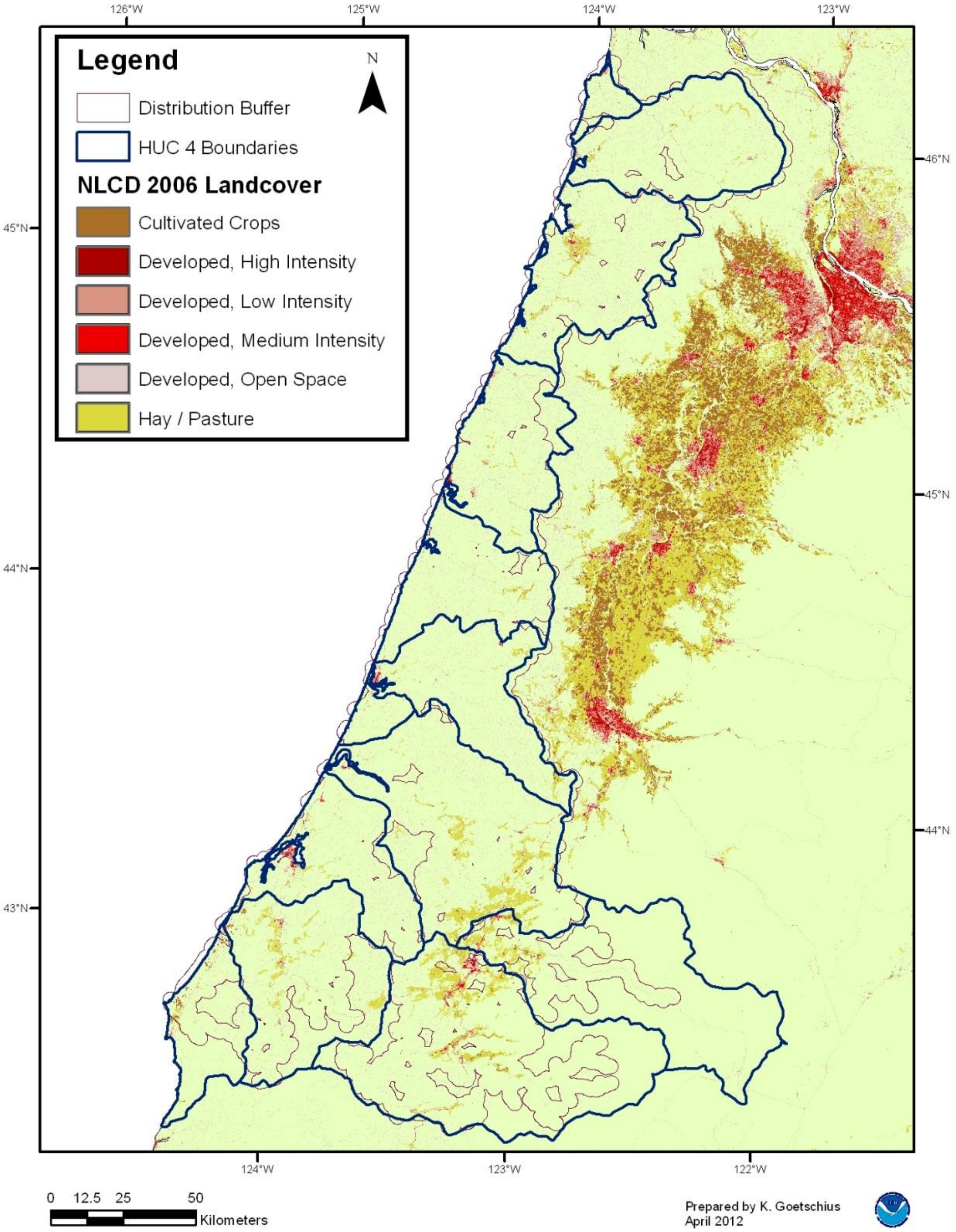


Prepared by K. Goetschius
April 2012

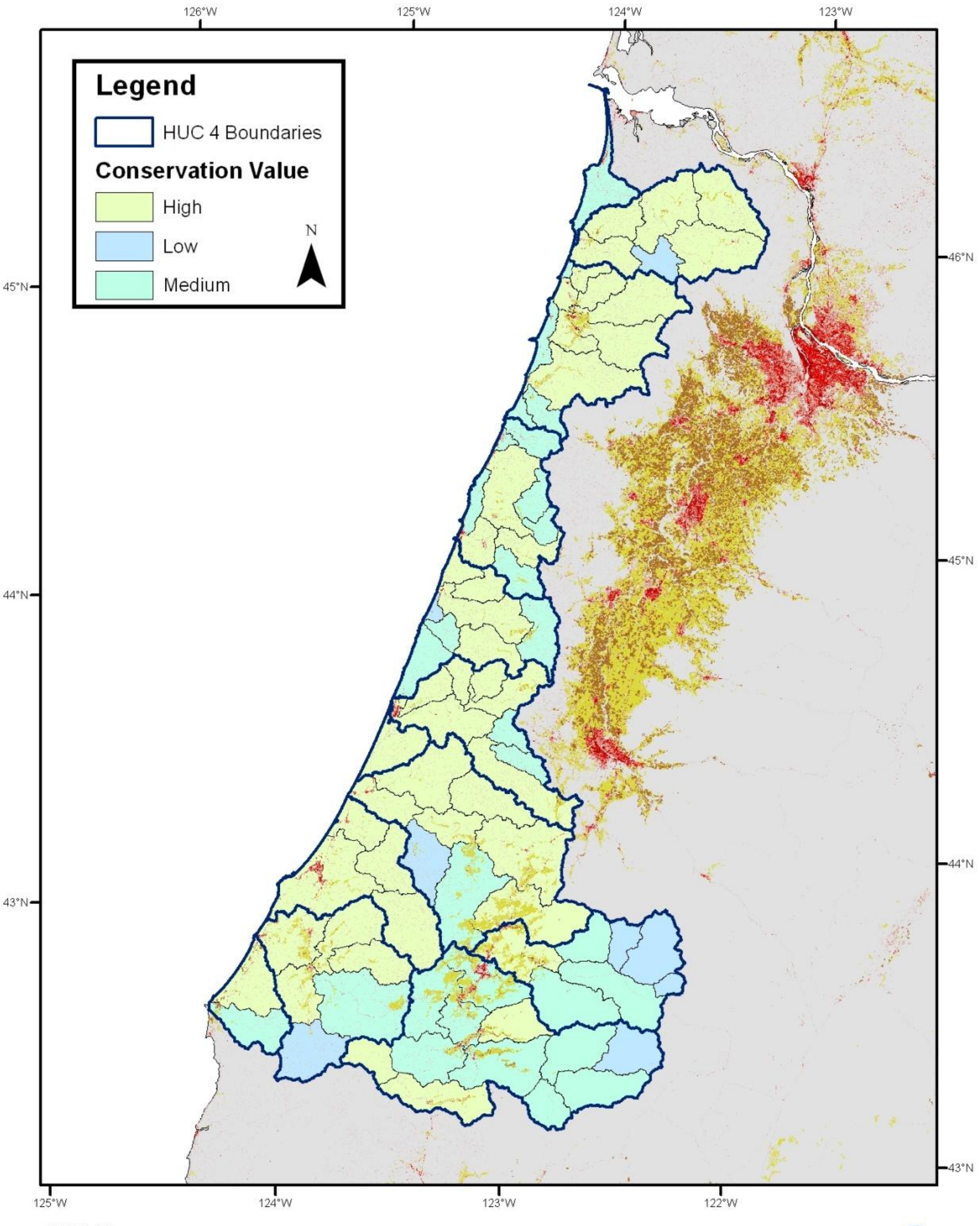
Lower Columbia River Coho ESU



Oregon Coast Coho ESU

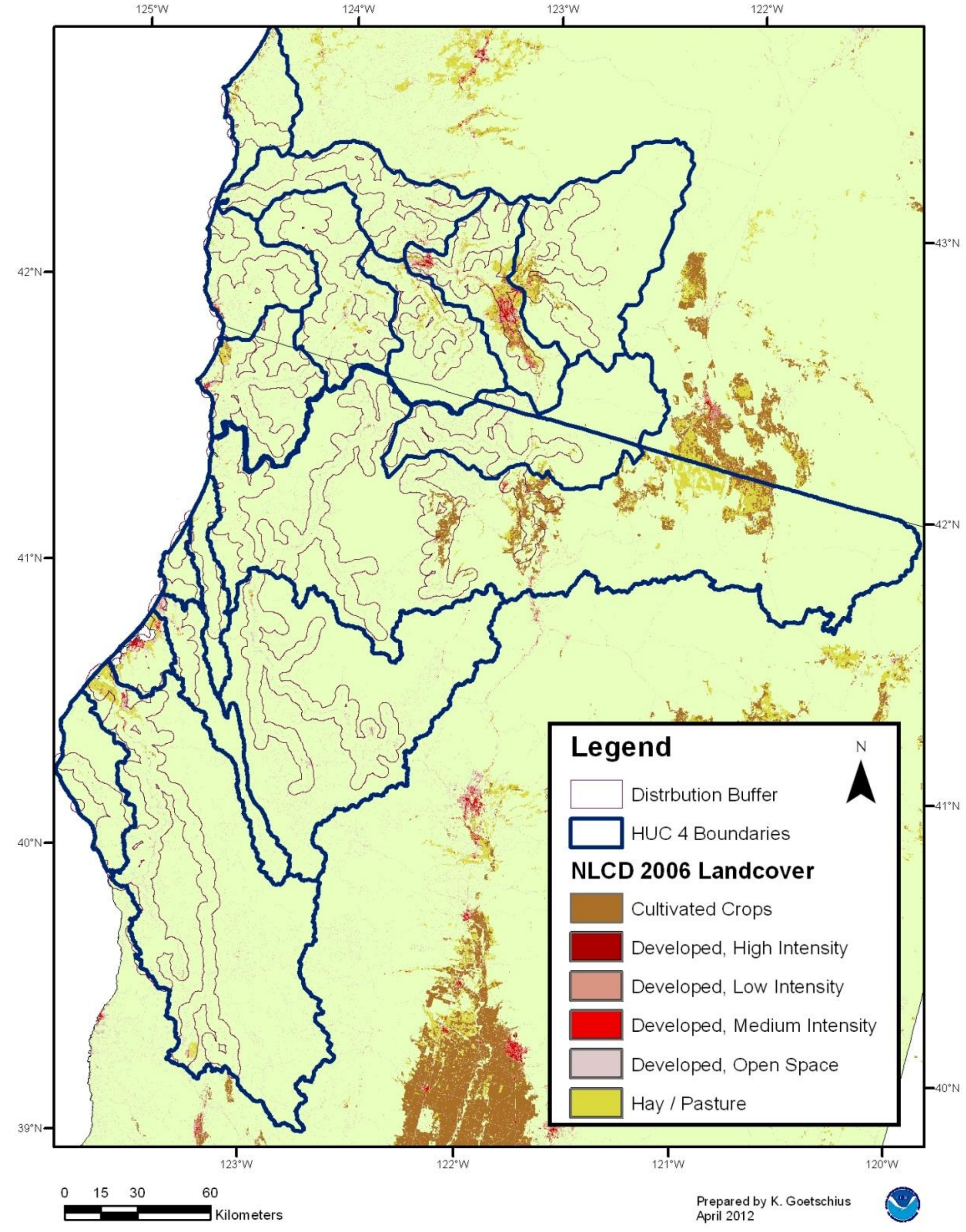


Oregon Coast Coho ESU



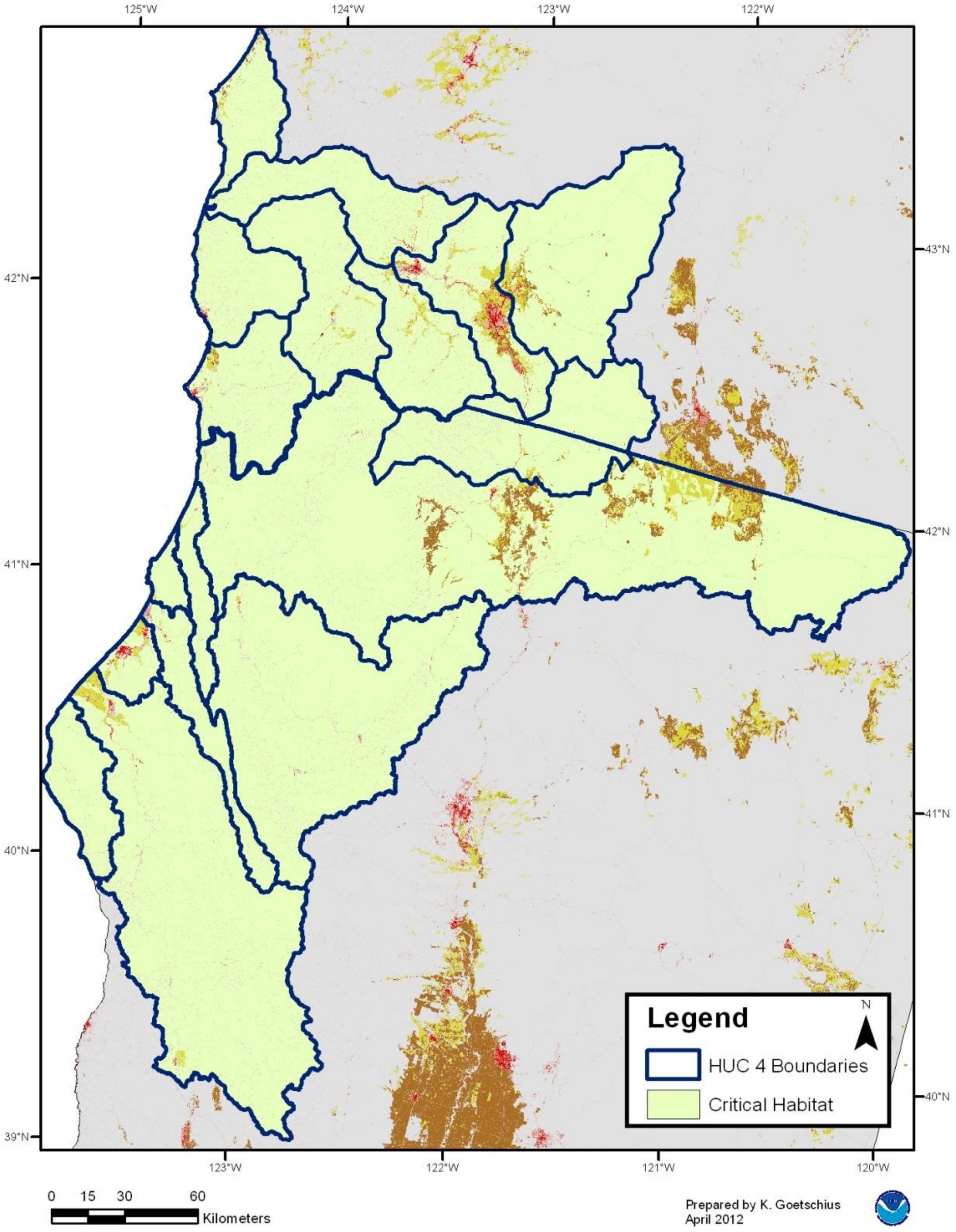
Prepared by K. Goetschius
April 2012

Southern Oregon Northern California Coho ESU

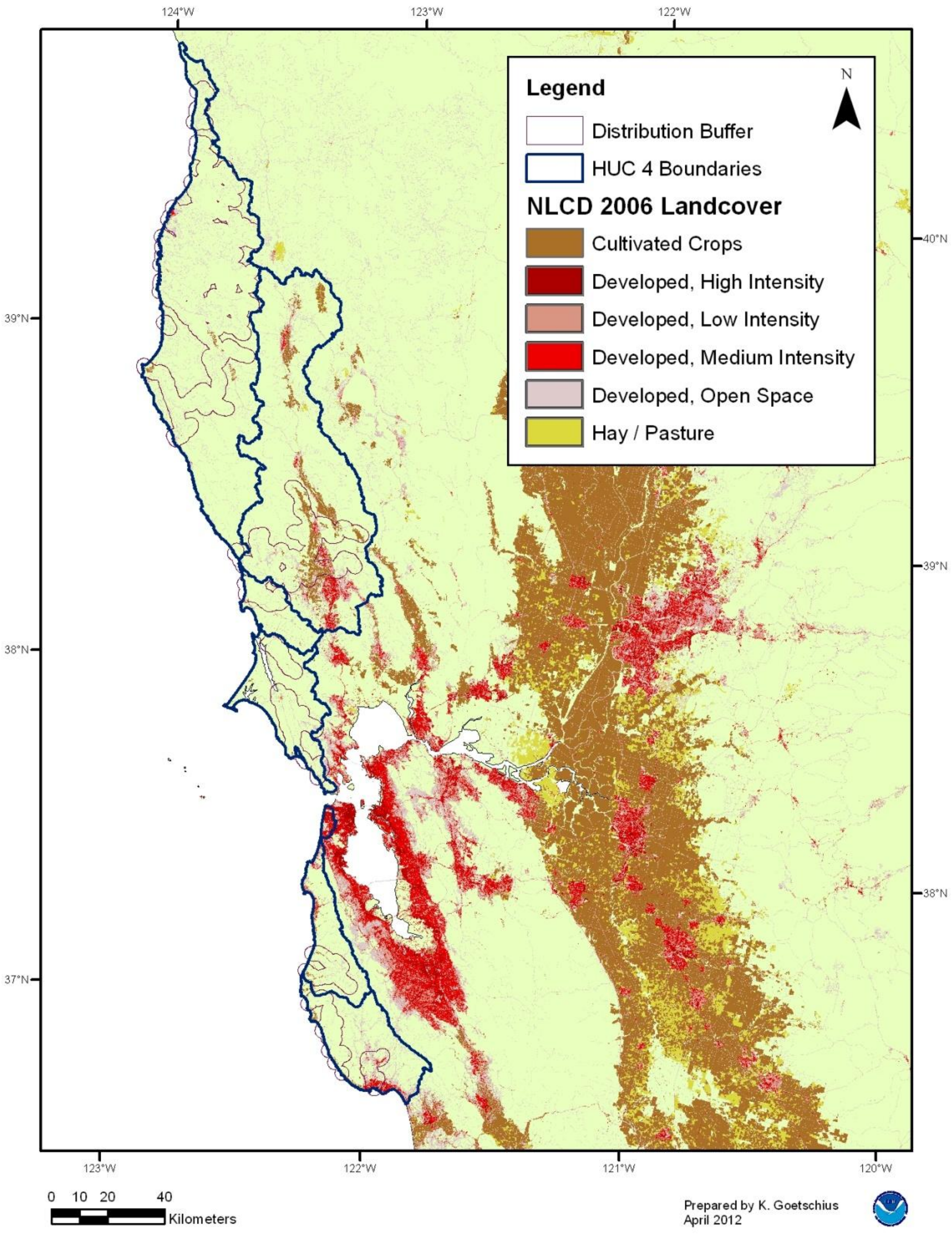


Prepared by K. Goetschius
April 2012

Southern Oregon Northern California Coho ESU
Critical Habitat

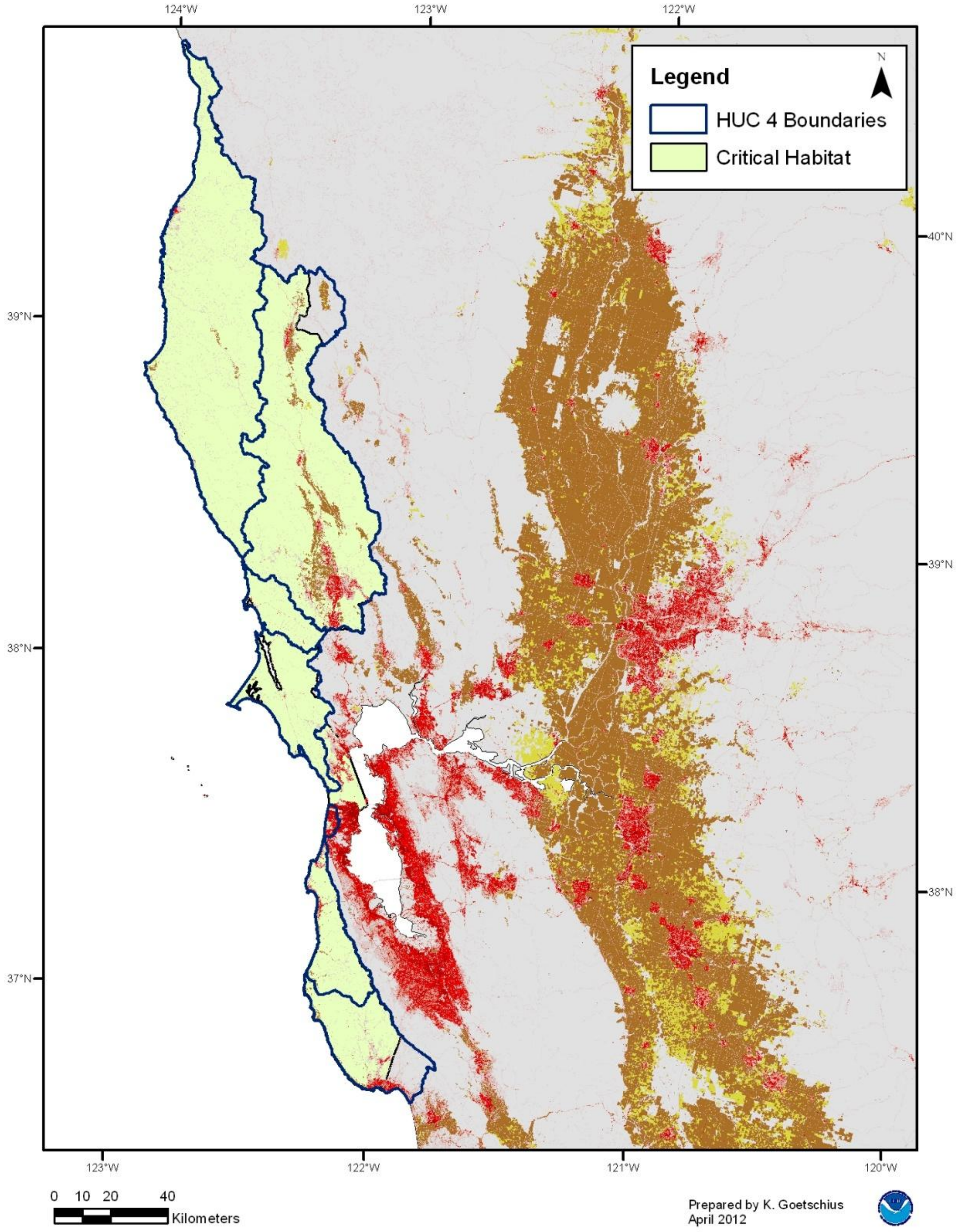


Central California Coastal Coho



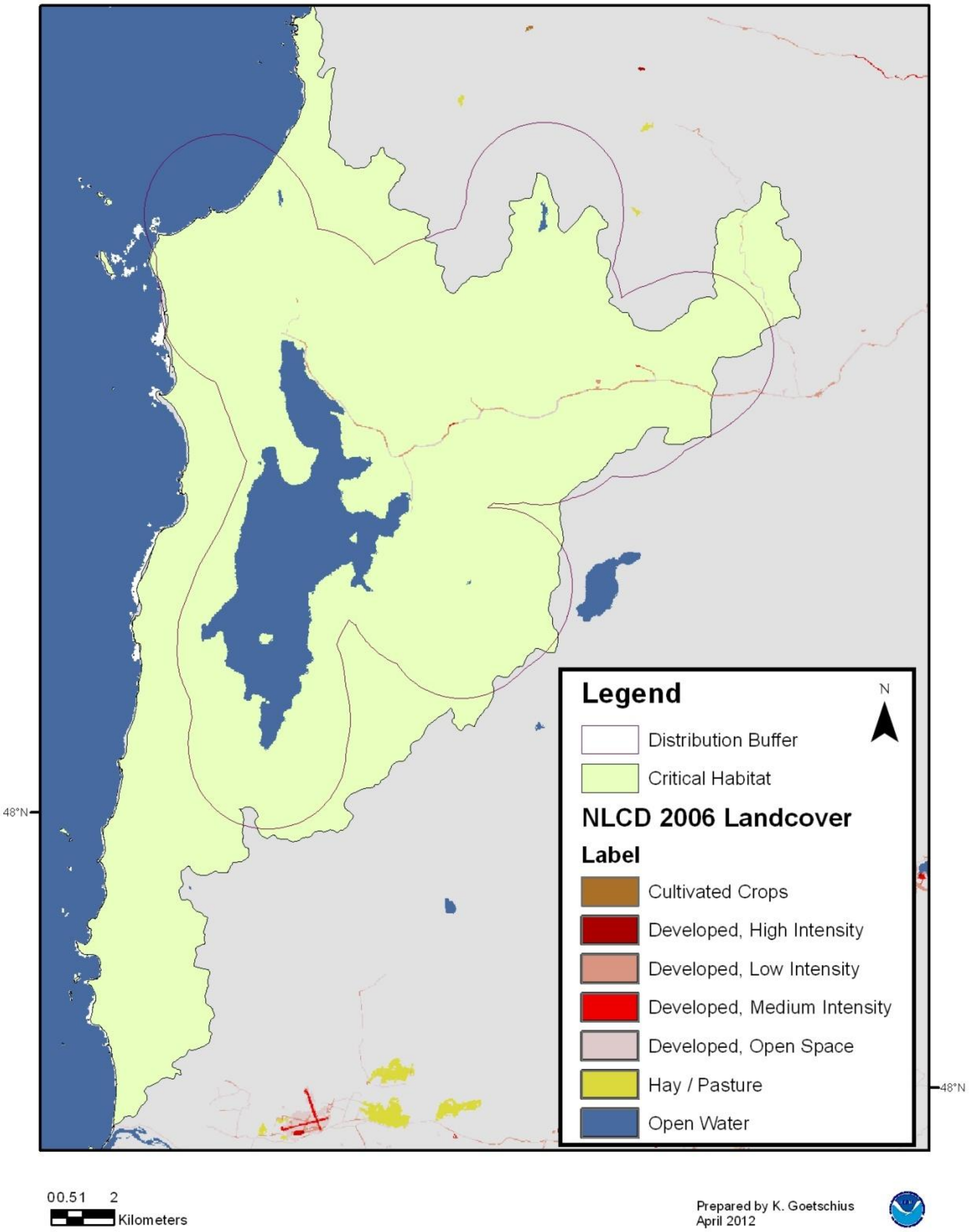
Prepared by K. Goetschius
April 2012

Central California Coastal Coho
Critical Habitat



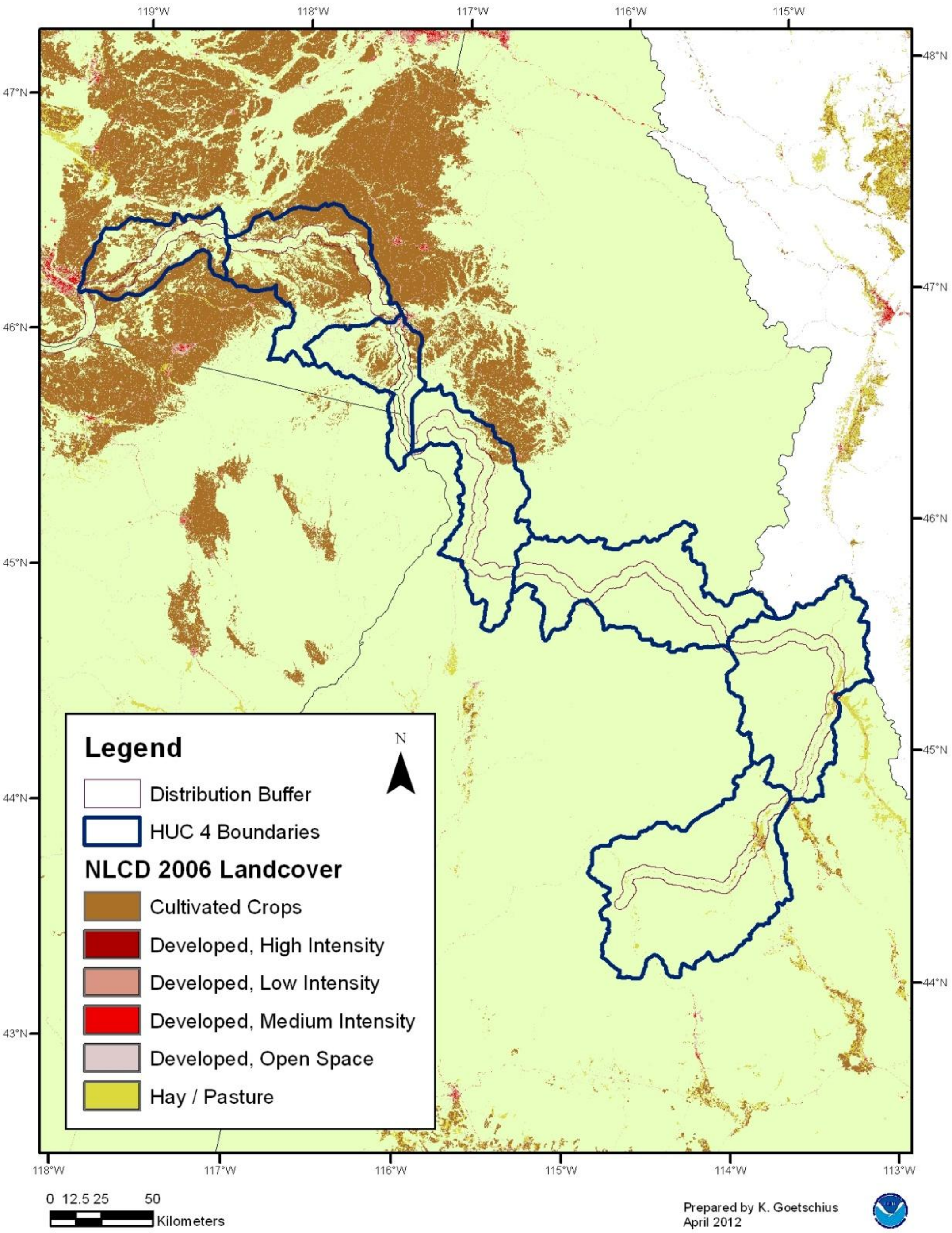
Prepared by K. Goetschius
April 2012

Ozette Lake Sockeye



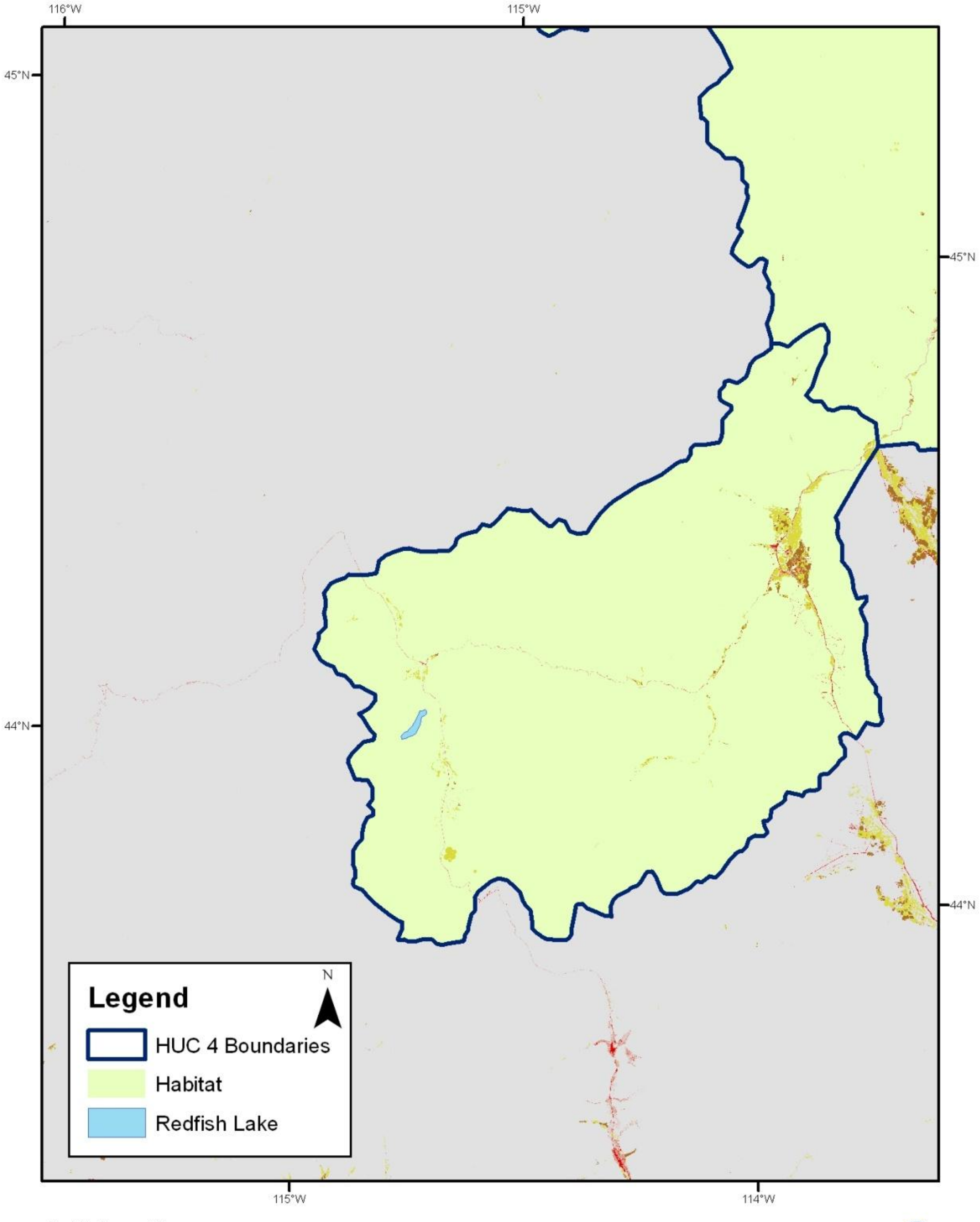
Prepared by K. Goetschius
April 2012

Snake River Sockeye



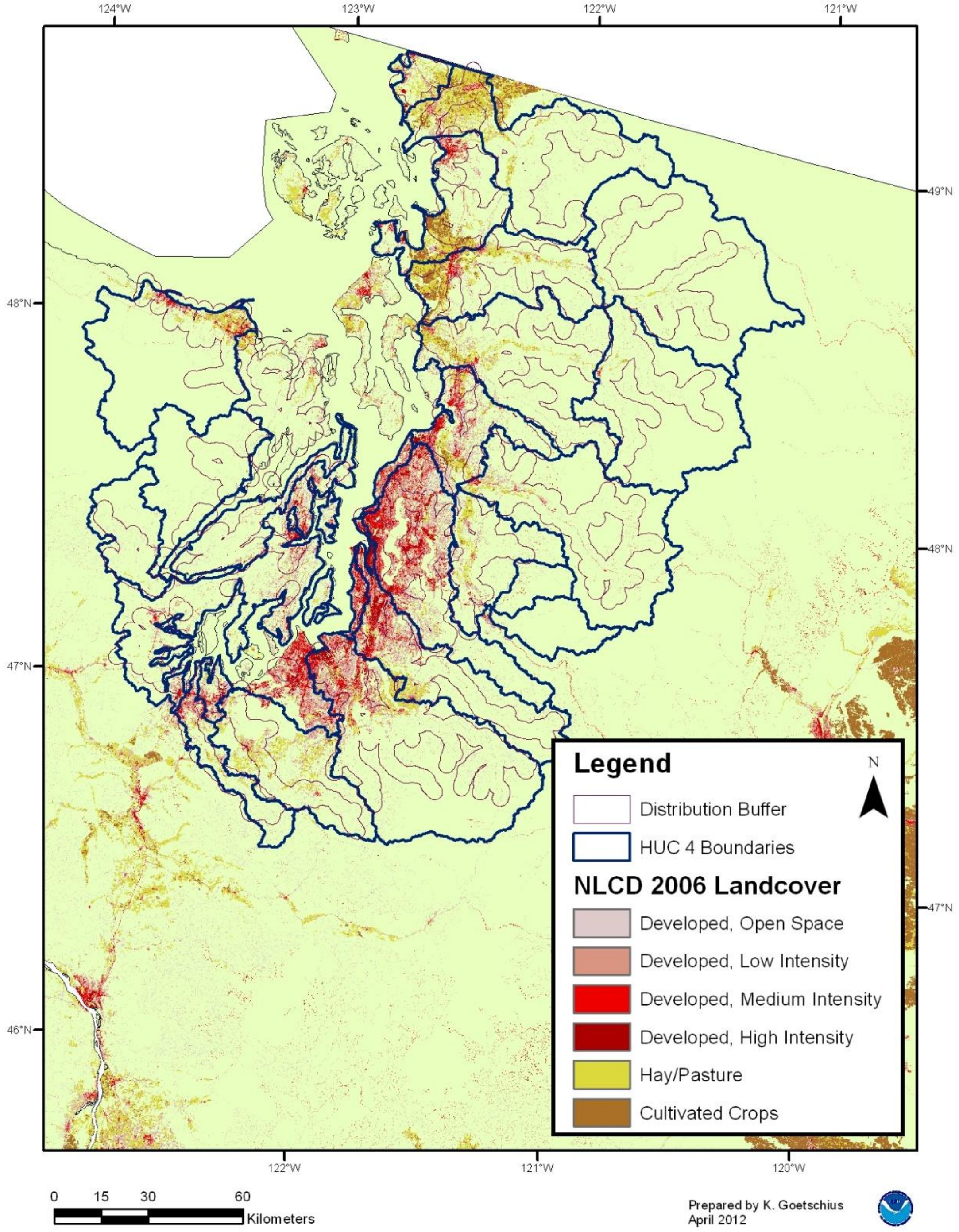
Prepared by K. Goetschius
April 2012

Snake River Sockeye
Redfish Lake

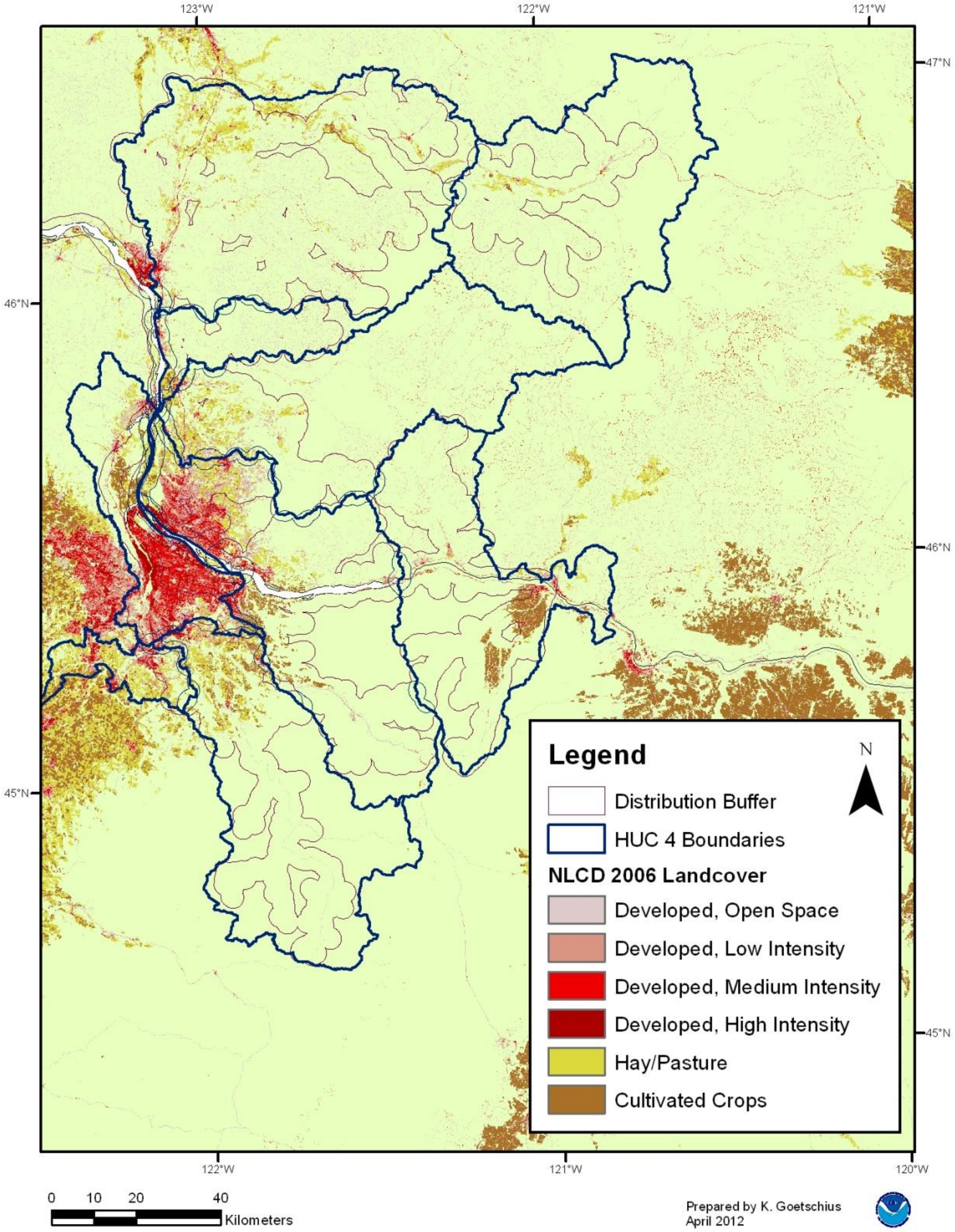


Prepared by K. Goetschius
April 2012

Puget Sound Steelhead DPS

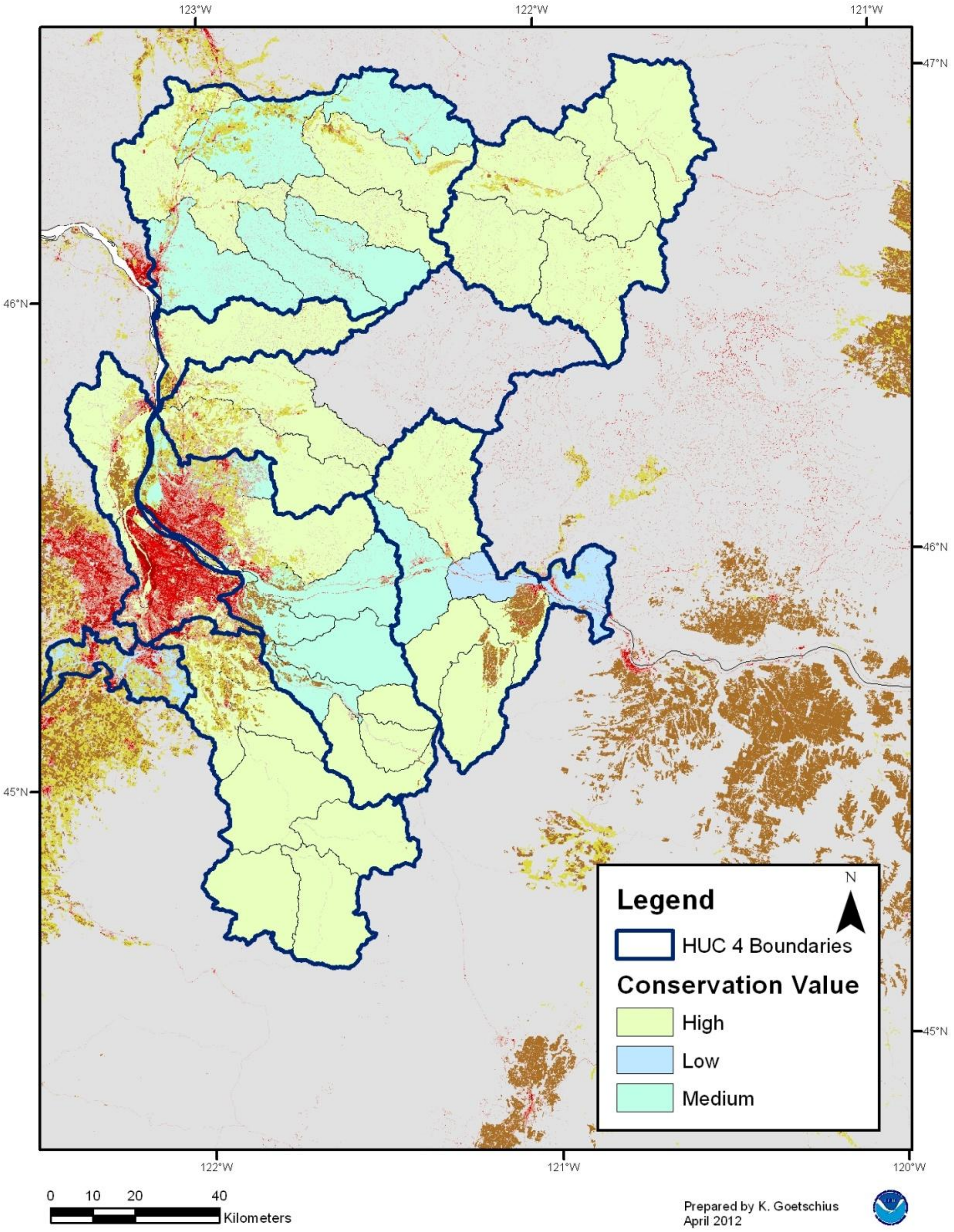


Lower Columbia River Steelhead DPS

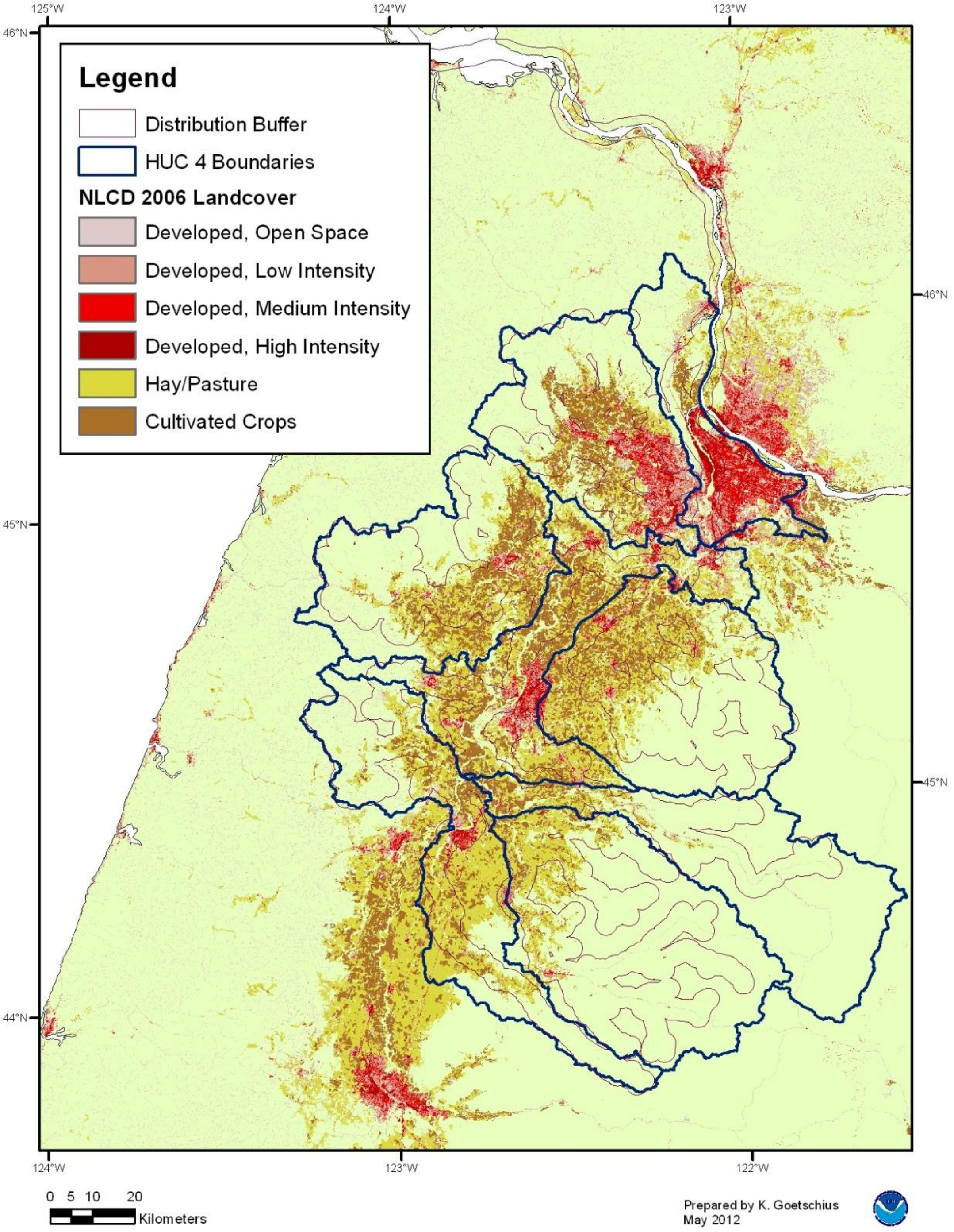


Prepared by K. Goetschius
April 2012

Lower Columbia River Steelhead DPS Critical Habitat



Upper Willamette River Steelhead DPS



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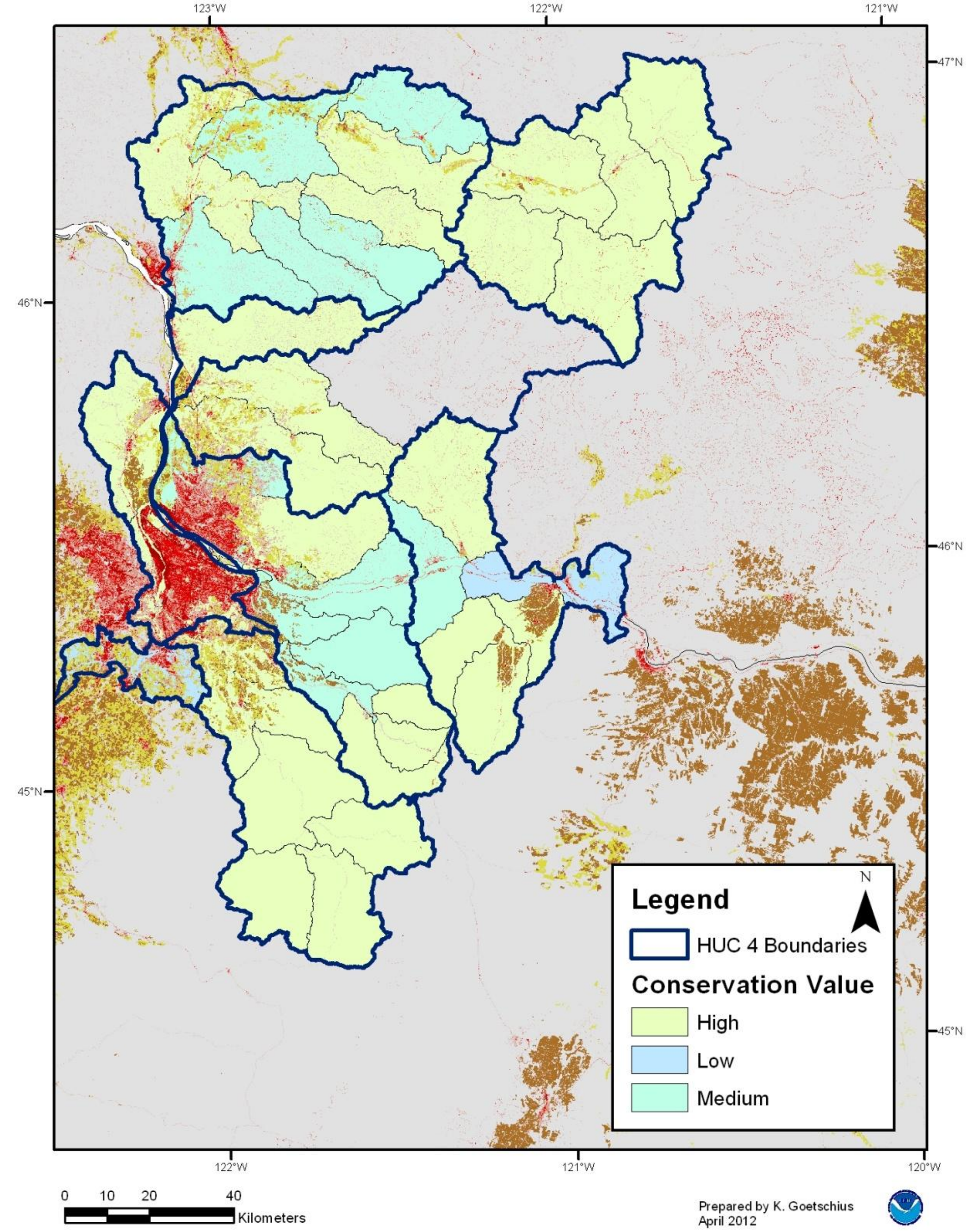
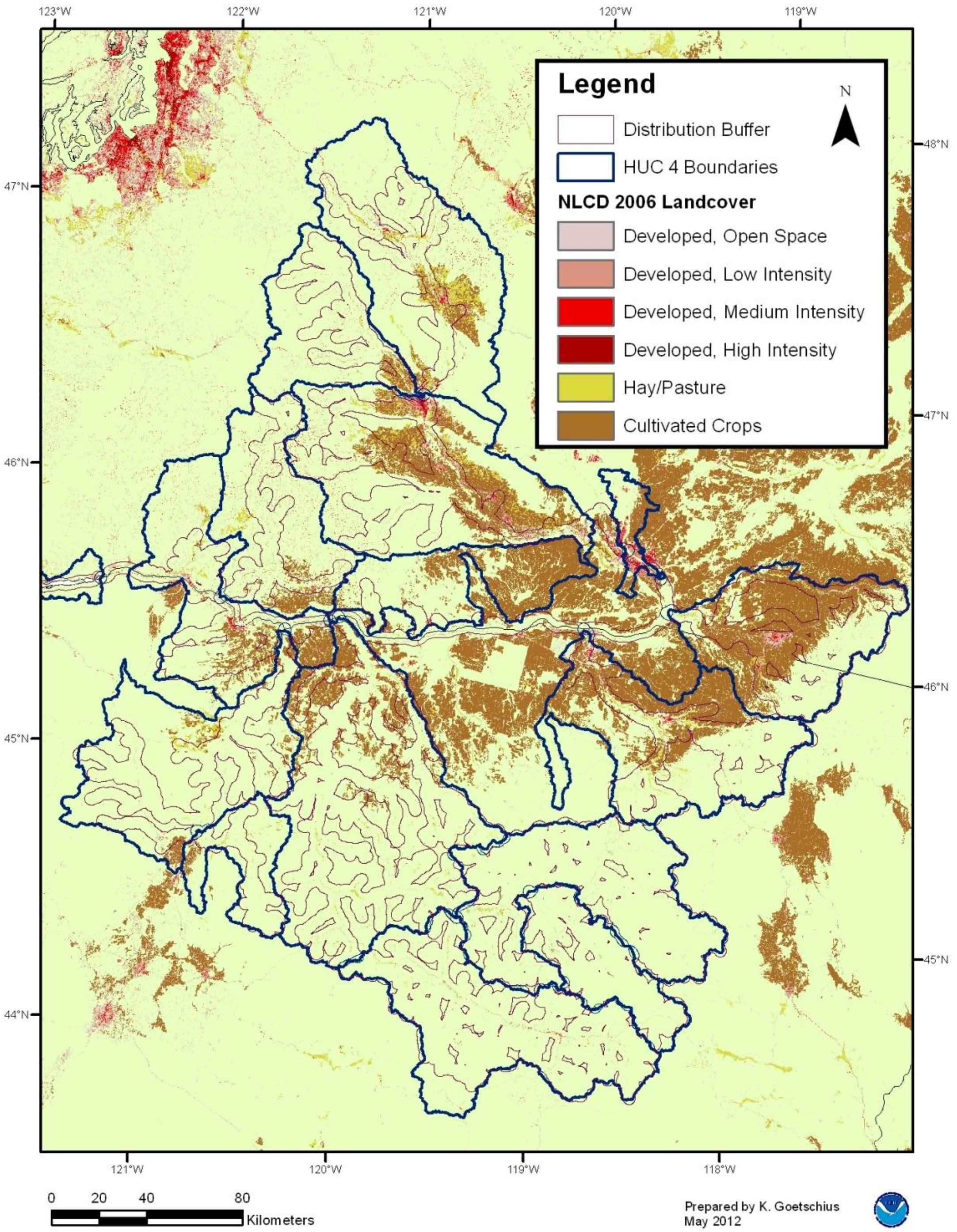
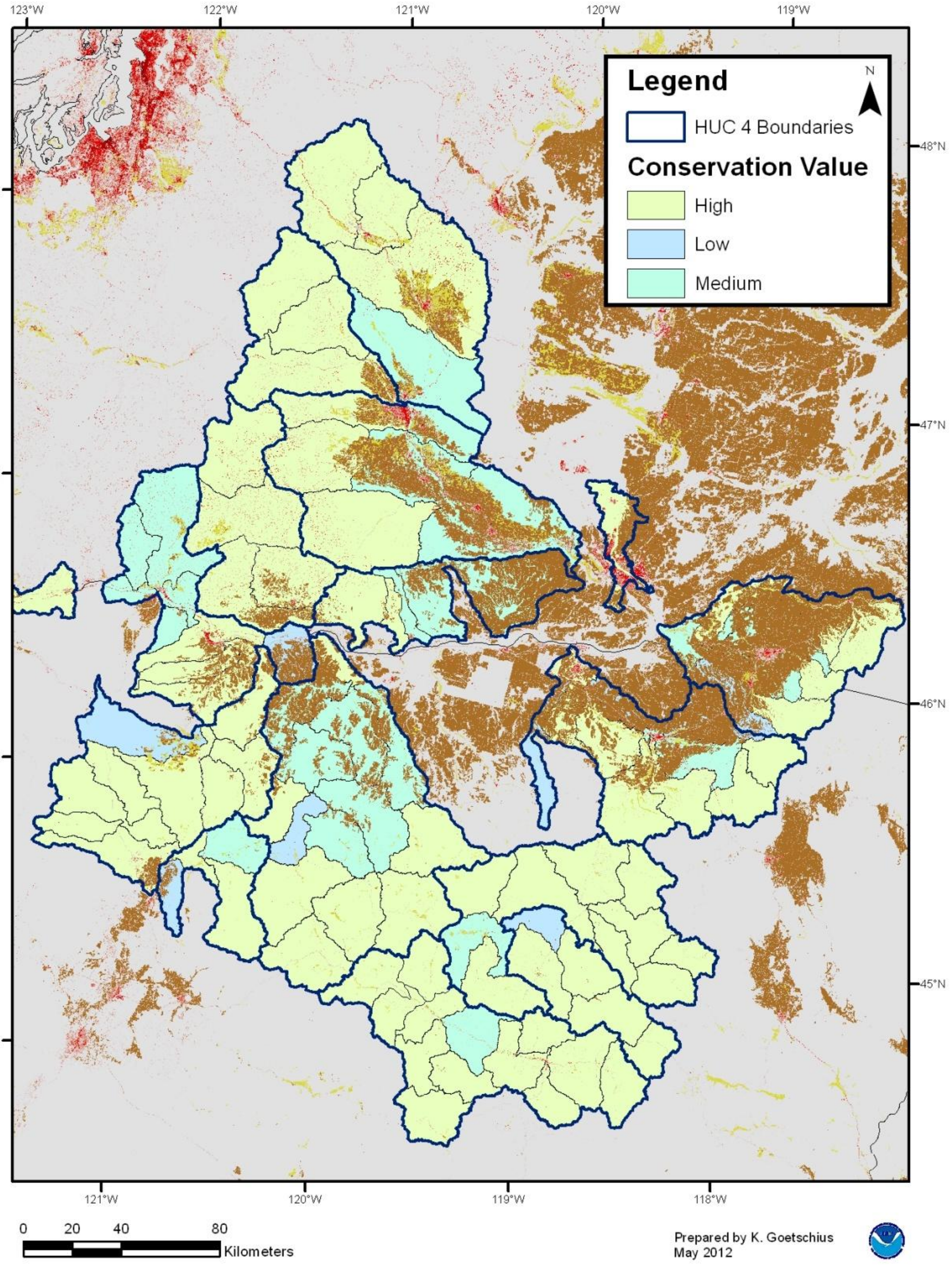


Prepared by K. Goetschius
April 2012

Middle Columbia River Steelhead DPS

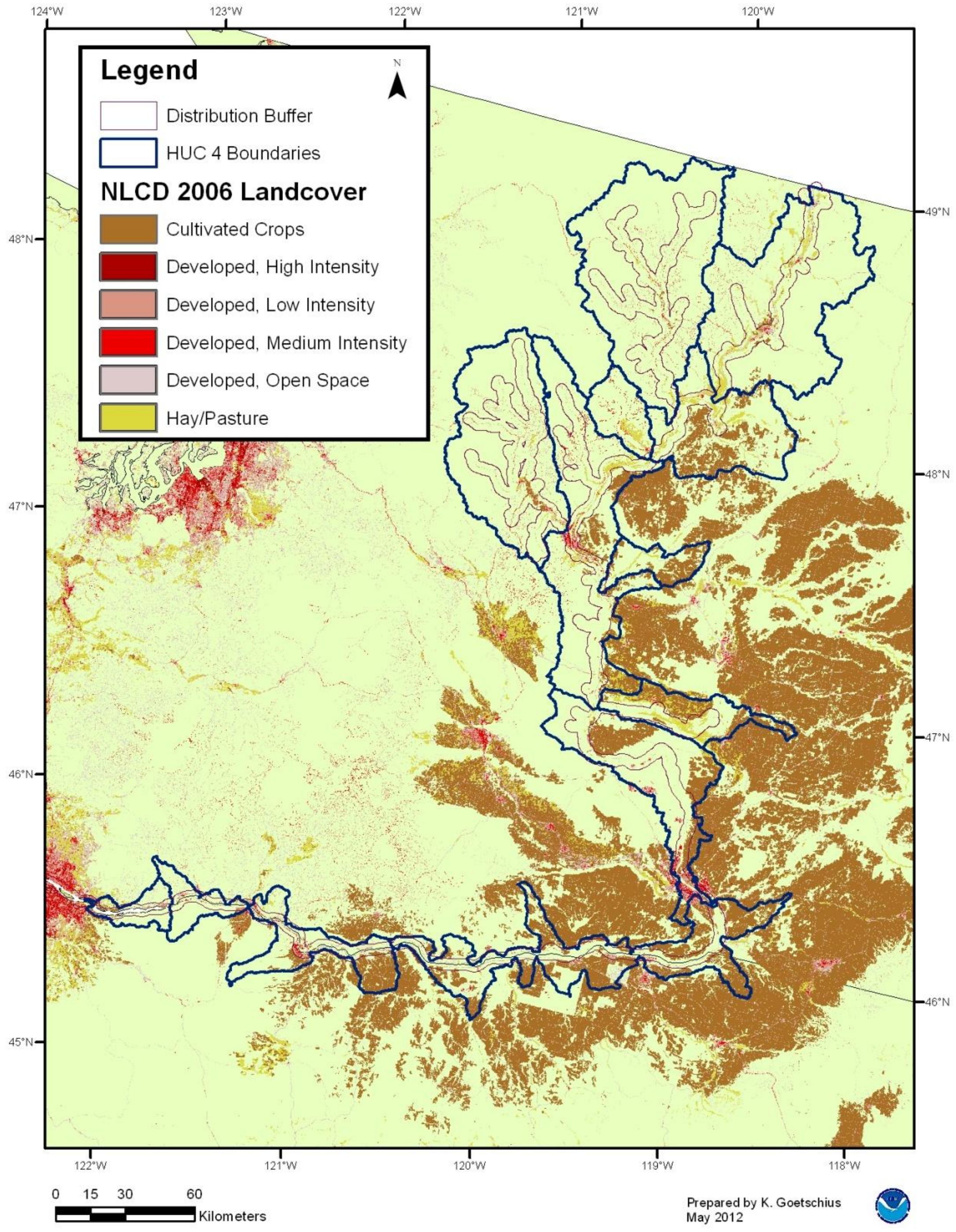


Middle Columbia River Steelhead DPS Critical Habitat



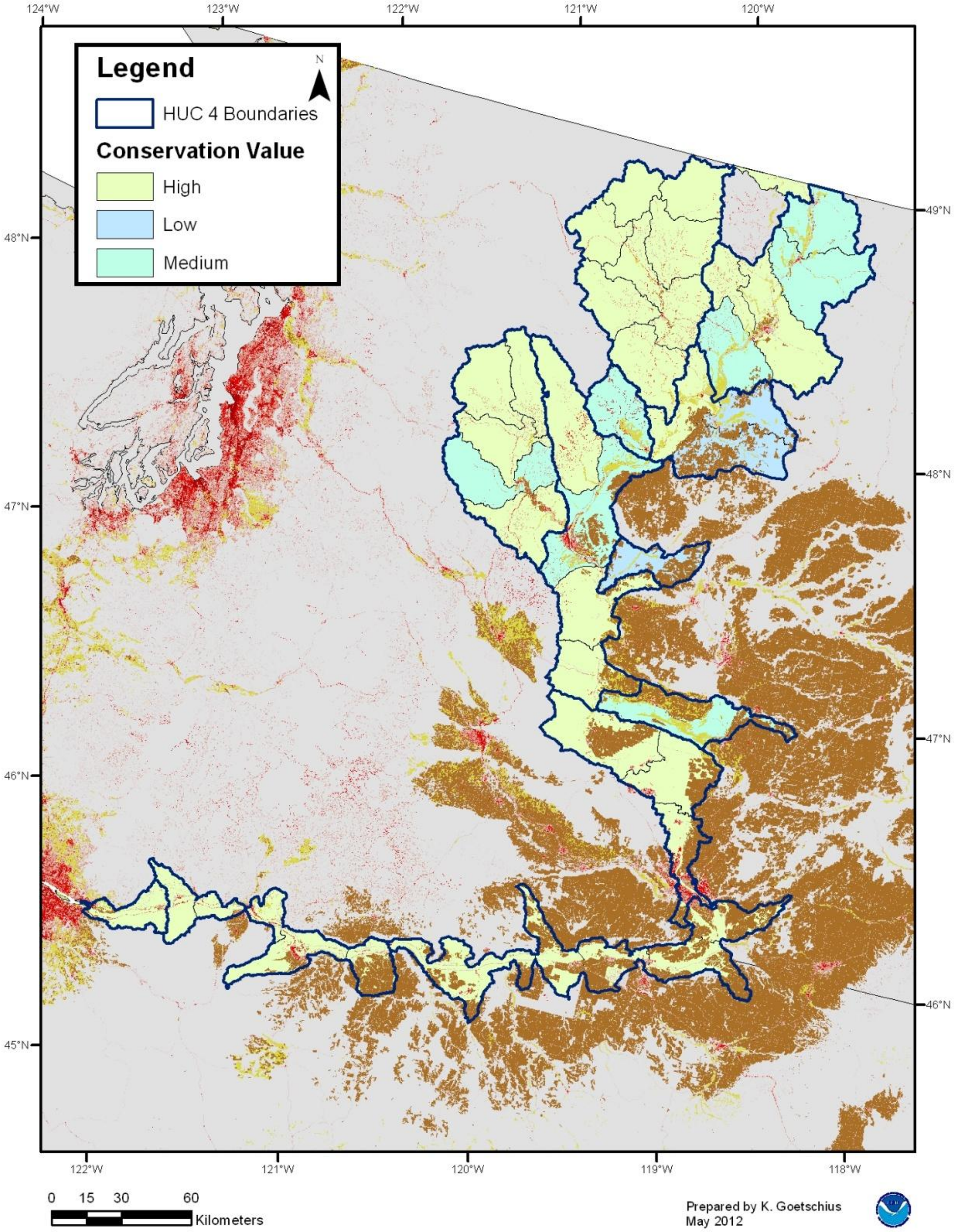
Prepared by K. Goetschius
May 2012

Upper Columbia River Steelhead DPS



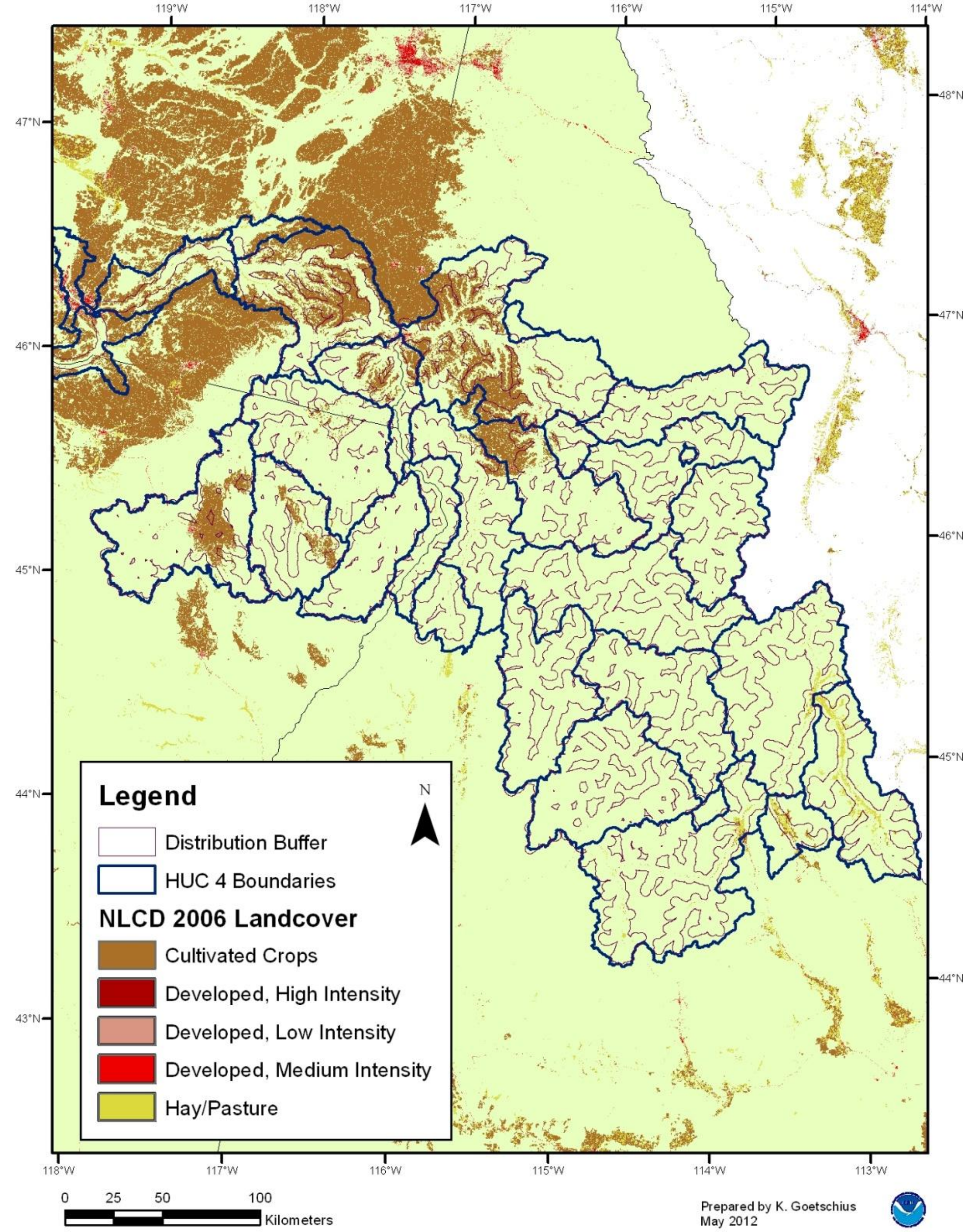
Prepared by K. Goetschius
May 2012

Upper Columbia River Steelhead DPS Critical Habitat

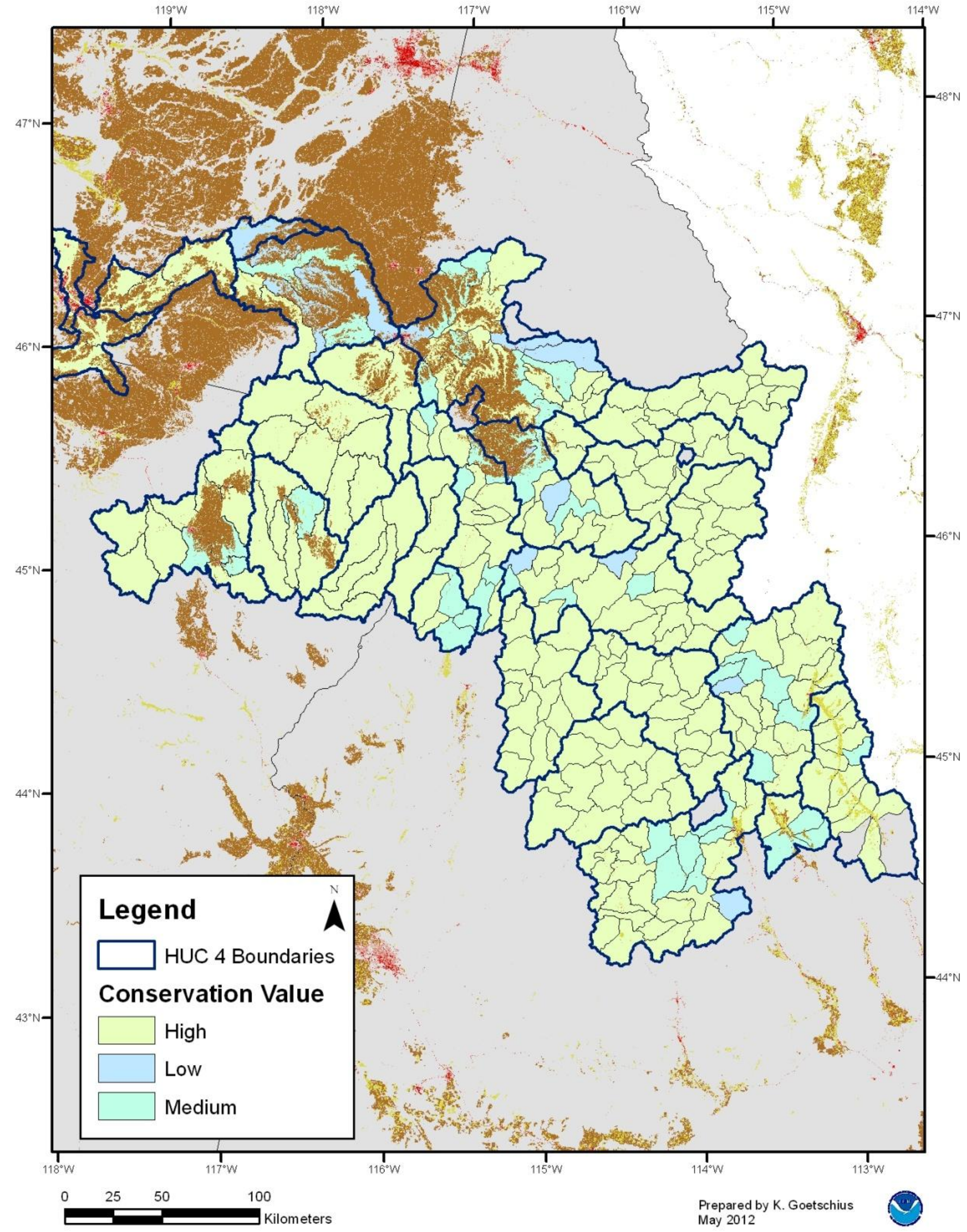


Prepared by K. Goetschius
May 2012

Snake River Steelhead DPS

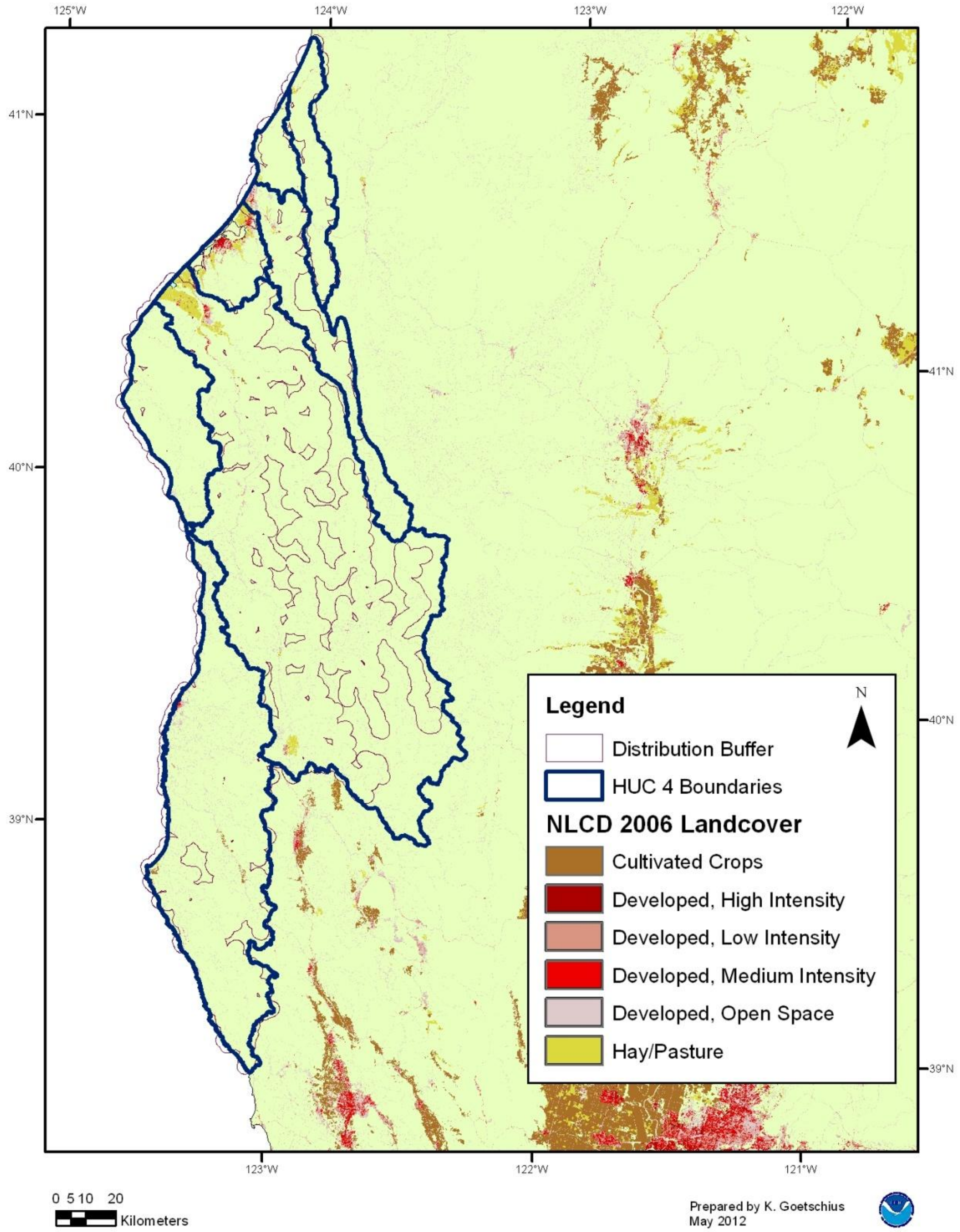


Snake River Steelhead DPS Critical Habitat

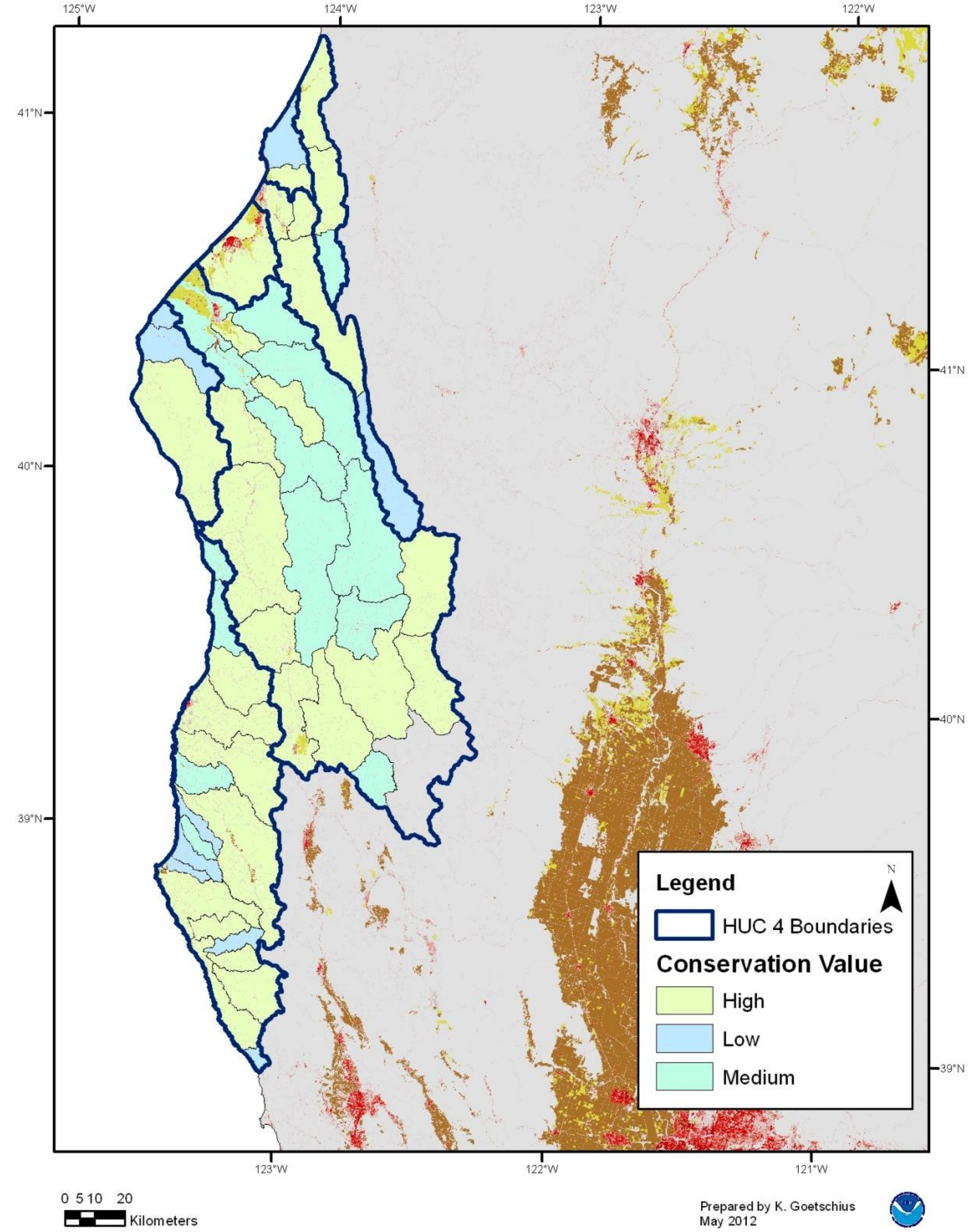


Prepared by K. Goetschius
May 2012

Northern California Steelhead DPS

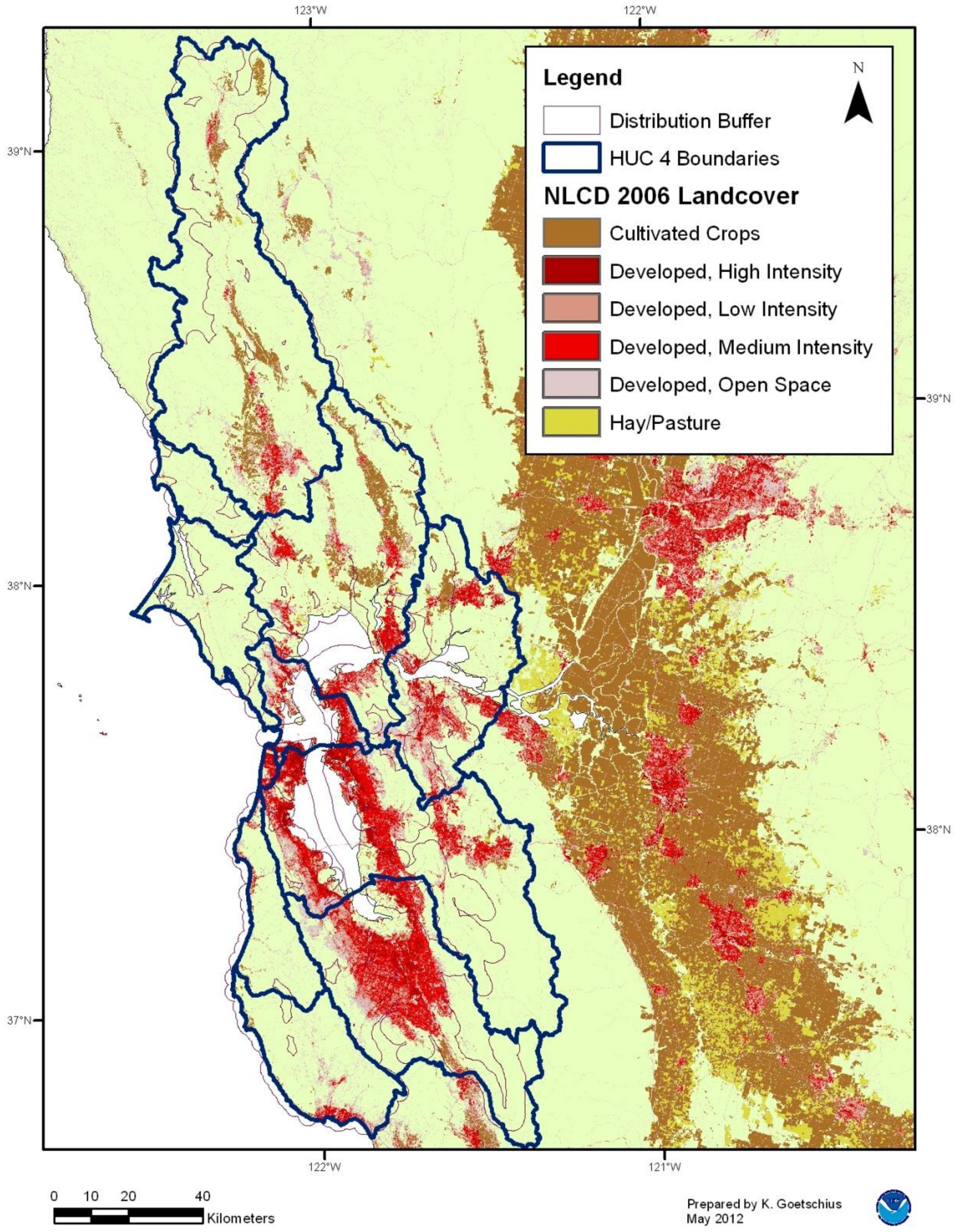


Northern California Steelhead DPS
Critical Habitat

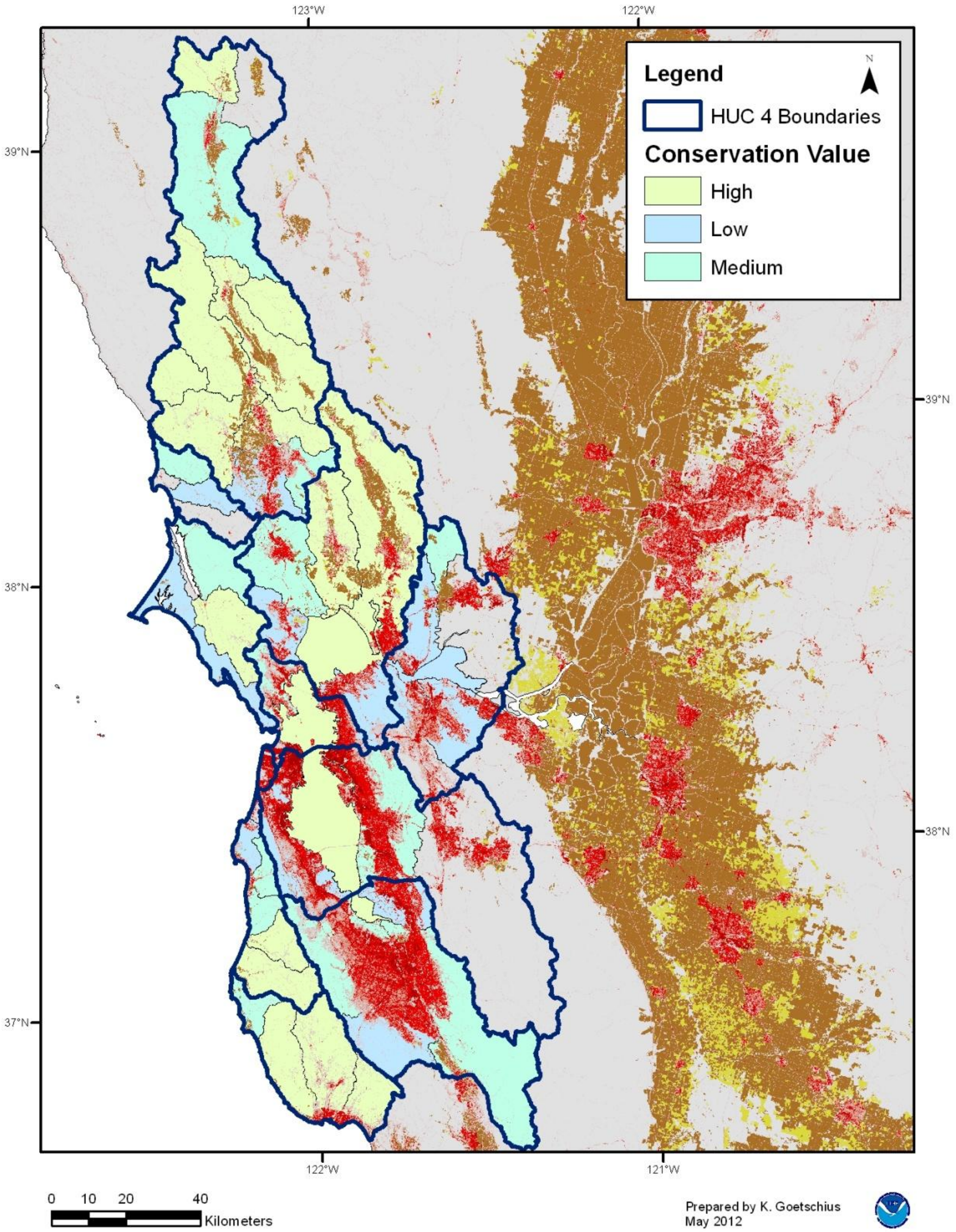


Prepared by K. Goetschius
May 2012

Central California Coast Steelhead DPS

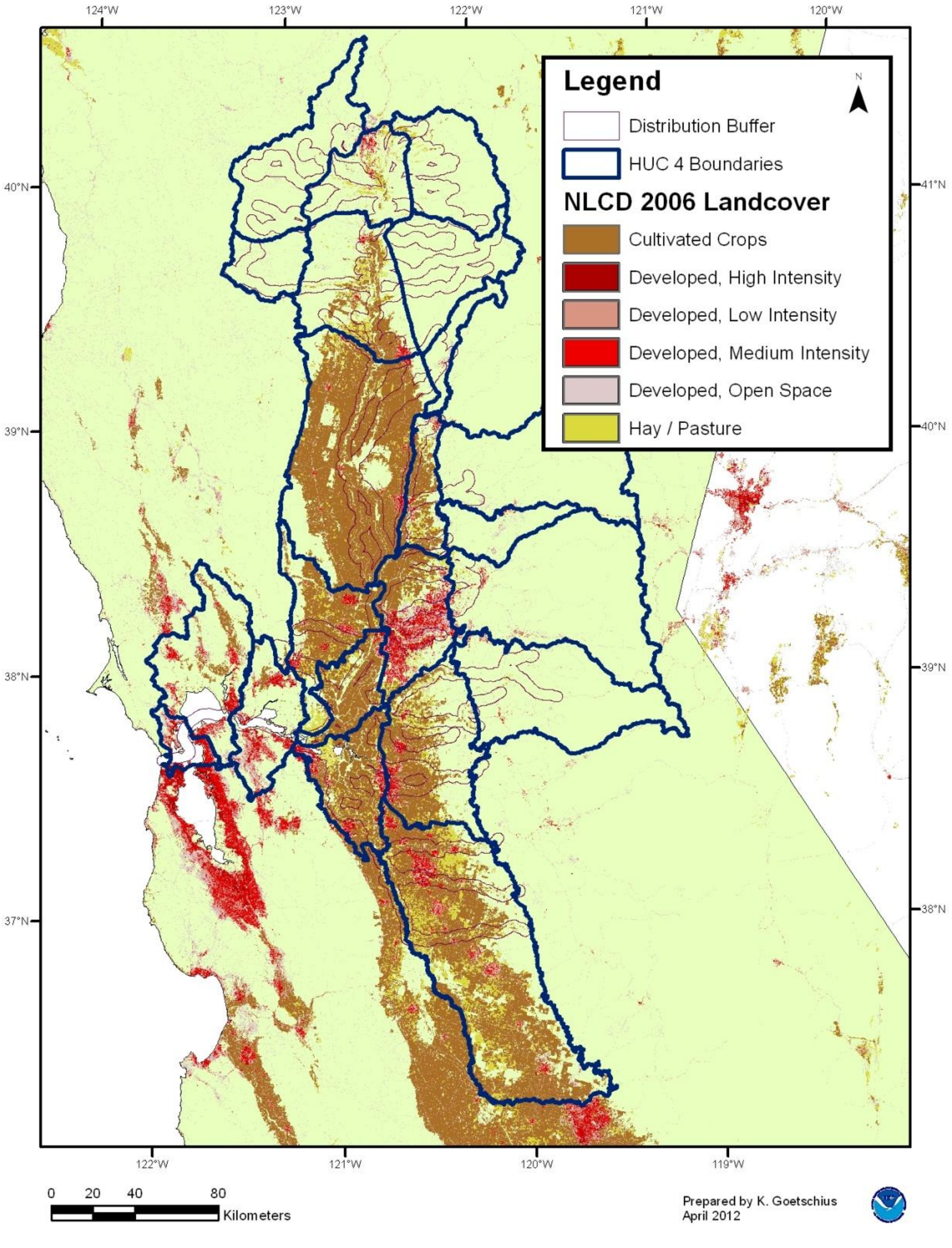


Central California Coast Steelhead DPS Critical Habitat



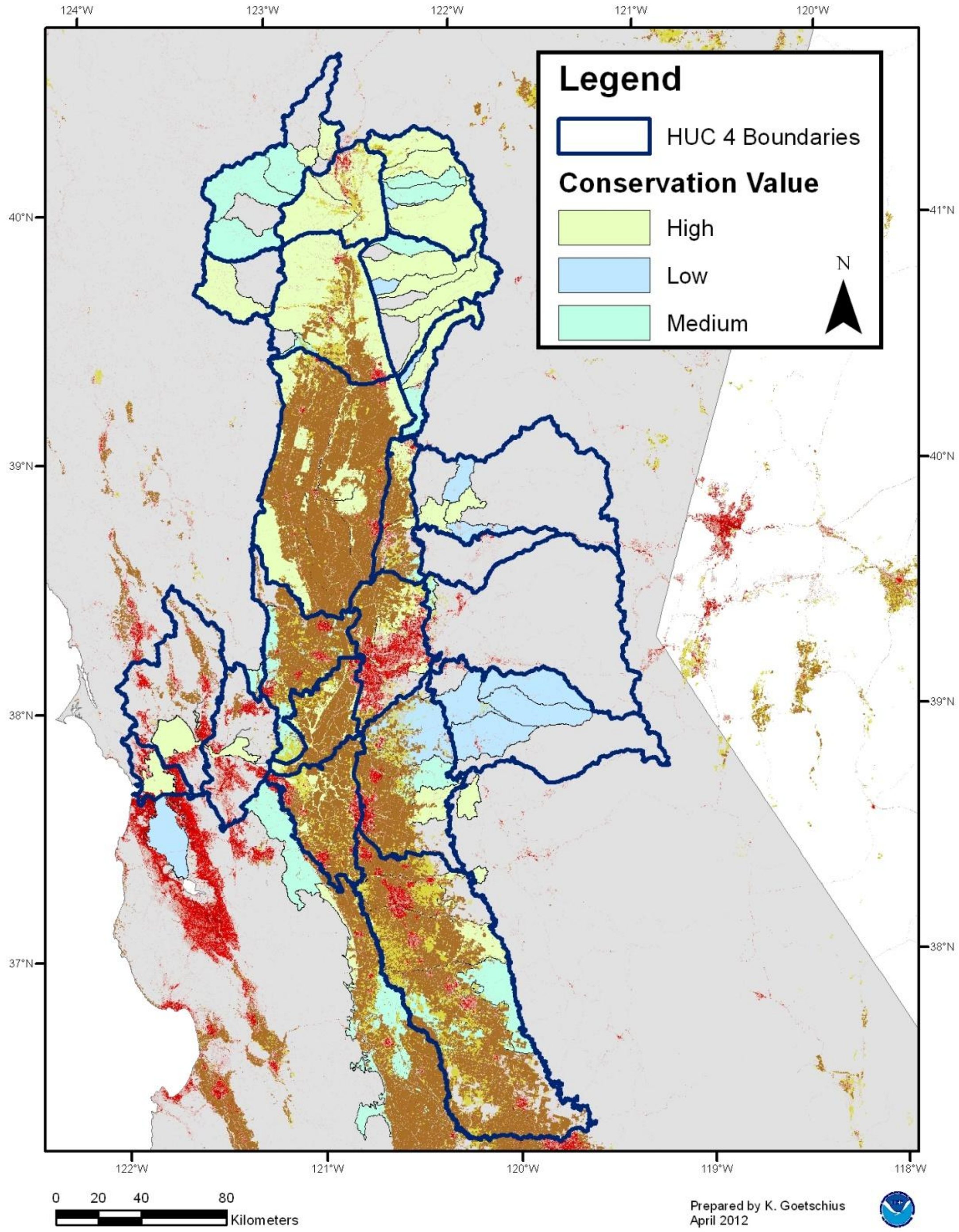
Prepared by K. Goetschius
May 2012

California Central Valley Steelhead DPS



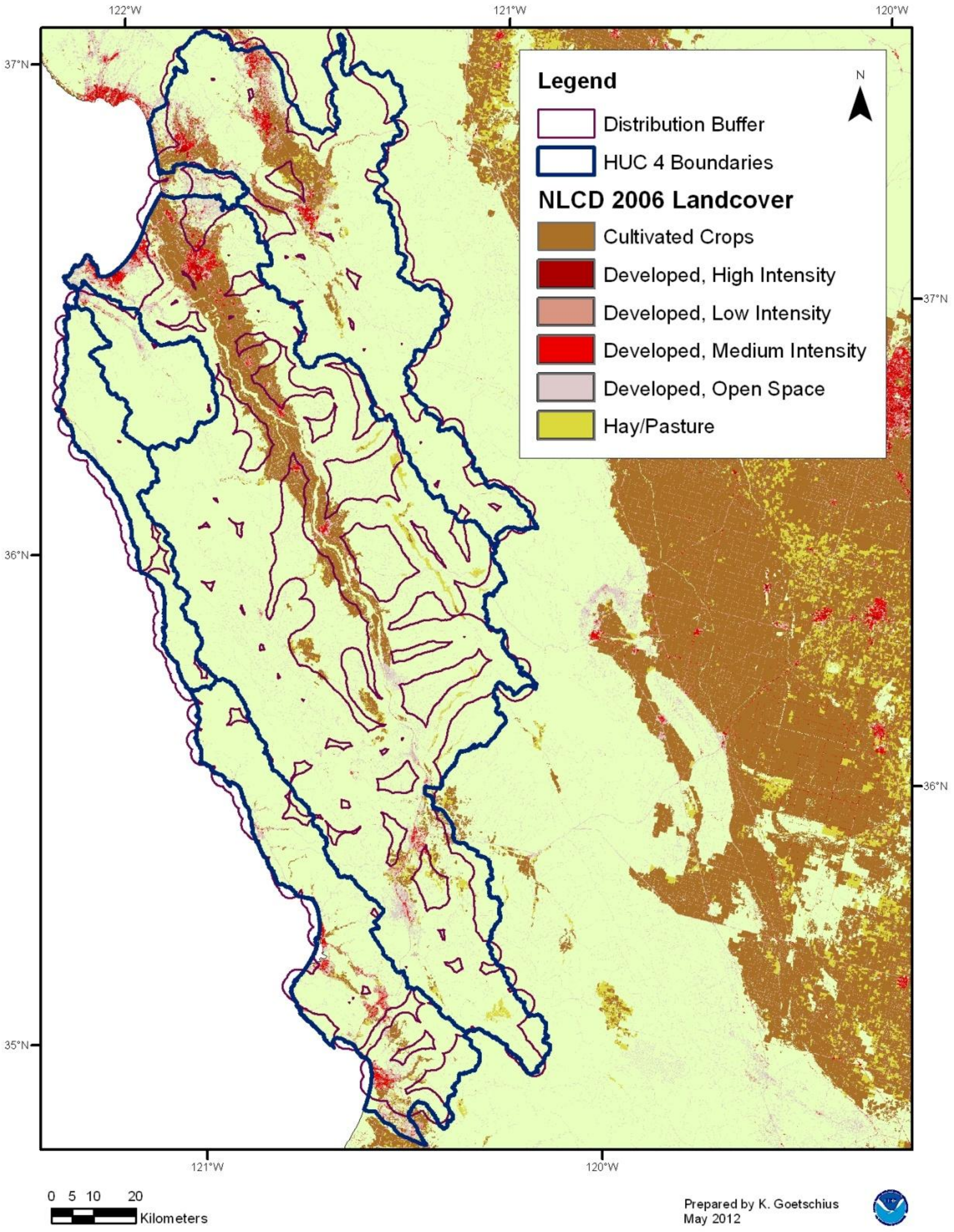
Prepared by K. Goetschius
April 2012

California Central Valley Steelhead DPS Critical Habitat



Prepared by K. Goetschius
April 2012

South-Central California Coastal Steelhead DPS



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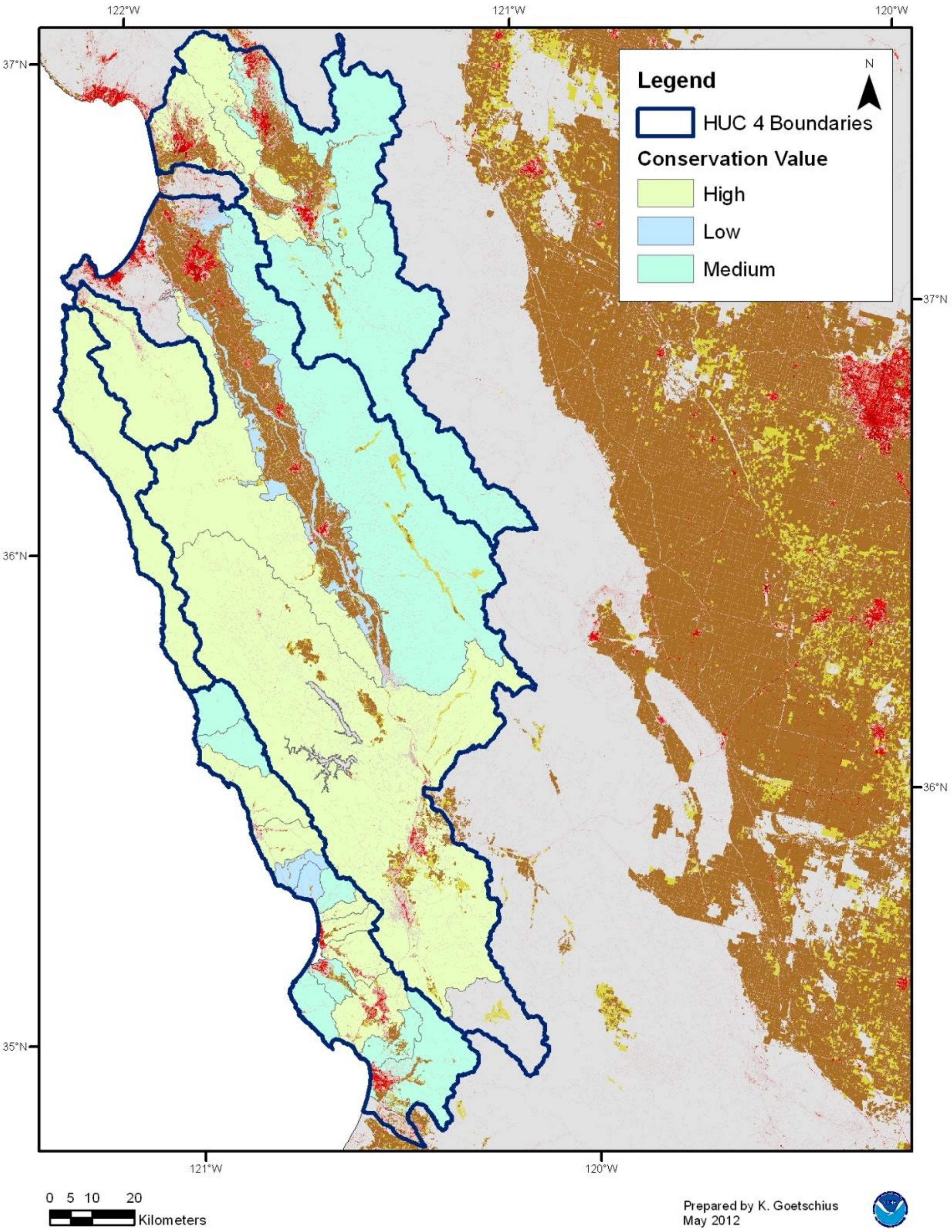
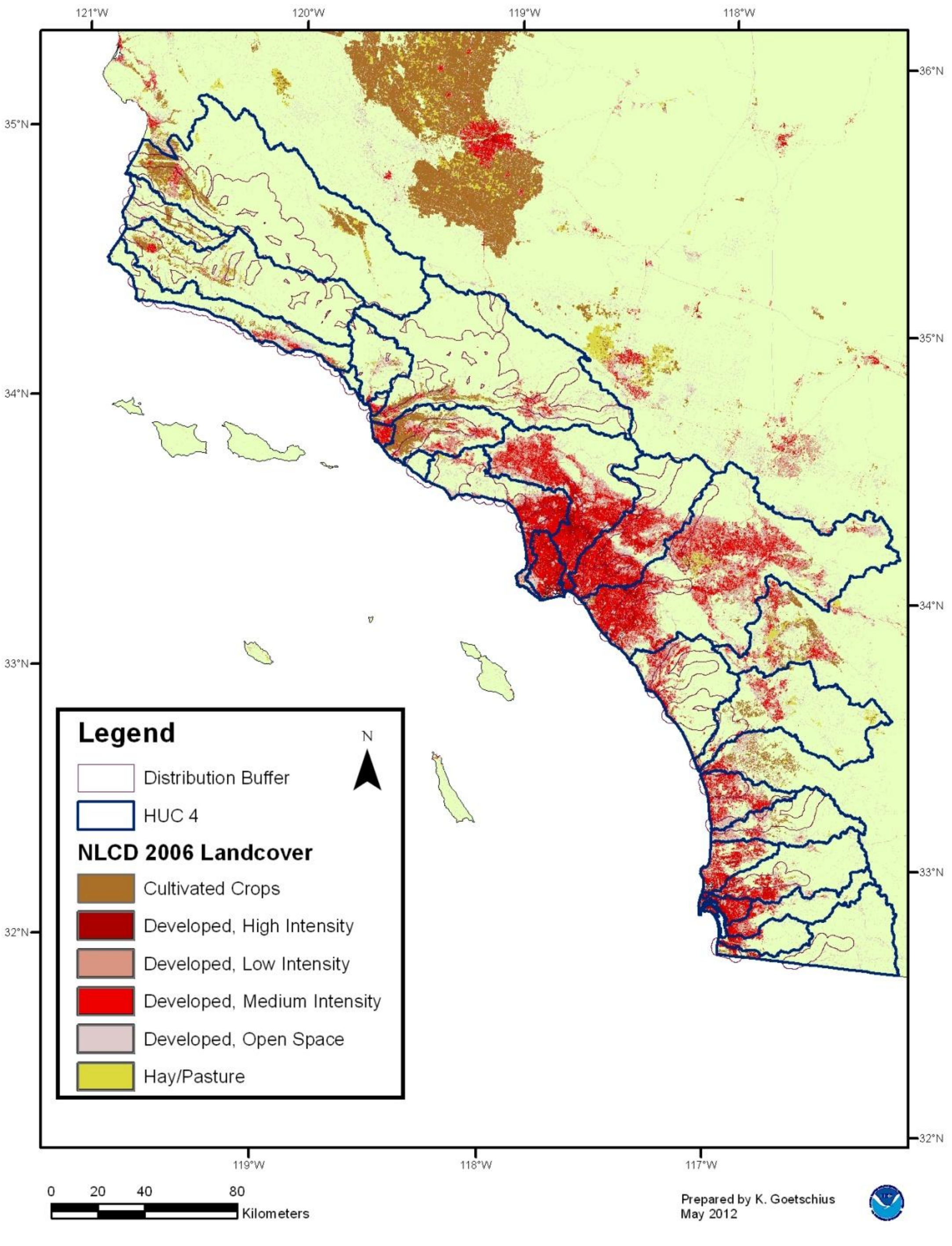
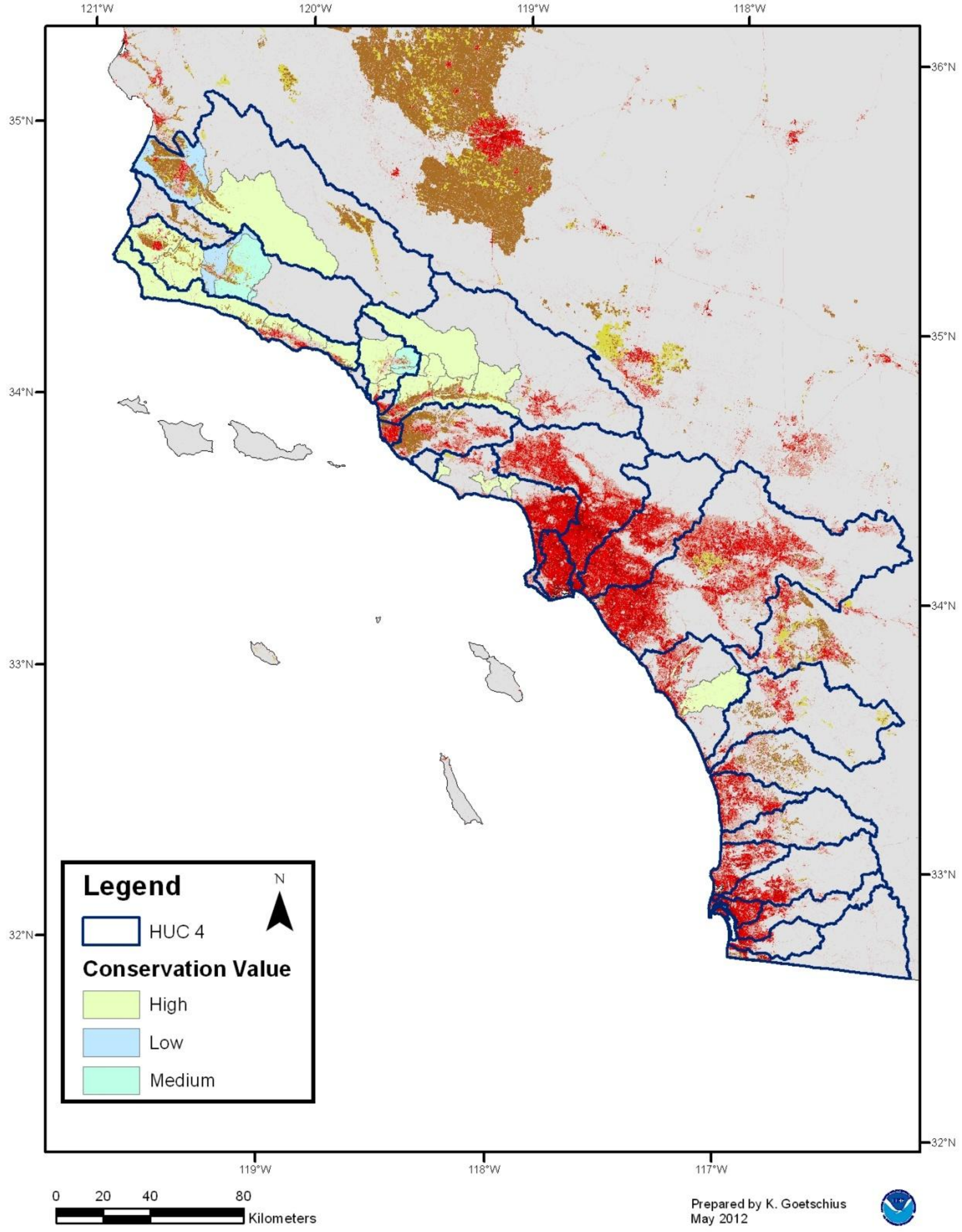


Prepared by K. Goetschius
May 2012

Southern California Steelhead DPS



Prepared by K. Goetschius
May 2012



Southern California Steelhead DPS
Critical Habitat

-

Appendix 5: Annual Run-timing for ESA listed Pacific Coast Salmon and Steelhead

An important part of determining if listed salmonids will be exposed to pesticides is determining if they are actually present in the system at the same time as the pesticide is present. Pesticides may enter waterbodies via several routes: runoff from a treated area near the stream, spray drift from a treated area near the stream, groundwater interchange, transport from a treated area upstream, partitioning from contaminated sediment, or atmospheric deposition. How important each of these pathways is depends greatly on physic-chemical properties of the a.i. itself, and the method of application. Landuse, soil types, and geography within the ESUs/DPSs are also factors.

The tables in this appendix provide presence/absence information on various salmonid lifestages for each of the ESUs/DPSs across the course of a calendar year. Shaded boxes indicate the lifestage is expected to be present; unshaded boxes indicate the lifestage is not expected to be present. This information was collated from a number of sources by OPR staff. It represents a generalized annual run-timing. There may be some variations on a local scale or in a particular year. However, one important conclusion we drew from this analysis is that *in most systems, some sensitive lifestage is present year-round.*

Chinook Salmon

Puget Sound Chinook (spring/summer, fall combined)

<table>
<tr><td>Life History phase</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td></td><td></td><td></td><td colspan="8">Present</td><td></td></tr>
<tr><td>Spawning</td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="6">Present</td></tr>
<tr><td>Incubation (eggs)</td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td colspan="6">Present</td></tr>
<tr><td>Emergence (alevin to fry phase)</td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Present</td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Lower Columbia River Chinook

<table>
<tr><td>Life History phase</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td></td><td></td><td colspan="10">Present</td></tr>
<tr><td>Spawning</td><td>Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="5">Present</td></tr>
<tr><td>Incubation (eggs)</td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td colspan="5">Present</td></tr>
<tr><td>Emergence (alevin to fry phases</td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Upper Columbia River Spring-run Chinook (Endangered)

<table>
<tr><td>Life History phase</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td></td><td></td><td colspan="7">Present</td><td></td><td></td><td></td></tr>
<tr><td>Spawning</td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td><td></td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="5">Present</td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Present</td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Snake River Fall Run Chinook

<table>
<tr><td>Life History phase</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td><td></td><td></td></tr>
<tr><td>Spawning</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td></tr>
<tr><td>Incubation (eggs)</td><td>Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td></tr>
<tr><td>Emergence (alevin to fry phases</td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Present</td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Snake River Spring/Summer Run Chinook

<table>
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<tr><td>Entering Fresh Water (adults/jacks)</td><td></td><td></td><td colspan="5">Present</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Spawning</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Present</td><td></td></tr>
<tr><td>Emergence (alevin to fry phases</td><td>Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Upper Willamette River Chinook

<table>
<tr><td>Life History phase</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td></td><td></td><td></td><td></td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Spawning</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Present</td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Present</td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

California Coastal Chinook

<table>
<tr><td>Life History phase</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td>Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td></tr>
<tr><td>Spawning</td><td>Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Present</td></tr>
<tr><td>Incubation (eggs)</td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Present</td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td></td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td></td><td colspan="5">Present</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Central Valley Spring-run Chinook

<table>
<tr><td>Life History phase</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td></td><td></td><td colspan="5">Present</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Spawning</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="5">Present</td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Present</td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Sacramento River Winter-run Chinook (endangered)

<table>
<tr><td>Life History phase</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td colspan="6">Present</td><td></td><td></td><td></td><td></td><td colspan="2">Present</td></tr>
<tr><td>Spawning</td><td></td><td></td><td></td><td colspan="5">Present</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td></td><td></td><td></td><td colspan="6">Present</td><td></td><td></td><td></td></tr>
<tr><td>Emergence (alevin to fry phases</td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Present</td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td colspan="5">Present</td></tr>
</table>

Chum Salmon

Hood Canal Summer-run

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
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<tr><td>Spawning</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Present</td><td></td><td></td></tr>
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<tr><td>Emergence (alevin to fry phases)</td><td></td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td></td><td colspan="5">Present</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Columbia River Chum

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Present</td></tr>
<tr><td>Spawning</td><td>Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Present</td></tr>
<tr><td>Incubation (eggs)</td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Present</td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td></td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td></td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Coho Salmon

Lower Columbia River Coho

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Present</td></tr>
<tr><td>Spawning</td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td></tr>
<tr><td>Incubation (eggs)</td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td></td><td></td><td colspan="5">Present</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Oregon Coast Coho

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td>Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td></tr>
<tr><td>Spawning</td><td>Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td></tr>
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<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Southern Oregon / North California Coast Coho

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
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<tr><td>Incubation (eggs)</td><td>Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Present</td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Central California Coast Coho

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Present</td></tr>
<tr><td>Spawning</td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Present</td></tr>
<tr><td>Incubation (eggs)</td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Present</td></tr>
<tr><td>Emergence
(alevin to fry phases)</td><td></td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Present</td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Sockeye Salmon

Ozette Lake Sockeye

<table>
<tr><td>Life History phase</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td>Present</td><td></td><td></td><td colspan="9">Present</td></tr>
<tr><td>Spawning</td><td>Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Present</td></tr>
<tr><td>Incubation (eggs)</td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td></tr>
<tr><td>Emergence
(alevin to fry phases)</td><td></td><td></td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
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Snake River Sockeye Salmon (Endangered)

<table>
<tr><td>Life History phase</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td colspan="12">Present</td></tr>
<tr><td>Spawning</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td><td></td></tr>
<tr><td>Incubation (eggs)</td><td>Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="4">Present</td></tr>
<tr><td>Emergence
(alevin to fry phases</td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Present</td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Steelhead

Puget Sound Steelhead (winter/summer runs)

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td colspan="12">Present</td></tr>
<tr><td>Spawning</td><td></td><td colspan="6">Present</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td></td><td colspan="7">Present</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td></td><td></td><td></td><td colspan="6">Present</td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Lower Columbia River Steelhead (winter/summer runs)

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td colspan="12">Present</td></tr>
<tr><td>Spawning</td><td></td><td></td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td></td><td></td><td colspan="5">Present</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Emergence (alevin to fry phases</td><td></td><td></td><td></td><td></td><td colspan="4">Present</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Upper Willamette River Steelhead

<table>
<tr><th>Life History phase</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td colspan="6">Present</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Spawning</td><td></td><td></td><td></td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">Present</td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Middle Columbia River Steelhead

<table>
<tr><td>Life History phase</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td colspan="12">Present</td></tr>
<tr><td>Spawning</td><td colspan="7">Present</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td colspan="7">Present</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Emergence
(alevin to fry phases)</td><td></td><td></td><td></td><td colspan="5">Present</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Upper Columbia River Steelhead

<table>
<tr><td>Life History phase</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td colspan="12">Present</td></tr>
<tr><td>Spawning</td><td></td><td></td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td></td><td></td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Emergence (alevin to fry phases</td><td></td><td></td><td></td><td></td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Snake River Basin Steelhead

<table>
<tr><td>Life History phase</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td></td><td></td><td></td><td></td><td colspan="6">Present</td><td></td><td></td></tr>
<tr><td>Spawning</td><td></td><td></td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td></td><td></td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Emergence
(alevin to fry phases)</td><td></td><td></td><td></td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
</table>

Northern California Steelhead

<table>
<tr><td>Life History phase</td><td>Jan</td><td>Feb</td><td>Mar</td><td>Apr</td><td>May</td><td>Jun</td><td>Jul</td><td>Aug</td><td>Sep</td><td>Oct</td><td>Nov</td><td>Dec</td></tr>
<tr><td>Entering Fresh Water (adults/jacks)</td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">Present</td></tr>
<tr><td>Spawning</td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Present</td></tr>
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<tr><td>Emergence (alevin to fry phases</td><td></td><td></td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
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Central California Coast Steelhead

<table>
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<tr><td>Entering Fresh Water (adults/jacks)</td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Present</td></tr>
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<tr><td>Incubation (eggs)</td><td colspan="5">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td></td><td></td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rearing and migration (juveniles)</td><td colspan="12">Present</td></tr>
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California Central Valley Steelhead

<table>
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<tr><td>Incubation (eggs)</td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Present</td></tr>
<tr><td>Emergence (alevin to fry phases)</td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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South- Central California Coast Steelhead

<table>
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(adults/jacks)</td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Spawning</td><td></td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td></td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Emergence
(alevin to fry phases)</td><td></td><td></td><td></td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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Southern California Steelhead (endangered)

<table>
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(adults/jacks)</td><td></td><td colspan="4">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Spawning</td><td></td><td></td><td></td><td colspan="2">Present</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Incubation (eggs)</td><td></td><td></td><td></td><td colspan="3">Present</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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<tr><td>Rearing and migration
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Appendix 6: Toxicity of Eleven Pesticides to Embryonic Zebrafish

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Northwest Fisheries Science Center
2725 Montlake Boulevard East
Seattle, WA 98112-2097

November 28, 2011

TO: F/PR3 – Rob Walton, Office of Protected Resources

Nathaniel L. Scholz

FROM: F/NWC5 – Nathaniel Scholz, Program Manager, Ecotoxicology Program

SUBJECT: Report - Toxicity of Eleven Pesticides to Embryonic Zebrafish

The Northwest Fisheries Science Center has completed a study requested by NOAA's Office of Protected Resources in support of a Biological Opinion. The requested experiment investigated the effects of eleven pesticides (oryzalin, trifluralin, prometryn, pendimethalin, fenbutatin oxide, thiobencarb, propargite, metolachlor, 1,3-dichloropropene, bromoxynil, and diflubenzuron) on developing zebrafish (*Danio rerio)*. Toxicity endpoints included mortality, developmental abnormalities, and body length following exposure. The attached report, "Toxicity of Eleven Pesticides to Embryonic Zebrafish", provides details on the study and its results.

Toxicity of Eleven Pesticides to Embryonic Zebrafish

November 2011
Project Summary

The Northwest Fisheries Science Center conducted an experiment requested by NOAA's Office of Protected Resources in support of a Biological Opinion regarding the toxicity of various pesticides to endangered salmon species. The experiment detailed here investigated the effects of eleven pesticides on developing zebrafish (*Danio rerio)*, a species that is widely used as a toxicological model for other fish species. Zebrafish are a useful model species because the early ontogeny of zebrafish is rapid and well documented (Kimmel et al., 1995) and their features are easily observed through translucent chorions and bodies. In this experiment, embryonic zebrafish were exposed to oryzalin, trifluralin, prometryn, pendimethalin, fenbutatin oxide, thiobencarb, propargite, metolachlor, 1,3-dichloropropene, bromoxynil and diflubenzuron in 5-day static-renewal exposures. Toxicity endpoints included mortality, developmental abnormalities, and body length on the final day of the experiment. Three of the chemicals tested, prometryn, fenbutatin oxide, and diflubenzuron, did not produce an adverse effect on zebrafish survival, morphology or length at the tested concentrations. The pesticides trifluralin, pendimethalin and thiobencarb increased the rate of abnormality in developing zebrafish without appreciably increasing the rate of mortality at the concentrations tested. Fish lengths were significantly smaller following exposure to oryzalin, bromoxynil, trifluralin, pendimethalin, thiobencarb, propargite, metolachlor and 1,3-dichloropropene.

Methods

Fish: Zebrafish (*D. rerio*) embryos were obtained from a colony maintained at the Northwest Fisheries Science Center according to standard operating procedures (Linbo, 2009). Male and female zebrafish were combined in spawning tanks and eggs were collected at the beginning of the next light cycle, approximately one hour after the spawning event. Embryos were housed in a temperature-controlled incubator at 28.5 °C for the duration of the experiment.

Pesticide stock solutions: Pesticides were obtained in pure form from Chem Service, Inc. (West Chester, Pennsylvania). Pesticide stock solutions were made in acetone and stored under dark conditions at 4 °C. A working solution composed of stock solution and water from the zebrafish colony (system water) was mixed fresh at the start of each day, and subsequent exposure concentrations serially diluted. The maximum acetone concentration for any exposure was 0.1%. The highest pesticide concentration of each compound tested was generally the reported rainbow trout or zebrafish 96-hr LC_{50} value (the concentration lethal to 50% of the test organisms). The highest exposure concentration of 1,3-dichloropropene was 100 times lower than the reported LC_{50} value because of observed developmental effects, while exposure concentrations of diflubenzuron were lower due to low solubility in acetone.

Pesticide exposures: Normally developing zebrafish embryos at 1.5-2.5 hpf (hours post-fertilization) were selected and placed in 60 mm acetone-washed glass Petri dishes with 10 ml of pesticide solution. Individual dishes contained 15 embryos and each exposure concentration was tested in triplicate. Exposures were conducted in batches comprised of one or two pesticides, water controls, and 0.1% acetone controls. Exposure solutions were renewed every 24 hours. Dead embryos were removed from the dishes each day to prevent fungal growth and contamination.

Anatomical screening and measurement of fish body length: Embryos were scored every 24 hr for mortality and abnormalities through 5 dpf (days post-fertilization). See Table 2 for a description of the observed developmental abnormalities. Daily anatomical screenings were performed using a Nikon-SMZ-800 stereomicroscope with a diascopic base (Meridian Instruments, Seattle, Washington). Only surviving fish were screened for anatomical abnormalities. At 5 dpf, the embryos were anesthetized with tricaine methanesulfonate (MS-222; Sigma-Aldrich, St. Louis, Missouri) to measure body length. All surviving embryos from each exposure dish were simultaneously photographed using a Spot RT digital camera (Diagnostic Instruments, Inc., Sterling Heights, Michigan) mounted on a stereomicroscope. Length was measured from the anterior tip of the mouth along the notochord to the posterior tip of the notochord, and quantified using ImageJ software (available online at http://rsbweb.nih.gov/ij/).

Statistical tests: Length was the only parameter explicitly tested. Lengths of control fish were compared using a two-factor ANOVA comparing type (water and acetone) and batch, and showed a significant result of batch only. Subsequent analyses of exposures compared the average of three dishes (n = 3) to their corresponding batch controls. Differences in embryo lengths between concentrations of a given pesticide were tested using one-way ANOVAs with a Tukey HSD post hoc (Tables 3-13).

Results

Chemical-specific mortality and abnormality data, as well as their respective controls, are presented in Figures 1-11. Both water and acetone controls showed consistently low rates of both mortality and abnormality. We found that 3 pesticides (prometryn, fenbutatin oxide and diflubenzuron) showed no increases in mortality or abnormality as well as no significant differences in embryo length. Three additional chemicals (trifluralin, pendimethalin and thiobencarb) produced higher rates of abnormalities and significantly shorter embryos at the highest exposure concentration without increasing mortality. While the remaining pesticides (oryzalin, bromoxynil, propargite, metolachlor, and 1,3-dichloropropene) produced significantly shorter embryos at various exposure concentrations with no effect on mortality or abnormality, there was no clear dose-dependent trend. Whether there is a biological consequence to these shorter lengths at the concentrations tested here is a subject for further investigation.

Table 1. Nominal concentrations of pesticides used in exposures and rainbow trout LC_{50} values.

Compound Name	Type	Exposure Concentrations (μg/l)	Rainbow Trout LC_{50} values (μg/l)
Oryzalin	Herbicide	3, 30, 300, 3000	3260
Trifluralin	Herbicide	0.05, 0.5, 5, 50	50
Prometryn	Herbicide	0.9, 9, 90, 900	2900
Pendimethalin	Herbicide	0.15, 1.5, 15, 150	138
Fenbutatin oxide	Insecticide	0.01, 0.1, 1, 10	10
Thiobencarb	Herbicide	0.8, 8, 80, 800	790
Propargite	Insecticide	0.15, 1.5, 15, 150	<168
Metolachlor	Herbicide	0.3, 3, 30, 300	300
1,3-Dichloropropene	Insecticide	0.03, 0.3, 0.3, 3	270
Bromoxynil	Herbicide	0.05, 0.5, 5, 50	41
Diflubenzuron	Insecticide/Fungicide	2, 20, 200, 2000	72000

Table 2. Abnormalities observed during zebrafish embryo exposures.

Abnormality	Description
Edema	Accumulation of excess fluid in any one of the following cavities: heart, yolk sac, yolk extension, eyes.
Unhatched	Failure to hatch at 5 dpf.
Curved	Curvature of the tail dorsally in the sagittal plane such that a line drawn from the posterior tip of the notochord to the mouth of the fish would yield a gap between the line and body.
Lethargic	An inability to maintain an upright posture and/or inactivity.
Deformed fins	The absence or improper formation of fin tissue.
Deformed tail	A notable shortening of the tail or improper notochord development.
Bent	A bend in the body or tail of the embryo in the coronal plane.

Oryzalin

Oryzalin exposure did not impact developing zebrafish in a dose-dependent manner. Mortality was the highest (20%) at 30 μg/l, but declined to 8.9% at 3000 μg/l. Abnormality was the highest at 3000 μg/l (17.1%), but was also elevated at 3 μg/l (16.2%). The most common abnormality observed was edema.

Figure 1: Percent mortality and abnormality observed in control and oryzalin-exposed zebrafish. Symbols are means (n = 3) ± SD.

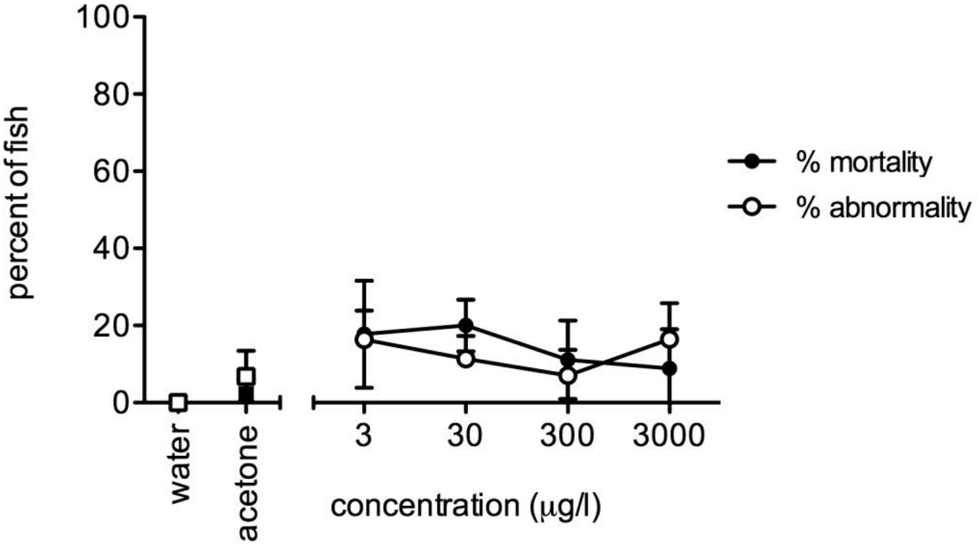

Table 3: Average length of fish exposed to oryzalin and controls (n = 3 dishes). There was a significant effect of oryzalin (One-way ANOVA, *p* < 0.0001). * Indicates treatment significantly different than controls (Tukey HSD, *p* < 0.01).

Treatment (μg/l)	Average length ± SD (mm)
Water control	4.49 ± 0.02
0.1% acetone	4.50 ± 0.02
3	4.53 ± 0.05
30	4.48 ± 0.02
300	4.51 ± 0.05
3000	4.27 ± 0.02*

Bromoxynil

Bromoxynil exposure did not cause an increase in mortality or abnormality in developing zebrafish. The highest rate of abnormality (6.7%) was observed at 0.05 μg/l and 50 μg/l. Mortality occurred the most frequently at 0.5 μg/l and 5 μg/l at a rate of 2.2%.

Figure 2. Percent mortality and abnormality in controls and zebrafish exposed to bromoxynil. Symbols are means (n = 3) ± SD.

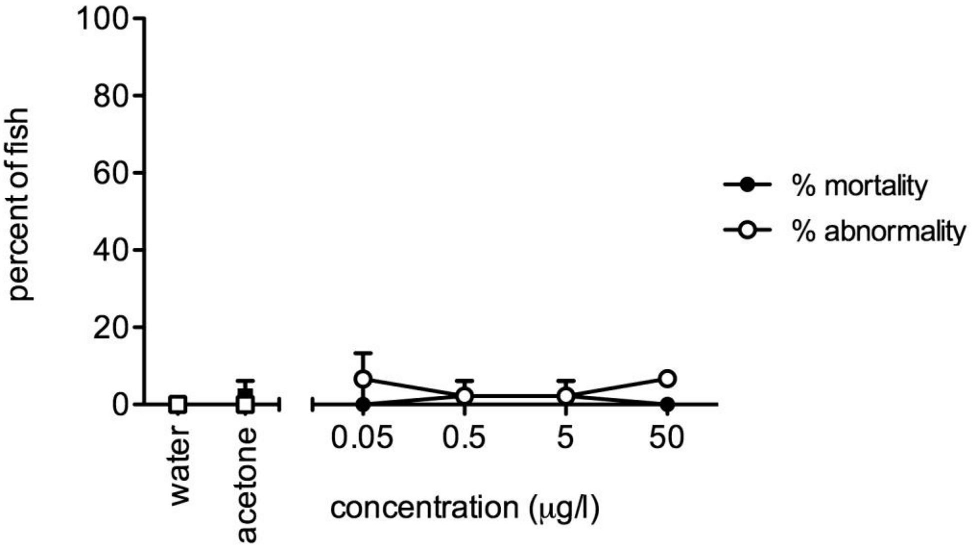

Table 4: Average length of fish exposed to bromoxynil and controls (n = 3 dishes). There was a significant effect of bromoxynil (One-way ANOVA, $p < 0.0001$). * Indicates treatment significantly different than controls (Tukey HSD, $p < 0.05$).

Treatment (μg/l)	Average length ± SD (mm)
Water control	4.20 ± 0.04
0.1% acetone	4.06 ± 0.02
0.05	3.97 ± 0.03*
0.5	4.08 ± 0.01
5	4.05 ± 0.04
50	4.13 ± 0.06

Trifluralin

Exposure to trifluralin caused significant abnormalities at the highest dose tested (50 μg/l). The rate of abnormality at this dose was 95.3%, and the most common abnormality noted was lethargy, characterized by the absence of active swimming and a tendency to lose upright posture. Mortality was the greatest (22.2%) at 0.5 μg/l.

Figure 3. Percent mortality and abnormality of controls and zebrafish exposed to trifluralin. Symbols are means (n = 3) ± SD.

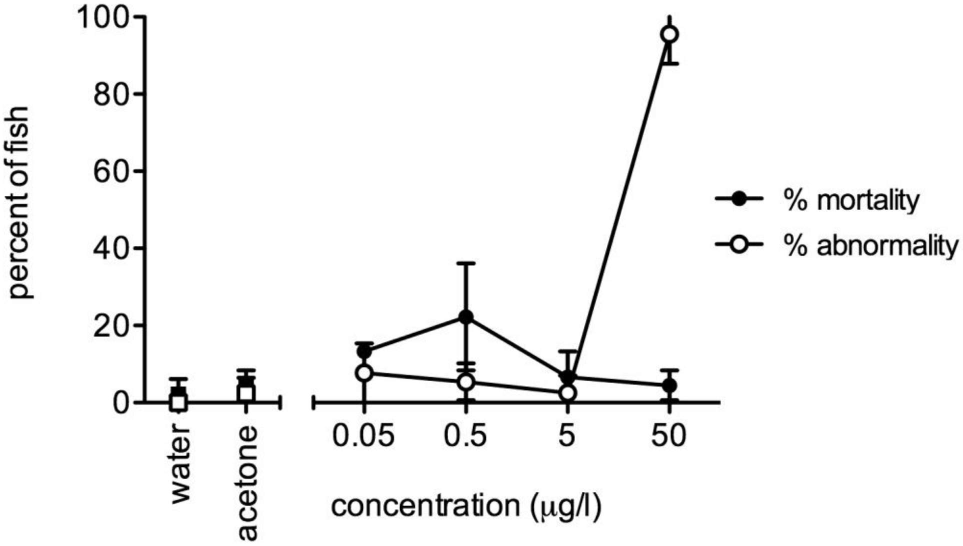

Table 5: Average lengths of fish exposed to trifluralin and controls (n = 3 dishes). There was a significant effect of trifluralin (One-way ANOVA, $p < 0.0001$). * Indicates treatment significantly different than controls (Tukey HSD, $p < 0.01$).

Treatment (μg/l)	Average length ± 1 SD (mm)
Water control	4.02 ± 0.01
0.1% acetone	4.11 ± 0.07
0.05	4.05 ± 0.02
0.5	4.11 ± 0.07
5	4.01 ± 0.07
50	3.59 ± 0.03*

Prometryn

Prometryn exposure did not adversely affect either the rate of abnormality or mortality in developing zebrafish. The highest rate of morality observed was at 9 µg/l (4.4%), and the highest rate of abnormality was at 0.9 µg/l and 900 µg/l (2.3%).

Figure 4. Percent mortality and abnormality of controls and prometryn exposed fish. Symbols are means (n = 3) ± SD.

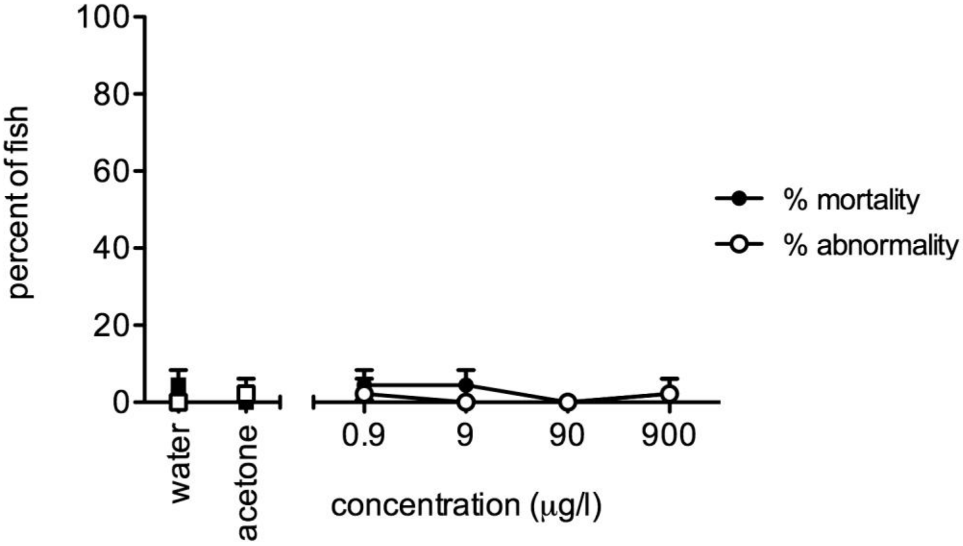

Table 6: Average lengths of fish exposed to prometryn and controls (n = 3 dishes). Exposure to prometryn did not significantly affect fish length (One-way ANOVA, p > 0.05).

Treatment (µg/l)	Average length ± SD (mm)
Water control	3.85 ± 0.06
0.1% acetone	3.96 ± 0.03
0.9	3.96 ± 0.06
9	3.95 ± 0.01
90	3.97 ± 0.03
900	3.85 ± 0.02

Pendimethalin

Embryos exposed to 150 μg/l of pendimethalin developed a significant amount (100%) of abnormalities. Abnormal embryos were lethargic and struggled to swim. The highest rate of mortality (11.1%) was noted at 15 μg/l.

Figure 5. Percent mortality and abnormality of controls and fish exposed to pendimethalin. Symbols are means (n = 3) ± SD.

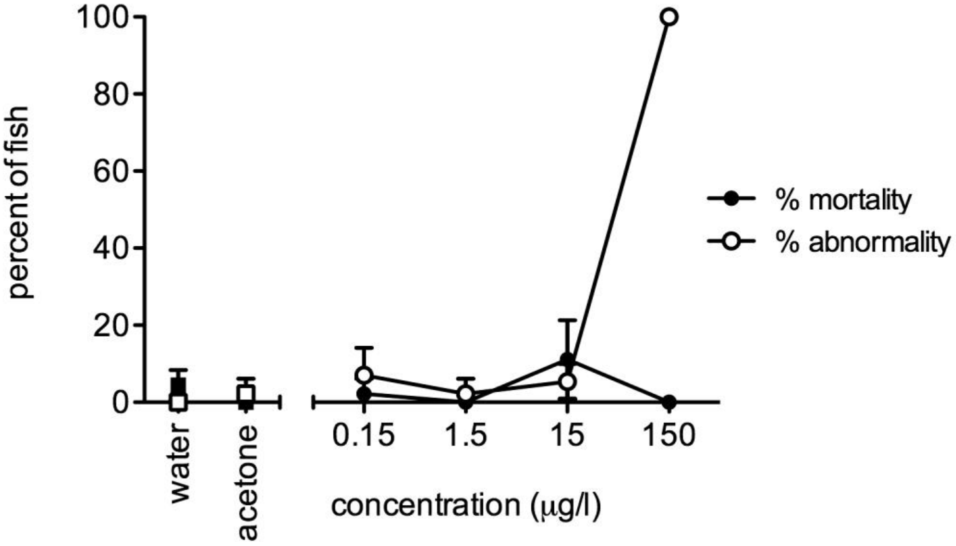

Table 7: Average lengths of fish exposed to pendimethalin and controls (n = 3 dishes). Pendimethalin exposure significantly impacted the length of larvae (One-way ANOVA, *p* <0.001). * Indicates treatment significantly different than controls (Tukey HSD, *p* < 0.01).

Treatment (μg/l)	Average length ± SD (mm)
Water control	3.85 ± 0.06
0.1% acetone	3.96 ± 0.03
0.15	3.98 ± 0.04
1.5	3.97 ± 0.03
15	3.94 ± 0.06
150	3.59 ± 0.03*

Fenbutatin oxide

Fenbutatin oxide did not cause a dose-dependent change in mortality or abnormality. Mortality occurred the most frequently at 10 μg/l (28.9%). Abnormality on the other hand was highest at 0.1 μg/l (26.3%), and declined at higher concentrations.

Figure 6. Percent mortality and abnormality of controls and fish exposed to fenbutatin oxide. Symbols are means (n = 3) ± SD.

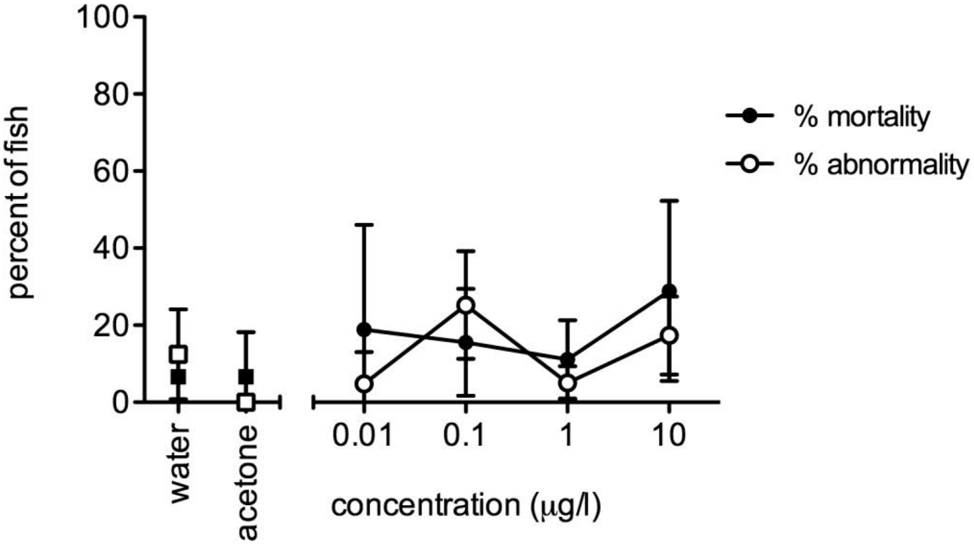

Table 8: Average lengths of fish exposed to fenbutatin oxide and controls (n = 3 dishes). Fenbutatin oxide exposure did not affect the length of fish (One-way ANOVA, p > 0.05).

Treatment (μg/l)	Average length ± SD (mm)
Water control	3.90 ± 0.06
0.1% acetone	3.93 ± 0.01
0.01	3.91 ± 0.03
0.1	3.88 ± 0.06
1	3.91 ± 0.04
10	3.87 ± 0.02

Thiobencarb

Exposing developing zebrafish to thiobencarb produced abnormalities in 100% of the embryos at 800 µg/l. The 5-dpf larvae behaved abnormally with erratic swimming patterns. Mortality at 800 µg/l was 13.3%.

Figure 7. Percent mortality and abnormality observed in controls and fish exposed to thiobencarb. Symbols are means (n = 3) ± SD.

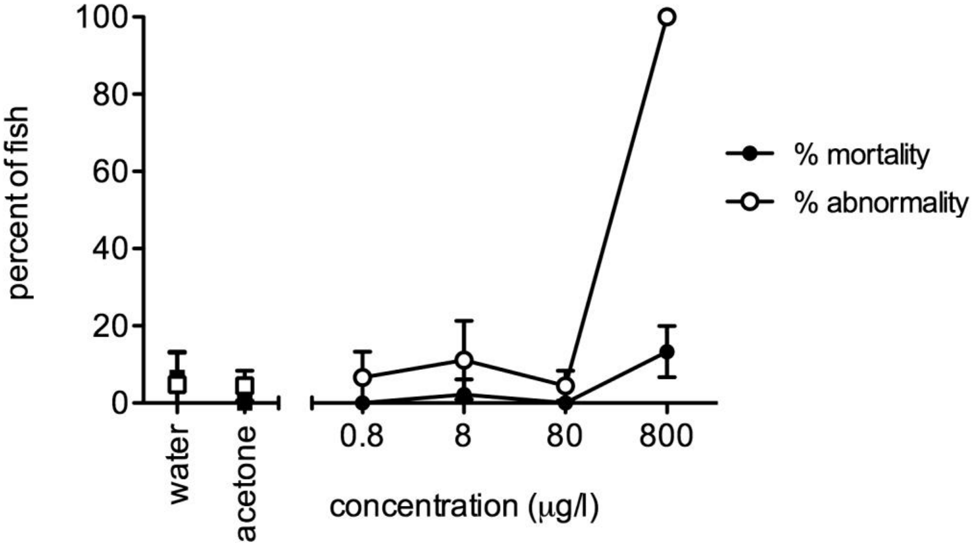

Table 9: Average lengths of fish exposed to thiobencarb and controls (n = 3 dishes). There was a significant effect of thiobencarb (One-way ANOVA, *p*<0.0001). * Indicates treatment significantly different than controls (Tukey HSD, *p* < 0.01).

Treatment (µg/l)	Average length ± SD (mm)
Water control	3.92 ± 0.04
0.1% acetone	3.99 ± 0.03
0.8	3.91 ± 0.03
8	3.87 ±0.04
80	3.91 ± 0.03
800	3.69 ± 0.07*

Propargite

Zebrafish embryos exposed to propargite did not show increased rates of mortality or abnormality. The highest rate of mortality (4.4 %) was observed at 0.15 μg/l and 1.5 μg/l. Embryos had the greatest number of abnormalities (13.6%) at 150 μg/l.

Figure 8. Percent mortality and abnormality in controls and fish exposed to propargite. Symbols are means (n = 3) ± SD.

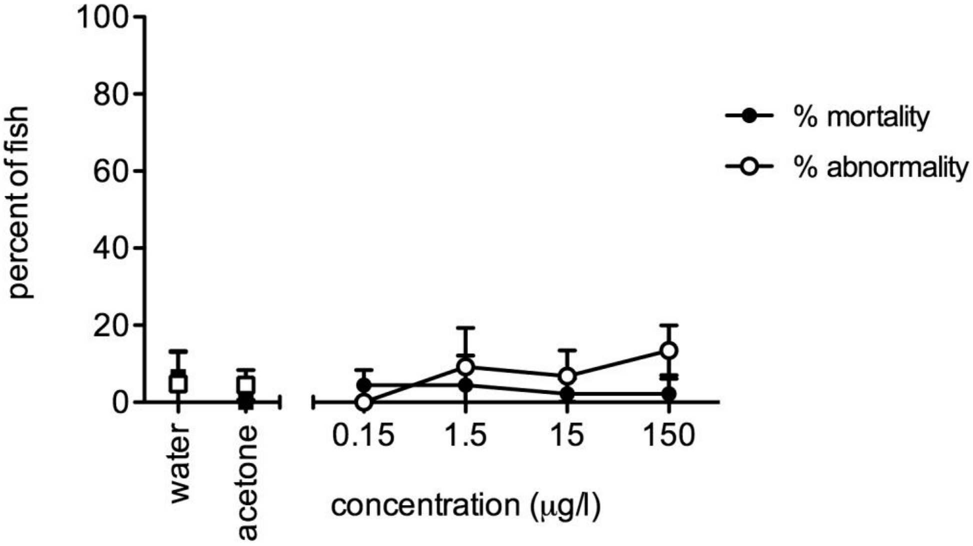

Table 10: Average lengths of fish exposed to propargite and controls (n = 3 dishes). Propargite produced significant effects (One-way ANOVA, *p*= 0.005). * Indicates treatment significantly different than controls (Tukey HSD, *p* < 0.01).

Treatment (μg/l)	Average length ± SD (mm)
Water control	3.92 ± 0.04
0.1% acetone	3.99 ± 0.03
0.15	3.95 ± 0.04
1.5	3.92 ± 0.04
15	3.94 ± 0.02
150	3.83 ± 0.01*

Metolachlor

Exposure to metolachlor did not alter zebrafish mortality, although a higher rate (28.6%) of abnormality was observed at 300 μg/l. The most frequent abnormality noted was a failure to hatch by 5 dpf.

Figure 9. Percent mortality and abnormality of zebrafish exposed to metolachlor and controls. Symbols are means (n = 3) ± SD.

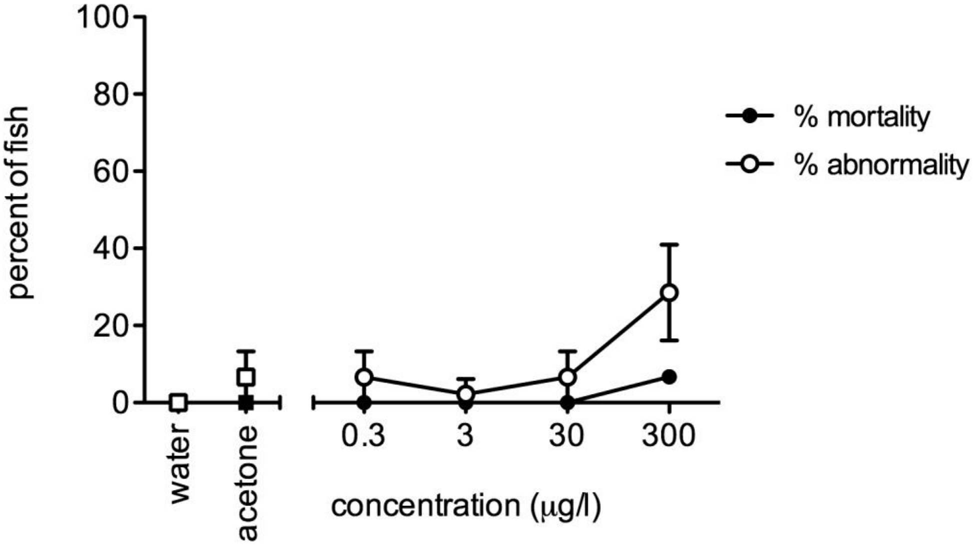

Table 11: Average lengths of fish exposed to metolachlor and controls (n = 3 dishes). There was a significant effect of metolachlor (One-way ANOVA, *p* < 0.0001). * Indicates treatment significantly different than controls (Tukey HSD, *p* < 0.01).

Treatment (μg/l)	Average length ± SD (mm)
Water control	4.42 ± 0.03
0.1% acetone	4.37 ± 0.03
0.3	4.24 ± 0.06*
3	4.40 ± 0.05
30	4.23 ± 0.05*
300	4.18 ± 0.05*

1,3-Dichloropropene

Exposure to 1,3-dichloropropene caused an increase in abnormality and mortality in developing zebrafish, but not in a dose dependent manner. The highest rate of mortality (28.9%) occurred at 0.3 μg/l, and declined at higher concentrations. The highest rate of abnormality (37.5%) was observed at 3 μg/l. The rate of abnormality remained between 28.1% and 37.5% for all exposure concentrations and the most commonly observed abnormality was failure to hatch by 5dpf.

Figure 10. Percent mortality and abnormality observed in fish exposed to 1,3-dichloropropene and controls. Symbols are means (n = 3) ± SD.

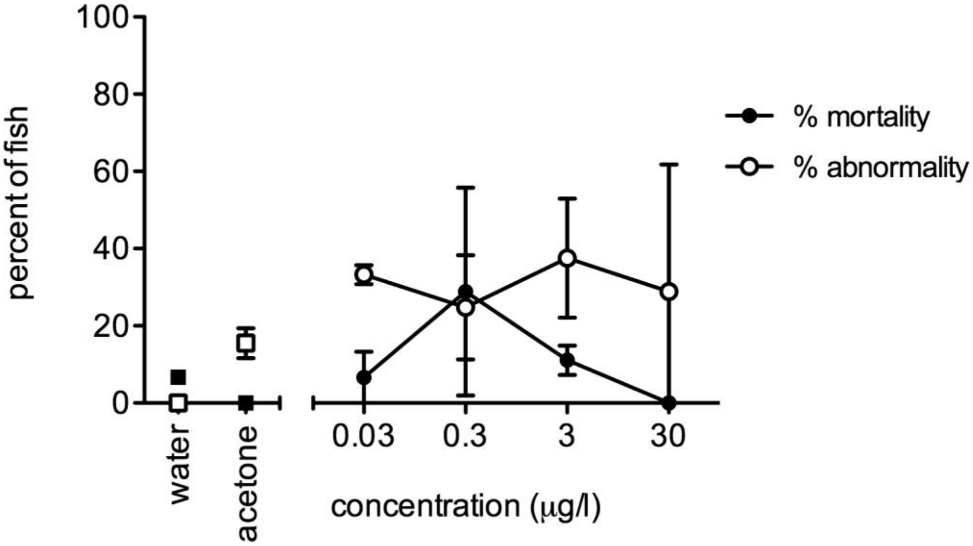

Table 12. Average lengths of fish exposed to 1,3-dichloropropene and controls (n = 3 dishes). There was a significant effect of 1,3-dichloropropene (One-way ANOVA, *p* <0.001). * Indicates treatment significantly different than controls (Tukey HSD, *p* < 0.01).

Treatment (μg/l)	Average length ± SD (mm)
Water control	4.46 ± 0.03
0.1% acetone	4.34 ± 0.03
0.03	4.32 ± 0.04
0.3	4.14 ± 0.05*
3	4.28 ± 0.08
30	4.27 ± 0.06

Diflubenzuron

Diflubenzuron did not influence zebrafish mortality or abnormality. The highest rate of abnormality (6.8%) was observed at 20 μg/l, and the highest rate of morality (4.4%) was observed at 2 μg/l. However, it is important to note that diflubenzuron was difficult to work with because of its low solubility in acetone (6.5 g/l). The most concentrated stock solution of diflubenzuron we were able to make was 2 g/l. Diflubenzuron appeared to remain in solution after dosing the exposure dishes, however after 24hrs, the highest exposure concentration dishes (2000 μg/l) had visible floating particles. Thus, without using alternative methodologies (e.g. DMSO as the carrier), we are not confident about accurate dosing for this compound.

Figure 11. Percent mortality and abnormality observed in control fish and fish exposed to diflubenzuron. Symbols are means (n = 3) ± SD.

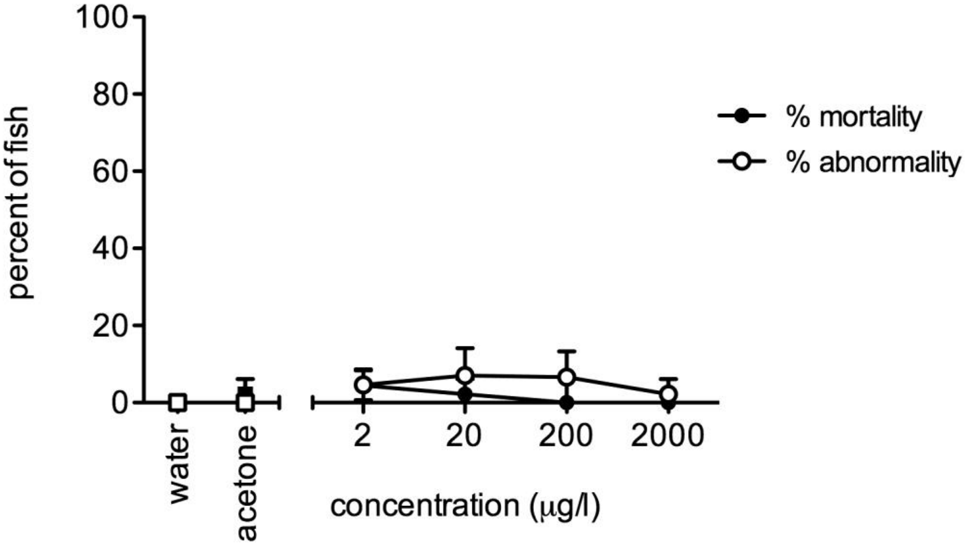

Table 13: Average lengths of fish exposed to diflubenzuron and controls (n = 3 dishes). There was not a significant effect of diflubenzuron on fish length (One-way ANOVA, p > 0.05).

Treatment (μg/l)	Average length ± SD (mm)
Water control	4.20 ± 0.04
0.1% acetone	4.06 ± 0.02
2	4.06 ± 0.03
20	4.88 ± 0.06
200	4.98 ± 0.03
2000	4.08 ± 0.03

References

Kimmel, CB, WW Ballard, SR Kimmel, B Ullman and TF Schilling. 1995. Stages of embryonic development of the zebrafish. *Developmental Dynamics* 203(3):253-310.

Linbo, TL. 2009. Zebrafish (*Danio rerio*) husbandry and colony maintenance at the Northwest Fisheries Science Center. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-100, 62p.

Appendix 7: Counties subject to RPAs and RPMs

When most of the ESU/DPSs were listed, and/or Critical Habitat was designated, the FR notice included HUCs and counties that overlap with the listed species. While HUS are a better delineator of where species are located, NMFS recognizes that counties are a more practical delineation for implementation purposes. As such, we have listed the counties in each state that are subject to RPAs and RPMs (Table -

Table 119). Following these is a table giving the sources of this information (Table 120) and a state-wise breakdown of the counties where each ESU/DPS is found (Table 121 - Table 129). In cases where it is available, we also provide the HUC and lat/long data of streams designated as Critical Habitat for the species. Species without lat/long designations for critical habitat are: Snake River Fall-run Chinook, Snake River Spring-Summer-run Chinook, Sacramento River Winter run Chinook, Lower Columbia River Coho, Snake River Sockeye, and Puget Sound Steelhead.

Table 1. Idaho counties subject to RPAs and RPMs.

ID County	Oryzalin	Pendimethalin	Trifluralin
Adams	RPM	RPM	RPM
Benewah	RPM	RPM	RPM
Blaine	RPM	RPM	RPM
Clearwater	RPM	RPM	RPM
Custer	RPM	RPM	RPM
Idaho	RPM	RPM	RPM
Latah	RPM	RPM	RPM
Lemhi	RPM	RPM	RPM
Lewis	RPM	RPM	RPM
Nez Perce	RPM	RPM	RPM
Shoshone	RPM	RPM	RPM
Valley	RPM	RPM	RPM

Table 2. California counties subject to RPAs and RPMs.

CA County	Oryzalin	Pendimethalin	Trifluralin
Alameda	RPA, RPM	RPA, RPM	RPA, RPM
Butte	RPA, RPM	RPA, RPM	RPA, RPM
Calaveras	RPA, RPM	RPA, RPM	RPA, RPM
Colusa	RPA, RPM	RPA, RPM	RPA, RPM
Contra Costa	RPA, RPM	RPA, RPM	RPA, RPM
Del Norte	RPM	RPM	RPM
Glenn	RPA, RPM	RPA, RPM	RPA, RPM
Humboldt	RPA, RPM	RPA, RPM	RPA, RPM
Lake	RPA, RPM	RPA, RPM	RPA, RPM
Los Angeles	RPM	RPA, RPM	RPA, RPM
Marin	RPA, RPM	RPA, RPM	RPA, RPM
Mendocino	RPA, RPM	RPA, RPM	RPA, RPM
Merced	RPA, RPM	RPA, RPM	RPA, RPM
Monterey	RPA, RPM	RPA, RPM	RPA, RPM
Napa	RPA, RPM	RPA, RPM	RPA, RPM
Orange	RPM	RPA, RPM	RPA, RPM
Placer	RPA, RPM	RPA, RPM	RPA, RPM
Sacramento	RPA, RPM	RPA, RPM	RPA, RPM
San Benito	RPA, RPM	RPA, RPM	RPA, RPM
San Diego	RPM	RPA, RPM	RPA, RPM
San Francisco	RPA, RPM	RPA, RPM	RPA, RPM
San Joaquin	RPA, RPM	RPA, RPM	RPA, RPM
San Luis Obispo	RPA, RPM	RPA, RPM	RPA, RPM
San Mateo	RPA, RPM	RPA, RPM	RPA, RPM
Santa Barbara	RPM	RPA, RPM	RPA, RPM
Santa Clara	RPA, RPM	RPA, RPM	RPA, RPM
Santa Cruz	RPA, RPM	RPA, RPM	RPA, RPM
Shasta	RPA, RPM	RPA, RPM	RPA, RPM
Siskiyou	RPM	RPM	RPM
Solano	RPA, RPM	RPA, RPM	RPA, RPM
Sonoma	RPA, RPM	RPA, RPM	RPA, RPM
Stanislaus	RPA, RPM	RPA, RPM	RPA, RPM
Sutter	RPA, RPM	RPA, RPM	RPA, RPM
Tehama	RPA, RPM	RPA, RPM	RPA, RPM
Trinity	RPA, RPM	RPA, RPM	RPA, RPM
Tuolumne	RPA, RPM	RPA, RPM	RPA, RPM
Ventura	RPM	RPA, RPM	RPA, RPM
Yolo	RPA, RPM	RPA, RPM	RPA, RPM
Yuba	RPA, RPM	RPA, RPM	RPA, RPM

Table 118. Oregon counties subject to RPAs and RPMs

OR County	Oryzalin	Pendimethalin	Trifluralin
Baker	RPM	RPM	RPM
Benton	RPA, RPM	RPA, RPM	RPA, RPM
Clackamas	RPA, RPM	RPA, RPM	RPA, RPM
Clatsop	RPA, RPM	RPA, RPM	RPA, RPM
Columbia	RPA, RPM	RPA, RPM	RPA, RPM
Coos	RPM	RPM	RPM
Crook	RPA, RPM	RPA, RPM	RPA, RPM
Curry	RPM	RPM	RPM
Douglas	RPM	RPM	RPM
Gilliam	RPA, RPM	RPA, RPM	RPA, RPM
Grant	RPA, RPM	RPA, RPM	RPA, RPM
Hood River	RPA, RPM	RPA, RPM	RPA, RPM
Jackson	RPM	RPM	RPM
Jefferson	RPA, RPM	RPA, RPM	RPA, RPM
Josephine	RPM	RPM	RPM
Klamath	RPM	RPM	RPM
Lane	RPA, RPM	RPA, RPM	RPA, RPM
Lincoln	RPM	RPM	RPM
Linn	RPA, RPM	RPA, RPM	RPA, RPM
Marion	RPA, RPM	RPA, RPM	RPA, RPM
Morrow	RPA, RPM	RPA, RPM	RPA, RPM
Multnomah	RPA, RPM	RPA, RPM	RPA, RPM
Polk	RPA, RPM	RPA, RPM	RPA, RPM
Sherman	RPA, RPM	RPA, RPM	RPA, RPM
Tillamook	RPA, RPM	RPA, RPM	RPA, RPM
Umatilla	RPA, RPM	RPA, RPM	RPA, RPM
Union	RPA, RPM	RPA, RPM	RPA, RPM
Wallowa	RPA, RPM	RPA, RPM	RPA, RPM
Wasco	RPA, RPM	RPA, RPM	RPA, RPM
Washington	RPM	RPM	RPM
Wheeler	RPA, RPM	RPA, RPM	RPA, RPM
Yamhill	RPA, RPM	RPA, RPM	RPA, RPM

Table 119. Washington counties subject to RPAs and RPMs.

WA County	Oryzalin	Pendimethalin	Trifluralin
Adams	RPM	RPM	RPM
Asotin	RPM	RPM	RPM
Benton	RPA, RPM	RPA, RPM	RPA, RPM
Chelan	RPM	RPM	RPM
Clallam	RPM	RPA, RPM	RPA, RPM
Clark	RPA, RPM	RPA, RPM	RPA, RPM
Columbia	RPA, RPM	RPA, RPM	RPA, RPM
Cowlitz	RPA, RPM	RPA, RPM	RPA, RPM
Douglas	RPM	RPM	RPM
Franklin	RPA, RPM	RPA, RPM	RPA, RPM
Garfield	RPM	RPM	RPM
Grant	RPM	RPM	RPM
Jefferson	RPM	RPA, RPM	RPA, RPM
King	RPA, RPM	RPA, RPM	RPA, RPM
Kitsap	RPM	RPM	RPM
Kittitas	RPA, RPM	RPA, RPM	RPA, RPM
Klickitat	RPA, RPM	RPA, RPM	RPA, RPM
Lewis	RPA, RPM	RPA, RPM	RPA, RPM
Lincoln	RPM	RPM	RPM
Mason	RPM	RPA, RPM	RPA, RPM
Okanogan	RPM	RPM	RPM
Pacific	RPA, RPM	RPA, RPM	RPA, RPM
Pierce	RPA, RPM	RPA, RPM	RPA, RPM
Skagit	RPM	RPA, RPM	RPA, RPM
Skamania	RPA, RPM	RPA, RPM	RPA, RPM
Snohomish	RPM	RPA, RPM	RPA, RPM
Spokane	RPM	RPM	RPM
Thurston	RPM	RPA, RPM	RPA, RPM
Wahkiakum	RPA, RPM	RPA, RPM	RPA, RPM
Walla Walla	RPA, RPM	RPA, RPM	RPA, RPM
Whatcom	RPM	RPA, RPM	RPA, RPM
Whitman	RPM	RPM	RPM
Yakima	RPA, RPM	RPA, RPM	RPA, RPM

Table 120. Sources of information regarding locations of listed salmonids.

Species	ESU	Data Available	Source
Chinook	Puget Sound	HUCs Counties Critical Habitat Streams	70 FR 52630 50 CFR 226.212
	Lower Columbia River	HUCs Counties Critical Habitat Streams	70 FR 52630 50 CFR 226.212
	Upper Columbia River Spring - Run	HUCs Counties Critical Habitat Streams	70 FR 52630 50 CFR 226.212
	Snake River Fall - Run	HUCs Counties	58 FR 68543 50 CFR 226.205, Table 3
	Snake River Spring/Summer - Run	HUCs Counties	58 FR 68543 50 CFR 226.205, Table 3
	Upper Willamette River	HUCs Counties Critical Habitat Streams	70 FR 52630 50 CFR 226.212
	California Coastal	HUCs Counties Critical Habitat Streams	70 FR 52488 50 CFR 226.211
	Central Valley Spring - Run	HUCs Counties Critical Habitat Streams	70 FR 52488 50 CFR 226.211
	Sacramento River Winter - Run	Counties	Assumed same as Central Valley Chinook (same range) 50 CFR 226.204
Chum	Hood Canal Summer - Run	HUCs Counties Critical Habitat Streams	70 FR 52630 50 CFR 226.212
	Columbia River	HUCs Counties Critical Habitat Streams	70 FR 52630 50 CFR 226.212
Coho	Lower Columbia River	Counties	Used range polygon provided by NW Region to determine county overlap

Species	ESU	Data Available	Source
	Oregon Coast	HUCs Counties Critical Habitat Streams	73 FR 7816 50 CFR 226.212
	Southern Oregon and Northern California Coast	HUCs Counties	64 FR 24049 50 CFR 226.210, Table 6
	Central California Coast	HUCs Counties	64 FR 24049 50 CFR 226.210, Table 5
Sockeye	Ozette Lake	HUCs Counties Critical Habitat Streams	70 FR 52630 50 CFR 226.212
	Snake River	HUCs Counties	58 FR 68543 50 CFR 226.205, Table 3
Steelhead	Puget Sound	Counties	Assumed same as Puget Sound Chinook (same range)
	Lower Columbia River	HUCs Counties Critical Habitat Streams	70 FR 52630 50 CFR 226.212
	Upper Willamette River	HUCs Counties Critical Habitat Streams	70 FR 52630 50 CFR 226.212
	Middle Columbia River	HUCs Counties Critical Habitat Streams	70 FR 52630 50 CFR 226.212
	Upper Columbia River	HUCs Counties Critical Habitat Streams	70 FR 52630 50 CFR 226.212
	Snake River	HUCs Counties Critical Habitat Streams	70 FR 52630 50 CFR 226.212
	Northern California	HUCs Counties Critical Habitat Streams	70 FR 52488 50 CFR 226.211

Species	ESU	Data Available	Source
	Central California Coast	HUCs Counties Critical Habitat Streams	70 FR 52488 50 CFR 226.211
	California Central Valley	HUCs Counties Critical Habitat Streams	70 FR 52488 50 CFR 226.211
	South-Central California Coast	HUCs Counties Critical Habitat Streams	70 FR 52488 50 CFR 226.211
	Southern California	HUCs Counties Critical Habitat Streams	70 FR 52488 50 CFR 226.211

Table 121. California Chinook and Coho Salmon ESUs by county. "X" indicates presence of the species in a county.

CA County	Chinook Salmon			Coho Salmon	
	CA Coastal	Central Valley	Sacramento River	Southern OR Northern CA Coast	Central CA Coast
Alameda		X	X		
Butte		X	X		
Calaveras					
Colusa	X	X	X		
Contra Costa		X	X		
Del Norte				X	
Glenn	X	X	X	X	
Humboldt	X			X	
Lake	X			X	
Los Angeles					
Marin					X
Mendocino	X			X	X
Merced					
Monterey					
Napa	X				X
Orange					
Placer					
Sacramento		X	X		
San Benito					
San Diego					
San Francisco					
San Joaquin		X	X		
San Luis Obispo					
San Mateo					X
Santa Barbara					
Santa Clara					
Santa Cruz					X
Shasta		X	X		
Siskiyou				X	
Solano		X	X		
Sonoma	X				X
Stanislaus					
Sutter		X	X		
Tehama	X	X	X		
Trinity	X	X	X	X	
Tuolumne					
Ventura					
Yolo		X	X		
Yuba		X	X		

Table 122. California Steelhead DPSs by county. “X” indicates presence of the species in a county.

CA County	Steelhead				
	Northern CA	Central CA Coast	CA Central Valley	South-Central CA coast	Southern CA
Alameda		X	X		
Butte			X		
Calaveras			X		
Colusa	X				
Contra Costa		X	X		
Del Norte					
Glenn	X		X		
Humboldt	X				
Lake	X	X			
Los Angeles					X
Marin		X			
Mendocino	X	X			
Merced			X		
Monterey				X	
Napa		X			
Orange					X
Placer			X		
Sacramento			X		
San Benito				X	
San Diego					X
San Francisco		X			
San Joaquin		X	X		
San Luis Obispo				X	X
San Mateo		X			
Santa Barbara					X
Santa Clara		X		X	
Santa Cruz		X		X	
Shasta			X		
Siskiyou					
Solano			X		
Sonoma	X	X			
Stanislaus			X		
Sutter			X		
Tehama	X		X		
Trinity	X				
Tuolumne			X		
Ventura					X
Yolo			X		
Yuba			X		

Table 123. Idaho ESU/DPSs by county. "X" indicates presence of the species in a county.

ID County	Chinook Salmon		Sockeye	Steelhead
	Snake River Fall-Run	Snake River Spring/Summer Run	Snake River	Snake River
Adams	X	X		X
Benewah	X			
Blaine		X	X	X
Clearwater	X			X
Custer		X	X	X
Idaho	X	X	X	X
Latah	X			X
Lemhi		X	X	X
Lewis	X	X	X	X
Nez Perce	X	X	X	X
Shoshone				
Valley		X		X

Table 124. Oregon Chinook ESUs by county. "X" indicates presence of the species in a county.

OR County	Chinook Salmon				
	Lower Columbia River	Upper Columbia River Spring Run	Snake River Fall Run	Snake River Spring/ Summer Run	Upper Willamette River
Baker			X	X	
Benton					X
Clackamas	X				X
Clatsop	X	X	X	X	X
Columbia	X	X	X	X	X
Coos					
Crook					
Curry					
Douglas					
Gilliam		X	X	X	
Grant					
Hood River	X	X	X	X	
Jackson					
Jefferson					
Josephine					
Klamath					
Lane					X
Lincoln					
Linn					X
Marion					X
Morrow		X	X	X	
Multnomah	X	X	X	X	X
Polk					X
Sherman		X	X	X	
Tillamook					
Umatilla		X	X	X	
Union				X	
Wallowa			X	X	
Wasco		X	X	X	
Washington					
Wheeler					
Yamhill					X

Table 125. Oregon Chum, Coho, and Sockeye Salmon ESUs by county. “X” indicates presence of the species in a county.

	Chum Salmon	Coho Salmon			Sockeye Salmon
OR County	Columbia River	Lower Columbia River	Oregon Coast	Southern OR Northern CA Coast	Snake River
Baker					
Benton			X		
Clackamas		X			
Clatsop	X	X	X		X
Columbia	X	X	X		X
Coos			X		
Crook					
Curry			X	X	
Douglas			X	X	
Gilliam					X
Grant					
Hood River	X	X			X
Jackson				X	
Jefferson					
Josephine				X	
Klamath				X	
Lane			X		
Lincoln			X		
Linn					
Marion		X			
Morrow					X
Multnomah	X	X			X
Polk			X		
Sherman					X
Tillamook			X		
Umatilla					X
Union					
Wallowa					X
Wasco		X			X
Washington			X		
Wheeler					
Yamhill			X		

Table 126. Oregon Steelhead DPSs by county. "X" indicates presence of the species in a county.

OR County	Steelhead				
	Lower Columbia River	Upper Willamette River	Middle Columbia River	Upper Columbia River	Snake River
Baker					
Benton		X			
Clackamas	X	X			
Clatsop	X	X	X	X	X
Columbia	X	X	X	X	X
Coos					
Crook			X		
Curry					
Douglas					
Gilliam			X	X	X
Grant			X		
Hood River	X		X	X	X
Jackson					
Jefferson			X		
Josephine					
Klamath					
Lane					
Lincoln					
Linn		X			
Marion	X	X			
Morrow			X	X	X
Multnomah	X	X	X	X	X
Polk		X			
Sherman			X		X
Tillamook		X			
Umatilla			X	X	X
Union			X		X
Wallowa			X		X
Wasco			X	X	X
Washington		X			
Wheeler			X		
Yamhill		X			

Table 127. Washington Chinook ESUs by county. “X” indicates presence of the species in a county.

	Chinook Salmon					
WA County	Puget Sound	Lower Columbia River	Upper Columbia River Spring Run	Snake River Fall Run	Snake River Spring/ Summer Run	Upper Willamette River
Adams				X		
Asotin				X	X	
Benton			X	X	X	
Chelan			X			
Clallam	X					
Clark		X	X	X	X	X
Columbia				X	X	
Cowlitz		X	X	X	X	X
Douglas			X			
Franklin			X	X	X	
Garfield				X	X	
Grant			X			
Jefferson	X					
King	X					
Kitsap						
Kittitas			X			
Klickitat		X	X	X	X	
Lewis		X				
Lincoln				X		
Mason	X					
Okanogan			X			
Pacific		X	X	X	X	X
Pierce	X					
Skagit	X					
Skamania		X	X	X	X	
Snohomish	X					
Spokane				X		
Thurston	X					
Wahkiakum		X	X	X	X	X
Walla Walla			X	X	X	
Whatcom	X					
Whitman				X	X	
Yakima			X			

Table 128. Washington Chum, Coho, and Sockeye Salmon ESUs by county. "X" indicates presence of the species in a county.

WA County	Chum Salmon		Coho Salmon	Sockeye Salmon	
	Hood Canal	Columbia River	Lower Columbia River	Ozette Lake	Snake River
Adams					
Asotin					X
Benton					X
Chelan					
Clallam	X			X	
Clark		X	X		X
Columbia					X
Cowlitz		X	X		X
Douglas					
Franklin					X
Garfield					X
Grant					
Jefferson	X				
King					
Kitsap	X				
Kittitas					
Klickitat		X	X		X
Lewis		X	X		
Lincoln					
Mason	X				
Okanogan					
Pacific		X	X		X
Pierce					
Skagit					
Skamania		X	X		X
Snohomish					
Spokane					
Thurston					
Wahkiakum		X	X		X
Walla Walla					X
Whatcom					
Whitman					X
Yakima					

Table 129. Washington Steelhead DPSs by county. "X" indicates presence of the species in a county.

WA County	Steelhead					
	Puget Sound	Lower Columbia River	Upper Willamette River	Middle Columbia River	Upper Columbia River	Snake River
Adams					X	
Asotin						X
Benton				X	X	X
Chelan					X	
Clallam	X					
Clark		X	X	X	X	X
Columbia				X		X
Cowlitz		X	X	X	X	X
Douglas					X	
Franklin				X	X	X
Garfield						X
Grant					X	
Jefferson	X					
King	X			X		
Kitsap						
Kittitas				X	X	
Klickitat		X		X	X	X
Lewis		X		X		
Lincoln						
Mason	X					
Okanogan					X	
Pacific		X	X	X	X	X
Pierce	X			X		
Skagit	X					
Skamania		X		X	X	X
Snohomish	X					
Spokane						
Thurston	X					
Wahkiakum		X	X	X	X	X
Walla Walla				X	X	X
Whatcom	X					
Whitman						X
Yakima				X	X	

Designated Critical Habitat Location Information

A) California Coast chinook salmon. Critical habitat is designated to include the areas defined in the following CALWATER Hydrologic units:
(1) Redwood Creek Hydrologic Unit 1107
(i) Orick Hydrologic Sub-area 110710.
Outlet(s) = Redwood Creek (Lat 41.2923, Long -124.0917)
Upstream to endpoint(s) in:
Boyes Creek (41.3639, -123.9845);
Bridge Creek (41.137, -124.0012);
Brown Creek (41.3986, -124.0012);
Emerald (Harry Weir) (41.2142, -123.9812);
Godwood Creek (41.3889, -124.0312);
Larry Dam Creek (41.3359, -124.003);
Little Lost Man Creek (41.2944, -124.0014);
Lost Man Creek (41.3133, -123.9854);
May Creek (41.3547, -123.999);
McArthur Creek (41.2705, -124.041);
North Fork Lost Man Creek (41.3374, -123.9935);
Prairie Creek (41.4239, -124.0367);
Tom McDonald (41.1628, -124.0419).
(ii) Beaver Hydrologic Sub-area 110720.
Outlet(s) = Redwood Creek (Lat 41.1367, Long -123.9309)
Upstream to endpoint(s):
Lacks Creek (41.0334, -123.8124);
Minor Creek (40.9706, -123.7899).
(iii) Lake Prairie Hydrologic Sub-area 110730.
Outlet(s) = Redwood Creek (Lat 40.9070, Long -123.8170)
Upstream to endpoint(s) in:
Redwood Creek (40.7432, -123.7206).
(2) Trinidad Hydrologic Unit 1108 -
(i) Big Lagoon Hydrologic Sub-area 110810.
Outlet(s) = Maple Creek (Lat 41.1555, Long -124.1380)
Upstream to endpoint(s) in:
North Fork Maple Creek (41.1317, -124.0824);
Maple Creek (41.1239, -124.1041).
(ii) Little River Hydrologic Sub-area 110820.
Outlet(s) = Little River (41.0277, -124.1112)
Upstream to endpoint(s) in:
South Fork Little River (40.9908, -124.0412);
Little River (41.0529, -123.9727);
Railroad Creek (41.0464, -124.0475);
Lower South Fork Little River (41.0077, -124.0078);
Upper South Fork Little River (41.0131, -123.9853).
(3) Mad River Hydrologic Unit 1109 -
(i) Blue Lake Hydrologic Sub-area 110910.

Outlet(s) = Mad River (Lat 40.9139, Long -124.0642)
Upstream to endpoint(s) in:
  Lindsay Creek (40.983, -124.0326);
  Mill Creek (40.9008, -124.0086);
  North Fork Mad River (40.8687, -123.9649);
  Squaw Creek (40.9426, -124.0202);
  Warren Creek (40.8901, -124.0402).
(ii) North Fork Mad River 110920.
Outlet(s) = North Fork Mad River (Lat 40.8687, Long -123.9649)
Upstream to endpoint(s) in:
  Sullivan Gulch (40.8646, -123.9553);
  North Fork Mad River (40.8837, -123.9436).
(iii) Butler Valley 110930.
Outlet(s) = Mad River (Lat 40.8449, Long -123.9807)
Upstream to endpoint(s) in:
  Black Creek (40.7547, -123.9016);
  Black Dog Creek (40.8334, -123.9805);
  Canon Creek (40.8362, -123.9028);
  Dry Creek (40.8218, -123.9751);
  Mad River (40.7007, -123.8642);
  Maple Creek (40.7928, -123.8742);
  Unnamed (40.8186, -123.9769).

(4) Eureka Plain Hydrologic Unit 1110 -
(i) Eureka Plain Hydrologic Subarea 111000.
Outlet(s) = Mad River (Lat 40.9560, Long -124.1278);
  Jacoby Creek (40.8436, -124.0834);
  Freshwater Creek (40.8088, -124.1442);
  Elk River (40.7568, -124.1948);
  Salmon Creek (40.6868, -124.2194)
Upstream to endpoint(s) in:
  Bridge Creek (40.6958, -124.0795);
  Dunlap Gulch (40.7101, -124.1155);
  Freshwater Creek (40.7389, -123.9944);
  Gannon Slough (40.8628, -124.0818);
  Jacoby Creek (40.7944, -124.0093);
  Little Freshwater Creek (40.7485, -124.0652);
  North Branch of the North Fork Elk River (40.6878, -124.0131);
  North Fork Elk River (40.6756, -124.0153);
  Ryan Creek (40.7835, -124.1198);
  Salmon Creek (40.6438, -124.1319);
  South Branch of the North Fork Elk River (40.6691, -124.0244);
  South Fork Elk River (40.6626, -124.061);
  South Fork Freshwater Creek (40.7097, -124.0277).
(i) Ferndale Hydrologic Sub-area 111111.
Outlet(s) = Eel River (Lat 40.6282, Long -124.2838)
Upstream to endpoint(s) in:

Atwell Creek (40.472, -124.1449);
Howe Creek (40.4748, -124.1827);
Price Creek (40.5028, -124.2035);
Strongs Creek (40.5986, -124.1222);
Van Duzen River (40.5337, -124.1262).

(ii) Scotia Hydrologic Sub-area 111112.

Outlet(s) = Eel River (Lat 40.4918, Long -124.0998)

Upstream to endpoint(s) in:

Bear Creek (40.391, -124.0156);
Chadd Creek (40.3921, -123.9542);
Jordan Creek (40.4324, -124.0428);
Monument Creek (40.4676, -124.1133).

(iii) Larabee Creek Hydrologic Subarea 111113.

Outlet(s) = Larabee Creek (40.4090, Long -123.9334)

Upstream to endpoint(s) in:

Carson Creek (40.4189, -123.8881);
Larabee Creek (40.3950, -123.8138).

(iv) Hydesville Hydrologic Sub-area 111121.

Outlet(s) = Van Duzen River (Lat 40.5337, Long -124.1262)

Upstream to endpoint(s) in:

Cummings Creek (40.5258, -123.9896);
Fielder Creek (40.5289, -124.0201);
Hely Creek (40.5042, -123.9703);
Yager Creek (40.5583, -124.0577).

(v) Yager Creek Hydrologic Sub-area 111123.

Outlet(s) = Yager Creek (Lat 40.5583, Long -124.0577)

Upstream to endpoint(s) in:

Corner Creek (40.6189, -123.9994);
Fish Creek (40.6392, -124.0032);
Lawrence Creek (40.6394, -123.9935);
Middle Fork Yager Creek (40.5799, -123.9015);
North Fork Yager Creek (40.6044, -123.9084);
Owl Creek (40.5557, -123.9362);
Shaw Creek (40.6245, -123.9518);
Yager Creek (40.5673, -123.9403).

(vi) Weott Hydrologic Sub-area 111131.

Outlet(s) = South Fork Eel River (Lat 40.3500, Long -213.9305)

Upstream to endpoint(s) in:

Bridge Creek (40.2929, -123.8569);
Bull Creek (40.3148, -124.0343);
Canoe Creek (40.2909, -123.922);
Cow Creek (40.3583, -123.9626);
Cuneo Creek (40.3377, -124.0385);
Elk Creek (40.2837, -123.8365);
Fish Creek (40.2316, -123.7915);
Harper Creek (40.354, -123.9895);

Mill Creek (40.3509, -124.0236);
Salmon Creek (40.2214, -123.9059);
South Fork Salmon River (40.1769, -123.8929);
Squaw Creek (40.3401, -123.9997);
Tostin Creek (40.1722, -123.8796).

(vii) Benbow Hydrologic Sub-area 111132.
Outlet(s) = South Fork Eel River (Lat 40.1932, Long -123.7692)
Upstream to endpoint(s) in:

Anderson Creek (39.9337, -123.8933);
Bear Pen Creek (39.9125, -123.8108);
Bear Wallow Creek (39.7296, -123.7172);
Bond Creek (39.7856, -123.6937);
Butler Creek (39.7439, -123.692);
China Creek (40.1035, -123.9493);
Connick Creek (40.0911, -123.8187);
Cox Creek (40.0288, -123.8542);
Cummings Creek (39.8431, -123.5752);
Dean Creek (40.1383, -123.7625);
Dinner Creek (40.0915, -123.937);
East Branch South Fork Eel River (39.9433, -123.6278);
Elk Creek (39.7986, -123.5981);
Fish Creek (40.0565, -123.7768);
Foster Creek (39.8455, -123.6185);
Grapewine Creek (39.7991, -123.5186);
Hartsook Creek (40.012, -123.7888);
Hollow Tree Creek (39.7316, -123.6918);
Huckleberry Creek (39.7315, -123.7253);
Indian Creek (39.9464, -123.8993);
Jones Creek (39.9977, -123.8378);
Leggett Creek (40.1374, -123.8312);
Little Sproul Creel (40.0897, -123.8585);
Low Gap Creek (39.993, -123.767);
McCoy Creek (39.9598, -123.7542);
Michaelís Creek (39.7642, -123.7175);
Miller Creek (40.1215, -123.916);
Moody Creek (39.9531, -123.8819);
Mud Creek (39.8232, -123.6107);
Piercy Creek (39.9706, -123.8189);
Pollock Creek (40.0822, -123.9184);
Rattlesnake Creek (39.7974, -123.5426);
Redwood Creek (39.7721, -123.7651);
Redwood Creek (40.0974, -123.9104);
Seely Creek (40.1494, -123.8825);
Somerville Creek (40.0896, -123.8913);
South Fork Redwood Creek (39.7663, -123.7579);
Spoul Creek (40.0125, -123.8585);

Standley Creek (39.9479, -123.8083);
Tom Long Creek (40.0315, -123.6891);
Twin Rocks Creek (39.8269, -123.5543);
Warden Creek (40.0625, -123.8546);
West Fork Sproul Creek (40.0386, -123.9015);
Wildcat Creek (39.9049, -123.7739);
Wilson Creek (39.841, -123.6452);
Unnamed Tributary (40.1136, -123.9359).

(viii) Laytonville Hydrologic Sub-area 111133.
Outlet(s) = South Fork Eel River (Lat 39.7665, Long -123.6484)
Upstream to endpoint(s) in:
Bear Creek (39.6413, -123.5797);
Cahto Creek (39.6624, -123.5453);
Dutch Charlie Creek (39.6892, -123.6818);
Grub Creek (39.7777, -123.5809);
Jack of Hearts Creek (39.7244, -123.6802);
Kenny Creek (39.6733, -123.6082);
Mud Creek (39.6561, -123.592);
Redwood Creek (39.6738, -123.6631);
Rock Creek (39.6931, -123.6204);
South Fork Eel River (39.6271, -123.5389);
Streeter Creek (39.7328, -123.5542);
Ten Mile Creek (39.6651, -123.451).

(ix) Sequoia Hydrologic Sub-area 111141.
Outlet(s) = Eel River (Lat 40.3557, Long -123.9191);
South Fork Eel River (40.3558, -123.9194)
Upstream to endpoint(s) in:
Brock Creek (40.2411, -123.7248);
Dobbyn Creek (40.2216, -123.6029);
Hoover Creek (40.2312, -123.5792);
Line Gulch (40.1655, -123.4831);
North Fork Dobbyn Creek (40.2669, -123.5467);
South Fork Dobbyn Creek (40.1723, -123.5112);
South Fork Eel River (40.35, -123.9305);
Unnamed Tributary (40.3137, -123.8333);
Unnamed Tributary (40.2715, -123.549).

(x) Spy Rock Hydrologic Sub-area 111142.
Outlet(s) = Eel River (Lat 40.1736, Long -123.6043)
Upstream to endpoint(s) in:
Bell Springs Creek (39.9399, -123.5144);
Burger Creek (39.6943, -123.413);
Chamise Creek (40.0563, -123.5479);
Jewett Creek (40.1195, -123.6027);
Kekawaka Creek (40.0686, -123.4087);
Woodman Creek (39.7639, -123.4338).

(xi) North Fork Eel River Hydrologic Sub-area 111150.

Outlet(s) = North Fork Eel River (Lat 39.9567, Long -123.4375)
Upstream to endpoint(s) in:
North Fork Eel River (39.9370, -123.3758).

(xii) Outlet Creek Hydrologic Sub-area 111161.
Outlet(s) = Outlet Creek (Lat 39.6263, Long -123.3453)
Upstream to endpoint(s) in:
Baechtel Creek (39.3688, -123.4028);
Berry Creek (39.4272, -123.2951);
Bloody Run (39.5864, -123.3545);
Broaddus Creek (39.3907, -123.4163);
Davis Creek (39.3701, -123.3007);
Dutch Henry Creek (39.5788, -123.4543);
Haehl Creek (39.3795, -123.3393);
Long Valley Creek (39.6091, -123.4577);
Ryan Creek (39.4803, -123.3642);
Upp Creek (39.4276, -123.3578);
Upp Creek VerDate Aug<18>2005 17: (39.4276, -123.3578);
Willits Creek (39.4315, -123.3794).

(xiii) Tomki Creek Hydrologic Subarea 111162.
Outlet(s) = Eel River (Lat 39.7138, Long -123.3531)
Upstream to endpoint(s) in:
Cave Creek (39.3925, -123.2318);
Long Branch Creek (39.4074, -123.1897);
Rocktree Creek (39.4533, -123.3079);
Salmon Creek (39.4461, -123.2104);
Scott Creek (39.456, -123.2297);
String Creek (39.4855, -123.2891);
Tomki Creek (39.549, -123.3613);
Wheelbarrow Creek (39.5029, -123.3287).

(xiv) Lake Pillsbury Hydrologic Subarea 111163.
Outlet(s) = Eel River (Lat 39.3860, Long -123.1163)
Upstream to endpoint(s) in:
Eel River (39.4078, -122.958).

(xv) Eden Valley Hydrologic Sub-area 111171.
Outlet(s) = Middle Fork Eel River (Lat 39.8146, Long -123.1332)
Upstream to endpoint(s) in:
Middle Fork Eel River (39.8145, -123.1333).

(xvi) Round Valley Hydrologic Subarea 111172.
Outlet(s) = Mill Creek (Lat 39.7396, Long -123.1420);
Williams Creek (39.8145, -123.1333)
Upstream to endpoint(s) in:
Mill Creek (39.8456, -123.2822);
Murphy Creek (39.8804, -123.1636);
Poor Mans Creek (39.8179, -123.1833);
Short Creek (39.8645, -123.2242);
Turner Creek (39.7238, -123.2191);

Williams Creek (39.8596, -123.1341).
(6) Cape Mendocino Hydrologic Unit 1112 -
(i) Capetown Hydrologic Subarea 111220.
Outlet(s) = Bear River (Lat 40.4744, Long -124.3881)
Upstream to endpoint(s) in:
Bear River (40.3591, -124.0536);
South Fork Bear River (40.4271, -124.2873).
(ii) Mattole River Hydrologic Sub-area 111230.
Outlet(s) = Mattole River (Lat 40.2942, Long -124.3536)
Upstream to endpoint(s) in:
Bear Creek (40.1262, -124.0631);
Blue Slide Creek (40.1286, -123.9579);
Bridge Creek (40.0503, -123.9885);
Conklin Creek (40.3169, -124.229);
Dry Creek (40.2389, -124.0621);
East Fork Honeydew Creek (40.1633, -124.0916);
East Fork of the North Fork Mattole River (40.3489, -124.2244);
Eubanks Creek (40.0893, -123.9743);
Gilham Creek (40.2162, -124.0309);
Grindstone Creek (40.1875, -124.0041);
Honeydew Creek (40.1942, -124.1363);
Mattole Canyon (40.1833, -123.9666);
Mattole River (39.9735, -123.9548);
McGinnis Creek (40.3013, -124.2146);
McKee Creek (40.0674, -123.9608);
Mill Creek (40.0169, -123.9656);
North Fork Mattole River (40.3729, -124.2461);
North Fork Bear Creek (40.1422, -124.0945);
Oil Creek (40.3008, -124.1253);
Rattlesnake Creek (40.2919, -124.1051);
South Fork Bear Creek (40.0334, -124.0232);
Squaw Creek (40.219, -124.1921);
Thompson Creek (39.9969, -123.9638);
Unnamed (40.1522, -124.0989);
Upper North Fork Mattole River (40.2907, -124.1115);
Westlund Creek (40.2333, -124.0336);
Woods creek (40.2235, -124.1574);
Yew Creek (40.0019, -123.9743).
(7) Mendocino Coast Hydrologic Unit 1113 -
(i) Wages Creek Hydrologic Subarea 111312.
Outlet(s) = Wages Creek (Lat 39.6513, Long -123.7851)
Upstream to endpoint(s) in:
Wages Creek (39.6393, -123.7146).
(ii) Ten Mile River Hydrologic Subarea 111313.
Outlet(s) = Ten Mile River (Lat 39.5529, Long -123.7658)
Upstream to endpoint(s) in:

Middle Fork Ten Mile River (39.5397, -123.5523);
Little North Fork Ten Mile River (39.6188, -123.7258);
Ten Mile River (39.5721, -123.7098);
South Fork Ten Mile River (39.4927, -123.6067);
North Fork Ten Mile River (39.5804, -123.5735).

(iii) Noyo River Hydrologic Sub-area 111320.
Outlet(s) = Noyo River (Lat 39.4274, Long -123.8096)
Upstream to endpoint(s) in:
North Fork Noyo River (39.4541, -123.5331);
Noyo River (39.431, 123.494);
South Fork Noyo River (39.3549, -123.6136).

(iv) Big River Hydrologic Sub-area 111330.
Outlet(s) = Big River (Lat 39.3030, Long -123.7957)
Upstream to endpoint(s) in:
Big River (39.3095, -123.4454).

(v) Albion River Hydrologic Sub-area 111340.
Outlet(s) = Albion River (Lat 39.2253, Long -123.7679)
Upstream to endpoint(s) in:
Albion River (39.2644, -123.6072).

(vi) Garcia River Hydrologic Sub-area 111370.
Outlet(s) = Garcia River (Lat 38.9455, Long -123.7257)
Upstream to endpoint(s) in:
Garcia River (38.9160, -123.4900).

(8) Russian River Hydrologic Unit 1114

(i) Guerneville Hydrologic Subarea 111411.
Outlet(s) = Russian River (Lat 38.4507, Long -123.1289)
Upstream to endpoint(s) in:
Austin Creek (38.5099, -123.0681);
Mark West Creek (38.4961, -122.8489).

(ii) Austin Creek Hydrologic Sub-area 111412.
Outlet(s) = Austin Creek (Lat 38.5099, Long -123.0681)
Upstream to endpoint(s) in:
Austin Creek (38.5326, -123.0844).

(iii) Warm Springs Hydrologic Subarea 111424.
Outlet(s) = Dry Creek (Lat 38.5861, Long -122.8573)
Upstream to endpoint(s) in:
Dry Creek (38.7179, -123.0075).

(iv) Geyserville Hydrologic Sub-area 111425.
Outlet(s) = Russian River (Lat 38.6132, Long -122.8321)
Upstream.

(v) Ukiah Hydrologic Sub-area 111431.
Outlet(s) = Russian River (Lat 38.8828, Long -123.0557)
Upstream to endpoint(s) in:
Feliz Creek (38.9941, -123.1779).

(vi) Forsythe Creek Hydrologic Subarea 111433.
Outlet(s) = Russian River (Lat 39.2257, Long -123.2012)

Upstream to endpoint(s) in:
Forsythe Creek (39.2780, -123.2608);
Russian River (39.3599, -123.2326).

(B) Northern California Steelhead (O. mykiss). Critical habitat is designated to include the areas defined in the following CALWATER Hydrologic units:

(1) Redwood Creek Hydrologic Unit 1107 -
(i) Orick Hydrologic Sub-area 110710.
Outlet(s) = Boat Creek (Lat 41.4059, Long -124.0675);
Home Creek (41.4027, -124.0683);
Redwood Creek (41.2923, -124.0917);
Squashan Creek (41.3889, -124.0703)
Upstream to endpoint(s) in:
Boat Creek (41.4110, -124.0583);
Bond Creek (41.2326, -124.0262);
Boyes Creek (41.3701, -124.9891);
Bridge Creek (41.1694, -123.9964);
Brown Creek (41.3986, -124.0012);
Cloquet Creek (41.2466, -123.9884);
Cole Creek (41.2209, -123.9931);
Copper Creek (41.1516, -123.9258);
Dolason Creek (41.1969, -123.9667);
Elam Creek (41.2613, -124.0321);
Emerald Creek (41.2164, -123.9808);
Forty Four Creek (41.2187, -124.0195);
Gans South Creek (41.2678, -124.0071);
Godwood Creek (41.3787, -124.0354);
Hayes Creek (41.2890, -124.0164);
Home Creek (41.3951, -124.0386);
Larry Dam Creek (41.3441, -123.9966);
Little Lost Man Creek (41.3078, -124.0084);
Lost Man Creek (41.3187, -123.9892);
May Creek (41.3521, -124.0164);
McArthur Creek (41.2702, -124.0427);
Miller Creek (41.2305, -124.0046);
North Fork Lost Man Creek (41.3405, -123.9859);
Oscar Larson Creek (41.2559, -123.9943);
Prairie Creek (41.4440, -124.0411);
Skunk Cabbage Creek (41.3211, -124.0802);
Slide Creek (41.1736, -123.9450);
Squashan Creek (41.3739, -124.0440);
Streelow Creek (41.3622, -124.0472);
Tom McDonald Creek (41.1933, -124.0164);
Unnamed Tributary (41.3619, -123.9967);
Unnamed Tributary (41.3424, -124.0572).
(ii) Beaver Hydrologic Sub-area 110720.

Outlet(s) = Redwood Creek (Lat 41.1367, Long -123.9309)
Upstream to endpoint(s) in:
Beaver Creek (41.0208, -123.8608);
Captain Creek (40.9199, -123.7944);
Cashmere Creek (41.0132, -123.8862);
Coyote Creek (41.1251, -123.8926);
Devils Creek (41.1224, -123.9384);
Garcia Creek (41.0180, -123.8923);
Garrett Creek (41.0904, -123.8712);
Karen Court Creek (41.0368, -123.8953);
Lacks Creek (41.0306, -123.8096);
Loin Creek (40.9465, -123.8454);
Lupton Creek (40.9058, -123.8286);
Mill Creek (41.0045, -123.8525);
Minor Creek (40.9706, -123.7899);
Molasses Creek (40.9986, -123.8490);
Moon Creek (40.9807, -123.8368);
Panther Creek (41.0732, -123.9275);
Pilchuck Creek (41.9986, -123.8710);
Roaring Gulch (41.0319, -123.8674);
Santa Fe Creek (40.9368, -123.8397);
Sweathouse Creek (40.9332, -123.8131);
Toss-Up Creek (40.9845, -123.8656);
Unnamed Tributary (41.1270, -123.8967);
Wiregrass Creek (40.9652, -123.8553).
(iii) Lake Prairie Hydrologic Sub-area 110730.
Outlet(s) = Redwood Creek (Lat 40.9070, Long -123.8170)
Upstream to endpoint(s) in:
Bradford Creek (40.7812, -123.7215);
Cut-Off Meander (40.8507, -123.7729);
Emmy Lou Creek (40.8655, -123.7771);
Gunrack Creek (40.8391, -123.7650);
High Prairie Creek (40.8191, -123.7723);
Jena Creek (40.8742, -123.8065);
Lake Prairie Creek (40.7984, -123.7558);
Lupton Creek (40.9058, -123.8286);
Minon Creek (40.8140, -123.7372);
Noisy Creek (40.8613, -123.8044);
Pardee Creek (40.7779, -123.7416);
Redwood Creek (40.7432, -123.7206);
Simion Creek (40.8241, -123.7560);
Six Rivers Creek (40.8352, -123.7842);
Smokehouse Creek (40.7405, -123.7278);
Snowcamp Creek (40.7415, -123.7296);
Squirrel Trail Creek (40.8692, -123.7844);
Twin Lakes Creek (40.7369, -123.7214);

Panther Creek (40.8019, -123.7094);
Windy Creek (40.8866, -123.7956).

(2) Trinidad Hydrologic Unit 1108 -

(i) Big Lagoon Hydrologic Sub-area 110810.

Outlet(s) = Maple Creek (Lat 41.1555, Long -124.1380);
McDonald Creek (41.2521, -124.0919)

Upstream to endpoint(s) in:
Beach Creek (41.0716, -124.0239);
Clear Creek (41.1031, -124.0030);
Diamond Creek (41.1571, -124.0926);
Maple Creek (41.0836, -123.9790);
McDonald Creek (41.1850, -124.0773);
M-Line Creek (41.0752, -124.0787);
North Fork Maple Creek (41.1254, -124.0539);
North Fork McDonald Creek (41.2107, -124.0664);
Pitcher Creek (41.1518, -124.0874);
South Fork Maple Creek (41.1003, -124.1119);
Tom Creek (41.1773, -124.0966);
Unnamed Tributary (41.1004, -124.0155);
Unnamed Tributary (41.0780, -124.0676);
Unnamed Tributary (41.1168, -124.0886);
Unnamed Tributary (41.0864, -124.0899);
Unnamed Tributary (41.1132, -124.0827);
Unnamed Tributary (41.0749, -124.0889);
Unnamed Tributary (41.1052, -124.0675);
Unnamed Tributary (41.0714, -124.0611);
Unnamed Tributary (41.0948, -124.0016).

(ii) Little River Hydrologic Sub-area 110820.

Outlet(s) = Little River (Lat 41.0277, Long -124.1112)

Upstream to endpoint(s) in:
Freeman Creek (41.0242, -124.0582);
Little River (40.9999, -123.9232);
Lower South Fork Little River (41.0077, -124.0079);
Railroad Creek (41.0468, -124.0466);
South Fork Little River (40.9899, -124.0394);
Unnamed Tributary (41.0356, -123.9958);
Unnamed Tributary (41.0407, -124.0598);
Unnamed Tributary (41.0068, -123.9830);
Unnamed Tributary (41.0402, -124.0111);
Unnamed Tributary (41.0402, -124.0189);
Unnamed Tributary (41.0303, -124.0366);
Unnamed Tributary (41.0575, -123.9710);
Unnamed Tributary (41.0068, -123.9830);
Upper South Fork Little River (41.0146, -123.9826).

(3) Mad River Hydrologic Unit 1109 -

(i) Blue Lake Hydrologic Sub-area 110910.

Outlet(s) = Mad River (Lat 40.9139, Long -124.0642);
Strawberry Creek (40.9964, -124.1155);
Widow White Creek (40.9635, -124.1253)
Upstream to endpoint(s) in:
Boundary Creek (40.8395, -123.9920);
Grassy Creek (40.9314, -124.0188);
Hall Creek (40.9162, -124.0141);
Kelly Creek (40.8656, -124.0260);
Leggit Creek (40.8808, -124.0269);
Lindsay Creek (40.9838, -124.0283);
Mather Creek (40.9796, -124.0526);
Mill Creek (40.9296, -124.1037);
Mill Creek (40.9162, -124.0141);
Mill Creek (40.8521, -123.9617);

North Fork Mad River (40.8687, -123.9649);
Norton Creek (40.9572, -124.1003);
Palmer Creek (40.8633, -124.0193);
Puter Creek (40.8474, -123.9966);
Quarry Creek (40.8526, -124.0098);
Squaw Creek (40.9426, -124.0202);
Strawberry Creek (40.9761, -124.0630);
Unnamed Tributary (40.9624, -124.0179);
Unnamed Tributary (40.9549, -124.0554);
Unnamed Tributary (40.9672, -124.0218);
Warren Creek (40.8860, -124.0351);
Widow White Creek (40.9522, -124.0784).
(ii) North Fork Mad River Hydrologic Sub-area 110920.
Outlet(s) = North Fork Mad River (Lat 40.8687, Long -123.9649)
Upstream to endpoint(s) in:
Bald Mountain Creek (40.8922, -123.9097);
Canyon Creek (40.9598, -123.9269);
Denman Creek (40.9293, -123.9429);
East Fork North Fork (40.9702, -123.9449);
Gosinta Creek (40.9169, -123.9420);
Hutchery Creek (40.8730, -123.9503);
Jackson Creek (40.9388, -123.9462);
Krueger Creek (40.9487, -123.9571);
Long Prairie Creek (40.9294, -123.8842);
Mule Creek (40.9416, -123.9309);
North Fork Mad River (40.9918, -123.9610);
Pine Creek (40.9274, -123.9096);
Pollock Creek (40.9081, -123.9071);
Sullivan Gulch (40.8646, -123.9553);
Tyson Creek (40.9559, -123.9738);
Unnamed Tributary (40.9645, -123.9338);

Unnamed Tributary (40.9879, -123.9511);
Unnamed Tributary (40.9906, -123.9540);
Unnamed Tributary (40.9866, -123.9788);
Unnamed Tributary (40.9927, -123.9736)

(iii) Butler Valley Hydrologic Sub-area 110930.
Outlet(s) = Mad River (Lat 40.8449, Long -123.9807)
Upstream to endpoint(s) in:

Bear Creek (40.5468, -123.6728);
Black Creek (40.7521, -123.9080);
Black Dog Creek (40.8334, -123.9805);
Blue Slide Creek (40.7333, -123.9225);
Boulder Creek (40.7634, -123.8667);
Bug Creek (40.6587, -123.7356);
Cannon Creek (40.8535, -123.8850);
Coyote Creek (40.6147, -123.6488);
Devil Creek (40.8032, -123.9175);
Dry Creek (40.8218, -123.9751);
East Creek (40.5403, -123.5579);
Maple Creek (40.7933, -123.8353);
Pilot Creek (40.5950, -123.5888);
Simpson Creek (40.8138, -123.9156);
Unnamed Tributary (40.7306, -123.9019);
Unnamed Tributary (40.7739, -123.9255);
Unnamed Tributary (40.7744, -123.9137);
Unnamed Tributary (40.8029, -123.8716);
Unnamed Tributary (40.8038, -123.8691);
Unnamed Tributary (40.8363, -123.9025).

(4) Eureka Plain Hydrologic Unit 1110 -

(i) Eureka Plain Hydrologic Subarea 111000 Outlet(s) = Elk River (Lat 40.7568, Long -124.1948);

Freshwater Creek (40.8088, -124.1442);
Jacoby Creek (40.8436, -124.0834);
Mad River (40.9560, -124.1278);
Rocky Gulch (40.8309, -124.0813);
Salmon Creek (40.6868, -124.2194);
Washington Gulch (40.8317, -124.0805)

Upstream to endpoint(s) in:

Bridge Creek (40.6958, -124.0805);
Browns Gulch (40.7038, -124.1074);
Clapp Gulch (40.6967, -124.1684);
Cloney Gulch (40.7826, -124.0347);
Doe Creek (40.6964, -124.0201);
Dunlap Gulch (40.7076, -124.1182);
Falls Gulch (40.7655, -124.0261);
Fay Slough (40.8033, -124.0574);
Freshwater Creek (40.7385, -124.0035);

Golf Course Creek (40.8406, -124.0402);
Graham Gulch (40.7540, -124.0228);
Guptil Gulch (40.7530, -124.1202);
Henderson Gulch (40.7357, -124.1394);
Jacoby Creek (40.7949, -124.0096);
Lake Creek (40.6848, -124.0831);
Line Creek (40.6578, -124.0460);
Little Freshwater Creek (40.7371, -124.0649);
Little North Fork Elk River (40.6972, -124.0100);
Little South Fork Elk River (40.6555, -124.0877);
Martin Slough (40.7679, -124.1578);
McCready Gulch (40.7824, -124.0441);
McWinney Creek (40.6968, -124.0616);
Morrison Gulch (40.8169, -124.0430);
North Branch of the North Fork Elk River (40.6879, -124.0130);
North Fork Elk River (40.6794- 123.9834);
Railroad Gulch (40.6955, -124.1545);
Rocky Gulch (40.8170, -124.0613);
Ryan Creek (40.7352, -124.0996);
Salmon Creek (40.6399, -124.1128);
South Branch of the North Fork Elk River (40.6700, -124.0251);
South Fork Elk River (40.6437, -124.0388);
South Fork Freshwater Creek (40.7110, -124.0367);
Swain Slough (40.7524, -124.1825);
Tom Gulch (40.6794, -124.1452);
Unnamed Tributary (40.7850, -124.0561);
Unnamed Tributary (40.7496, -124.1651);
Unnamed Tributary (40.7785, -124.1081);
Unnamed Tributary (40.7667, -124.1054);
Unnamed Tributary (40.7559, -124.0870);
Unnamed Tributary (40.7952, -124.0568);
Unnamed Tributary (40.7408, -124.1118);
Unnamed Tributary (40.7186, -124.1385);
Unnamed Tributary (40.7224, -124.1038);
Unnamed Tributary (40.8210, -124.0111);
Unnamed Tributary (40.8106, -124.0083);
Unnamed Tributary (40.7554, -124.1379);
Unnamed Tributary (40.7457, -124.1138);
Washington Gulch (40.8205, -124.0549).

(5) Eel River Hydrologic Unit 1111 -

(i) Ferndale Hydrologic Sub-area 111111.

Outlet(s) = Eel River (Lat 40.6275, Long -124.2520)

Upstream to endpoint(s) in:

Atwell Creek (40.4824, -124.1498);
Dean Creek (40.4847, -124.1217);
Horse Creek (40.5198, -124.1702);

Howe Creek (40.4654, -124.1916);
Nanning Creek (40.4914, -124.0652);
North Fork Strongs Creek (40.6077, -124.1047);
Price Creek (40.5101, -124.2731);
Rohner Creek (40.6151, -124.1408);
Strongs Creek (40.5999, -124.0985);
Sweet Creek (40.4900, -124.2007);
Van Duzen River (40.5337, -124.1262).

(ii) Scotia Hydrologic Sub-area 111112.
Outlet(s) = Eel River (Lat 40.4918, Long -124.0988)
Upstream to endpoint(s) in:

Bear Creek (40.3942, -124.0262);
Bridge Creek (40.4278, -123.9317);
Chadd Creek (40.3919, -123.9540);
Darnell Creek (40.4533, -123.9808);
Dinner Creek (40.4406, -124.0855);
Greenlow Creek (40.4315, -124.0231);
Jordan Creek (40.4171, -124.0517);
Kiler Creek (40.4465, -124.0952);
Monument Creek (40.4371, -124.1165);
Shively Creek (40.4454, -123.9539);
South Fork Bear Creek (40.3856, -124.0182);
Stitz Creek (40.4649, -124.0531);
Twin Creek (40.4419, -124.0714);
Unnamed Tributary (40.3933, -123.9984);
Weber Creek (40.3767, -123.9094).

(iii) Larabee Creek Hydrologic Subarea 111113.
Outlet(s) = Larabee Creek (Lat 40.4090, Long -123.9334)
Upstream to endpoint(s) in:

Arnold Creek (40.4006, -123.8583);
Balcom Creek (40.4030, -123.8986);
Bosworth Creek (40.3584, -123.7089);
Boulder Flat Creek (40.3530, -123.6381);
Burr Creek (40.4250, -123.7767);
Carson Creek (40.4181, -123.8879);
Chris Creek (40.4146, -123.9235);
Cooper Creek (40.3123, -123.6463);
Dauphiny Creek (40.4049, -123.8893);
Frost Creek (40.3765, -123.7357);
Hayfield Creek (40.3350, -123.6535);
Knack Creek (40.3788, -123.7385);
Larabee Creek (40.2807, -123.6445);
Martin Creek (40.3730, -123.7060);
Maxwell Creek (40.3959, -123.8049);
McMahon Creek (40.3269, -123.6363);
Mill Creek (40.3849, -123.7440);

Mountain Creek (40.2955, -123.6378);
Scott Creek (40.4020, -123.8738);
Smith Creek (40.4194, -123.8568);
Thurman Creek (40.3506, -123.6669);
Unnamed Tributary (40.3842, -123.8062);
Unnamed Tributary (40.3982, -123.7862);
Unnamed Tributary (40.3806, -123.7564);
Unnamed Tributary (40.3661, -123.7398);
Unnamed Tributary (40.3524, -123.7330).
(iv) Hydesville Hydrologic Sub-area 111121.
Outlet(s) = Van Duzen River (Lat 40.5337, Long -124.1262)
Upstream to endpoint(s) in:
Cuddeback Creek (40.5421, -124.0263);
Cummings Creek (40.5282, -123.9770);
Fiedler Creek (40.5351, -124.0106);
Hely Creek (40.5165, -123.9531);
Yager Creek (40.5583, -124.0577);
Unnamed Tributary (40.5718, -124.0946).
(v) Bridgeville Hydrologic Sub-area 111122.
Outlet(s) = Van Duzen River (Lat 40.4942, Long -123.9720)
Upstream to endpoint(s) in:
Bear Creek (40.3455, -123.5763);
Blanket Creek (40.3635, -123.5710);
Browns Creek (40.4958, -123.8103);
Butte Creek (40.4119, -123.7047);
Dairy Creek (40.4174, -123.5981);
Fish Creek (40.4525, -123.8434);
Grizzly Creek (40.5193, -123.8470);
Little Larabee Creek (40.4708, -123.7395);
Little Van Duzen River (40.3021, -123.5540);
North Fork Van Duzen (40.4881, -123.6411);
Panther Creek (40.3921, -123.5866);
Root Creek (40.4490, -123.9018);
Stevens Creek (40.5062, -123.9073);
Thompson Creek (40.4222, -123.6084);
Van Duzen River (40.4820, -123.6629);
Unnamed Tributary (40.3074, -123.5834).
(vi) Yager Creek Hydrologic Sub-area 111123.
Outlet(s) = Yager Creek (Lat 40.5583, Long -124.0577)
Upstream to endpoint(s) in:
Bell Creek (40.6809, -123.9685);
Blanten Creek (40.5839, -124.0165);
Booths Run (40.6584, -123.9428);
Corner Creek (40.6179, -124.0010);
Fish Creek (40.6390, -124.0024);
Lawrence Creek (40.6986, -123.9314);

Middle Fork Yager Creek (40.5782, -123.9243);
North Fork Yager Creek (40.6056, -123.9080);
Shaw Creek (40.6231, -123.9509);
South Fork Yager Creek (40.5451, -123.9409);
Unnamed Yager Creek (40.5673, -123.9403).

(vii) Weott Hydrologic Sub-area 111131.
Outlet(s) = South Fork Eel River (Lat 40.3500, Long -123.9305)
Upstream to endpoint(s) in:

Albee Creek (40.3592, -124.0088);
Bull Creek (40.3587, -123.9624);
Burns Creek (40.3194, -124.0420);
Butte Creek (40.1982, -123.8387);
Canoe Creek (40.2669, -123.9556);
Coon Creek (40.2702, -123.9013);
Cow Creek (40.2664, -123.9838);
Cuneo Creek (40.3401, -124.0494);
Decker Creek (40.3312, -123.9501);
Elk Creek (40.2609, -123.7957);
Fish Creek (40.2459, -123.7729);
Harper Creek (40.3591, -123.9930);
Mill Creek (40.3568, -124.0333);
Mowry Creek (40.2937, -123.8895);
North Fork Cuneo Creek (40.3443, -124.0488);
Ohman Creek (40.1924, -123.7648);
Panther Creek (40.2775, -124.0289);
Preacher Gulch (40.2944, -124.0047);
Salmon Creek (40.2145, -123.8926);
Slide Creek (40.3011, -124.0390);
South Fork Salmon Creek (40.1769, -123.8929);
Squaw Creek (40.3167, -123.9988);
Unnamed Tributary (40.3065, -124.0074);
Unnamed Tributary (40.2831, -124.0359).

(viii) Benbow Hydrologic Sub-area 111132.
Outlet(s) = South Fork Eel River (Lat 40.1929, Long -123.7692)
Upstream to endpoint(s) in:

Anderson Creek (39.9325, -123.8928);
Bear Creek (39.7885, -123.7620);
Bear Pen Creek (39.9201, -123.7986);
Bear Wallow Creek (39.7270, -123.7140);
Big Dan Creek (39.8430, -123.6992);
Bond Creek (39.7778, -123.7060);
Bridges Creek (39.9087, -123.7142);
Buck Mountain Creek (40.0944, -123.7423);
Butler Creek (39.7423, -123.6987);
Cedar Creek (39.8834, -123.6216);
China Creek (40.1035, -123.9493);

Connick Creek (40.0912, -123.8154);
Cox Creek (40.0310, -123.8398);
Cruso Cabin Creek (39.9281, -123.5842);
Durphy Creek (40.0205, -123.8271);
East Branch South Fork Eel River (39.9359, -123.6204);
Elkhorn Creek (39.9272, -123.6279);
Fish Creek (40.0390, -123.7630);
Hartsook Creek (40.0081, -123.8113);
Hollow Tree Creek (39.7250, -123.6924);
Huckleberry Creek (39.7292, -123.7275);
Indian Creek (39.9556, -123.9172);
Islam John Creek (39.8062, -123.7363);
Jones Creek (39.9958, -123.8374);
Leggett Creek (40.1470, -123.8375);
Little Sproul Creek (40.0890, -123.8577);
Lost Man Creek (39.7983, -123.7287);
Low Gap Creek (39.8029, -123.6803);
Low Gap Creek (39.9933, -123.7601);
McCoy Creek (39.9572, -123.7369);
Michaelís Creek (39.7665, -123.7035);
Middle Creek (39.8052, -123.7691);
Milk Ranch Creek (40.0102, -123.7514);
Mill Creek (39.8673, -123.7605);
Miller Creek (40.1319, -123.9302);
Moody Creek (39.9471, -123.8827);
Mule Creek (39.8169, -123.7745);
North Fork Cedar Creek (39.8864, -123.6363);
North Fork McCoy Creek (39.9723, -123.7496);
Piercy Creek (39.9597, -123.8442);
Pollock Creek (40.0802, -123.9341);
Red Mountain Creek (39.9363, -123.7203);
Redwood Creek (39.7723, -123.7648);
Redwood Creek (40.0974, -123.9104);
Rock Creek (39.8962, -123.7065);
Sebbas Creek (39.9934, -123.8903);
Somerville Creek (40.1006, -123.8884);
South Fork Mule Creek (39.8174, -123.7788);
South Fork Redwood Creek (39.7662, -123.7579);
Sproul Creek (40.0226, -123.8649);
Squaw Creek (40.0760, -123.7257);
Standly Creek (39.9327, -123.8309);
Tom Long Creek (40.0175, -123.6551);
Waldron Creek (39.7469, -123.7465);
Walterís Creek (39.7921, -123.7250);
Warden Creek (40.0629, -123.8551);
West Fork Sproul Creek (40.0587, -123.9170);

Wildcat Creek (39.8956, -123.7820);
Unnamed Tributary (39.9927, -123.8807).

(ix) Laytonville Hydrologic Sub-area 111133.
Outlet(s) = South Fork Eel River (Lat 39.7665, Long -123.6484)
Upstream to endpoint(s) in:
Bear Creek (39.6418, -123.5853);
Big Rick Creek (39.7117, -123.5512);
Cahto Creek (39.6527, -123.5579);
Dark Canyon Creek (39.7333, -123.6614);
Dutch Charlie Creek (39.6843, -123.7023);
Elder Creek (39.7234, -123.6192);
Fox Creek (39.7441, -123.6142);
Grub Creek (39.7777, -123.5809);
Jack of Hearts Creek (39.7136, -123.6896);
Kenny Creek (39.6838, -123.5929);
Little Case Creek (39.6892, -123.5441);
Mill Creek (39.6839, -123.5118);
Mud Creek (39.6713, -123.5741);
Mud Springs Creek (39.6929, -123.5629);
Redwood Creek (39.6545, -123.6753);
Rock Creek (39.6922, -123.6090);
Section Four Creek (39.6137, -123.5297);
South Fork Eel River (39.6242, -123.5468);
Streeter Creek (39.7340, -123.5606);
Ten Mile Creek (39.6652, -123.4486);
Unnamed Tributary (39.7004, -123.5678).

(x) Sequoia Hydrologic Sub-area 111141.
Outlet(s) = Eel River (Lat 40.3557, Long -123.9191)
Upstream to endpoint(s) in:
Beatty Creek (40.3198, -123.7500);
Brock Creek (40.2410, -123.7246);
Cameron Creek (40.3313, -123.7707);
Dobbyn Creek (40.2216, -123.6029);
Kapple Creek (40.3531, -123.8585);
Line Gulch Creek (40.1640, -123.4783);
Mud Creek (40.2078, -123.5143);
North Fork Dobbyn Creek (40.2669, -123.5467);
Sonoma Creek (40.2974, -123.7953);
South Fork Dobbyn Creek (40.1723, -123.5112);
South Fork Eel River (40.3500, -123.9305);
South Fork Thompson Creek (40.3447, -123.8334);
Thompson Creek (40.3552, -123.8417);
Unnamed Tributary (40.2745, -123.5487).

(xi) Spy Rock Hydrologic Sub-area 111142.
Outlet(s) = Eel River (Lat 40.1736, Long -123.6043)
Upstream to endpoint(s) in:

Bear Pen Canyon (39.6943, -123.4359);
Bell Springs Creek (39.9457, -123.5313);
Blue Rock Creek (39.8937, -123.5018);
Burger Creek (39.6693, -123.4034);
Chamise Creek (40.0035, -123.5945);
Gill Creek (39.7879, -123.3465);
Iron Creek (39.7993, -123.4747);
Jewett Creek (40.1122, -123.6171);
Kekawaka Creek (40.0686, -123.4087);
Rock Creek (39.9347, -123.5187);
Shell Rock Creek (39.8414, -123.4614);
Unnamed Tributary (39.7579, -123.4709);
White Rock Creek (39.7646, -123.4684);
Woodman Creek (39.7612, -123.4364).

(xii) Outlet Creek Hydrologic Sub-area 111161.

Outlet(s) = Outlet Creek (Lat 39.6265, Long -123.3449)

Upstream to endpoint(s) in:

Baechtel Creek (39.3623, -123.4143);
Berry Creek (39.4271, -123.2777);
Bloody Run Creek (39.5864, -123.3545);
Broaddus Creek (39.3869, -123.4282);
Cherry Creek (39.6043, -123.4073);
Conklin Creek (39.3756, -123.2570);
Davis Creek (39.3354, -123.2945);
Haehl Creek (39.3735, -123.3172);
Long Valley Creek (39.6246, -123.4651);
Mill Creek (39.4196, -123.3919);
Outlet Creek (39.4526, -123.3338);
Ryan Creek (39.4804, -123.3644);
Unnamed Tributary (39.4956, -123.3591);
Unnamed Tributary (39.4322, -123.3848);
Unnamed Tributary (39.5793, -123.4546);
Unnamed Tributary (39.3703, -123.3419);
Upp Creek (39.4479, -123.3825);
Willts Creek (39.4686, -123.4299).

(xiii) Tomki Creek Hydrologic Subarea 111162.

Outlet(s) = Eel River (Lat 39.7138, Long -123.3532)

Upstream to endpoint(s) in:

Cave Creek (39.3842, -123.2148);
Dean Creek (39.6924, -123.3727);
Garcia Creek (39.5153, -123.1512);
Little Cave Creek (39.3915, -123.2462);
Little Creek (39.4146, -123.2595);
Long Branch Creek (39.4074, -123.1897);
Rocktree Creek (39.4534, -123.3053);
Salmon Creek (39.4367, -123.1939);

Scott Creek (39.4492, -123.2286);
String Creek (39.4658, -123.3206);
Tarter Creek (39.4715, -123.2976);
Thomas Creek (39.4768, -123.1230);
Tomki Creek (39.5483, -123.3687);
Whitney Creek (39.4399, -123.1084);
Wheelbarrow Creek (39.5012, -123.3304).

(xiv) Eden Valley Hydrologic Sub-area 111171.

Outlet(s) = Middle Fork Eel River (Lat 39.7138, Long -123.3532)

Upstream to endpoint(s) in:

Crocker Creek (39.5559, -123.0409);
Eden Creek (39.5992, -123.1746);
Elk Creek (39.5371, -123.0101);
Hayshed Creek VerDate Aug<18>2005 17: (39.7082, -123.0967);
Salt Creek (39.6765, -123.2740);
Sportsmans Creek (39.5373, -123.0247);
Sulper Springs (39.5536, -123.0365);
Thatcher Creek (39.6686, -123.0639).

(xv) Round Valley Hydrologic Subarea 111172.

Outlet(s) = Mill Creek (Lat 39.7396, Long -123.1420);
Williams Creek (39.8145, -123.1333)

Upstream to endpoint(s) in:

Cold Creek (39.8714, -123.2991);
Grist Creek (39.7640, -123.2883);
Mill Creek (39.8481, -123.2896);
Murphy Creek (39.8885, -123.1612);
Short Creek (39.8703, -123.2352);
Town Creek (39.7991, -123.2889);
Turner Creek (39.7218, -123.2175);
Williams Creek (39.8903, -123.1212);
Unnamed Tributary (39.7428, -123.2757);
Unnamed Tributary (39.7493, -123.2584).

(xvi) Black Butte River Hydrologic Sub-area 111173.

Outlet(s) = Black Butte River (Lat 39.8239, Long -123.0880)

Upstream to endpoint(s) in:

Black Butte River (39.5946, -122.8579);
Buckhorn Creek (39.6563, -122.9225);
Cold Creek (39.6960, -122.9063);
Estell Creek (39.5966, -122.8224);
Spanish Creek (39.6287, -122.8331).

(xvii) Wilderness Hydrologic Sub-area 111174.

Outlet(s) = Middle Fork Eel River (Lat 39.8240, Long -123.0877)

Upstream to endpoint(s) in:

Beaver Creek (39.9352, -122.9943);
Fossil Creek (39.9447, -123.0403);
Middle Fork Eel River (40.0780, -123.0442);

North Fork Middle Fork Eel River (40.0727, -123.1364);
Palm of Gileade Creek (40.0229, -123.0647);
Pothole Creek (39.9347, -123.0440).
(6) Cape Mendocino Hydrologic Unit 1112 -
(i) Oil Creek Hydrologic Sub-area 111210.
Outlet(s) = Guthrie Creek (Lat 40.5407, Long -124.3626);
Oil Creek (40.5195, -124.3767)
Upstream to endpoint(s) in:
Guthrie Creek (40.5320, -124.3128);
Oil Creek (40.5061, -124.2875);
Unnamed Tributary (40.4946, -124.3091);
Unnamed Tributary (40.4982, -124.3549);
Unnamed Tributary (40.5141, -124.3573);
Unnamed Tributary (40.4992, -124.3070).
(ii) Capetown Hydrologic Sub-area 111220.
Outlet(s) = Bear River (Lat 40.4744, Long -124.3881);
Davis Creek (40.3850, -124.3691);
Singley Creek (40.4311, -124.4034)
Upstream to endpoint(s) in:
Antone Creek (40.4281, -124.2114);
Bear River (40.3591, -124.0536);
Beer Bottle Gulch (40.3949, -124.1410);
Bonanza Gulch (40.4777, -124.2966);
Brushy Creek (40.4102, -124.1050);
Davis Creek (40.3945, -124.2912);
Harmonica Creek (40.3775, -124.0735);
Hollister Creek (40.4109, -124.2891);
Nelson Creek (40.3536, -124.1154);
Peaked Creek (40.4123, -124.1897);
Pullen Creek (40.4057, -124.0814);
Singley Creek (40.4177, -124.3305);
South Fork Bear River (40.4047, -124.2631);
Unnamed Tributary (40.4271, -124.3107);
Unnamed Tributary (40.4814, -124.2741);
Unnamed Tributary (40.3633, -124.0651);
Unnamed Tributary (40.3785, -124.0599);
Unnamed Tributary (40.4179, -124.2391);
Unnamed Tributary (40.4040, -124.0923);
Unnamed Tributary (40.3996, -124.3175);
Unnamed Tributary (40.4045, -124.0745);
Unnamed Tributary (40.4668, -124.2364);
Unnamed Tributary (40.4389, -124.2350);
Unnamed Tributary (40.4516, -124.2238);
Unnamed Tributary (40.4136, -124.1594);
Unnamed Tributary (40.4350, -124.1504);
Unnamed Tributary (40.4394, -124.3745);

West Side Creek (40.4751, -124.2432).

(iii) Mattole River Hydrologic Subarea 111230.

Outlet(s) = Big Creek (Lat 40.1567, Long -124.2114);
Big Flat Creek (40.1275, -124.1764);
Buck Creek (40.1086, -124.1218);
Cooskie Creek (40.2192, -124.3105);
Fourmile Creek (40.2561, -124.3578);
Gitchell Creek (40.0938, -124.1023);
Horse Mountain Creek (40.0685, -124.0822);
Kinsey Creek (40.1717, -124.2310);
Mattole River (40.2942, -124.3536);
McNutt Gulch (40.3541, -124.3619);
Oat Creek (40.1785, -124.2445);
Randall Creek (40.2004, -124.2831);
Shipman Creek (40.1175, -124.1449);
Spanish Creek (40.1835, -124.2569);
Telegraph Creek (40.0473, -124.0798);
Whale Gulch (39.9623, -123.9785)

Upstream to endpoint(s) in:
Anderson Creek (40.0329, -123.9674);
Baker Creek (40.0143, -123.9048);
Bear Creek (40.1262, -124.0631);
Bear Creek (40.2819, -124.3336);
Bear Trap Creek (40.2157, -124.1422);
Big Creek (40.1742, -124.1924);
Big Finley Creek (40.0910, -124.0179);
Big Flat Creek (40.1444, -124.1636);
Blue Slide Creek (40.1562, -123.9283);
Box Canyon Creek (40.1078, -123.9854);
Bridge Creek (40.0447, -124.0118);
Buck Creek (40.1166, -124.1142);
Conklin Creek (40.3197, -124.2055);
Cooskie Creek (40.2286, -124.2986);
Devils Creek (40.3432, -124.1365);
Dry Creek (40.2646, -124.0660);
East Branch North Fork Mattole River (40.3333, -124.1490);
East Fork Honeydew Creek (40.1625, -124.0929);
Eubank Creek (40.0997, -123.9661);
Fire Creek (40.1533, -123.9509);
Fourmile Creek (40.2604, -124.3079);
Fourmile Creek (40.1767, -124.0759);
French Creek (40.1384, -124.0072);
Gibson Creek (40.0304, -123.9279);
Gilham Creek (40.2078, -124.0085);
Gitchell Creek (40.1086, -124.0947);
Green Ridge Creek (40.3254, -124.1258);

Grindstone Creek (40.2019, -123.9890);
Harris Creek (40.0381, -123.9304);
Harrow Creek (40.1612, -124.0292);
Helen Barnum Creek (40.0036, -123.9101);
Honeydew Creek (40.1747, -124.1410);
Horse Mountain Creek (40.0769, -124.0729);
Indian Creek (40.2772, -124.2759);
Jewett Creek (40.1465, -124.0414);
Kinsey Creek (40.1765, -124.2220);
Lost Man Creek (39.9754, -123.9179);
Mattole Canyon (40.2021, -123.9570);
Mattole River (39.9714, -123.9623);
McGinnis Creek (40.3186, -124.1801);
McKee Creek (40.0864, -123.9480);
McNutt Gulch (40.3458, -124.3418);
Middle Creek (40.2591, -124.0366);
Mill Creek (40.0158, -123.9693);
Mill Creek (40.3305, -124.2598);
Mill Creek (40.2839, -124.2946);
Nooning Creek (40.0616, -124.0050);
North Fork Mattole River (40.3866, -124.1867);
North Fork Bear Creek (40.1494, -124.1060);
North Fork Fourmile Creek (40.2019, -124.0722);
Oat Creek (40.1884, -124.2296);
Oil Creek (40.3214, -124.1601);
Painter Creek (40.0844, -123.9639);
Prichett Creek (40.2892, -124.1704);
Randall Creek (40.2092, -124.2668);
Rattlesnake Creek (40.3250, -124.0981);
Shipman Creek (40.1250, -124.1384);
Sholes Creek (40.1603, -124.0619);
South Branch West Fork Bridge Creek (40.0326, -123.9853);
South Fork Bear Creek (40.0176, -124.0016);
Spanish Creek (40.1965, -124.2429);
Squaw Creek (40.1934, -124.2002);
Stanley Creek (40.0273, -123.9166);
Sulphur Creek (40.3647, -124.1586);
Telegraph Creek (40.0439, -124.0640);
Thompson Creek (39.9913, -123.9707);
Unnamed Tributary (40.3475, -124.1606);
Unnamed Tributary (40.3522, -124.1533);
Unnamed Tributary (40.0891, -123.9839);
Unnamed Tributary (40.2223, -124.0172);
Unnamed Tributary (40.1733, -123.9515);
Unnamed Tributary (40.2899, -124.0955);
Unnamed Tributary (40.2853, -124.3227);

Unnamed Tributary (39.9969, -123.9071);
Upper East Fork Honeydew Creek (40.1759, -124.1182);
Upper North Fork Mattole River (40.2907, -124.1115);
Vanauken Creek (40.0674, -123.9422);
West Fork Bridge Creek (40.0343, -123.9990);
West Fork Honeydew Creek (40.1870, -124.1614);
Westlund Creek (40.2440, -124.0036);
Whale Gulch (39.9747, -123.9812);
Woods Creek (40.2119, -124.1611);
Yew Creek (40.0018, -123.9762).
(7) Mendocino Coast Hydrologic Unit 1113 -
(i) Usal Creek Hydrologic Subarea 111311.
Outlet(s) = Jackass Creek (Lat 39.8806, Long -123.9155);
Bear Creek (39.8898, -123.8344);
Jackass Creek (39.8901, -123.8928);
Julias Creek (39.8542, -123.7937);
Little Bear Creek (39.8629, -123.8400);
North Fork Jackass Creek (39.9095, -123.9101);
North Fork Julias Creek (39.8581, -123.8045);
Soldier Creek (39.8679, -123.8162);
South Fork Usal Creek (39.8356, -123.7865);
Unnamed Tributary (39.8890, -123.8480);
Usal Creek (39.8957, -123.8797);
Waterfall Gulch (39.8787, -123.8680).
(ii) Wages Creek Hydrologic Sub-area 111312.
Outlet(s) = Cottaneva Creek (Lat 39.7360, Long -123.8293);
DeHaven Creek (39.6592, -123.7863);
Hardy Creek (39.7107, -123.8082);
Howard Creek (39.6778, -123.7915);
Juan Creek (39.7028, -123.8042);
Wages Creek (39.6513, -123.7851)
Upstream to endpoint(s) in:
Cottaneva Creek (39.7825, -123.8210);
DeHaven Creek (39.6687, -123.7060);
Dunn Creek (39.8103, -123.8320);
Hardy Creek (39.7221, -123.7822);
Howard Creek (39.6808, -123.7463);
Juan Creek (39.7107, -123.7472);
Kimball Gulch (39.7559, -123.7828);
Little Juan Creek (39.7003, -123.7609);
Middle Fork Cottaneva Creek (39.7738, -123.8058);
North Fork Cottaneva Creek (39.8011, -123.8047);
North Fork Dehaven Creek (39.6660, -123.7382);
North Fork Wages Creek (39.6457, -123.7066);
Rider Gulch (39.6348, -123.7621);
Rockport Creek (39.7346, -123.8021);

Slaughterhouse Gulch (39.7594, -123.7914);
South Fork Cottaneva Creek (39.7447, -123.7773);
South Fork Wages Creek (39.6297, -123.6862);
Wages Creek (39.6297, -123.6862).
(iii) Ten Mile River Hydrologic Subarea 111313.
Outlet(s) = Abalobadiah Creek (Lat 39.5654, Long -123.7672);
Chadbourne Gulch (39.6133, -123.7822);
Ten Mile River (39.5529, -123.7658);
Seaside Creek (39.5592, -123.7655)
Upstream to endpoint(s) in:
Abalobadiah Creek (39.5878, -123.7503);
Bald Hill Creek (39.6278, -123.6461);
Barlow Gulch (39.6046, -123.7384);
Bear Pen Creek (39.5824, -123.6402);
Booth Gulch (39.5567, -123.5918);
Buckhorn Creek (39.6093, -123.6980);
Campbell Creek (39.5053, -123.6610);
Cavanough Gulch (39.6107, -123.6776);
Chadbourne Gulch (39.6190, -123.7682);
Clark Fork (39.5280, -123.5134);
Curchman Creek (39.4789, -123.6398);
Gulch 11 (39.4687, -123.5816);
Gulch 19 (39.5939, -123.5781);
Little Bear Haven Creek (39.5655, -123.6147);
Little North Fork (39.6264, -123.7350);
Mill Creek (39.5392, -123.7068);
North Fork Ten Mile River (39.5870, -123.5480);
OíConner Gulch (39.6042, -123.6632);
Patsy Creek (39.5714, -123.5669);
Redwood Creek (39.5142, -123.5620);
Seaside Creek (39.5612, -123.7501);
Smith Creek (39.5251, -123.6499);
South Fork Bear Haven Creek (39.5688, -123.6527);
South Fork Ten Mile River (39.5083, -123.5395);
Ten Mile River (39.5721, -123.7098);
Unnamed Tributary (39.5180, -123.5948);
Unnamed Tributary (39.5146, -123.6183);
Unnamed Tributary (39.5898, -123.7657);
Unnamed Tributary (39.5813, -123.7526);
Unnamed Tributary (39.5936, -123.6034).
(iv) Noyo River Hydrologic Sub-area 111320.
Outlet(s) = Digger Creek (Lat 39.4088, Long -123.8164);
Hare Creek (39.4171, -123.8128);
Jug Handle Creek (39.3767, -123.8176);
Mill Creek (39.4894, -123.7967);
Mitchell Creek (39.3923, -123.8165);

Noyo River (39.4274, -123.8096);
Pudding Creek (39.4588, -123.8089);
Virgin Creek (39.4714, -123.8045)
Upstream to endpoint(s) in:
Bear Gulch (39.3881, -123.6614);
Brandon Gulch (39.4191, -123.6645);
Bunker Gulch (39.3969, -123.7153);
Burbeck Creek (39.4354, -123.4235);
Covington Gulch (39.4099, -123.7546);
Dewarren Creek (39.4974, -123.5535);
Digger Creek (39.3932, -123.7820);
Duffy Gulch (39.4469, -123.6023);
Gulch Creek (39.4441, -123.4684);
Gulch Seven (39.4523, -123.5183);
Hare Creek (39.3781, -123.6922);
Hayworth Creek (39.4857, -123.4769);
Hayshed Creek (39.4200, -123.7391);
Jug Handle Creek (39.3647, -123.7523);
Kass Creek (39.4262, -123.6807);
Little North Fork (39.4532, -123.6636);
Little Valley Creek (39.5026, -123.7277);
Marble Gulch (39.4423, -123.5479);
McMullen Creek (39.4383, -123.4488);
Middle Fork North Fork (39.4924, -123.5231);
Mill Creek (39.4813, -123.7600);
Mitchell Creek (39.3813, -123.7734);
North Fork Hayworth Creek (39.4891, -123.5026);
North Fork Noyo River (39.4765, -123.5535);
North Fork Noyo (39.4765, -123.5535);
North Fork South Fork Noyo River (39.3971, -123.6108);
Noyo River (39.4242, -123.4356);
Olds Creek (39.3964, -123.4448);
Parlin Creek (39.3700, -123.6111);
Pudding Creek (39.4591, -123.6516);
Redwood Creek (39.4660, -123.4571);
South Fork Hare Creek (39.3785, -123.7384);
South Fork Noyo River (39.3620, -123.6188);
Unnamed Tributary (39.4113, -123.5621);
Unnamed Tributary (39.3918, -123.6425);
Unnamed Tributary (39.4168, -123.4578);
Unnamed Tributary (39.4656, -123.7467);
Unnamed Tributary (39.4931, -123.7371);
Unnamed Tributary (39.4922, -123.7381);
Unnamed Tributary (39.4939, -123.7184);
Unnamed Tributary (39.4158, -123.6428);
Unnamed Tributary (39.4002, -123.7347);

Unnamed Tributary (39.3831, -123.6177);
Unnamed Tributary (39.4926, -123.4764);
Virgin Creek (39.4621, -123.7855);
Unnamed Tributary (39.4650, -123.7463).
(v) Big River Hydrologic Sub-area 111330.
Outlet(s) = Big River (Lat 39.3030, Long -123.7957);
Casper Creek (39.3617, -123.8169);
Doyle Creek (39.3603, -123.8187);
Jack Peters Creek (39.3193, -123.8006);
Russian Gulch (39.3288, -123.8050)
Upstream to endpoint(s) in:
Berry Gulch (39.3585, -123.6930);
Big River (39.3166, -123.3733);
Casper Creek (39.3462, -123.7556);
Chamberlain Creek (39.4007, -123.5317);
Daugherty Creek (39.1700, -123.3699);
Doyle Creek (39.3517, -123.8007);
East Branch Little North Fork Big River (39.3372, -123.6410);
East Branch North Fork Big River (39.3354, -123.4652);
Gates Creek (39.2083, -123.3944);
Jack Peters Gulch (39.3225, -123.7850);
James Creek (39.3922, -123.4747);
Johnson Creek (39.1963, -123.3927);
Johnson Creek (39.2556, -123.4485);
Laguna Creek (39.2910, -123.6334);
Little North Fork Big River (39.3497, -123.6242);
Marten Creek (39.3290, -123.4279);
Mettick Creek (39.2591, -123.5193);
Middle Fork North Fork Casper Creek (39.3575, -123.7170);
North Fork Big River (39.3762, -123.4591);
North Fork Casper Creek (39.3610, -123.7356);
North Fork James Creek (39.3980, -123.4939);
North Fork Ramone Creek (39.2760, -123.4846);
Pig Pen Gulch (39.3226, -123.4609);
Pruitt Creek (39.2592, -123.3812);
Ramone Creek (39.2714, -123.4415);
Rice Creek (39.2809, -123.3963);
Russell Brook (39.2863, -123.4461);
Russian Gulch (39.3237, -123.7650);
Snuffins Creek (39.1836, -123.3854);
Soda Creek (39.2230, -123.4239);
South Fork Big River (39.2317, -123.3687);
South Fork Casper Creek (39.3493, -123.7216);
Two Log Creek (39.3484, -123.5781);
Unnamed Tributary (39.3897, -123.5556);
Unnamed Tributary (39.3637, -123.5464);

Unnamed Tributary (39.3776, -123.5274);
Unnamed Tributary (39.4029, -123.5771);
Valentine Creek (39.2694, -123.3957);
Water Gulch (39.3607, -123.5891).

(vi) Albion River Hydrologic Sub-area 111340.

Outlet(s) = Albion River (Lat 39.2253, Long -123.7679);
Big Salmon Creek (39.2150, -123.7660);
Buckhorn Creek (39.2593, -123.7839);
Dark Gulch (39.2397, -123.7740);
Little Salmon Creek (39.2150, -123.7660);
Little River (39.2734, -123.7914)

Upstream to endpoint(s) in:
Albion River (39.2613, -123.5766);
Big Salmon Creek (39.2070, -123.6514);
Buckhorn Creek (39.2513, -123.7595);
Dark Gulch (39.2379, -123.7592);
Duck Pond Gulch (39.2456, -123.6960);
East Railroad Gulch (39.2604, -123.6381);
Hazel Gulch (39.2141, -123.6418);
Kaison Gulch (39.2733, -123.6803);
Little North Fork South Fork Albion River (39.2350, -123.6431);
Little River (39.2683, -123.7190);
Little Salmon Creek (39.2168, -123.7515);
Marsh Creek (39.2325, -123.5596);
Nordon Gulch (39.2489, -123.6503);
North Fork Albion River (39.2854, -123.5752);
Pleasant Valley Gulch (39.2379, -123.6965);
Railroad Gulch (39.2182, -123.6932);
Soda Springs Creek (39.2943, -123.5944);
South Fork Albion River (39.2474, -123.6107);
Tom Bell Creek (39.2805, -123.6519);
Unnamed Tributary (39.2279, -123.6972);
Unnamed Tributary (39.2194, -123.7100);
Unnamed Tributary (39.2744, -123.5889);
Unnamed Tributary (39.2254, -123.6733).

(vii) Navarro River Hydrologic Subarea 111350.

Outlet(s) = Navarro River (Lat 39.1921, Long -123.7611)

Upstream to endpoint(s) in:
Alder Creek (38.9830, -123.3946);
Anderson Creek (38.9644, -123.2907);
Bailey Creek (39.1733, -123.4804);
Barton Gulch (39.1804, -123.6783);
Bear Creek (39.1425, -123.4326);
Bear Wallow Creek (39.0053, -123.4075);
Beasley Creek (38.9366, -123.3265);
Bottom Creek (39.2117, -123.4607);

Camp 16 Gulch (39.1937, -123.6095);
Camp Creek (38.9310, -123.3527);
Cold Spring Creek (39.0376, -123.5027);
Con Creek (39.0374, -123.3816);
Cook Creek (39.1879, -123.5109);
Cune Creek (39.1622, -123.6014);
Dago Creek (39.0731, -123.5068);
Dead Horse Gulch (39.1576, -123.6124);
Dutch Henry Creek (39.2112, -123.5794);
Floodgate Creek (39.1291, -123.5365);
Fluem Gulch (39.1615, -123.6695);
Flynn Creek (39.2099, -123.6032);
German Creek (38.9452, -123.4269);
Gut Creek (39.0803, -123.3312);
Ham Canyon (39.0164, -123.4265);
Horse Creek (39.0144, -123.4960);
Hungry Hollow Creek (39.1327, -123.4488);
Indian Creek (39.0708, -123.3301);
Jimmy Creek (39.0117, -123.2888);
John Smith Creek (39.2275, -123.5366);
Little North Fork Navarro River (39.1941, -123.4553);
Low Gap Creek (39.1590, -123.3783);
Navarro River (39.0537, -123.4409);
Marsh Gulch (39.1692, -123.7049);
McCarvey Creek (39.1589, -123.4048);
Mill Creek (39.1270, -123.4315);
Minnie Creek (38.9751, -123.4529);
Murray Gulch (39.1755, -123.6966);
Mustard Gulch (39.1673, -123.6393);
North Branch (39.2069, -123.5361);
North Fork Indian Creek (39.1213, -123.3345);
North Fork Navarro River (39.1708, -123.5606);
Parkinson Gulch (39.0768, -123.4070);
Perry Gulch (39.1342, -123.5707);
Rancheria Creek (38.8626, -123.2417);
Ray Gulch (39.1792, -123.6494);
Robinson Creek (38.9845, -123.3513);
Rose Creek (39.1358, -123.3672);
Shingle Mill Creek (39.1671, -123.4223);
Soda Creek (39.0238, -123.3149);
Soda Creek (39.1531, -123.3734);
South Branch (39.1409, -123.3196);
Spooner Creek (39.2221, -123.4811);
Tramway Gulch (39.1481, -123.5958);
Yale Creek (38.8882, -123.2785).

(viii) Greenwood Creek Hydrologic Sub-area 111361.

Outlet(s) = Greenwood Creek (Lat 39.1262, Long -123.7181)
Upstream to endpoint(s) in:
Greenwood Creek (39.0894, -123.5924).
(ix) Elk Creek Hydrologic Sub-area 111362.
Outlet(s) = Elk Creek (Lat 39.1024, Long -123.7080)
Upstream to endpoint(s) in:
Elk Creek (39.0657, -123.6245).
(x) Alder Creek Hydrologic Sub-area 111363.
Outlet(s) = Alder Creek (Lat 39.0044, Long -123.6969);
Mallo Pass Creek (39.0341, -123.6896)
Upstream to endpoint(s) in:
Alder Creek (38.9961, -123.6471);
Mallo Pass Creek (39.0287, -123.6373).
(xi) Brush Creek Hydrologic Sub-area 111364.
Outlet(s) = Brush Creek (Lat 38.9760, Long -123.7120)
Upstream to endpoint(s) in:
Brush Creek (38.9730, -123.5563);
Mill Creek (38.9678, -123.6515);
Unnamed Tributary (38.9724, -123.6571).
(xii) Garcia River Hydrologic Sub-area 111370.
Outlet(s) = Garcia River (Lat 38.9550, Long -123.7338);
Point Arena Creek (38.9141, -123.7103);
Schooner Gulch (38.8667, -123.6550)
Upstream to endpoint(s) in:
Blue Water Hole Creek (38.9378, -123.5023);
Flemming Creek (38.8384, -123.5361);
Garcia River (38.8965, -123.3681);
Hathaway Creek (38.9287, -123.7011);
Inman Creek (38.8804, -123.4370);
Larmour Creek (38.9419, -123.4469);
Mill Creek (38.9078, -123.3143);
North Fork Garcia River (38.9233, -123.5339);
North Fork Schooner Gulch (38.8758, -123.6281);
Pardaloe Creek (38.8895, -123.3423);
Point Arena Creek (38.9069, -123.6838);
Redwood Creek (38.9241, -123.3343);
Rolling Brook (38.8965, -123.5716);
Schooner Gulch (38.8677, -123.6198);
South Fork Garcia River (38.8450, -123.5420);
Stansburry Creek (38.9422, -123.4720);
Signal Creek (38.8639, -123.4414);
Unnamed Tributary (38.8758, -123.5692);
Unnamed Tributary (38.8818, -123.5723);
Whitlow Creek (38.9141, -123.4624).
(xiii) North Fork Gualala River Hydrologic Sub-area 111381.
Outlet(s) = North Fork Gualala River (Lat 38.7784, Long -123.4992)

Upstream to endpoint(s) in:
Bear Creek (38.8347, -123.3842);
Billings Creek (38.8652, -123.3496);
Doty Creek (38.8495, -123.5131);
Dry Creek (38.8416, -123.4455);
Little North Fork Gualala River (38.8295, -123.5570);
McGann Gulch (38.8026, -123.4458);
North Fork Gualala River (38.8479, -123.4113);
Robinson Creek (38.8416, -123.3725);
Robinson Creek (38.8386, -123.4991);
Stewart Creek (38.8109, -123.4157);
Unnamed Tributary (38.8487, -123.3820).
(xiv) Rockpile Creek Hydrologic Subarea 111382.
Outlet(s) = Rockpile Creek (Lat 38.7507, Long -123.4706)
Upstream to endpoint(s) in:
Rockpile Creek (38.7966, -123.3872).
(xv) Buckeye Creek Hydrologic Subarea 111383.
Outlet(s) = Buckeye Creek (Lat 38.7403, Long -123.4580)
Upstream to endpoint(s) in:
Buckeye Creek (38.7400, -123.2697);
Flat Ridge Creek (38.7616, -123.2400);
Franchini Creek (38.7500, -123.3708);
North Fork Buckeye (38.7991, -123.3166).
(xvi) Wheatfield Fork Hydrologic Subarea 111384.
Outlet(s) = Wheatfield Fork Gualala River (Lat 38.7018, Long -123.4168)
Upstream to endpoint(s) in:
Danfield Creek (38.6369, -123.1431);
Fuller Creek (38.7109, -123.3256);
Haupt Creek (38.6220, -123.2551);
House Creek (38.6545, -123.1184);
North Fork Fuller Creek (38.7252, -123.2968);
Pepperwood Creek (38.6205, -123.1665);
South Fork Fuller Creek (38.6973, -123.2860);
Tombs Creek (38.6989, -123.1616);
Unnamed Tributary (38.7175, -123.2744);
Wheatfield Fork Gualala River (38.7497, -123.2215).
(xvii) Gualala Hydrologic Sub-area 111385.
Outlet(s) = Fort Ross Creek (Lat 38.5119, Long -123.2436);
Gualala River (38.7687, -123.5334);
Kolmer Gulch (38.5238, -123.2646)
Upstream to endpoint(s) in:
Big Pepperwood Creek (38.7951, -123.4638);
Carson Creek (38.5653, -123.1906);
Fort Ross Creek (38.5174, -123.2363);
Groshong Gulch (38.7814, -123.4904);
Gualala River (38.7780, -123.4991);

Kolmer Gulch (38.5369, -123.2247);
Little Pepperwood (38.7738, -123.4427);
Marshall Creek (38.5647, -123.2058);
McKenzie Creek (38.5895, -123.1730);
Palmer Canyon Creek (38.6002, -123.2167);
South Fork Gualala River (38.5646, -123.1689);
Sproule Creek (38.6122, -123.2739);
Turner Canyon (38.5294, -123.1672);
Unknown Tributary (38.5634, -123.2003).

(xviii) Russian Gulch Hydrologic Subarea 111390.

Outlet(s) = Russian Gulch VerDate Aug<18>2005 17: Russian Gulch Creek (38.4956, -123.1535);
West Branch Russian Gulch Creek (38.4968, -123.1631).

(C) Central California Coast Steelhead (O. mykiss). Critical habitat is designated to include the areas defined in the following CALWATER Hydrologic Units:

(1) Russian River Hydrologic Unit 1114 -

(i) Guerneville Hydrologic Subarea 111411.

Outlet(s) = Russian River (Lat 38.4507, Long -123.1289)
Upstream to endpoint(s) in:
Atascadero Creek (38.3473, -122.8626);
Austin Creek (38.5098, -123.0680);
Baumert Springs (38.4195, -122.9658);
Dutch Bill Creek (38.4132, -122.9508);
Duvoul Creek (38.4527, -122.9525);
Fife Creek (38.5584, -122.9922);
Freezeout Creek (38.4405, -123.0360);
Green Valley Creek, (38.4445, -122.9185);
Grub Creek (38.4411, -122.9636);
Hobson Creek (38.5334, -122.9401);
Hulbert Creek (38.5548, -123.0362);
Jenner Gulch (38.4869, -123.0996);
Kidd Creek (38.5029, -123.0935);
Lancel Creek (38.4247, -122.9322);
Mark West Creek (38.4961, -122.8489);
Mays Canyon (38.4800, -122.9715);
North Fork Lancel Creek (38.4447, -122.9444);
Pocket Canyon (38.4650, -122.9267);
Porter Creek (38.5435, -122.9332);
Purrington Creek (38.4083, -122.9307);
Sheep House Creek (38.4820, -123.0921);
Smith Creek (38.4622, -122.9585);
Unnamed Tributary (38.4560, -123.0246);
Unnamed Tributary (38.3976, -122.8994);
Unnamed Tributary (38.3772, -122.8938);
Willow Creek (38.4249, -123.0022).

(ii) Austin Creek Hydrologic Sub-area 111412.
Outlet(s) = Austin Creek (Lat 38.5098, Long -123.0680)
Upstream to endpoint(s) in:
Austin Creek (38.6262, -123.1347);
Bear Pen Creek (38.5939, -123.1644);
Big Oat Creek (38.5615, -123.1299);
Black Rock Creek (38.5586, -123.0730);
Blue Jay Creek (38.5618, -123.1399);
Conshea Creek (38.5830, -123.0824);
Devil Creek (38.6163, -123.0425);
East Austin Creek (38.6349, -123.1238);
Gilliam Creek (38.5803, -123.0152);
Gray Creek (38.6132, -123.0107);
Thompson Creek (38.5747, -123.0300);
Pole Mountain Creek (38.5122, -123.1168);
Red Slide Creek (38.6039, -123.1141);
Saint Elmo Creek (38.5130, -123.1125);
Schoolhouse Creek (38.5595, -123.0175);
Spring Creek (38.5041, -123.1364);
Sulphur Creek (38.6187, -123.0553);
Ward Creek (38.5720, -123.1547).
(iii) Mark West Hydrologic Sub-area 111423.
Outlet(s) = Mark West Creek (Lat 38.4962, Long -122.8492)
Upstream to endpoint(s) in:
Humbug Creek (38.5412, -122.6249);
Laguna de Santa Rosa (38.4526, -122.8347);
Mark West Creek (38.5187, -122.5995);
Pool Creek (38.5486, -122.7641);
Pruit Creek (38.5313, -122.7615);
Windsor Creek (38.5484, -122.8101).
(iv) Warm Springs Hydrologic Subarea 111424.
Outlet(s) = Dry Creek (Lat 38.5862, Long -122.8577)
Upstream to endpoint(s) in:
Angel Creek (38.6101, -122.9833);
Crane Creek (38.6434, -122.9451);
Dry Creek (38.7181, -123.0091);
Dutcher Creek (38.7223, -122.9770);
Felta Creek (38.5679, -122.9379);
Foss Creek (38.6244, -122.8754);
Grape Creek (38.6593, -122.9707);
Mill Creek (38.5976, -122.9914);
North Slough Creek (38.6392, -122.8888);
Palmer Creek (38.5770, -122.9904);
Pena Creek (38.6384, -123.0743);
Redwood Log Creek (38.6705, -123.0725);
Salt Creek (38.5543, -122.9133);

Wallace Creek (38.6260, -122.9651);
Wine Creek (38.6662, -122.9682);
Woods Creek (38.6069, -123.0272).
(v) Geyserville Hydrologic Sub-area 111425.
Outlet(s) = Russian River (Lat 38.6132, Long -122.8321)
Upstream to endpoint(s) in:
Ash Creek (38.8556, -123.0082);
Bear Creek (38.7253, -122.7038);
Bidwell Creek (38.6229, -122.6320);
Big Sulphur Creek (38.8279, -122.9914);
Bluegum Creek (38.6988, -122.7596);
Briggs Creek (38.6845, -122.6811);
Coon Creek (38.7105, -122.6957);
Crocker Creek (38.7771, -122.9595);
Edwards Creek (38.8592, -123.0758);
Foote Creek (38.6433, -122.6797);
Foss Creek (38.6373, -122.8753);
Franz Creek (38.5726, -122.6343);
Gill Creek (38.7552, -122.8840);
Gird Creek (38.7055, -122.8311);
Ingalls Creek (38.7344, -122.7192);
Kellog Creek (38.6753, -122.6422);
Little Briggs Creek (38.7082, -122.7014);
Maacama Creek (38.6743, -122.7431);
McDonnell Creek (38.7354, -122.7338);
Mill Creek (38.7009, -122.6490);
Miller Creek (38.7211, -122.8608);
Oat Valley Creek (38.8461, -123.0712);
Redwood Creek (38.6342, -122.6720);
Sausal Creek (38.6924, -122.7930);
South Fork Gill Creek (38.7420, -122.8760);
Unnamed Tributary (38.7329, -122.8601);
Yellowjacket Creek (38.6666, -122.6308).
(vi) Sulphur Creek Hydrologic Subarea 111426.
Outlet(s) = Big Sulphur Creek (Lat 38.8279, Long -122.9914)
Upstream to endpoint(s) in:
Alder Creek (38.8503, -122.8953);
Anna Belcher Creek (38.7537, -122.7586);
Big Sulphur Creek (38.8243, -122.8774);
Frasier Creek (38.8439, -122.9341);
Humming Bird Creek (38.8460, -122.8596);
Little Sulphur Creek (38.7469, -122.7425);
Lovers Gulch (38.7396, -122.8275);
North Branch Little Sulphur Creek (38.7783, -122.8119);
Squaw Creek (38.8199, -122.7945).
(vii) Ukiah Hydrologic Sub-area 111431.

Outlet(s) = Russian River (Lat 38.8828, Long -123.0557)
Upstream to endpoint(s) in:
Pieta Creek (38.8622, -122.9329).
(viii) Forsythe Creek Hydrologic Subarea 111433.
Outlet(s) = West Branch Russian River (Lat 39.2257, Long -123.2012)
Upstream to endpoint(s) in:
Bakers Creek (39.2859, -123.2432);
Eldridge Creek (39.2250, -123.3309);
Forsythe Creek (39.2976, -123.2963);
Jack Smith Creek (39.2754, -123.3421);
Mariposa Creek (39.3472, -123.2625);
Mill Creek (39.2969, -123.3360);
Salt Hollow Creek (39.2585, -123.1881);
Seward Creek (39.2606, -123.2646);
West Branch Russian River (39.3642, -123.2334).
(2) Bodega Hydrologic Unit 1115 -
(i) Salmon Creek Hydrologic Sub-area 111510.
Outlet(s) = Salmon Creek (Lat 38.3554, Long -123.0675)
Upstream to endpoint(s) in:
Coleman Valley Creek (38.3956, -123.0097);
Faye Creek (38.3749, -123.0000);
Finley Creek (38.3707, -123.0258);
Salmon Creek (38.3877, -122.9318);
Tannery Creek (38.3660, -122.9808).
(ii) Estero Americano Hydrologic Subarea 111530.
Outlet(s) = Estero Americano (Lat 38.2939, Long -123.0011)
Upstream to endpoint(s) in:
Estero Americano (38.3117, -122.9748);
Ebabias Creek (38.3345, -122.9759).
(3) Marin Coastal Hydrologic Unit 2201 -
(i) Walker Creek Hydrologic Subarea 220112.
Outlet(s) = Walker Creek (Lat 38.2213, Long -122.9228);
Millerton Gulch (38.1055, -122.8416)
Upstream to endpoint(s) in:
Chileno Creek (38.2145, -122.8579);
Frink Canyon (38.1761, -122.8405);
Millerton Gulch (38.1376, -122.8052);
Verde Canyon (38.1630, -122.8116);
Unnamed Tributary (38.1224, -122.8095);
Walker Creek (38.1617, -122.7815).
(ii) Lagunitas Creek Hydrologic Subarea 220113.
Outlet(s) = Lagunitas Creek (Lat 38.0827, Long -122.8274)
Upstream to endpoint(s) in:
Cheda Creek (38.0483, -122.7329);
Devilís Gulch (38.0393, -122.7128);
Giacomini Creek (38.0075, -122.7386);

Horse Camp Gulch (38.0078, -122.7624);
Lagunitas Creek (37.9974, -122.7045);
Olema Creek (37.9719, -122.7125);
Quarry Gulch (38.0345, -122.7639);
San Geronimo Creek (38.0131, -122.6499);
Unnamed Tributary (37.9893, -122.7328);
Unnamed Tributary (37.9976, -122.7553).
(iii) Point Reyes Hydrologic Sub-area 220120.
Outlet(s) = Creamery Bay Creek (Lat 38.0779, Long -122.9572);
East Schooner Creek (38.0913, -122.9293);
Home Ranch (38.0705, -122.9119);
Laguna Creek (38.0235, -122.8732);
Muddy Hollow Creek (38.0329, -122.8842)
Upstream to endpoint(s) in:
Creamery Bay Creek (38.0809, -122.9561);
East Schooner Creek (38.0928, -122.9159);
Home Ranch Creek (38.0784, -122.9038);
Laguna Creek (38.0436, -122.8559);
Muddy Hollow Creek (38.0549, -122.8666).
(iv) Bolinas Hydrologic Sub-area 220130.
Outlet(s) = Easkoot Creek (Lat 37.9026, Long -122.6474);
McKinnon Gulch (37.9126, -122.6639);
Morse Gulch (37.9189, -122.6710);
Pine Gulch Creek (37.9218, -122.6882);
Redwood Creek (37.8595, -122.5787);
Stinson Gulch (37.9068, -122.6517);
Wilkins Creek (37.9343, -122.6967)
Upstream to endpoint(s) in:
Easkoot Creek (37.8987, -122.6370);
Kent Canyon (37.8866, -122.5800);
McKinnon Gulch (37.9197, -122.6564);
Morse Gulch (37.9240, -122.6618);
Pine Gulch Creek (37.9557, -122.7197);
Redwood Creek (37.9006, -122.5787);
Stinson Gulch (37.9141, -122.6426);
Wilkins Creek (37.9450, -122.6910).
(4) San Mateo Hydrologic Unit 2202 -
(i) San Mateo Coastal Hydrologic Subarea 220221.
Outlet(s) = Denniston Creek (37.5033, -122.4869);
Frenchmans Creek (37.4804, -122.4518);
San Pedro Creek (37.5964, -122.5057)
Upstream to endpoint(s) in:
Denniston Creek (37.5184, -122.4896);
Frenchmans Creek (37.5170, -122.4332);
Middle Fork San Pedro Creek (37.5758, -122.4591);
North Fork San Pedro Creek (37.5996, -122.4635).

(ii) Half Moon Bay Hydrologic Subarea 220222.
Outlet(s) = Pilarcitos Creek (Lat 37.4758, Long -122.4493)
Upstream to endpoint(s) in:
    Apanolio Creek (37.5202, -122.4158);
    Arroyo Leon Creek (37.4560, -122.3442);
    Mills Creek (37.4629, -122.3721);
    Pilarcitos Creek (37.5259, -122.3980);
    Unnamed Tributary (37.4705, -122.3616).
(iii) Tunitas Creek Hydrologic Subarea 220223.
Outlet(s) = Lobitos Creek (Lat 37.3762, Long -122.4093);
    Tunitas Creek (37.3567, -122.3999)
Upstream to endpoint(s) in:
    East Fork Tunitas Creek (37.3981, -122.3404);
    Lobitos Creek (37.4246, -122.3586);
    Tunitas Creek (37.4086, -122.3502).
(iv) San Gregorio Creek Hydrologic Sub-area 220230.
Outlet(s) = San Gregorio Creek (Lat 37.3215, Long -122.4030)
Upstream to endpoint(s) in:
    Alpine Creek (37.3062, -122.2003);
    Bogess Creek (37.3740, -122.3010);
    El Corte Madera Creek (37.3650, -122.3307);
    Harrington Creek (37.3811, -122.2936);
    La Honda Creek (37.3680, -122.2655);
    Langley Creek (37.3302, -122.2420);
    Mindego Creek (37.3204, -122.2239);
    San Gregorio Creek (37.3099, -122.2779);
    Woodruff Creek (37.3415, -122.2495).
(v) Pescadero Creek Hydrologic Subarea 220240.
Outlet(s) = Pescadero Creek (Lat 37.2669, Long -122.4122);
    Pomponio Creek (37.2979, -122.4061)
Upstream to endpoint(s) in:
    Bradley Creek (37.2819, -122.3802);
    Butano Creek (37.2419, -122.3165);
    Evans Creek (37.2659, -122.2163);
    Honsinger Creek (37.2828, -122.3316);
    Little Boulder Creek (37.2145, -122.1964);
    Little Butano Creek (37.2040, -122.3492);
    Oil Creek (37.2572, -122.1325);
    Pescadero Creek (37.2320, -122.1553);
    Lambert Creek (37.3014, -122.1789);
    Peters Creek (37.2883, -122.1694);
    Pomponio Creek (37.3030, -122.3805);
    Slate Creek (37.2530, -122.1935);
    Tarwater Creek (37.2731, -122.2387);
    Waterman Creek (37.2455, -122.1568).
(5) Bay Bridge Hydrologic Unit 2203 -

(i) San Rafael Hydrologic Subarea 220320.

Outlet(s) = Arroyo Corte Madera del Presidio (Lat 37.8917, Long -122.5254);

Corte Madera Creek (37.9425, -122.5059)

Upstream to endpoint(s) in:

Arroyo Corte Madera del Presidio (37.9298, -122.5723);
Cascade Creek (37.9867, -122.6287);
Cascade Creek (37.9157, -122.5655);
Larkspur Creek (37.9305, -122.5514);
Old Mill Creek (37.9176, -122.5746);
Ross Creek (37.9558, -122.5752);
San Anselmo Creek (37.9825, -122.6420);
Sleepy Hollow Creek (38.0074, -122.5794);
Tamalpais Creek (37.9481, -122.5674).

(6) Santa Clara Hydrologic Unit 2205 -

(i) Coyote Creek Hydrologic Subarea 220530.

Outlet(s) = Coyote Creek (Lat 37.4629, Long -121.9894; 37.2275, -121.7514)

Upstream to endpoint(s) in:

Arroyo Aguague (37.3907, -121.7836);
Coyote Creek (37.2778, -121.8033; 37.1677, -121.6301);
Upper Penitencia Creek (37.3969, -121.7577).

(ii) Guadalupe River -San Jose Hydrologic Sub-area 220540.

Outlet(s) = Coyote Creek (Lat 37.2778, Long -121.8033)

Upstream to endpoint(s) in:

Coyote Creek (37.2275, -121.7514).

(iii) Palo Alto Hydrologic Sub-area 220550.

Outlet(s) = Guadalupe River (Lat 37.4614, Long -122.0240);

San Francisquito Creek (37.4658, -122.1152);
Stevens Creek (37.4456, -122.0641)

Upstream to endpoint(s) in:

Bear Creek (37.4164, -122.2690);
Corte Madera Creek (37.4073, -122.2378);
Guadalupe River (37.3499, -.121.9094);
Los Trancos (37.3293, -122.1786);
McGarvey Gulch (37.4416, -122.2955);
Squealer Gulch (37.4335, -122.2880);
Stevens Creek (37.2990, -122.0778);
West Union Creek (37.4528, -122.3020).

(7) San Pablo Hydrologic Unit 2206 -

(i) Petaluma River Hydrologic Sub-area 220630.

Outlet(s) = Petaluma River (Lat 38.1111, Long -122.4944)

Upstream to endpoint(s) in:

Adobe Creek (38.2940, -122.5834);
Lichau Creek (38.2848, -122.6654);
Lynch Creek (38.2748, -122.6194);

Petaluma River (38.3010, -122.7149);
Schultz Slough (38.1892, -122.5953);
San Antonio Creek (38.2049, -122.7408);
Unnamed Tributary (38.3105, -122.6146);
Willow Brook (38.3165, -122.6113).

(ii) Sonoma Creek Hydrologic Subarea 220640.
Outlet(s) = Sonoma Creek (Lat 38.1525, Long -122.4050)
Upstream to endpoint(s) in:

Agua Caliente Creek (38.3368, -122.4518);
Asbury Creek (38.3401, -122.5590);
Bear Creek (38.4656, -122.5253);
Calabazas Creek (38.4033, -122.4803);
Carriger Creek (38.3031, -122.5336);
Graham Creek (38.3474, -122.5607);
Hooker Creek (38.3809, -122.4562);
Mill Creek (38.3395, -122.5454);
Nathanson Creek (38.3350, -122.4290);
Rodgers Creek (38.2924, -122.5543);
Schell Creek (38.2554, -122.4510);
Sonoma Creek (38.4507, -122.4819);
Stuart Creek (38.3936, -122.4708);
Yulupa Creek (38.3986, -122.5934).

(iii) Napa River Hydrologic Sub-area 220650.
Outlet(s) = Napa River (Lat 38.0786, Long -122.2468)
Upstream to endpoint(s) in:

Bale Slough (38.4806, -122.4578);
Bear Canyon Creek (38.4512, -122.4415);
Bell Canyon Creek (38.5551, -122.4827);
Brownís Valley Creek (38.3251, -122.3686);
Canon Creek (38.5368, -122.4854);
Carneros Creek (38.3108, -122.3914);
Conn Creek (38.4843, -122.3824);
Cyrus Creek (38.5776, -122.6032);
Diamond Mountain Creek (38.5645, -122.5903);
Dry Creek (38.4334, -122.4791);
Dutch Henery Creek (38.6080, -122.5253);
Garnett Creek (38.6236, -122.5860);
Huichica Creek (38.2811, -122.3936);
Jericho Canyon Creek (38.6219, -122.5933);
Miliken Creek (38.3773, -122.2280);
Mill Creek (38.5299, -122.5513);
Murphy Creek (38.3155, -122.2111);
Napa Creek (38.3047, -122.3134);
Napa River (38.6638, -122.6201);
Pickle Canyon Creek (38.3672, -122.4071);
Rector Creek (38.4410, -122.3451);

Redwood Creek (38.3765, -122.4466);
Ritchie Creek (38.5369, -122.5652);
Sarco Creek (38.3567, -122.2071);
Soda Creek (38.4156, -122.2953);
Spencer Creek (38.2729, -122.1909);
Sulphur Creek (38.4895, -122.5088);
Suscol Creek (38.2522, -122.2157);
Tulucay Creek (38.2929, -122.2389);
Unnamed Tributary (38.4248, -122.4935);
Unnamed Tributary (38.4839, -122.5161);
York Creek (38.5128, -122.5023).

(8) Big Basin Hydrologic Unit 3304 -

(i) Davenport Hydrologic Sub-area 330411.

Outlet(s) = Baldwin Creek (Lat 36.9669, -122.1232);
Davenport Landing Creek (37.0231, -122.2153);
Laguna Creek (36.9824, -122.1560);
Liddell Creek (37.0001, -122.1816);
Majors Creek (36.9762, -122.1423);
Molino Creek (37.0368, -122.2292);
San Vicente VerDate Aug<18>2005 17: Scott Creek (37.0404, -122.2307);
Waddell Creek (37.0935, -122.2762);
Wilder Creek (36.9535, -122.0775)

Upstream to endpoint(s) in:
Baldwin Creek (37.0126, -122.1006);
Bettencourt Creek (37.1081, -122.2386);
Big Creek (37.0832, -122.2175);
Davenport Landing Creek (37.0475, -122.1920);
East Branch Waddell Creek (37.1482, -122.2531);
East Fork Liddell Creek (37.0204, -122.1521);
Henry Creek (37.1695, -122.2751);
Laguna Creek (37.0185, -122.1287);
Little Creek (37.0688, -122.2097);
Majors Creek (36.9815, -122.1374);
Middle Fork East Fork Liddell Creek (37.0194, -122.1608);
Mill Creek (37.1034, -122.2218);
Mill Creek (37.0235, -122.2218);
Molino Creek (37.0384, -122.2125);
Peasley Gulch (36.9824, -122.0861);
Queseria Creek (37.0521, -122.2042);
San Vicente Creek (37.0417, -122.1741);
Scott Creek (37.1338, -122.2306);
West Branch Waddell Creek (37.1697, -122.2642);
West Fork Liddell Creek (37.0117, -122.1763);
Unnamed Tributary (37.0103, -122.0701);
Wilder Creek (37.0107, -122.0770).

(ii) San Lorenzo Hydrologic Sub-area 330412.
Outlet(s) = Arana Gulch Creek (Lat 36.9676, Long -122.0028);
    San Lorenzo River (36.9641, -122.0125)
Upstream to endpoint(s) in:
    Arana Gulch Creek (37.0270, -121.9739);
    Bean Creek (37.0956, -122.0022);
    Bear Creek (37.1711, -122.0750);
    Boulder Creek (37.1952, -122.1892);
    Bracken Brae Creek (37.1441, -122.1459);
    Branciforte Creek (37.0701, -121.9749);
    Crystal Creek (37.0333, -121.9825);
    Carbonera Creek (37.0286, -122.0202);
    Central Branch Arana Gulch Creek (37.0170, -121.9874);
    Deer Creek (37.2215, -122.0799);
    Fall Creek (37.0705, -122.1063);
    Gold Gulch Creek (37.0427, -122.1018);
    Granite Creek (37.0490, -121.9979);
    Hare Creek (37.1544, -122.1690);
    Jameson Creek (37.1485, -122.1904);
    Kings Creek (37.2262, -122.1059);
    Lompico Creek (37.1250, -122.0496);
    Mackenzie Creek (37.0866, -122.0176);
    Mountain Charlie Creek (37.1385, -121.9914);
    Newell Creek (37.1019, -122.0724);
    San Lorenzo River (37.2276, -122.1384);
    Two Bar Creek (37.1833, -122.0929);
    Unnamed Tributary (37.2106, -122.0952);
    Unnamed Tributary (37.2032, -122.0699);
    Zayante Creek (37.1062, -122.0224).
(iii) Aptos-Soquel Hydrologic Subarea 330413.
Outlet(s) = Aptos Creek (Lat 36.9692, Long -121.9065);
    Soquel Creek (36.9720, -121.9526)
Upstream to endpoint(s) in:
    Amaya Creek (37.0930, -121.9297);
    Aptos Creek (37.0545, -121.8568);
    Bates Creek (37.0099, -121.9353);
    Bridge Creek (37.0464, -121.8969);
    East Branch Soquel Creek (37.0690, -121.8297);
    Hester Creek (37.0967, -121.9458);
    Hinckley Creek (37.0671, -121.9069);
    Moores Gulch (37.0573, -121.9579);
    Valencia Creek (37.0323, -121.8493);
    West Branch Soquel Creek (37.1095, -121.9606).
(iv) Ano Nuevo Hydrologic Sub-area 330420.
Outlet(s) = Ano Nuevo Creek (Lat 37.1163, Long -122.3060);
    Gazos Creek (37.1646, -122.3625);

Whitehouse Creek (37.1457, -122.3469)
Upstream to endpoint(s) in:
Ano Nuevo Creek (37.1269, -122.3039);
Bear Gulch (37.1965, -122.2773);
Gazos Creek (37.2088, -122.2868);
Old Womans Creek (37.1829, -122.3033);
Whitehouse Creek (37.1775, -122.2900).

(D) South-Central California Coast Steelhead (O. mykiss). Critical habitat is designated to include the areas defined in the following CALWATER Hydrologic Units:
(1) Pajaro River Hydrologic Unit 3305 -
(i) Watsonville Hydrologic Subarea 330510.
Outlet(s) = Pajaro River (Lat 36.8506, Long -121.8101)
Upstream to endpoint(s) in:
Banks Canyon Creek (36.9958, -121.7264);
Browns Creek (37.0255, -121.7754);
Casserly Creek (36.9902, -121.7359);
Corralitos Creek (37.0666, -121.8359);
Gaffey Creek (36.9905, -121.7132);
Gamecock Canyon (37.0362, -121.7587);
Green Valley Creek (37.0073, -121.7256);
Ramsey Gulch (37.0447, -121.7755);
Redwood Canyon (37.0342, -121.7975);
Salsipuedes Creek (36.9350, -121.7426);
Shingle Mill Gulch (37.0446, -121.7971).
(ii) Santa Cruz Mountains Hydrologic Sub-area 330520.
Outlet(s) = Pajaro River (Lat 36.9010, Long -121.5861);
Bodfish Creek (37.0041, -121.6667);
Pescadero Creek (36.9125, -121.5882);
Tar Creek (36.9304, -121.5520);
Uvas Creek (37.0146, -121.6314)
Upstream to endpoint(s) in:
Blackhawk Canyon (37.0168, -121.6912);
Bodfish Creek (36.9985, -121.6859);
Little Arthur Creek (37.0299, -121.6874);
Pescadero Creek (36.9826, -121.6274);
Tar Creek (36.9558, -121.6009);
Uvas Creek (37.0660, -121.6912).
(iii) South Santa Clara Valley Hydrologic Sub-area 330530.
Outlet(s) = San Benito River (Lat 36.8961, Long -121.5625);
Pajaro River (36.9222, -121.5388)
Upstream to endpoint(s) in:
Arroyo Dos Picachos (36.8866, -121.3184);
Bodfish Creek (37.0080, -121.6652);
Bodfish Creek (37.0041, -121.6667);
Carnadero Creek (36.9603, -121.5328);

Llagas Creek (37.1159, -121.6938);
Miller Canal (36.9698, -121.4814);
Pacheco Creek (37.0055, -121.3598);
San Felipe Lake (36.9835, -121.4604);
Tar Creek (36.9304, -121.5520);
Tequisquita Slough (36.9170, -121.3887);
Uvas Creek (37.0146, -121.6314).
(iv) Pacheco-Santa Ana Creek Hydrologic Sub-area 330540.
Outlet(s) = Arroyo Dos Picachos (Lat 36.8866, Long -121.3184);
Pacheco Creek (37.0055, -121.3598)
Upstream to endpoint(s) in:
Arroyo Dos Picachos (36.8912, -121.2305);
Cedar Creek (37.0922, -121.3641);
North Fork Pacheco Creek (37.0514, -121.2911);
Pacheco Creek (37.0445, -121.2662);
South Fork Pacheco Creek (37.0227, -121.2603).
(v) San Benito River Hyddrologic Subarea 330550.
Outlet(s) = San Benito River (Lat 36.7838, Long -121.3731)
Upstream to endpoint(s) in:
Bird Creek (36.7604, -121.4506);
Pescadero Creek (36.7202, -121.4187);
San Benito River (36.3324, -120.6316);
Sawmill Creek (36.3593, -120.6284).
(2) Carmel River Hydrologic Unit 3307 -
(i) Carmel River Hydrologic Subarea 330700.
Outlet(s) = Carmel River (Lat 36.5362, Long -121.9285)
Upstream to endpoint(s) in:
Aqua Mojo Creek (36.4711, -121.5407);
Big Creek (36.3935, -121.5419);
Blue Creek (36.2796, -121.6530);
Boronda Creek (36.3542, -121.6091);
Bruce Fork (36.3221, -121.6385);
Cachagua Creek (36.3909 , -121.5950);
Carmel River (36.2837, -121.6203);
Danish Creek (36.3730, -121.7590);
Hitchcock Canyon Creek (36.4470, -121.7597);
James Creek (36.3235, -121.5804);
Las Garzas Creek (36.4607, -121.7944);
Millers Fork (36.2961, -121.5697);
Pinch Creek (36.3236, -121.5574);
Pine Creek (36.3827, -121.7727);
Potrero Creek (36.4801, -121.8258);
Rana Creek (36.4877, -121.5840);
Rattlesnake Creek (36.3442, -121.7080);
Robertson Canyon Creek (36.4776, -121.8048);
Robertson Creek (36.3658, -121.5165);

San Clemente Creek (36.4227, -121.8115);
Tularcitos Creek (36.4369, -121.5163);
Ventana Mesa Creek (36.2977, -121.7116).

(3) Santa Lucia Hydrologic Unit 3308

(i) Santa Lucia Hydrologic Sub-area 330800.

Outlet(s) = Alder Creek (Lat 35.8578, Long -121.4165);
Big Creek (36.0696, -121.6005);
Big Sur River (36.2815, -121.8593);
Bixby Creek (36.3713, -121.9029);
Garrapata Creek (36.4176, -121.9157);
Limekiln Creek (36.0084, -121.5196);
Little Sur River (36.3350, -121.8934);
Malpaso Creek (36.4814, -121.9384);
Mill Creek (35.9825, -121.4917);
Partington Creek (36.1753, -121.6973);
Plaskett Creek (35.9195, -121.4717);
Prewitt Creek (35.9353, -121.4760);
Rocky Creek (36.3798, -121.9028);
Salmon Creek (35.3558, -121.3634);
San Jose Creek (36.5259, -121.9253);
Vicente Creek (36.0442, -121.5855);
Villa Creek (35.8495, -121.4087);
Willow Creek (35.8935, -121.4619)

Upstream to endpoint(s) in:
Alder Creek (35.8685, -121.3974);
Big Creek (36.0830, -121.5884);
Big Sur River (36.2490, -121.7269);
Bixby Creek (36.3715, -121.8440);
Devilís Canyon Creek (36.0773, -121.5695);
Garrapata Creek (36.4042, -121.8594);
Joshua Creek (36.4182, -121.9000);
Limekiln Creek (36.0154, -121.5146);
Little Sur River (36.3312, -121.7557);
Malpaso Creek (36.4681, -121.8800);
Mill Creek (35.9907, -121.4632);
North Fork Big Sur River (36.2178, -121.5948);
Partington Creek (36.1929, -121.6825);
Plaskett Creek (35.9228, -121.4493);
Prewitt Creek (35.9419, -121.4598);
Redwood Creek (36.2825, -121.6745);
Rocky Creek (36.3805, -121.8440);
San Jose Creek (36.4662, -121.8118);
South Fork Little Sur River (36.3026, -121.8093);
Vicente Creek (36.0463, -121.5780);
Villa Creek (35.8525, -121.3973);
Wildcat Canyon Creek (36.4124, -121.8680);

Williams Canyon Creek (36.4466, -121.8526);
Willow Creek (35.9050, -121.3851).

(4) Salinas River Hydrologic Unit 3309

(i) Neponset Hydrologic Sub-area 330911.
Outlet(s) = Salinas River (Lat 36.7498, Long -121.8055);
Upstream to endpoint(s) in:
Gabilan Creek (36.6923, -121.6300);
Old Salinas River (36.7728, -121.7884);
Tembladero Slough (36.6865, -121.6409).

(ii) Chualar Hydrologic Sub-area 330920.
Outlet(s) = Gabilan Creek (Lat 36.6923, Long -121.6300) upstream.

(iii) Soledad Hydrologic Sub-area 330930.
Outlet(s) = Salinas River (Lat 36.4878, Long -121.4688)
Upstream to endpoint(s) in:
Arroyo Seco River (36.2644, -121.3812);
Reliz Creek (36.2438, -121.2881).

(iv) Upper Salinas Valley Hydrologic Sub-area 330940.
Outlet(s) = Salinas River (Lat 36.3183, Long -121.1837) upstream.

(v) Arroyo Seco Hydrologic Sub-area 330960.
Outlet(s) = Arroyo Seco River (Lat 36.2644, Long -121.3812);
Reliz Creek (36.2438, -121.2881);
Vasqueros Creek (36.2648, -121.3368)
Upstream to endpoint(s) in:
Arroyo Seco River (36.2041, -121.5002);
Calaboose Creek (36.2942, -121.5082);
Church Creek (36.2762, -121.5877);
Horse Creek (36.2046, -121.3931);
Paloma Creek (36.3195, -121.4894);
Piney Creek (36.3023, -121.5629);
Reliz Creek (36.1935, -121.2777);
Rocky Creek (36.2676, -121.5225);
Santa Lucia Creek (36.1999, -121.4785);
Tassajara Creek (36.2679, -121.6149);
Vaqueros Creek (36.2479, -121.3369);
Willow Creek (36.2059, -121.5642).

(vi) Gabilan Range Hydrologic Subarea 330970.
Outlet(s) = Gabilan Creek (Lat 36.7800, -121.5836)
Upstream to endpoint(s) in:
Gabilan Creek (36.7335, -121.4939).

(vii) Paso Robles Hydrologic Sub-area 330981.
Outlet(s) = Salinas River (Lat 35.9241, Long -120.8650)
Upstream to endpoint(s) in:
Atascadero Creek (35.4468, -120.7010);
Graves Creek (35.4838, -120.7631);
Jack Creek (35.5815, -120.8560);
Nacimiento River (35.7610, -120.8853);

Paso Robles Creek (35.5636, -120.8455);
Salinas River (35.3886, -120.5582);
San Antonio River (35.7991, -120.8849);
San Marcos Creek (35.6734, -120.8140);
Santa Margarita Creek (35.3923, -120.6619);
Santa Rita Creek (35.5262, -120.8396)
Sheepcamp Creek (35.6145, -120.7795);
Summit Creek (35.6441, -120.8046);
Tassajera Creek (35.3895, -120.6926);
Trout Creek (35.3394, -120.5881);
Willow Creek (35.6107, -120.7720).
(5) Estero Bay Hydrologic Unit 3310 -
(i) San Carpoforo Hydrologic Sub-area 331011.
Outlet(s) = San Carpoforo Creek (Lat 35.7646, Long -121.3247)
Upstream to endpoint(s) in:
Dutra Creek (35.8197, -121.3273);
Estrada Creek (35.7710, -121.2661);
San Carpoforo Creek (35.8202, -121.2745);
Unnamed Tributary (35.7503, -121.2703);
Wagner Creek (35.8166, -121.2387).
(ii) Arroyo De La Cruz Hydrologic Sub-area 331012.
Outlet(s) = Arroyo De La Cruz (Lat 35.7097, Long -121.3080)
Upstream to endpoint(s) in:
Arroyo De La Cruz (35.6986, -121.1722);
Burnett Creek (35.7520, -121.1920);
Green Canyon Creek (35.7375 , -121.2314);
Marmolejo Creek (35.6774, -121.1082);
Spanish Cabin Creek (35.7234, -121.1497);
Unnamed Tributary (35.7291, -121.1977);
West Fork Burnett Creek (35.7516, -121.2075).
(iii) San Simeon Hydrologic Sub-area 331013.
Outlet(s) = Arroyo del Corral (Lat 35.6838, Long -121.2875);
Arroyo del Puerto (35.6432, -121.1889);
Little Pico Creek (35.6336, -121.1639);
Oak Knoll Creek (35.6512, -121.2197);
Pico Creek (35.6155, -121.1495);
San Simeon Creek (35.5950, -121.1272)
Upstream to endpoint(s) in:
Arroyo Laguna (35.6895, -121.2337);
Arroyo del Corral (35.6885, -121.2537);
Arroyo del Puerto (35.6773, -121.1713);
Little Pico Creek (35.6890, -121.1375);
Oak Knoll Creek (35.6718, -121.2010);
North Fork Pico Creek (35.6886, -121.0861);
San Simeon Creek (35.6228, -121.0561);
South Fork Pico Creek (35.6640, -121.0685);

Steiner Creek (35.6032, -121.0640);
Unnamed Tributary (35.6482, -121.1067);
Unnamed Tributary (35.6616, -121.0639);
Unnamed Tributary (35.6741, -121.0981);
Unnamed Tributary (35.6777, -121.1503);
Unnamed Tributary (35.6604, -121.1571);
Unnamed Tributary (35.6579, -121.1356);
Unnamed Tributary (35.6744, -121.1187);
Unnamed Tributary (35.6460, -121.1373);
Unnamed Tributary (35.6839, -121.0955);
Unnamed Tributary (35.6431, -121.0795);
Unnamed Tributary (35.6820, -121.2130);
Unnamed Tributary (35.6977, -121.2613);
Unnamed Tributary (35.6702, -121.1884);
Unnamed Tributary (35.6817, -121.0885);
Van Gordon Creek (35.6286, -121.0942).

(iv) Santa Rosa Hydrologic Sub-area 331014.

Outlet(s) = Santa Rosa Creek (Lat 35.5685, Long -121.1113)

Upstream to endpoint(s) in:

Green Valley Creek (35.5511, -120.9471);
Perry Creek (35.5323-121.0491);
Santa Rosa Creek (35.5525, -120.9278);
Unnamed Tributary (35.5965, -120.9413);
Unnamed Tributary (35.5684, -120.9211);
Unnamed Tributary (35.5746, -120.9746).

(v) Villa Hydrologic Sub-area 331015.

Outlet(s) = Villa Creek (Lat 35.4601, Long -120.9704)

Upstream to endpoint(s) in:

Unnamed Tributary (35.4798, -120.9630);
Unnamed Tributary (35.5080, -121.0171);
Unnamed Tributary (35.5348, -120.8878);
Unnamed Tributary (35.5510, -120.9406);
Unnamed Tributary (35.5151, -120.9497);
Unnamed Tributary (35.4917, -120.9584);
Unnamed Tributary (35.5173, -120.9516);
Villa Creek (35.5352, -120.8942).

(vi) Cayucos Hydrologic Sub-area 331016.

Outlet(s) = Cayucos Creek (Lat 35.4491, Long -120.9079)

Upstream to endpoint(s) in:

Cayucos Creek (35.5257, -120.9271);
Unnamed Tributary (35.5157, -120.9005);
Unnamed Tributary (35.4943, -120.9513);
Unnamed Tributary (35.4887, -120.8968).

(vii) Old Hydrologic Sub-area 331017.

Outlet(s) = Old Creek (Lat 35.4345, Long -120.8868)

Upstream to endpoint(s) in:

Old Creek (35.4480, -120.8871)

(viii) Toro Hydrologic Sub-area 331018.

Outlet(s) = Toro Creek (Lat 35.4126, Long -120.8739)

Upstream to endpoint(s) in:

Toro Creek (35.4945, -120.7934);
Unnamed Tributary (35.4917, -120.7983).

(ix) Morro Hydrologic Sub-area 331021.

Outlet(s) = Morro Creek (Lat 35.3762, Long -120.8642)

Upstream to endpoint(s) in:

East Fork Morro Creek (35.4218, -120.7282);
Little Morro Creek (35.4155, -120.7532);
Morro Creek (35.4291, -120.7515);
Unnamed Tributary (35.4292, -120.8122);
Unnamed Tributary (35.4458, -120.7906);
Unnamed Tributary (35.4122, -120.8335);
Unnamed Tributary (35.4420, -120.7796).

(x) Chorro Hydrologic Sub-area 331022.

Outlet(s) = Chorro Creek (Lat 35.3413, Long -120.8388)

Upstream to endpoint(s) in:

Chorro Creek (35.3340, -120.6897);
Dairy Creek (35.3699, -120.6911);
Pennington Creek (35.3655, -120.7144);
San Bernardo Creek (35.3935, -120.7638);
San Luisito (35.3755, -120.7100);
Unnamed Tributary (35.3821, -120.7217);
Unnamed Tributary (35.3815, -120.7350).

(xi) Los Osos Hydrologic Sub-area 331023.

Outlet(s) = Los Osos Creek (Lat 35.3379, Long -120.8273)

Upstream to endpoint(s) in:

Los Osos Creek (35.2718, -120.7627).

(xii) San Luis Obispo Creek Hydrologic Sub-area 331024.

Outlet(s) = San Luis Obispo Creek (Lat 35.1822, Long -120.7303)

Upstream to endpoint(s) in:

Brizziolari Creek (35.3236, -120.6411);
Froom Creek (35.2525, -120.7144);
Prefumo Creek (35.2615, -120.7081);
San Luis Obispo Creek (35.3393, -120.6301);
See Canyon Creek (35.2306, -120.7675);
Stenner Creek (35.3447, -120.6584);
Unnamed Tributary (35.2443, -120.7655).

(xiii) Point San Luis Hydrologic Subarea 331025.

Outlet(s) = Coon Creek (Lat 35.2590, Long -120.8951);

Islay Creek (35.2753, -120.8884)

Upstream to endpoint(s) in:

Coon Creek (35.2493, -120.7774);
Islay Creek (35.2574, -120.7810);

Unnamed Tributary (35.2753, -120.8146);
Unnamed Tributary (35.2809, -120.8147);
Unnamed Tributary (35.2648, -120.7936).
(xiv) Pismo Hydrologic Sub-area 331026.
Outlet(s) = Pismo Creek (Lat 35.1336, Long -120.6408)
Upstream to endpoint(s) in:
East Corral de Piedra Creek (35.2343, -120.5571);
Pismo Creek (35.1969, -120.6107);
Unnamed Tributary (35.2462, -120.5856).
(xv) Oceano Hydrologic Sub-area 331031.
Outlet(s) = Arroyo Grande Creek (Lat 35.1011, Long -120.6308)
Upstream to endpoint(s) in:
Arroyo Grande Creek (35.1868, -120.4881);
Los Berros Creek (35.0791, -120.4423).

(E) Southern California Steelhead (O. mykiss). Critical habitat is designated to include the areas defined in the following CALWATER Hydrologic Units:
(1) Santa Maria River Hydrologic Unit 3312 -
(i) Santa Maria Hydrologic Subarea 331210.
Outlet(s) = Santa Maria River (Lat 34.9710, Long -120.6504)
Upstream to endpoint(s) in:
Cuyama River (34.9058, -120.3026);
Santa Maria River (34.9042, -120.3077);
Sisquoc River (34.8941, -120.3063).
(ii) Sisquoc Hydrologic Sub-area 331220.
Outlet(s) = Sisquoc River (Lat 34.8941, Long -120.3063)
Upstream to endpoint(s) in:
Abel Canyon (34.8662, -119.8354);
Davey Brown Creek (34.7541, -119.9650);
Fish Creek (34.7531, -119.9100);
Foresters Leap (34.8112, -119.7545);
La Brea Creek (34.8804, -120.1316);
Horse Creek (34.8372, -120.0171);
Judell Creek (34.7613, -119.6496);
Manzana Creek (34.7082, -119.8324);
North Fork La Brea Creek (34.9681, -120.0112);
Sisquoc River (34.7087, -119.6409);
South Fork La Brea Creek (34.9543, -119.9793);
South Fork Sisquoc River (34.7300, -119.7877);
Unnamed Tributary (34.9342, -120.0589);
Unnamed Tributary (34.9510, -120.0140);
Unnamed Tributary (34.9687, -120.1419);
Unnamed Tributary (34.9626, -120.1500);
Unnamed Tributary (34.9672, -120.1194);
Unnamed Tributary (34.9682, -120.0990);
Unnamed Tributary (34.9973, -120.0662);

Unnamed Tributary (34.9922, -120.0294);
Unnamed Tributary (35.0158, -120.0337);
Unnamed Tributary (34.9464, -120.0309);
Unnamed Tributary (34.7544, -119.9476);
Unnamed Tributary (34.7466, -119.9047);
Unnamed Tributary (34.7646, -119.8673);
Unnamed Tributary (34.8726, -119.9525);
Unnamed Tributary (34.8884, -119.9325);
Unnamed Tributary (34.8659, -119.8982);
Unnamed Tributary (34.8677, -119.8513);
Unnamed Tributary (34.8608, -119.8541);
Unnamed Tributary (34.8784, -119.8458);
Unnamed Tributary (34.8615, -119.8159);
Unnamed Tributary (34.8694, -119.8229);
Unnamed Tributary (34.7931, -119.8485);
Unnamed Tributary (34.7846, -119.8337);
Unnamed Tributary (34.7872, -119.7684);
Unnamed Tributary (34.7866, -119.7552);
Unnamed Tributary (34.8129, -119.7714);
Unnamed Tributary (34.7760, -119.7448);
Unnamed Tributary (34.7579, -119.7999);
Unnamed Tributary (34.7510, -119.7921);
Unnamed Tributary (34.7769, -119.7149);
Unnamed Tributary (34.7617, -119.6878);
Unnamed Tributary (34.7680, -119.6503);
Unnamed Tributary (34.7738, -119.6493);
Unnamed Tributary (34.7332, -119.6286);
Unnamed Tributary (34.7519, -119.6209);
Unnamed Tributary (34.7188, -119.6673);
Water Canyon (34.8754, -119.9324).

(2) Santa Ynex Hydrologic Unit 3314 -

(i) Mouth of Santa Ynez Hydrologic Sub-area 331410.
Outlet(s) = Santa Ynez River (Lat 34.6930, Long -120.6033)
Upstream to endpoint(s) in:
San Miguelito Creek (34.6309, -120.4631).

(ii) Santa Ynez, Salsipuedes Hydrologic Sub-area 331420.
Outlet(s) = Santa Ynez River (Lat 34.6335, Long -120.4126)
Upstream to endpoint(s) in:
El Callejon Creek (34.5475, -120.2701);
El Jaro Creek (34.5327, -120.2861);
Llanito Creek (34.5499, -120.2762);
Salsipuedes Creek (34.5711, -120.4076).

(iii) Santa Ynez, Zaca Hydrologic Sub-area 331430.
Outlet(s) = Santa Ynez River (Lat 34.6172, Long -120.2352) upstream.

(iv) Santa Ynez to Bradbury Hydrologic Sub-area 331440.
Outlet(s) = Santa Ynez River (Lat 34.5847, Long -120.1445)

Upstream to endpoint(s) in:
    Alisal Creek (34.5465, -120.1358);
    Hilton Creek (34.5839, -119.9855);
    Quiota Creek (34.5370, -120.0321);
    San Lucas Creek (34.5558, -120.0119);
    Santa Ynez River (34.5829, -119.9805);
    Unnamed Tributary (34.5646, -120.0043).

(3) South Coast Hydrologic Unit 3315 -

(i) Arroyo Hondo Hydrologic Sub-area 331510.

Outlet(s) = Alegria Creek (Lat 34.4688, Long -120.2720);
    Arroyo Hondo Creek (34.4735, -120.1415);
    Cojo Creek (34.4531, -120.4165);
    Dos Pueblos Creek (34.4407, -119.9646);
    El Capitan Creek (34.4577, -120.0225);
    Gato Creek (34.4497, -119.9885);
    Gaviota Creek (34.4706, -120.2267);
    Jalama Creek (34.5119, -120.5023);
    Refugio Creek (34.4627, -120.0696);
    Sacate Creek (34.4708, -120.2942);
    San Augustine Creek (34.4588, -120.3542);
    San Onofre Creek (34.4699, -120.1872);
    Santa Anita Creek (34.4669, -120.3066);
    Tecolote Creek (34.4306, -119.9173)

Upstream to endpoint(s) in:
    Alegria Creek (34.4713, -120.2714);
    Arroyo Hondo Creek (34.5112, -120.1704);
    Cojo Creek (34.4840, -120.4106);
    Dos Pueblos Creek (34.5230, -119.9249);
    El Capitan Creek (34.5238, -119.9806);
    Escondido Creek (34.5663, -120.4643);
    Gato Creek (34.5203, -119.9758);
    Gaviota Creek (34.5176, -120.2179);
    Jalama Creek (34.5031, -120.3615);
    La Olla (34.4836, -120.4071);
    Refugio Creek (34.5109, -120.0508);
    Sacate Creek (34.4984, -120.2993);
    San Augustine Creek (34.4598, -120.3561);
    San Onofre Creek (34.4853, -120.1890);
    Santa Anita Creek (34.4742, -120.3085);
    Tecolote Creek (34.5133, -119.9058);
    Unnamed Tributary (34.5527, -120.4548);
    Unnamed Tributary (34.4972, -120.3026).

(ii) UCSB Slough Hydrologic Sub-area 331531.

Outlet(s) = San Pedro Creek (Lat 34.4179, Long -119.8295);
    Tecolito Creek (34.4179, -119.8295)

Upstream to endpoint(s) in:

Atascadero Creek (34.4345, -119.7755);
Carneros Creek (34.4674, -119.8584);
Cieneguitas Creek (34.4690, -119.7565);
Glen Annie Creek (34.4985, -119.8666);
Maria Ygnacio Creek (34.4900, -119.7830);
San Antonio Creek (34.4553, -119.7826);
San Pedro Creek (34.4774, -119.8359);
San Jose Creek (34.4919, -119.8032);
Tecolito Creek (34.4478, -119.8763);
Unnamed Tributary (34.4774, -119.8846).

(iii) Mission Hydrologic Sub-area 331532.

Outlet(s) = Arroyo Burro Creek (Lat 34.4023, Long -119.7430);
Mission Creek (34.4124, -119.6876);
Sycamore Creek (34.4166, -119.6668)

Upstream to endpoint(s) in:
Arroyo Burro Creek (34.4620, -119.7461);
Mission Creek (34.4482, -119.7089);
Rattlesnake Creek (34.4633, -119.6902);
San Roque Creek (34.4530, -119.7323);
Sycamore Creek (34.4609, -119.6841).

(iv) San Ysidro Hydrologic Sub-area 331533.

Outlet(s) = Montecito Creek (Lat 34.4167, Long -119.6344);
Romero Creek (34.4186, -119.6208);
San Ysidro Creek (34.4191, -119.6254);

Upstream to endpoint(s) in:
Cold Springs Creek (34.4794, -119.6604);
Montecito Creek (34.4594, -119.6542);
Romero Creek (34.4452, -119.5924);
San Ysidro Creek (34.4686, -119.6229);
Unnamed Tributary (34.4753, -119.6437).

(v) Carpinteria Hydrologic Sub-area 331534.

Outlet(s) = Arroyo Paredon (Lat 34.4146, Long -119.5561);
Carpenteria Lagoon (Carpenteria Creek) (34.3904, -119.5204);
Rincon Lagoon (Rincon Creek) (34.3733, -119.4769)

Upstream to endpoint(s) in:
Arroyo Paredon (34.4371, -119.5481);
Carpinteria Creek (34.4429, -119.4964);
El Dorado Creek (34.4682, -119.4809);
Gobernador Creek (34.4249, -119.4746);
Rincon Lagoon (Rincon Creek) (34.3757, -119.4777);
Steer Creek (34.4687, -119.4596);
Unnamed Tributary (34.4481, -119.5112).

(4) Ventura River Hydrologic Unit 4402 -

(i) Ventura Hydrologic Sub-area 440210.

Outlet(s) = Ventura Estuary (Ventura River) (Lat 34.2742, Long -119.3077)

Upstream to endpoint(s) in:
  - Canada Larga (34.3675, -119.2377);
  - Hammond Canyon (34.3903, -119.2230);
  - Sulphur Canyon (34.3727, -119.2362);
  - Unnamed Tributary (34.3344, -119.2426);
  - Unnamed Tributary (34.3901, -119.2747).

(ii) Ventura Hydrologic Sub-area 440220.
Outlet(s) = Ventura River (Lat 34.3517, Long -119.3069)
Upstream to endpoint(s) in:
  - Coyote Creek (34.3735, -119.3337);
  - Matilija Creek (34.4846, -119.3086);
  - North Fork Matilija Creek (34.5129, -119.2737);
  - San Antonio Creek (34.4224, -119.2644);
  - Ventura River (34.4852, -119.3001).

(iii) Lions Hydrologic Sub-area 440231.
Outlet(s) = Lion Creek (Lat 34.4222, Long -119.2644)
Upstream to endpoint(s) in:
  - Lion Creek (34.4331, -119.2004).

(iv) Thatcher Hydrologic Sub-area 440232.
Outlet(s) = San Antonio Creek (Lat 34.4224, Long -119.2644)
Upstream to endpoint(s) in:
  - San Antonio Creek (34.4370, -119.2417).

(5) Santa Clara Calleguas Hydrologic Unit 4403 -

(i) Mouth of Santa Clara Hydrologic Sub-area 440310.
Outlet(s) = Santa Clara River (Lat 34.2348, Long -119.2568)
Upstream.

(ii) Santa Clara, Santa Paula Hydrologic Sub-area 440321.
Outlet(s) = Santa Clara River (Lat 34.2731, Long -119.1474)
Upstream to endpoint(s) in:
  - Santa Paula Creek (34.4500, -119.0563).

(iii) Sisar Hydrologic Sub-area 440322.
Outlet(s) = Sisar Creek (Lat 34.4271, Long -119.0908)
Upstream to endpoint(s) in:
  - Sisar Creek (34.4615, -119.1312).

(iv) Sespe, Santa Clara Hydrologic Sub-area 440331.
Outlet(s) = Santa Clara River (Lat 34.3513, Long -119.0397)
Upstream to endpoint(s) in:
  - Sespe Creek (34.4509, -118.9258).

(v) Sespe Hydrologic Sub-area 440332.
Outlet(s) = Sespe Creek (Lat 34.4509, Long -118.9258)
Upstream to endpoint(s) in:
  - Abadi Creek (34.6099, -119.4223);
  - Alder Creek (34.5691, -118.9528);
  - Bear Creek (34.5314, -119.1041);
  - Chorro Grande Creek (34.6285, -119.3245);
  - Fourfork Creek (34.4735, -118.8893);

Howard Creek (34.5459, -119.2154);
Lady Bug Creek (34.5724, -119.3173);
Lion Creek (34.5047, -119.1101);
Little Sespe Creek (34.4598, -118.8938);
Munson Creek (34.6152, -119.2963);
Park Creek (34.5537, -119.0028);
Piedra Blanca Creek (34.6109, -119.1838);
Pine Canyon Creek (34.4488, -118.9661);
Portrero John Creek (34.6010, -119.2695);
Red Reef Creek (34.5344, -119.0441);
Rose Valley Creek (34.5195, -119.1756);
Sespe Creek (34.6295, -119.4412);
Timber Creek (34.5184, -119.0698);
Trout Creek (34.5869, -119.1360);
Tule Creek (34.5614, -119.2986);
Unnamed Tributary (34.5125, -118.9311);
Unnamed Tributary (34.5537, -119.0088);
Unnamed Tributary (34.5537, -119.0048);
Unnamed Tributary (34.5757, -119.3051);
Unnamed Tributary (34.5988, -119.2736);
Unnamed Tributary (34.5691, -119.3428);
West Fork Sespe Creek (34.5106, -119.0502).
(vi) Santa Clara, Hopper Canyon, Piru Hydrologic Sub-area 440341.
Outlet(s) = Santa Clara River (Lat 34.3860, Long -118.8711)
Upstream to endpoint(s) in:
Hopper Creek (34.4263, -118.8309);
Piru Creek (34.4613, -118.7537);
Santa Clara River (34.3996, -118.7837).
(6) Santa Monica Bay Hydrologic Unit 4404 -
(i) Topanga Hydrologic Sub-area 440411.
Outlet(s) = Topanga Creek (Lat 34.0397, Long -118.5831)
Upstream to endpoint(s) in:
Topanga Creek (34.0838, -118.5980).
(ii) Malibu Hydrologic Sub-area 440421.
Outlet(s) = Malibu Creek (Lat 34.0322, Long -118.6796)
Upstream to endpoint(s) in:
Malibu Creek (34.0648, -118.6987).
(iii) Arroyo Sequit Hydrologic Subarea 440444.
Outlet(s) = Arroyo Sequit (Lat 34.0445, Long -118.9338)
Upstream to endpoint(s) in:
Arroyo Sequit (34.0839, -118.9186);
West Fork Arroyo Sequit (34.0909, -118.9235).
(7) Calleguas Hydrologic Unit 4408 -
(i) Calleguas Estuary Hydrologic Subarea 440813.
Outlet(s) = Mugu Lagoon (Calleguas Creek) (Lat 34.1093, Long -119.0917)

Upstream to endpoint(s) in:
Mugu Lagoon (Calleguas Creek) (Lat 34.1125, Long -119.0816).
(8) San Juan Hydrologic Unit 4901 -
(i) Middle Trabuco Hydrologic Sub-area 490123.
Outlet(s) = Trabuco Creek (Lat 33.5165, Long -117.6727)
Upstream to endpoint(s) in:
Trabuco Creek (33.5264, -117.6700).
(ii) Lower San Juan Hydrologic Subarea 490127.
Outlet(s) = San Juan Creek (Lat 33.4621, Long -117.6842)
Upstream to endpoint(s) in:
San Juan Creek (33.4929, -117.6610);
Trabuco Creek (33.5165, -117.6727).
(iii) San Mateo Hydrologic Sub-area 490140.
Outlet(s) = San Mateo Creek (Lat 33.3851, Long -117.5933)
Upstream to endpoint(s) in:
San Mateo Creek (33.4779, -117.4386);
San Mateo Canyon (33.4957, -117.4522).

(F) Central Valley Spring Run Chinook Salmon (O. tshawytscha). Critical habitat is designated to include the areas defined in the following CALWATER Hydrologic Units:

(1) Tehama Hydrologic Unit 5504 -
(i) Lower Stony Creek Hydrologic Sub-area 550410.
Outlet(s) = Glenn-Colusa Canal (Lat 39.6762, Long -122.0151);
Stony Creek (39.7122, -122.0072)
Upstream to endpoint(s) in:
Glenn-Colusa Canal (39.7122, -122.0072);
Stony Creek (39.8178, -122.3253).
(ii) Red Bluff Hydrologic Sub-area 550420.
Outlet(s) = Sacramento River (Lat 39.6998, Long -121.9419)
Upstream to endpoint(s) in:
Antelope Creek (40.2023, -122.1275);
Big Chico Creek (39.7757, -121.7525);
Blue Tent Creek (40.2284, -122.2551);
Burch Creek (39.8526, -122.1502);
Butler Slough (40.1579, -122.1320);
Coyote Creek (40.0929, -122.1621);
Craig Creek (40.1617, -122.1350);
Deer Creek (40.0144, -121.9481);
Dibble Creek (40.2003, -122.2420);
Dye Creek (40.0904, -122.0767);
Elder Creek (40.0526, -122.1717);
Jewet Creek (39.8913, -122.1005);
Kusal Slough (39.7577, -121.9699);
Lindo Channel (39.7623, -121.7923);
McClure Creek (40.0074, -122.1729);
Mill Creek (40.0550, -122.0317);
Mud Creek (39.7931, -121.8865);

New Creek (40.1873, -122.1350);
Oat Creek (40.0847, -122.1658);
Pine Creek (39.8760, -121.9777);
Red Bank Creek (40.1391, -122.2157);
Reeds Creek (40.1687, -122.2377);
Rice Creek (39.8495, -122.1626);
Rock Creek (39.8189, -121.9124);
Salt Creek (40.1869, -122.1845);
Singer Creek (39.9200, -121.9612);
Thomes Creek (39.8822, -122.5527);
Toomes Creek (39.9808, -122.0642);
Unnamed Tributary (39.8532, -122.1627);
Unnamed Tributary (40.1682, -122.1459);
Unnamed Tributary (40.1867, -122.1353).

(2) Whitmore Hydrologic Unit 5507 -

(i) Inks Creek Hydrologic Sub-area 550711.
Outlet(s) = Inks Creek (Lat 40.3305, Long -122.1520)
Upstream to endpoint(s) in:
Inks Creek 40.3418, -122.1332).

(ii) Battle Creek Hydrologic Sub-area 550712 Outlet(s) = Battle Creek (Lat 40.4083, Long -122.1102)
Upstream to endpoint(s) in:
Battle Creek (40.4228, -121.9975);
North Fork Battle Creek (40.4746, -121.8436);
South Fork Battle Creek (40.3549, -121.6861).

(iii) Inwood Hydrologic Sub-area 550722.
Outlet(s) = Bear Creek (Lat 40.4352, Long -122.2039)
Upstream to endpoint(s) in:
Bear Creek (40.4859, -122.1529);
Dry Creek (40.4574, -122.1993).

(3) Redding Hydrologic Unit 5508 -

(i) Enterprise Flat Hydrologic Sub-area 550810.
Outlet(s)= Sacramento River (Lat 40.2526, Long -122.1707)
Upstream to endpoint(s) in:
Anderson Creek (40.3910, -122.1984);
Ash Creek (40.4451, -122.1815);
Battle Creek (40.4083, -122.1102);
Churn Creek (40.5431, -122.3395);
Clear Creek (40.5158, -122.5256);
Cow Creek (40.5438, -122.1318);
Olney Creek (40.5262, -122.3783);
Paynes Creek (40.2810, -122.1587);
Stillwater Creek (40.4789, -122.2597).

(ii) Lower Cottonwood Hydrologic Sub-area 550820.
Outlet(s) = Cottonwood Creek (Lat 40.3777, Long -122.1991)
Upstream to endpoint(s) in:

Cottonwood Creek (40.3943, -122.5254);
Middle Fork Cottonwood Creek (40.3314, -122.6663);
South Fork Cottonwood Creek (40.1578, -122.5809).
(4) Eastern Tehama Hydrologic Unit 5509 -
(i) Big Chico Creek Hydrologic Sub-area 550914.
Outlet(s) = Big Chico Creek (Lat 39.7757, Long -121.7525)
Upstream to endpoint(s) in:
Big Chico Creek (39.8873, -121.6979).
(ii) Deer Creek Hydrologic Sub-area 550920.
Outlet(s) = Deer Creek (Lat 40.0144, Long -121.9481)
Upstream to endpoint(s) in:
Deer Creek (40.2019, -121.5130).
(iii) Upper Mill Creek Hydrologic Subarea 550942.
Outlet(s) = Mill Creek (Lat 40.0550, Long -122.0317)
Upstream to endpoint(s) in:
Mill Creek (40.3997, -121.5131).
(iv) Antelope Creek Hydrologic Subarea 550963.
Outlet(s) = Antelope Creek (Lat 40.2023, Long -122.1272)
Upstream to endpoint(s) in:
Antelope Creek (40.2416, -121.8630);
North Fork Antelope Creek (40.2691, -121.8226);
South Fork Antelope Creek (40.2309, -121.8325).
(5) Sacramento Delta Hydrologic Unit 5510 -
(i) Sacramento Delta Hydrologic Sub-area 551000.
Outlet(s) = Sacramento River (Lat 38.0612, Long -121.7948)
Upstream to endpoint(s) in:
Cache Slough (38.3086, -121.7633);
Delta Cross Channel (38.2433, -121.4964);
Elk Slough (38.4140, -121.5212);
Elkhorn Slough (38.2898, -121.6271);
Georgiana Slough (38.2401, -121.5172);
Miners Slough (38.2864, -121.6051);
Prospect Slough (38.1477, -121.6641);
Sevenmile Slough (38.1171, -121.6298);
Steamboat Slough (38.3052, -121.5737);
Sutter Slough (38.3321, -121.5838);
Threemile Slough (38.1155, -121.6835);
Yolo Bypass (38.5800, -121.5838).
(6) Valley-Putah-Cache Hydrologic Unit 5511 -
(i) Lower Putah Creek Hydrologic Sub-area 551120.
Outlet(s) = Yolo Bypass (Lat 38.5800, Long -121.5838)
Upstream to endpoint(s) in:
Sacramento Bypass (38.6057, -121.5563);
Yolo Bypass (38.7627, -121.6325).
(7) Marysville Hydrologic Unit 5515 -
(i) Lower Yuba River Hydrologic Subarea 551510.

Outlet(s) = Bear River (Lat 38.9398, Long -121.5790)
Upstream to endpoint(s) in:
Bear River (38.9783, -121.5166).
(ii) Lower Yuba River Hydrologic Subarea 551530.
Outlet(s) = Yuba River (Lat 39.1270, Long -121.5981)
Upstream to endpoint(s) in:
Yuba River (39.2203, -121.3314).
(iii) Lower Feather River Hydrologic Sub-area 551540.
Outlet(s) = Feather River (Lat 39.1270, Long -121.5981)
Upstream to endpoint(s) in:
Feather River (39.5203, -121.5475).
(8) Yuba River Hydrologic Unit 5517 -
(i) Browns Valley Hydrologic Sub-Area 551712.
Outlet(s) = Dry Creek (Lat 39.2207, Long -121.4088);
Yuba River (39.2203, -121.3314)
Upstream to endpoint(s) in:
Dry Creek (39.3201, -121.3117);
Yuba River (39.2305, -121.2813).
(ii) Englebright Hydrologic Sub-area 551714.
Outlet(s) = Yuba River (Lat 39.2305, Long -121.2813)
Upstream to endpoint(s) in:
Yuba River (39.2388, -121.2698).
(9) Valley-American Hydrologic Unit 5519 -
(i) Lower American Hydrologic Sub-area 551921.
Outlet(s) = American River (Lat 38.5971, Long -121.5088)
Upstream to endpoint(s) in:
American River (38.5669, -121.3827).
(ii) Pleasant Grove Hydrologic Subarea 551922.
Outlet(s) = Sacramento River (Lat 38.5965, Long -121.5086)
Upstream to endpoint(s) in:
Feather River (39.1270, -121.5981).
(10) Colusa Basin Hydrologic Unit 5520 -
(i) Sycamore-Sutter Hydrologic Sub-area 552010.
Outlet(s) = Sacramento River (Lat 38.7604, Long -121.6767)
Upstream to endpoint(s) in:
Tisdale Bypass (39.0261, -121.7456).
(ii) Sutter Bypass Hydrologic Sub-area 552030.
Outlet(s) = Sacramento River (Lat 38.7849, Long -121.6219)
Upstream to endpoint(s) in:
Butte Creek (39.1987, -121.9285);
Butte Slough (39.1987, -121.9285);
Nelson Slough (38.8901, -121.6352);
Sacramento Slough (38.7843, -121.6544);
Sutter Bypass (39.1417, -121.8196; 39.1484, -121.8386);
Tisdale Bypass (39.0261, -121.7456);
Unnamed Tributary (39.1586, -121.8747).

(iii) Butte Basin Hydrologic Sub-area 552040.
Outlet(s) = Butte Creek (Lat 39.1990, Long -121.9286);
Sacramento River (39.4141, -122.0087)
Upstream to endpoint(s) in:
Butte creek (39.7095, -121.7506);
Colusa Bypass (39.2276, -121.9402);
Unnamed Tributary (39.6762, -122.0151).

(11) Butte Creek Hydrologic Unit 5521
(i) Upper Little Chico Hydrologic Sub-area 552130.
Outlet(s) = Butte Creek (Lat 39.7096, -121.7504)
Upstream to endpoint(s) in Butte Creek (39.8665, -121.6344).

(12) Shasta Bally Hydrologic Unit 5524 -
(i) Platina Hydrologic Sub-area 552436.
Outlet(s) = Middle Fork Cottonwood Creek (Lat 40.3314, -122.6663)
Upstream to endpoint(s) in Beegum Creek (40.3066, -122.9205);
Middle Fork Cottonwood Creek (40.3655, -122.7451).
(ii) Spring Creek Hydrologic Sub-area 552440.
Outlet(s) = Sacramento River (Lat 40.5943, Long -122.4343)
Upstream to endpoint(s) in:
Sacramento River (40.6116, -122.4462)
(iii) Kanaka Peak Hydrologic Sub-area 552462.
Outlet(s) = Clear Creek (Lat 40.5158, Long -122.5256)
Upstream to endpoint(s) in:
Clear Creek (40.5992, -122.5394).

(G) Central Valley steelhead (O. mykiss). Critical habitat is designated to include the areas defined in the following CALWATER Hydrologic Units:

(1) Tehama Hydrologic Unit 5504 -
(i) Lower Stony Creek Hydrologic Sub-area 550410.
Outlet(s) = Stony Creek (Lat 39.6760, Long -121.9732)
Upstream to endpoint(s) in:
Stony Creek (39.8199, -122.3391).
(ii) Red Bluff Hydrologic Sub-area 550420.
Outlet(s) = Sacramento River (Lat 39.6998, Long -121.9419)
Upstream to endpoint(s) in:
Antelope Creek (40.2023, -122.1272);
Big Chico Creek (39.7757, -121.7525);
Blue Tent Creek (40.2166, -122.2362);
Burch Creek (39.8495, -122.1615);
Butler Slough (40.1579, -122.1320);
Craig Creek (40.1617, -122.1350);
Deer Creek (40.0144, -121.9481);
Dibble Creek (40.2002, -122.2421);
Dye Creek (40.0910, -122.0719);
Elder Creek (40.0438, -122.2133);
Lindo Channel (39.7623, -121.7923);

McClure Creek (40.0074, -122.1723);
Mill Creek (40.0550, -122.0317);
Mud Creek (39.7985, -121.8803);
New Creek (40.1873, -122.1350);
Oat Creek (40.0769, -122.2168);
Red Bank Creek (40.1421, -122.2399);
Rice Creek (39.8495, -122.1615);
Rock Creek (39.8034, -121.9403);
Salt Creek (40.1572, -122.1646);
Thomes Creek (39.8822, -122.5527);
Unnamed Tributary (40.1867, -122.1353);
Unnamed Tributary (40.1682, -122.1459);
Unnamed Tributary (40.1143, -122.1259);
Unnamed Tributary (40.0151, -122.1148);
Unnamed Tributary (40.0403, -122.1009);
Unnamed Tributary (40.0514, -122.0851);
Unnamed Tributary (40.0530, -122.0769).

(2) Whitmore Hydrologic Unit 5507 -

(i) Inks Creek Hydrologic Sub-area 550711.
Outlet(s) = Inks Creek (Lat 40.3305, Long -122.1520)
Upstream to endpoint(s) in:
Inks Creek (40.3418, -122.1332).

(ii) Battle Creek Hydrologic Sub-area 550712.
Outlet(s) = Battle Creek (Lat 40.4083, Long -122.1102)
Upstream to endpoint(s) in:
Baldwin Creek (40.4369, -121.9885);
Battle Creek (40.4228, -121.9975);
Brush Creek (40.4913, -121.8664);
Millseat Creek (40.4808, -121.8526);
Morgan Creek (40.3654, -121.9132);
North Fork Battle Creek (40.4877, -121.8185);
Panther Creek (40.3897, -121.6106);
South Ditch (40.3997, -121.9223);
Ripley Creek (40.4099, -121.8683);
Soap Creek (40.3904, -121.7569);
South Fork Battle Creek (40.3531, -121.6682);
Unnamed Tributary (40.3567, -121.8293);
Unnamed Tributary (40.4592, -121.8671).

(iii) Ash Creek Hydrologic Sub-area 550721.
Outlet(s) = Ash Creek (Lat 40.4401, Long -122.1375)
Upstream to endpoint(s) in:
Ash Creek (40.4628, -122.0066).

(iv) Inwood Hydrologic Sub-area 550722.
Outlet(s) = Ash Creek (Lat 40.4628, Long -122.0066);
Bear Creek (40.4352, -122.2039)
Upstream to endpoint(s) in:

Ash Creek (40.4859, -121.8993);
Bear Creek (40.5368, -121.9560);
North Fork Bear Creek (40.5736, -121.8683).

(v) South Cow Creek Hydrologic Subarea 550731.
Outlet(s) = South Cow Creek (Lat 40.5438, Long -122.1318)
Upstream to endpoint(s) in:
South Cow Creek (40.6023, -121.8623).

(vi) Old Cow Creek Hydrologic Subarea 550732.
Outlet(s) = Clover Creek (Lat 40.5788, Long -122.1252);
Old Cow Creek (40.5442, -122.1317)
Upstream to endpoint(s) in:
Clover Creek (40.6305, -122.0304);
Old Cow Creek (40.6295, -122.9619).

(vii) Little Cow Creek Hydrologic Subarea 550733.
Outlet(s) = Little Cow Creek (Lat 40.6148, -122.2271);
Oak Run Creek (40.6171, -122.1225)
Upstream to endpoint(s) in:
Little Cow Creek (40.7114, -122.0850);
Oak Run Creek (40.6379, -122.0856).

(3) Redding Hydrologic Unit 5508 -

(i) Enterprise Flat Hydrologic Sub-area 550810.
Outlet(s) = Sacramento River (Lat 40.2526, Long -122.1707)
Upstream to endpoint(s) in:
Ash Creek (40.4401, -122.1375);
Battle Creek (40.4083, -122.1102);
Bear Creek (40.4360, -122.2036);
Calaboose Creek (40.5742, -122.4142);
Canyon Creek (40.5532, -122.3814);
Churn Creek (40.5986, -122.3418);
Clear Creek (40.5158, -122.5256);
Clover Creek (40.5788, -122.1252);
Cottonwood Creek (40.3777, -122.1991);
Cow Creek (40.5437, -122.1318);
East Fork Stillwater Creek (40.6495, -122.2934);
Inks Creek (40.3305, -122.1520);
Jenny Creek (40.5734, -122.4338);
Little Cow Creek (40.6148, -122.2271);
Oak Run (40.6171, -122.1225);
Old Cow Creek (40.5442, -122.1317);
Olney Creek (40.5439, -122.4687);
Oregon Gulch (40.5463, -122.3866);
Paynes Creek (40.3024, -122.1012);
Stillwater Creek (40.6495, -122.2934);
Sulphur Creek (40.6164, -122.4077).

(ii) Lower Cottonwood Hydrologic Sub-area 550820.
Outlet(s) = Cottonwood Creek (Lat 40.3777, Long -122.1991)

Upstream to endpoint(s) in:
Cold Fork Cottonwood Creek (40.2060, -122.6608);
Cottonwood Creek (40.3943, -122.5254);
Middle Fork Cottonwood Creek (40.3314, -122.6663);
North Fork Cottonwood Creek (40.4539, -122.5610);
South Fork Cottonwood Creek (40.1578, -122.5809).
(4) Eastern Tehama Hydrologic Unit 5509 -
(i) Big Chico Creek Hydrologic Sub-area 550914.
Outlet(s) = Big Chico Creek (Lat 39.7757, Long -121.7525)
Upstream to endpoint(s) in:
Big Chico Creek (39.8898, -121.6952).

(ii) Deer Creek Hydrologic Sub-area 550920.
Outlet(s) = Deer Creek (Lat 40.0142, Long -121.9476)
Upstream to endpoint(s) in:
Deer Creek (40.2025, -121.5130).
(iii) Upper Mill Creek Hydrologic Subarea 550942.
Outlet(s) = Mill Creek (Lat 40.0550, Long -122.0317)
Upstream to endpoint(s) in:
Mill Creek (40.3766, -121.5098);
Rocky Gulch Creek (40.2888, -121.5997).
(iv) Dye Creek Hydrologic Sub-area 550962.
Outlet(s) = Dye Creek (Lat 40.0910, Long -122.0719)
Upstream to endpoint(s) in:
Dye Creek (40.0996, -121.9612).
(v) Antelope Creek Hydrologic Subarea 550963.
Outlet(s) = Antelope Creek (Lat 40.2023, Long -122.1272)
Upstream to endpoint(s) in:
Antelope Creek (40.2416, -121.8630);
Middle Fork Antelope Creek (40.2673, -121.7744);
North Fork Antelope Creek (40.2807, -121.7645);
South Fork Antelope Creek (40.2521, -121.7575).
(5) Sacramento Delta Hydrologic Unit 5510 -
(i) Sacramento Delta Hydrologic Sub-area 551000.
Outlet(s) = Sacramento River (Lat 38.0653, Long -121.8418)
Upstream to endpoint(s) in:
Cache Slough (38.2984, -121.7490);
Elk Slough (38.4140, -121.5212);
Elkhorn Slough (38.2898, -121.6271);
Georgiana Slough (38.2401, -121.5172);
Horseshoe Bend (38.1078, -121.7117);
Lindsey Slough (38.2592, -121.7580);
Miners Slough (38.2864, -121.6051);
Prospect Slough (38.2830, -121.6641);
Putah Creek (38.5155, -121.5885);
Sevenmile Slough (38.1171, -121.6298);

Streamboat Slough (38.3052, -121.5737);
Sutter Slough (38.3321, -121.5838);
Threemile Slough (38.1155, -121.6835);
Ulatis Creek (38.2961, -121.7835);
Unnamed Tributary (38.2937, -121.7803);
Unnamed Tributary (38.2937, -121.7804);
Yolo Bypass (38.5800, -121.5838).

(6) Valley-Putah-Cache Hydrologic Unit 5511 -
(i)Lower Putah Creek Hydrologic Sub-area 551120.
Outlet(s) = Sacramento Bypass (Lat 38.6057, Long -121.5563);

Yolo Bypass (38.5800, -121.5838)
Upstream to endpoint(s) in:
Sacramento Bypass (38.5969, -121.5888);
Yolo Bypass (38.7627, -121.6325).

(7) American River Hydrologic Unit 5514 -
(i)Auburn Hydrologic Sub-area 551422.
Outlet(s) = Auburn Ravine (Lat 38.8921, Long -121.2181);
Coon Creek (38.9891, -121.2556);
Doty Creek (38.9401, -121.2434)
Upstream to endpoint(s) in:
Auburn Ravine (38.8888, -121.1151);
Coon Creek (38.9659, -121.1781);
Doty Creek (38.9105, -121.1244).

(8) Marysville Hydrologic Unit 5515 -
(i) Lower Bear River Hydrologic Subarea 551510.
Outlet(s) = Bear River (Lat 39.9398, Long -121.5790)
Upstream to endpoint(s) in:
Bear River (39.0421, -121.3319).
(ii) Lower Yuba River Hydrologic Subarea 551530.
Outlet(s) = Yuba River (Lat 39.1270, Long -121.5981)
Upstream to endpoint(s) in:
Yuba River (39.2203, -121.3314).
(iii) Lower Feather River Hydrologic Sub-area 551540.
Outlet(s) = Feather River (Lat 39.1264, Long -121.5984)
Upstream to endpoint(s) in:
Feather River (39.5205, -121.5475).

(9) Yuba River Hydrologic Unit 5517 -
(i) Browns Valley Hydrologic Sub-area 551712.
Outlet(s) = Dry Creek (Lat 39.2215, Long -1121.4082);
Yuba River (39.2203, -1121.3314)
Upstream to endpoint(s) in:
Dry Creek (39.3232, Long -1121.3155);
Yuba River (39.2305, -1121.2813).
(ii) Englebright Hydrologic Sub-area 551714.
Outlet(s) = Yuba River (Lat 39.2305, Long -1121.2813)

Upstream to endpoint(s) in:
Yuba River (39.2399, -1121.2689).
(10) Valley American Hydrologic Unit 5519 -
(i) Lower American Hydrologic Sub-area 551921.
Outlet(s) = American River (Lat 38.5971, -1121.5088)
Upstream to endpoint(s) in:
American River (38.6373, -1121.2202);
Dry Creek (38.7554, -1121.2676);
Minerís Ravine (38.8429, -1121.1178);
Natomas East Main Canal (38.6646, -1121.4770);
Secret Ravine(38.8541, -1121.1223).

(ii) Pleasant Grove Hydrologic Subarea 551922.
Outlet(s) = Sacramento River (Lat 38.6026, Long -1121.5155)
Upstream to endpoint(s) in:
Auburn Ravine (38.8913, -1121.2424);
Coon Creek (38.9883, -1121.2609);
Doty Creek (38.9392, -1121.2475);
Feather River (39.1264, -1121.5984).
(11) Colusa Basin Hydrologic Unit 5520 -
(i) Sycamore-Sutter Hydrologic Sub-area 552010.
Outlet(s) = Sacramento River (Lat 38.7604, Long -1121.6767)
Upstream to endpoint(s) in:
Tisdale Bypass (39.0261, -1121.7456).
(ii) Sutter Bypass Hydrologic Sub-area 552030.
Outlet(s) = Sacramento River (Lat 38.7851, Long -1121.6238)
Upstream to endpoint(s) in:
Butte Creek (39.1990, -1121.9286);
Butte Slough (39.1987, -1121.9285);
Nelson Slough (38.8956, -1121.6180);
Sacramento Slough (38.7844, -1121.6544);
Sutter Bypass (39.1586, -1121.8747).
(iii) Butte Basin Hydrologic Sub-area 552040.
Outlet(s) = Butte Creek (Lat 39.1990, Long -1121.9286);
Sacramento River (39.4141, -1122.0087)
Upstream to endpoint(s) in:
Butte Creek (39.7096, -1121.7504);
Colusa Bypass (39.2276, -1121.9402);
Little Chico Creek (39.7380, -1121.7490);
Little Dry Creek (39.6781, -1121.6580).
(12) Butte Creek Hydrologic Unit 5521 -
(i) Upper Dry Creek Hydrologic Sub-area 552110.
Outlet(s) = Little Dry Creek (Lat 39.6781, -1121.6580)
Upstream to endpoint(s) in:
Little Dry Creek (39.7424, -1121.6213).
(ii) Upper Butte Creek Hydrologic Sub-area 552120.

Outlet(s) = Little Chico Creek (Lat 39.7380, Long -1121.7490)
Upstream to endpoint(s) in:
Little Chico Creek (39.8680, -1121.6660).
(iii) Upper Little Chico Hydrologic Sub-area 552130.
Outlet(s) = Butte Creek (Lat 39.7096, Long -1121.7504)
Upstream to endpoint(s) in:
Butte Creek (39.8215, -1121.6468);
Little Butte Creek (39.8159, -1121.5819).
(13) Ball Mountain Hydrologic Unit 5523
(i) Thomes Creek Hydrologic Subarea 552310.
Outlet(s) = Thomes Creek (39.8822, -1122.5527)
Upstream to endpoint(s) in:
Doll Creek (39.8941, -1122.9209);
Fish Creek (40.0176, -1122.8142);
Snake Creek (39.9945, -1122.7788);
Thomes Creek (39.9455, -1122.8491);
Willow Creek (39.8941, -1122.9209).
(14) Shasta Bally Hydrologic Unit 5524 -
(i) South Fork Hydrologic Subarea 552433.
Outlet(s) = Cold Fork Cottonwood Creek (Lat 40.2060, Long -1122.6608);
South Fork Cottonwood Creek (40.1578, -1122.5809)
Upstream to endpoint(s) in:
Cold Fork Cottonwood Creek (40.1881, -1122.8690);
South Fork Cottonwood Creek (40.1232, -1122.8761).
(ii) Platina Hydrologic Sub-area 552436.
Outlet(s) = Middle Fork Cottonwood Creek (Lat 40.3314, Long -1122.6663)
Upstream to endpoint(s) in:
Beegum Creek (40.3149, -1122.9776);
Middle Fork Cottonwood Creek (40.3512, -1122.9629).
(iii) Spring Creek Hydrologic Sub-area 552440.
Outlet(s) = Sacramento River (Lat 40.5943, Long -1122.4343)
Upstream to endpoint(s) in:
Middle Creek (40.5904, -1121.4825);
Rock Creek (40.6155, -1122.4702);
Sacramento River (40.6116, -1122.4462);
Salt Creek (40.5830, -1122.4586);
Unnamed Tributary (40.5734, -1122.4844).
(iv) Kanaka Peak Hydrologic Sub-area 552462.
Outlet(s) = Clear Creek (Lat 40.5158, Long -1122.5256)
Upstream to endpoint(s) in:
Clear Creek (40.5998, 122.5399).
(15) North Valley Floor Hydrologic Unit 5531 -
(i) Lower Mokelumne Hydrologic Sub-area 553120.
Outlet(s) = Mokelumne River (Lat 38.2104, Long -1121.3804)

Upstream to endpoint(s) in:
Mokelumne River (38.2263, -1121.0241);
Murphy Creek (38.2491, -1121.0119).
(ii) Lower Calaveras Hydrologic Subarea 553130.
Outlet(s) = Calaveras River (Lat 37.9836, Long -1121.3110);
Mormon Slough (37.9456,-121.2907)
Upstream to endpoint(s) in:
Calaveras River (38.1025, -1120.8503);
Mormon Slough (38.0532, -1121.0102);
Stockton Diverting Canal (37.9594, -1121.2024).
(16) Upper Calaveras Hydrologic Unit 5533 -
(i) New Hogan Reservoir Hydrologic Sub-area 553310.
Outlet(s) = Calaveras River (Lat 38.1025, Long -1120.8503)
Upstream to endpoint(s) in:
Calaveras River (38.1502, -1120.8143).
(17) Stanislaus River Hydrologic Unit 5534 -
(i)Table Mountain Hydrologic Subarea 553410.
Outlet(s) = Stanislaus River (Lat 37.8355, Long -1120.6513)
Upstream to endpoint(s) in:
Stanislaus River (37.8631, -1120.6298).
(18) San Joaquin Valley Floor Hydrologic Unit 5535 -
(i) Riverbank Hydrologic Sub-area 553530.
Outlet(s) = Stanislaus River (Lat 37.6648, Long -1121.2414)
Upstream to endpoint(s) in:
Stanislaus River (37.8355, -1120.6513).
(ii) Turlock Hydrologic Sub-area 553550.
Outlet(s) = Tuolumne River (Lat 37.6059, Long -1121.1739)
Upstream to endpoint(s) in:
Tuolumne River (37.6401, -1120.6526).
(iii) Montpelier Hydrologic Sub-area 553560.
Outlet(s) = Tuolumne River (Lat 37.6401, Long -1120.6526)
Upstream to endpoint(s) in:
Tuolumne River (37.6721, -1120.4445).
(iv) El Nido-Stevinson Hydrologic Sub-area 553570.
Outlet(s) = Merced River (Lat 37.3505, Long -1120.9619)
Upstream to endpoint(s) in:
Merced River (37.3620, -1120.8507).
(v) Merced Hydrologic Sub-area 553580.
Outlet(s) = Merced River (Lat 37.3620, Long -1120.8507)
Upstream to endpoint(s) in:
Merced River (37.4982, -1120.4612).
(vi) Fahr Creek Hydrologic Sub-area 553590.
Outlet(s) = Merced River (Lat 37.4982, Long -1120.4612)
Upstream to endpoint(s) in:
Merced River (37.5081, -1120.3581).
(19) Delta-Mendota Canal Hydrologic Unit 5541 -

(i) Patterson Hydrologic Sub-area 554110.
Outlet(s) = San Joaquin River (Lat 37.6763, Long -1121.2653)
Upstream to endpoint(s) in:
San Joaquin River (37.3491, -1120.9759).
(ii) Los Banos Hydrologic Sub-area 554120.
Outlet(s) = Merced River (Lat 37.3490, Long -1120.9756)
Upstream to endpoint(s) in:
Merced River (37.3505, -1120.9619).
(20) North Diablo Range Hydrologic Unit 5543 –
(i) North Diabolo Range Hydrologic Sub-area 554300.
Outlet(s) = San Joaquin River (Lat 38.0247, Long -1121.8218)
Upstream to endpoint(s) in:
San Joaquin River (38.0246, -1121.7471).
(21) San Joaquin Delta Hydrologic Unit 5544 -
(i) San Joaquin Delta Hydrologic Sub-area 554400.
Outlet(s) = San Joaquin River (Lat 38.0246, Long -1121.7471)
Upstream to endpoint(s) in:
Big Break (38.0160, -1121.6849);
Bishop Cut (38.0870, -1121.4158);
Calaveras River (37.9836, -1121.3110);
Cosumnes River (38.2538, -1121.4074);
Disappointment Slough (38.0439, -1121.4201);
Dutch Slough (38.0088, -1121.6281);
Empire Cut (37.9714, -1121.4762);
False River (38.0479, -1121.6232);
Frankís Tract (38.0220, -1121.5997);
Frankís Tract (38.0300, -1121.5830);
Holland Cut (37.9939, -1121.5757);
Honker Cut (38.0680, -1121.4589);
Kellog Creek (37.9158, -1121.6051);
Latham Slough (37.9716, -1121.5122);
Middle River (37.8216, -1121.3747);
Mokelumne River (38.2104, -1121.3804);
Mormon Slough (37.9456,-121.2907);
Mosher Creek (38.0327, -1121.3650);
North Mokelumne River (38.2274, -1121.4918);
Old River (37.8086, -1121.3274);
Orwood Slough (37.9409, -1121.5332);
Paradise Cut (37.7605, -1121.3085);
Pixley Slough (38.0443, -1121.3868);
Potato Slough (38.0440, -1121.4997);
Rock Slough (37.9754, -1121.5795);
Sand Mound Slough (38.0220, -1121.5997);
Stockton Deep Water Channel (37.9957, -1121.4201);
Turner Cut (37.9972, -1121.4434);
Unnamed Tributary (38.1165, -1121.4976);

Victoria Canal (37.8891, -1121.4895);
White Slough (38.0818, -1121.4156);
Woodward Canal (37.9037, -1121.4973).

(J) Puget Sound Chinook Salmon (Oncorhynchus tshawytscha). Critical habitat is designated to include the areas defined in the following subbasins:

(1) Nooksack Subbasin 17110004—

(i) Upper North Fork Nooksack River Watershed 1711000401.
Outlet(s) = North Fork Nooksack River (Lat 48.9055, Long –121.9886)
Upstream to endpoint(s) in:
Boyd Creek (48.8998, –121.8640);
Canyon Creek (48.9366, –121.9451);
Cascade Creek (48.8996, –121.8621);
Cornell Creek (48.8882, –121.9594);
Deadhorse Creek (48.9024, –121.8359);
Gallop Creek (48.8849, –121.9447);
Glacier Creek (48.8197, –121.8931);
Hedrick Creek (48.8953, –121.9705);
Thompson Creek (48.8837, –121.9028);
Wells Creek (48.8940, –121.7976).

(ii) Middle Fork Nooksack River Watershed 1711000402.
Outlet(s) = Middle Fork Nooksack River (Lat 48.8342, Long –122.1540)
Upstream to endpoint(s) in:
Canyon Creek (48.8374, –122.1198);
Clearwater Creek (48.7841, –122.0293);
Middle Fork Nooksack River (48.7249, –121.8999);
Porter Creek (48.7951, –122.1098);
Sister Creek (48.7492, –121.9736);
Unnamed (48.7809, –122.1157);
Unnamed (48.7860, –122.1214);
Warm Creek (48.7559, –121.9741).

(iii) South Fork Nooksack River Watershed 1711000403.
Outlet(s) = South Fork Nooksack River (Lat 48.8095, Long –122.2026)
Upstream to endpoint(s) in:
Black Slough (48.7715, –122.1931);
Cavanaugh Creek (48.6446, –122.1094);
Deer Creek (48.6041, –122.0912);
Edfro Creek (48.6607, –122.1206);
Fobes Creek (48.6230, –122.1139);
Hard Scrabble Falls Creek (48.7601, –122.2273);
Howard Creek (48.6118, –121.9639);
Hutchinson Creek (48.7056, –122.1663);
Jones Creek (48.7186, –122.2130);

McCarty Creek (48.7275, –122.2188);
Plumbago Creek (48.6088, –122.0949);
Pond Creek (48.6958, –122.1651);
Skookum Creek (48.6871, –122.1029);
South Fork Nooksack River (48.6133, –121.9000);
Standard Creek (48.7444, –122.2191);
Sygitowicz Creek (48.7722, –122.2269);
Unnamed (48.6048, –121.9143);
Unnamed (48.6213, –122.1039);
Unnamed (48.7174, –122.1815);
Unnamed (48.7231, –122.1968);
Unnamed (48.7843, –122.2188).

(iv) Lower North Fork Nooksack River Watershed 1711000404.

Outlet(s) = Nooksack River (Lat 48.8711, Long –122.3227)

Upstream to endpoint(s) in:

Anderson Creek (48.8088, –122.3410);
Boulder Creek (48.9314, –122.0258);
Coal Creek (48.8889, –122.1506);
Kendall Creek (48.9251, –122.1455);
Kenney Creek (48.8510, –122.1368);
Macaulay Creek (48.8353, –122.2345);
Maple Creek (48.9262, –122.0751);
Mitchell Creek (48.8313, –122.2174);
North Fork Nooksack River (48.9055, –121.9886);
Racehorse Creek (48.8819, –122.1272);
Smith Creek (48.8439, –122.2544);
Unnamed (48.8103, –122.1855);
Unnamed (48.9002, –122.1205);
Unnamed (48.9040, –122.0875);
Unnamed (48.9131, –122.0127);
Unnamed (48.9158, –122.0091);
Unnamed (48.9162, –122.0615);
Unnamed (48.9200, –122.0463);
Wildcat Creek (48.9058, –121.9995);
Deer Creek (48.8439, –122.4839).

(v) Nooksack River Watershed 1711000405.

Outlet(s) = Lummi River (Lat 48.8010, Long –122.6582);
Nooksack River (48.7737, –122.5986);
Silver Creek (48.7786, –122.5635);
Slater Slough (48.7759, –122.6029);
Unnamed (48.7776, –122.5708);
Unnamed (48.7786, –122.5677);
Unnamed (48.7973, –122.6717);
Unnamed (48.8033, –122.6771)

Upstream to endpoint(s) in:

Fishtrap Creek (49.0025, –122.4053);

Fourmile Creek (48.8890, –122.4213);
Lummi River (48.8198, –122.6049);
Nooksack River (48.8711, –122.3227);
Pepin Creek (49.0024, –122.4724);
Slater Slough (48.7778, –122.6041);
Tenmile Creek (48.8457, –122.3661);
Unnamed (48.8191, –122.5705);
Unnamed (48.8453, –122.6071);
Unnamed (48.8548, –122.4749);
Unnamed (48.9609, –122.5312);
Unnamed (48.9634, –122.3928);
Unnamed (49.0024, –122.4730);
Unnamed (49.0025, –122.5218).

(2) Upper Skagit Subbasin 17110005—

(i) Skagit River/Gorge Lake Watershed 1711000504.
Outlet(s) = Skagit River (Lat 48.6725, Long –121.2633)
Upstream to endpoint(s) in:
Goodell Creek (48.6890, –121.2718);
Skagit River (48.6763, –121.2404).

(ii) Skagit River/Diobsud Creek Watershed 1711000505.
Outlet(s) = Skagit River (Lat 48.5218, Long –121.4315)
Upstream to endpoint(s) in:
Bacon Creek (48.6456, –121.4244);
Diobsud Creek (48.5761, –121.4309);
Falls Creek (48.6334, –121.4258);
Skagit River (48.6725, –121.2633).

(iii) Cascade River Watershed 1711000506.
Outlet(s) = Cascade River (Lat 48.5218, Long –121.4315)
Upstream to endpoint(s) in:
Found Creek (48.4816, –121.2437);
Kindy Creek (48.4613, –121.2094);
Marble Creek (48.5398, –121.2612);
North Fork Cascade River (48.4660, –121.1641);
South Fork Cascade River (48.4592, –121.1494).

(iv) Skagit River/Illabot Creek Watershed 1711000507.
Outlet(s) = Skagit River (Lat 48.5333, Long –121.7370)
Upstream to endpoint(s) in:
Illabot Creek (48.4498, –121.4551);
Jackman Creek (48.5294, –121.6957);
Skagit River (48.5218, –121.4315);
Unnamed (48.5013, –121.6598).

(3) Sauk Subbasin 17110006—

(i) Upper Sauk River Watershed 1711000601.
Outlet(s) = Sauk River (Lat 48.1731, Long –121.4714)
Upstream to endpoint(s) in:
Camp Creek (48.1559, –121.2909);

North Fork Sauk River (48.0962, –121.3710);
Owl Creek (48.1623, –121.2948);
South Fork Sauk River (48.0670, –121.4088);
Swift Creek (48.1011, –121.3975);
Unnamed (48.1653, –121.3288);
White Chuck River (48.1528, –121.2645).
(ii) Upper Suiattle River Watershed 1711000602.
Outlet(s) = Suiattle River (Lat 48.2586, Long –121.2237)
Upstream to endpoint(s) in:
Downey Creek (48.2828, –121.2083);
Milk Creek (48.2207, –121.1634);
Suiattle River (48.2211, –121.1609);
Sulphur Creek (48.2560, –121.1773);
Unnamed (48.2338, –121.1792).
(iii) Lower Suiattle River Watershed 1711000603.
Outlet(s) = Suiattle River (Lat 48.3384, Long –121.5482)
Upstream to endpoint(s) in:
Big Creek (48.3435, –121.4416);
Buck Creek (48.2753, –121.3268);
Circle Creek (48.2555, –121.3395);
Lime Creek (48.2445, –121.2933);
Straight Creek (48.2594 – 121.4009);
Suiattle River (48.2586, –121.2237);
Tenas Creek (48.3371, –121.4304).
(iv) Lower Sauk River Watershed 1711000604.
Outlet(s) = Sauk River (Lat 48.4821, Long –121.6060)
Upstream to endpoint(s) in:
Dan Creek (48.2702, –121.5473);
Sauk River (48.1731, –121.4714);
Unnamed (48.2247, –121.5826);
Unnamed (48.3187, –121.5480).
(4) Lower Skagit Subbasin 17110007—
(i) Middle Skagit River/ Finney Creek Watershed 1711000701.
Outlet(s) = Skagit River (Lat 48.4891, Long –122.2178)
Upstream to endpoint(s) in:
Alder Creek (48.5280, –121.9498);
Day Creek (48.4689, –122.0216);
Finney Creek (48.4655, –121.6858);
Grandy Creek (48.5510, –121.8621);
Hansen Creek (48.5600, –122.2069);
Jims Slough (48.5274, –122.0227);
Jones Creek (48.5418, –122.0494);
Mannser Creek (48.5260, –122.0430);
Muddy Creek (48.5278, –122.0007);
Pressentin Creek (48.5099, –121.8449);
Skagit River (48.5333, –121.7370);

Sorenson Creek (48.4875, –122.1029);
Unnamed (48.4887, –122.0747);
Unnamed (48.5312, –122.0149);
Wiseman Creek (48.5160, –122.1286).

(ii) Lower Skagit River/Nookachamps Creek Watershed 1711000702.

Outlet(s) = Browns Slough (Lat 48.3305, Long –122.4194);
Freshwater Slough (48.3109, –122.3883);
Hall Slough (48.3394, –122.4426);
Isohis Slough (48.2975, –122.3711);
North Fork Skagit River (48.3625, –122.4689);
South Fork Skagit River (48.2920, –122.3670);
Unnamed (48.3085, –122.3868);
Unnamed (48.3831, –122.4842)

Upstream to endpoint(s) in:
Britt Slough (48.3935, –122.3571);
Browns Slough (48.3411, –122.4127);
East Fork Nookachamps Creek (48.4044, –122.1790);
Hall Slough (48.3437, –122.4376);
Mundt Creek (48.4249, –122.2007);
Skagit River (48.4891, –122.2178);
Unnamed (48.3703, –122.3081);
Unnamed (48.3827, –122.1893);
Unnamed (48.3924, –122.4822);
Walker Creek (48.3778, –122.1899).

(5) Stillaguamish Subbasin 17110008—

(i) North Fork Stillaguamish River Watershed 1711000801.

Outlet(s) = North Fork Stillaguamish River (Lat 48.2037, Long –122.1256)

Upstream to endpoint(s) in:
Ashton Creek (48.2545, –121.6708);
Boulder River (48.2624, –121.8090);
Deer Creek (48.2835, –121.9255);
French Creek (48.2534, –121.7856);
Furland Creek (48.2624, –121.6749);
Grant Creek (48.2873, –122.0118);
North Fork Stillaguamish River (48.3041, –121.6360);
Rollins Creek (48.2908, –121.8441);
Squire Creek (48.2389, –121.6374);
Unnamed (48.2393, –121.6285);
Unnamed (48.2739, –121.9948).

(ii) South Fork Stillaguamish River Watershed 1711000802.

Outlet(s) = South Fork Stillaguamish River (Lat 48.2037, Long –122.1256)

Upstream to endpoint(s) in:
Jim Creek (48.2230, –121.9483);
North Fork Canyon Creek (48.1697, –121.8194);

Siberia Creek (48.1731, –122.0377);
South Fork Canyon Creek (48.1540, –121.7840);
South Fork Stillaguamish River (48.0454, –121.4819);
Unnamed (48.1463, –122.0162).
(iii) Lower Stillaguamish River Waterhed 1711000803.
Outlet(s) = Stillaguamish River (Lat 48.2385, Long –122.3749);
Unnamed (48.1983, –122.3579)
Upstream to endpoint(s) in:
Armstrong Creek (48.2189, –122.1347);
Pilchuck Creek (48.2983, –122.1672);
Stillaguamish River (48.2037, –122.1256).
(6) Skykomish Subbasin 17110009—
(i) Tye and Beckler River Watershed 1711000901.
Outlet(s) = South Fork Skykomish River (Lat 47.7147, Long –121.3393)
Upstream to endpoint(s) in:
East Fork Foss River (47.6522, –121.2792);
Rapid River (47.8131, –121.2470)
Tye River (47.7172, –121.2254)
Unnamed (47.8241, –121.2979);
West Fork Foss River (47.6444, –121.2972).
(ii) Skykomish River Forks Watershed 1711000902.
Outlet(s) = North Fork Skykomish River (Lat 47.8133, Long –121.5782)
Upstream to endpoint(s) in:
Bridal Veil Creek (47.7987, –121.5597);
Lewis Creek (47.8223, –121.5160);
Miller River (47.7018, –121.3950);
Money Creek (47.7208, –121.4062);
North Fork Skykomish River (47.9183, –121.3073);
South Fork Skykomish River (47.7147, –121.3393);
Unnamed (47.7321, –121.4176);
Unnamed (47.8002, –121.5548).
(iii) Skykomish River/Wallace River Watershed 1711000903.
Outlet(s) = Skykomish River (Lat 47.8602, Long– 121.8190)
Upstream to endpoint(s) in:
Deer Creek (47.8191, –121.5805);
Olney Creek (47.8796, –121.7163);
Proctor Creek (47.8216, –121.6460);
Skykomish River (47.8133, –121.5782);
Unnamed (47.8507, –121.8010);
Wagleys Creek (47.8674, –121.7972);
Wallace River (47.8736, –121.6491).
(iv) Sultan River Watershed 1711000904.
Outlet(s) = Sultan River (Lat 47.8602, Long –121.8190)
Upstream to endpoint(s) in:

Sultan River (47.9598, –121.7951).
(v) Skykomish River/Woods Creek Watershed 1711000905.
Outlet(s) = Skykomish River (Lat 47.8303, Long –122.0451)
Upstream to endpoint(s) in:
Elwell Creek (47.8038, –121.8524);
Skykomish River (47.8602, –121.8190);
Unnamed (47.8890, –121.8637);
West Fork Woods Creek (47.9627, –121.9707);
Woods Creek (47.8953, –121.8742);
Youngs Creek (47.8081, –121.8332).
(7) Snoqualmie Subbasin 17110010—
(i) Middle Fork Snoqualmie River Watershed 1711001003.
Outlet(s) = Snoqualmie River (Lat 47.6407, Long –121.9261)
Upstream to endpoint(s) in:
Canyon Creek (47.5837, –121.9623);
Deep Creek (47.4764, –121.8905);
Griffin Creek (47.6164, –121.9014);
Lake Creek (47.5036, –121.9035);
Patterson Creek (47.6276, –121.9855);
Raging River (47.4795, –121.8691);
Snoqualmie River (47.5415, –121.8362);
Tokul Creek (47.5563, –121.8285).
(ii) Lower Snoqualmie River Watershed 1711001004.
Outlet(s) = Snoqualmie River (Lat 47.8303, Long –122.0451)
Upstream to endpoint(s) in:
Cherry Creek (47.7465, –121.8953);
Margaret Creek (47.7547, –121.8933);
North Fork Tolt River (47.7060, –121.7957);
Snoqualmie River (47.6407, –121.9261);
South Fork Tolt River (47.6969, –121.7861);
Tuck Creek (47.7442, –122.0032);
Unnamed (47.6806, –121.9730);
Unnamed (47.6822, –121.9770);
Unnamed (47.7420, –122.0084);
Unnamed (47.7522, –121.9745);
Unnamed (47.7581, –121.9586).
(8) Snohomish Subbasin 17110011—
(i) Pilchuck River Watershed 1711001101.
Outlet(s) = Pilchuck River (Lat 47.9013, Long –122.0917)
Upstream to endpoint(s) in:
Pilchuck River (48.0052, –121.7718).
(ii) Snohomish River Watershed 1711001102.
Outlet(s) = Quilceda Creek (Lat 48.0556, Long –122.1908);

Skykomish River (48.0173, –122.1877);
Steamboat Slough (48.0365, –122.1814);

Union Slough (48.0299, –122.1794);
Unnamed (48.0412, –122.1723)
Upstream to endpoint(s) in:
Allen Creek (48.0767, –122.1404);
Quilceda Creek (48.1124, –122.1540);
Skykomish River (47.8303, –122.0451);
Unnamed (47.9545, –122.1969);
Unnamed (47.9777, –122.1632);
Unnamed (48.0019, –122.1283);
Unnamed (48.0055, –122.1303);
Unnamed (48.1330, –122.1472).
(9) Lake Washington Subbasin 17110012—
(i) Cedar River Watershed 1711001201.
Outlet(s) = Cedar River (Lat 47.5003, Long –122.2146)
Upstream to endpoint(s) in:
Cedar River (47.4192, –121.7805);
Rock Creek (47.3673, –122.0132);
Unnamed (47.4092, –122.0358);
Webster Creek (47.3857, –121.9845).
(ii) Lake Washington Watershed 1711001203.
Outlet(s) = Lake Washington (Lat 47.6654, Long –122.3960)
Upstream to endpoint(s) in:
Cedar River (47.5003, –122.2146);
Sammamish River (47.7543, –122.2465).
(10) Duwamish Subbasin 17110013—
(i) Upper Green River Watershed 1711001301.
Outlet(s) = Green River (Lat 47.2234, Long –121.6081)
Upstream to endpoint(s) in:
Friday Creek (47.2204, –121.4559);
Intake Creek (47.2058, –121.4049);
McCain Creek (47.2093, –121.5292);
Sawmill Creek (47.2086, –121.4675);
Smay Creek (47.2508, –121.5872);
Snow Creek (47.2607, –121.4046);
Sunday Creek (47.2587, –121.3659);
Tacoma Creek (47.1875, –121.3630);
Unnamed (47.2129, –121.4579).
(ii) Middle Green River Watershed 1711001302.
Outlet(s) = Green River (Lat 47.2911, Long –121.9714)
Upstream to endpoint(s) in:
Bear Creek (47.2774, –121.7990);
Cougar Creek (47.2439, –121.6442);
Eagle Creek (47.3051, –121.7219);
Gale Creek (47.2644, –121.7085);
Green River (47.2234, –121.6081);
Piling Creek (47.2820, –121.7553);

Sylvester Creek (47.2457, –121.6537);
Unnamed (47.2360, –121.6333).

(iii) Lower Green River Watershed 1711001303.

Outlet(s) = Duwamish River (Lat 47.5113, Long –122.2951)

Upstream to endpoint(s) in:

Big Soos Creek (47.4191, –122.1599);
Burns Creek (47.2779, –122.1087);
Covington Creek (47.3341, –122.0399);
Crisp Creek (47.2897, –122.0590);
Green River (47.2911, –121.9714);
Jenkins Creek (47.3791, –122.0899);
Little Soos Creek (47.4031, –122.1235);
Mill Creek (47.3263, –122.2455);
Newaukum Creek (47.2303, –121.9518);
Unnamed (47.2765, –121.9730);
Unnamed (47.2891, –122.1557);
Unnamed (47.3007, –122.1774);
Unnamed (47.3250, –122.1961);
Unnamed (47.3464, –122.2397);
Unnamed (47.3751, –122.2648);
Unnamed (47.4046, –122.2134);
Unnamed (47.4525, –122.2354);
Unnamed (47.4618, –122.2315);
Unnamed (47.4619, –122.2554);
Unnamed (47.4876, –122.2781).

(11) Puyallup Subbasin 17110014—

(i) Upper White River Watershed 1711001401.

Outlet(s) = White River (Lat 47.1588, Long –121.6587)

Upstream to endpoint(s) in:

Greenwater River (47.1204, –121.5055);
Huckleberry Creek (47.0612, –121.6033);
Pinochle Creek (47.0478, –121.7043);
Unnamed (46.9935, –121.5295);
West Fork White River (47.0483, –121.6916);
Wrong Creek (47.0403, –121.6999).

(ii) Lower White River Watershed 1711001402.

Outlet(s) = White River (Lat 47.2001, Long –122.2579)

Upstream to endpoint(s) in:

Boise Creek (47.1958, –121.9467);
Camp Creek (47.1430, –121.7012);
Clearwater River (47.0852, –121.7823);
Unnamed (47.1509, –121.7236);
Unnamed (47.2247, –122.1072);
Unnamed (47.2307, –122.1079);
Unnamed (47.2383, –122.2234);
Unnamed (47.2498, –122.2346);

White River (47.1588, –121.6587).
(iii) Carbon River Watershed 1711001403.
Outlet(s) = Carbon River (Lat 47.1308, Long –122.2315)
Upstream to endpoint(s) in:
Carbon River (46.9965, –121.9198);
South Fork South Prairie Creek (47.1203, –121.9963);
Voight Creek (47.0751, –122.1285);
Wilkeson Creek (47.0972, –122.0245).
(iv) Upper Puyallup River Watershed 1711001404.
Outlet(s) = Puyallup River (Lat 47.1308, Long –122.2315)
Upstream to endpoint(s) in:
Deer Creek (46.8547, –121.9680);
Kapowsin Creek (46.9854, –122.2008);
Kellog Creek (46.9164, –122.0652);
Mowich River (46.9209, –121.9739);
Rushingwater Creek (46.8971, –121.9439);
Unnamed (46.8867, –122.0194);
Unnamed (46.8899, –121.9657).
(v) Lower Puyallup River Watershed 1711001405.
Outlet(s) = Hylebos Creek (Lat 47.2611, Long –122.3591);
Puyallup River (47.2501, –122.4131)
Upstream to endpoint(s) in:
Canyonfalls Creek (47.1421, –122.2186);
Clarks Creek (47.1757.–122.3168);
Clear Creek (47.2187, –122.3727);
Fennel Creek (47.1495, –122.1849);
Puyallup River (47.1308, –122.2315);
Unnamed (47.1779, –122.1992);
Unnamed (47.1799, –122.3066);
Unnamed (47.1928, –122.3371);
Unnamed (47.2723, –122.3216);
West Hylebos Creek (47.2736, –122.3289).
(12) Nisqually Subbasin 17110015—
(i) Mashel/Ohop Watershed 1711001502.
Outlet(s) = Nisqually River (Lat 46.8646, Long –122.4776)
Upstream to endpoint(s) in:
Little Mashel River (46.8504, –122.2724);
Lynch Creek (46.8760, –122.2625);
Mashel River (46.8431, –122.1205);
Nisqually River (46.8303, –122.3225);
Ohop Creek (46.9264, –122.2603);
Powell Creek (46.8528, –122.4505);
Tanwax Creek (46.8630, –122.4549);
Twentyfive Mile Creek (46.9274, –122.2558).
(ii) Lowland Watershed 1711001503.

Outlet(s) = McAllister Creek (Lat 47.1120, Long –122.7215);

Nisqually River (47.1110, –122.7026);
Unnamed (47.0071, –122.6556);
Yelm Creek (46.9712, –122.6263)
Upstream to endpoint(s) in:
Horn Creek (46.9042, –122.4776);
McAllister Creek (47.0299, –122.7236);
Nisqually River (46.8646, –122.4776);
Unnamed (46.9108, –122.5032);
Unnamed (47.0001, –122.6510);
Unnamed (47.0055, –122.6520);
Yelm Creek (46.9629, –122.6194).
Excluded is that segment of the Nisqually River from Lat 47.0703, Long –122.7017,
to Lat 46.9668, Long –122.5640.
(13) Skokomish Subbasin 17110017— Skokomish River Watershed 1711001701.
Outlet(s) = Skokomish River (Lat 47.3543, Long –123.1122);

Unnamed (47.3420, –123.1092);
Unnamed (47.3471, –123.1275);
Unnamed (47.3509, –123.1101)
Upstream to endpoint(s) in:
Brown Creek (47.4238, –123.3052);
Fir Creek (47.3363, –123.3016);
McTaggert Creek (47.3749, –123.2318);
North Fork Skokomish River (47.5197, –123.3329);
Purdy Canyon (47.3021, –123.1803);
Unnamed (47.3048, –123.1528);
Unnamed (47.3077, –123.2012);
Unnamed (47.3146, –123.1353);
Unnamed (47.3209, –123.2212);
Unnamed (47.3222, –123.3060);
Unnamed (47.3237, –123.1467);
Unnamed (47.3250, –123.1250);
Vance Creek (47.3300, –123.3137);
Weaver Creek (47.3097, –123.2384).
(14) Hood Canal Subbasin 17110018—
(i) Hamma Hamma River Watershed 1711001803.
Outlet(s) = Hamma Hamma River (Lat 47.5471, Long –123.0440)
Upstream to endpoint(s) in:
Hamma Hamma River (47.5590, –123.0632);
North Fork John Creek (47.5442, –123.0696)
(ii) Duckabush River Watershed 1711001804.
Outlet(s) = Duckabush River (Lat 47.6502, Long –122.9348)
Upstream to endpoint(s) in:

Duckabush River (47.6825, –123.0675).
(iii) Dosewallips River Watershed 1711001805.
Outlet(s) = Dosewallips River (Lat 47.6881, Long –122.8945);

Unnamed (47.6857, –122.8967)
Upstream to endpoint(s) in:
Dosewallips River (47.7289, –123.1111);
Rocky Brook (47.7212, –122.9405);
Unnamed (47.6886, –122.8977).
(15) Dungeness/Elwha 17110020—
(i) Dungeness River Watershed 1711002003.
Outlet(s) = Dungeness River (Lat 48.1506, Long –123.1311);

Unnamed (48.1537, –123.1267)
Upstream to endpoint(s) in:
Dungeness River (47.9386, –123.0885);
Gray Wolf River (47.9168, –123.2409);
Matriotti Creek (48.1368, –123.1428);
Unnamed (48.1514, –123.1216).
(ii) Elwha River Watershed 1711002007.
Outlet(s) = Elwha River (Lat 48.1466, Long –123.5671);
Unnamed (48.1483, –123.5599)
Upstream to endpoint(s) in:
Elwha River (48.0927, –123.5614).
(16) Nearshore Marine Areas—
Except as provided in paragraph (e) of this section, critical habitat includes all nearshore marine areas (including areas adjacent to islands) of the Strait of Georgia (south of the international border), Puget Sound, Hood Canal, and the Strait of Juan de Fuca (to the western end of the Elwha River delta) from the line of extreme high tide out to a depth of 30 meters.

(K) Lower Columbia River Chinook Salmon (Oncorhynchus tshawytscha). Critical habitat is designated to include the areas defined in the following subbasins:
(1) Middle Columbia/Hood Subbasin 17070105—
(i) East Fork Hood River Watershed 1707010506.
Outlet(s) = Hood River (Lat 45.6050, Long –121.6323)
Upstream to endpoint(s) in:
Dog River (45.4655, –121.5656);
East Fork Hood River (45.4665, –121.5669);
Pinnacle Creek (45.4595, –121.6568);
Tony Creek (45.5435, –121.6411).
(ii) West Fork Hood River Watershed 1707010507.
Outlet(s) = West Fork Hood River (Lat 45.6050, Long –121.6323)
Upstream to endpoint(s) in:
Divers Creek (45.5457, –121.7447);
Elk Creek (45.4277, –121.7889);

Indian Creek (45.5375, –121.7857);
Jones Creek (45.4629, –121.7942);
Lake Branch (45.5083, –121.8485);
McGee Creek (45.4179, –121.7675);
No Name Creek (45.5347, –121.7929);
Red Hill Creek (45.4720, –121.7705)
Unnamed (45.5502 –121.7014).

(iii) Hood River Watershed 1707010508.
Outlet(s) = Hood River (Lat 45.7205, Long –121.5055)
Upstream to endpoint(s) in:
Hood River (45.6050, –121.6323).

(iv) White Salmon River Watershed 1707010509.
Outlet(s) = White Salmon River (Lat 45.7226, Long –121.5214)
Upstream to endpoint(s) in:
White Salmon River (45.7677, –121.5374).

(v) Wind River Watershed 1707010511.
Outlet(s) = Wind River (Lat 45.7037, Long –121.7946)
Upstream to endpoint(s) in:
Bear Creek (45.7620, –121.8293);
Big Hollow Creek (45.9399, –121.9996);
Dry Creek (45.9296, –121.9721);
Falls Creek (45.9105, –121.9222);
Little Wind River (45.7392, –121.7772);
Ninemile Creek (45.8929, –121.9526);
Paradise Creek (45.9527, –121.9408);
Trapper Creek (45.8887, –122.0065);
Trout Creek (45.8021, –121.9313);
Wind River (45.9732, –121.9031).

(vi) Middle Columbia/Grays Creek Watershed 1707010512.
Outlet(s) = Columbia River (Lat 45.7044, Long –121.7980)
Upstream to endpoint(s) in:
Columbia River (45.7205, –121.5056).

(vii) Middle Columbia/Eagle Creek Watershed 1707010513.
Outlet(s) = Columbia River (Lat 45.6447, Long –121.9395)
Upstream to endpoint(s) in:
Camp Creek (45.6676, –121.8167);
Carson Creek (45.7206, –121.8184);
Columbia River (45.7044, –121.7980);
Dry Creek (45.6717, –121.8732);
Eagle Creek (45.6365, –121.9171);
East Fork Herman Creek (45.6538, –121.8122);
Herman Creek (45.6749, –121.8477);
Rock Creek (45.6958, –121.8915);
Unnamed (45.6654, –121.8164);
Unnamed (45.6674, –121.8487);
Unnamed (45.6689, –121.8444);

Unnamed (45.6762, –121.9350);
Unnamed (45.6902, –121.9034);
Unnamed (45.6948, –121.9424).
(2) Lower Columbia/Sandy Subbasin 17080001—
(i) Salmon River Watershed 1708000101.
Outlet(s) = Salmon River (Lat 45.3768, Long –122.0293)
Upstream to endpoint(s) in:
Cheeney Creek (45.3104, –121.9561);
Copper Creek (45.2508, –121.9053);
Salmon River (45.2511, –121.9025);
South Fork Salmon River (45.2606, –121.9474);
Unnamed (45.3434, –121.9920).
(ii) Zigzag River Watershed 1708000102.
Outlet(s) = Zigzag River (Lat 45.3489, Long –121.9442)
Upstream to endpoint(s) in:
Henry Creek (45.3328, –121.9110);
Still Creek (45.2755, –121.8413);
Unnamed (45.3019, –121.8202);
Zigzag River (45.3092, –121.8642).
(iii) Upper Sandy River Watershed 1708000103.
Outlet(s) = Sandy River (Lat 45.3489, Long –121.9442)
Upstream to endpoint(s) in:
Clear Creek (45.3712, –121.9246);
Clear Fork Sandy River (45.3994, –121.8525);
Horseshoe Creek (45.3707, –121.8936);
Lost Creek (45.3709, –121.8150);
Sandy River (45.3899, –121.8620).
(iv) Middle Sandy River Watershed 1708000104.
Outlet(s) = Sandy River (Lat 45.4464, Long –122.2459)
Upstream to endpoint(s) in:
Alder Creek (45.3776, –122.0994);
Bear Creek (45.3368, –121.9265);
Cedar Creek (45.4087, –122.2617);
North Boulder Creek (45.3822, –122.0168);
Sandy River (45.3489, –121.9442).
(v) Bull Run River Watershed 1708000105.
Outlet(s) = Bull Run River (Lat 45.4464, Long –122.2459)
Upstream to endpoint(s) in:
Bull Run River (45.4455, –122.1561);
Little Sandy Creek (45.4235, –122.1975).
(vi) Washougal River (1708000106).
Outlet(s) = Washougal River (Lat 45.5795, Long –122.4022)
Upstream(s) to endpoint(s) in:
Cougar Creek (45.6265, –122.2987);
Dougan Creek (45.6770, –122.1522);
Lacamas Creek (45.5972, –122.3933);

Little Washougal River (45.6315, –122.3767);
Washougal River (45.6729, –122.1524);
West Fork Washougal River (45.6205, –122.2149).

(vii) Columbia Gorge Tributaries Watershed 1708000107.

Outlet(s) = Columbia River (Lat 45.5735, Long –122.3945)
Upstream to endpoint(s) in:

Bridal Veil Creek (45.5542, –122.1793);
Columbia River (45.6447, –121.9395);
Coopey Creek (45.5656, –122.1671);
Government Cove (45.5948, –122.0630);
Hamilton Creek (45.6414, –121.9764);
Hardy Creek (45.6354, –121.9987);
Horsetail Creek (45.5883, –122.0675);
Latourell Creek (45.5388, –122.2173);
McCord Creek (45.6115, –121.9929);
Moffett Creek (45.6185, –121.9662);
Oneonta Creek (45.5821 –122.0718);
Multnomah Creek (45.5761, –122.1143)
Tanner Creek (45.6264, –121.9522);
Turnaft Creek (45.6101, –122.0284);
Unnamed (45.5421, –122.2624);
Unnamed (45.5488, –122.3504);
Unnamed (45.6025, –122.0443);
Unnamed (45.6055, –122.0392);
Unnamed (45.6083, –122.0329);
Unnamed (45.6118, –122.0216);
Unnamed (45.6124, –122.0172);
Unnamed (45.6133, –122.0055);
Wahkeena Creek (45.5755, –122.1266);
Young Creek (45.5480, –122.1997).

(viii) Lower Sandy River Watershed 1708000108.

Outlet(s) = Sandy River (Lat 45.5680, Long –122.4023)
Upstream to endpoint(s) in:

Beaver Creek (45.5258, –122.3822);
Gordon Creek (45.4915, –122.2423);
Sandy River (45.4464, –122.2459);
Trout Creek (45.4844, –122.2785);
Unnamed (45.5542, –122.3768);
Unnamed (45.5600, –122.3650).

(3) Lewis Subbasin 17080002—

(i) East Fork Lewis River Watershed 1708000205.

Outlet(s) = East Fork Lewis River (Lat 45.8664, Long –122.7189)
Upstream to endpoint(s) in:

East Fork Lewis River (45.8395, –122.4463).

(ii) Lower Lewis River Watershed 1708000206.

Outlet(s) = Lewis River (Lat 45.8519, Long –122.7806)

Upstream to endpoint(s) in:
Cedar Creek (45.9049, –122.3684);
Chelatchie Creek (45.9169, –122.4130);
Johnson Creek (45.9385, –122.6261);
Lewis River (45.9570, –122.5550);
Pup Creek (45.9391, –122.5440);
Unnamed (45.8882, –122.7412);
Unnamed (45.9153, –122.4362).

(4) Lower Columbia/Clatskanie Subbasin 17080003—

(i) Kalama River Watershed 1708000301.
Outlet(s) = Burris Creek (45.8926, –122.7892);
Kalama River (46.0340, –122.8695)
Upstream to endpoint(s) in:
Arnold Creek (46.0463, –122.5938);
Burris Creek (45.9391, –122.7780);
Elk Creek (46.0891, –122.5117);
Gobar Creek (46.0963, –122.6042);
Hatchery Creek (46.0459, –122.8027);
Kalama River (46.1109, –122.3579);
Little Kalama River (45.9970, –122.6939);
North Fork Kalama River (46.1328, –122.4118);
Wild Horse Creek (46.0626, –122.6367).

(ii) Clatskanie River Watershed 1708000303.
Outlet(s) = Clatskanie River (Lat 46.1398, Long –123.2303)
Upstream to endpoint(s) in:
Clatskanie River (46.0435, –123.0829);
Merrill Creek (46.0916, –123.1727);
Perkins Creek (46.0826, –123.1678).

(iii) Skamokawa/Elochoman Watershed 1708000305.
Outlet(s) = Elochoman River (Lat 46.2269, Long –123.4040);

Skamokawa Creek (46.2677, –123.4562);
Unnamed (46.2243, –123.3975)
Upstream to endpoint(s) in:
Beaver Creek (46.2256, –123.3071);
Elochoman River (46.3503, –123.2428);
Falk Creek (46.2954, –123.4413);
Left Fork Skamokawa Creek (46.3249, –123.4538);
McDonald Creek (46.3398, –123.4116);
Standard Creek (46.3292, –123.3999);
West Fork Elochoman River (46.3211, –123.2605);
West Fork Skamokawa Creek (46.2871, –123.4654);
Wilson Creek (46.2970, –123.3434).

(iv) Plympton Creek Watershed 1708000306.
Outlet(s) = Westport Slough (Lat 46.1434, Long –123.3816)
Upstream to endpoint(s) in:

        Plympton Creek (46.1261, –123.3842);
        Westport Slough (46.1195, –123.2797).

(5) Upper Cowlitz Subbasin 17080004—

- (i) Headwaters Cowlitz River 1708000401.
    - Outlet(s) = Cowlitz River (Lat 46.6580, Lat –121.6032)
    - Upstream to endpoint(s) in:
        - Clear Fork Cowlitz River (46.6858, –121.5668);
        - Muddy Fork Cowlitz River (46.6994, –121.6169);
        - Ohanapecosh River (46.6883, –121.5809).
- (ii) Upper Cowlitz River Watershed 1708000402.
    - Outlet(s) = Cowlitz River (Lat 46.5763, Long –121.7051)
    - Upstream to endpoint(s) in:
        - Cowlitz River (46.6580, –121.6032).
- (iii) Cowlitz Valley Frontal Watershed 1708000403.
    - Outlet(s) = Cowlitz River (Lat 46.4765, Long –122.0952)
    - Upstream to endpoint(s) in:
        - Cowlitz River (46.5763, –121.7051);
        - Silver Creek (46.5576, –121.9178).
- (iv) Upper Cispus River Watershed 1708000404.
    - Outlet(s) = Cispus River (Lat 46.4449, Long –121.7954)
    - Upstream to endpoint(s) in:
        - Cispus River (46.3410, –121.6709);
        - East Canyon Creek (46.3454, –121.7031);
        - North Fork Cispus River (46.4355, –121.654).
- (v) Lower Cispus River Watershed 1708000405.
    - Outlet(s) = Cispus River (Lat 46.4765, Long –122.0952)
    - Upstream to endpoint(s) in:
        - Cispus River (46.4449, –121.7954);
        - McCoy Creek (46.3892, –121.8190);
        - Yellowjacket Creek (46.3871, –121.8335).

(6) Cowlitz Subbasin 17080005—

- (i) Riffe Reservoir Watershed 1708000502.
    - Outlet(s) = Cowlitz River (Lat 46.5033, Long –122.5870)
    - Upstream to endpoint(s) in:
        - Cowlitz River (46.4765, –122.0952).
- (ii) Jackson Prairie Watershed 1708000503.
    - Outlet(s) = Cowlitz River (Lat 46.3678, Long –122.9337)
    - Upstream to endpoint(s) in:
        - Bear Creek (46.4215, –122.9224);
        - Blue Creek (46.4885, –122.7253);
        - Cowlitz River (46.5033, –122.5870);
        - Lacamas Creek (46.5118, –122.8113);
        - Mill Creek (46.4701, –122.8557);
        - Mill Creek (46.5176, – 122.6209);
        - Otter Creek (46.4800, –122.6996);
        - Salmon Creek (46.4237, –122.8400);

Skook Creek (46.5035, –122.7556).

(iii) North Fork Toutle River Watershed 1708000504.

Outlet(s) = North Fork Toutle River (Lat 46.3669, Long –122.5859)

Upstream to endpoint(s) in:

North Fork Toutle River (46.3718, –122.5847).

(iv) Green River Watershed 1708000505.

Outlet(s) = Green River (Lat 46.3718, Long –122.5847)

Upstream to endpoint(s) in:

Cascade Creek (46.3924, –122.3530);
Devils Creek (46.3875, –122.5113);
Elk Creek (46.3929, –122.3224);
Green River (46.3857, –122.1815);
Miners Creek (46.3871, –122.2091);
Shultz Creek (46.3744, –122.2987);
Unnamed (46.3796, –122.3632).

(v) South Fork Toutle River Watershed 1708000506.

Outlet(s) = South Fork Toutle River (Lat 46.3282, Long –122.7215)

Upstream to endpoint(s) in:

Johnson Creek (46.3100, –122.6338);
South Fork Toutle River (46.2306, –122.4439);
Studebaker Creek (46.3044, –122.6777).

(vi) East Willapa Watershed 1708000507.

Outlet(s) = Cowlitz River (Lat 46.2660, Long –122.9154)

Upstream to endpoint(s) in:

Arkansas Creek (46.3275, –123.0123);
Baxter Creek (46.3034, –122.9709);
Brim Creek (46.4263, –123.0139);
Campbell Creek (46.3756, –123.0401);
Cowlitz River (46.3678, –122.9337);
Delameter Creek (46.2495, –122.9916);
Hemlock Creek (46.2585, –122.7269);
Hill Creek (46.3724, –122.9211);
King Creek (46.5076, –122.9885);
Monahan Creek (46.2954, –123.0286);
North Fork Toutle River (46.3669, –122.5859);
Olequa Creek (46.5174, –122.9042);
Stillwater Creek (46.3851, –123.0478);
Sucker Creek (46.2628, –122.8116);
Unnamed (46.5074, –122.9585);
Unnamed (46.5405, –122.9090);
Wyant Creek (46.3424, –122.6302).

(vii) Coweeman Watershed 1708000508.

Outlet(s) = Cowlitz River (Lat 46.0977, Long –122.9141);

Owl Creek (46.0771, –122.8676)

Upstream to endpoint(s) in:
  - Baird Creek (46.1704, –122.6119);
  - Coweeman River (46.1505, –122.5792);
  - Cowlitz River (46.2660, –122.9154);
  - Leckler Creek (46.2092, –122.9206);
  - Mulholland Creek (46.1932, –122.6992);
  - North Fork Goble Creek (46.1209, –122.7689);
  - Ostrander Creek (46.2095, –122.8623);
  - Owl Creek (46.0914, –122.8692);
  - Salmon Creek (46.2547, –122.8839);
  - South Fork Ostrander Creek (46.1910, –122.8600);
  - Unnamed (46.0838, –122.7264).

(7) Lower Columbia Subbasin 17080006—

(i) Big Creek Watershed 1708000602.

Outlet(s) = Bear Creek (Lat 46.1719;
  - Long –123.6642);
  - Big Creek (46.1847, –123.5943);
  - Blind Slough (46.2011, –123.5822);
  - John Day River (46.1820, –123.7392)

Upstream to endpoint(s) in:
  - Bear Creek (46.1181, –123.6388);
  - Big Creek (46.1475, –123.5819);
  - Gnat Creek (46.1614, –123.4813);
  - John Day River (46.1763, –123.7474).

(ii) Grays Bay Watershed 1708000603.

Outlet(s) = Crooked Creek (Lat 46.2962, Long –123.6795);
  - Deep River (46.3035, –123.7092);
  - Grays River (46.3035, –123.6867);
  - Sisson Creek (46.3011, –123.7237);
  - Unnamed (46.3042, –123.6870)

Upstream to endpoint(s) in:
  - Crooked Creek (46.3033, –123.6222);
  - East Fork Grays River (46.4425, –123.4081);
  - Fossil Creek (46.3628, –123.5530);
  - Grays River (46.4910, –123.4334);
  - Hull Creek (46.3725, –123.5866);
  - Johnson Canyon (46.3699, –123.6659);
  - Klints Creek (46.3562, –123.5675);
  - Malone Creek (46.3280, –123.6545);
  - Mitchell Creek (46.4512, –123.4371);
  - South Fork Grays River (46.3813, –123.4581);
  - Sweigiler Creek (46.4195, –123.5375);
  - Unnamed (46.3283, –123.7376);
  - Unnamed (46.3651, –123.6839);
  - Unnamed (46.4701, –123.4515);
  - West Fork Grays River (46.4195, –123.5530).

(8) Clackamas Subbasin 17090011—

- (i) Lower Clackamas River Watershed 1709001106.
  - Outlet(s) = Clackamas River (Lat 45.3719, Long –122.6071)
  - Upstream to endpoint(s) in:
    - Clackamas River (45.2440, –122.2798);
    - Clear Creek (45.3568, –122.4781);
    - Deep Creek (45.3916, –122.4028);
    - Richardson Creek (45.3971, –122.4712);
    - Rock Creek (45.4128, –122.5043).
- (ii) [Reserved] (9) Lower Willamette Subbasin 17090012—
- (i) Johnson Creek Watershed 1709001201.
  - Outlet(s) = Willamette River (Lat 45.4423, Long –122.6453)
  - Upstream to endpoint(s) in:
    - Crystal Springs Creek (45.4770, –122.6403);
    - Kellogg Creek (45.4344, –122.6314);
    - Tryon Creek (45.4239, –122.6595);
    - Unnamed (45.4002, –122.6423);
    - Willamette River (45.3719, –122.6071).
- (ii) Scappoose Creek Watershed 1709001202.
  - Outlet(s) = Multnomah Channel (Lat 45.8577, Long –122.7919)
  - Upstream to endpoint(s) in:
    - Cunningham Slough (45.8250, –122.8069);
    - Multnomah Channel (45.6188, –122.7921);
    - North Scappoose Creek (45.8014, –122.9340).
- (iii) Columbia Slough/Willamette River Watershed 1709001203.
  - Outlet(s) = Willamette River (Lat 45.6530, Long –122.7646)
  - Upstream to endpoint(s) in:
    - Bybee/Smith Lakes (45.6189, –122.7333);
    - Columbia Slough (45.5979, –122.7137);
    - Willamette River (45.4423, –122.6453).

(10) Lower Columbia River Corridor— Lower Columbia River Corridor.

- Outlet(s) = Columbia River (Lat 46.2485, Long –124.0782)
- Upstream to endpoint(s) in:
  - Columbia River (45.5709, –122.4021).

(L) Upper Willamette River Chinook Salmon (Oncorhynchus tshawytscha). Critical habitat is to include the areas defined in the following subbasins:

(1) Middle Fork Willamette Subbasin 17090001—

- (i) Upper Middle Fork Willamette River Watershed 1709000101.
  - Outlet(s) = Middle Fork Willamette River (Lat 43.4961, Long –122.3989)
  - Upstream to endpoint(s) in:
    - Echo Creek (43.4670, –122.3172);
    - Found Creek (43.5048, –122.2831);
    - Middle Fork Willamette River (43.4801, –122.2534);
    - Noisy Creek (43.5083, –122.3016);

Simpson Creek (43.5031, –122.3801);
Skunk Creek (43.5069, –122.2866);
Staley Creek (43.4527, –122.3650);
Swift Creek (43.5438, –122.2431);
Tumblebug Creek (43.4740, –122.2549);
Unnamed (43.4967, –122.2645);
Unnamed (43.4986, –122.2686);
Unnamed (43.5020, –122.2764).

(ii) Hills Creek Watershed 1709000102.
Outlet(s) = Hills Creek (Lat 43.7071, Long –122.4195)
Upstream to endpoint(s) in:
Hills Creek (43.6718, –122.3502).

(iii) Salt Creek/Willamette River Watershed 1709000103.
Outlet(s) = Salt Creek (Lat 43.7261, Long –122.4381)
Upstream to endpoint(s) in:
Coyote Creek (43.6682, –122.2378);
Eagle Creek (43.6795, –122.2293);
Salt Creek (43.6204, –122.1413);
South Fork Salt Creek (43.6518, –122.2261).

(iv) Hills Creek Reservoir Watershed 1709000105.
Outlet(s) = Middle Fork Willamette River (Lat 43.7589, Long –122.5242)
Upstream to endpoint(s) in:
Big Willow Creek (43.6341, –122.4139);
Buck Creek (43.5945, –122.4272);
Bull Creek (43.6598, –122.4014);
Coal Creek (43.4882, –122.4246);
Coffeepot Creek (43.6182, –122.4160);
Gold Creek (43.5860, –122.4768);
Indian Creek (43.5034, –122.4638);
Larison Creek (43.6851, –122.4760);
Middle Fork Willamette River (43.4961, –122.3989);
Packard Creek (43.6516, –122.4904);
Snake Creek (43.5388, –122.4554)
Snow Creek (43.6061, –122.4585);
Windfall Creek (43.5984, –122.4638).

(v) North Fork of Middle Fork Willamette River Watershed 1709000106.
Outlet(s) = North Fork Middle Fork Willamette River (Lat 43.7589, Long –122.5242)
Upstream to endpoint(s) in:
Cayuse Creek (43.8651, –122.1856);
Chalk Creek (43.8750, –122.4044);
Christy Creek (43.9079, –122.3796);
Fisher Creek (43.8699, –122.1551);
North Fork Middle Fork Willamette River (43.8671, –122.0711).

(vi) Middle Fork Willamette/Lookout Point Watershed 1709000107.
Outlet(s) = Middle Fork Willamette River (Lat 43.9495, Long –122.8471)
Upstream to endpoint(s) in:
Anthony Creek (43.8799, –122.8498);
Bannister Creek (43.8743, –122.6538);
Buckhead Creek (43.7753, –122.5253);
Burnt Bridge Creek (43.7900, –122.5334);
Carr Creek (43.8558, –122.8177);
Deception Creek (43.7551, –122.5541);
East Fork Minnow Creek (43.8902, –122.7342);
Goodman Creek (43.8309, –122.6940);
Gosage Creek (43.8446, –122.8129);
Guiley Creek (43.8419, –122.7962);
Hazel Creek (43.8637, –122.6891);
Lost Creek (43.8427, –122.7781);
Middle Creek (43.8624, –122.8323);
Middle Fork Willamette River (43.7589, –122.5242);
Minnow Creek (43.8872, –122.7458);
North Creek (43.8247, –122.6236);
Rolling Riffle Creek (43.8750, –122.7052);
School Creek (43.8604, –122.6099);
South Creek (43.8230, –122.6216);
Unnamed (43.8329, –122.6775);
Unnamed (43.8427, –122.6643);
Unnamed (43.8433, –122.6950).
(vii) Little Fall Creek Watershed 1709000108.
Outlet(s) = Little Fall Creek (Lat 43.9577, Long –122.8166)
Upstream to endpoint(s) in:
Little Fall Creek (44.0579, –122.5440);
Norton Creek (44.0006, –122.7044);
Sturdy Creek (44.0196, –122.6475).
(viii) Fall Creek Watershed 1709000109.
Outlet(s) = Fall Creek (Lat 43.9707, Long –122.8677)
Upstream to endpoint(s) in:
Alder Creek (44.0000, –122.4993);
Fall Creek (43.9922, –122.3758);
Gold Creek (43.9772, –122.4051);
Logan Creek (43.9447, –122.4504);
Nelson Creek (43.9285, –122.6850);
Portland Creek (43.9331, –122.4655);
Sunshine Creek (43.9943, –122.4672);
Winberry Creek (43.9142, –122.6890).
(ix) Lower Middle Fork Willamette River Wateshed 1709000110.
Outlet(s) = Middle Fork Willamette River (Lat 44.0226, Long –123.0169)

Upstream to endpoint(s) in:
Hills Creek (43.9945, –122.8651);
Middle Fork Willamette River (43.9495, –122.8471);
Mill Race (44.0407, –123.0004);
Pudding Creek (44.0173, –122.9501);
Rattlesnake Creek (43.9352, –122.8608);
Wallace Creek (44.0074, –122.8984).

(2) Upper Willamette Subbasin 17090003—

(i) Muddy Creek Watershed 1709000302.
Outlet(s) = Willamette River (Lat 44.6400, Long –123.1096)
Upstream to endpoint(s) in:
Willamette River (44.0226, –123.0169).

(ii) Calapooia River Watershed 1709000303.
Outlet(s) = Calapooia River (Lat 44.5088, Long –123.1101)
Upstream to endpoint(s) in:
Calapooia River (44.2354, –122.4128).

(iii) Oak Creek Watershed 1709000304.
Outlet(s) = Willamette River (Lat 44.7504, Long –123.1421)
Upstream to endpoint(s) in:
Calapooia River (44.5088, –123.1101);
Willamette River (44.6400, –123.1096).

(iv) Marys River Watershed 1709000305.
Outlet(s) = Marys River (Lat 44.5566, Long –123.2597)
Upstream to endpoint(s) in:
Beaver Creek (44.4554, –123.3748);
Marys River (44.5373, –123.3762);
Oak Creek (44.5636, –123.2932).

(v) Luckiamute River Watershed 1709000306.
Outlet(s) = Luckiamute River (Lat 44.7561, Long –123.1468)
Upstream to endpoint(s) in:
Soap Creek (44.7317, –123.2151);
Unnamed (44.7661, –123.2011).

(3) McKenzie Subbasin 17090004—

(i) Upper McKenzie River Watershed 1709000401.
Outlet(s) = McKenzie River (Lat 44.1721, Long –122.2058)
Upstream to endpoint(s) in:
Deer Creek (44.2677, –122.0712);
Frissell Creek (44.2288, –122.0699);
Lost Creek (44.1729, –122.0401);
McKenzie River (44.3109, –122.0199);
Scott Creek (44.1981, –122.0195);
Smith River (44.2824, –122.0506).

(ii) Horse Creek Watershed 1709000402.
Outlet(s) = West Fork Horse Creek (Lat 44.1721, Long –122.2058)
Upstream to endpoint(s) in:
Cedar Swamp Creek (44.1563, –122.1132);

Horse Creek (44.0602, –122.0087);
King Creek (44.1635, –122.1693);
Separation Creek (44.1274, –122.0077).
(iii) South Fork McKenzie River Watershed 1709000403.
Outlet(s) = South Fork McKenzie River (Lat 44.1595, Long –122.2946)
Upstream to endpoint(s) in:
Augusta Creek (43.9562, –122.1632);
Cougar Creek (44.1397, –122.2437);
East Fork South Fork McKenzie (44.0850, –122.0997);
Elk Creek (43.9455, –122.0384);
French Pete Creek (44.0402, –122.1854);
Hardy Creek (44.0345, –122.2047);
Rebel Creek (44.0167, –122.1505);
Roaring River (43.9479, –122.0811);
South Fork McKenzie River (43.9533, –121.9995).
(iv) McKenzie River/Quartz Creek Watershed 1709000405.
Outlet(s) = McKenzie River (Lat 44.1112, Long –122.4209)
Upstream to endpoint(s) in:
Cone Creek (44.1528, –122.3649);
McKenzie River (44.1721, –122.2058);
Quartz Creek (44.0188, –122.3015);
Wycoff Creek (44.0846, –122.3143).
(v) Lower McKenzie River Watershed 1709000407.
Outlet(s) = McKenzie River (Lat 44.1255, Long –123.1059)
Upstream to endpoint(s) in:
Boulder Creek (44.0601, –122.7825);
Camp Creek (44.0896, –122.8544);
Deer Creek (44.0895, –122.4234);
Ennis Creek (44.0804, –122.3754);
Finn Creek (44.1471, –122.5972);
Forest Creek (44.0861, –122.7153);
Haagen Creek (44.0880, –122.7126);
Hatchery Creek (44.1449, –122.6056);
Holden Creek (44.1056, –122.7061);
Indian Creek (44.1526, –122.5816);
Lane Creek (44.0928, –122.7323);
Marten Creek (44.1075, –122.5046);
McKenzie River (44.1112, –122.4209);
North Fork Gate Creek (44.1718, –122.5248);
Osborn Creek (44.0565, –122.7880);
Ritchie Creek (44.1028, –122.6567);
South Fork Gate Creek (44.1667, –122.4980);
Taylor Creek (44.0783, –122.7481);
Toms Creek (44.1316, –122.5586);
Unnamed (44.0646, –122.9399);

Walterville Canal (44.0765, –122.7537).

(4) North Santiam Subbasin 17090005—

(i) Middle North Santiam River Watershed 1709000504.

Outlet(s) = North Santiam River (Lat 44.7852, Long –122.6079)

Upstream to endpoint(s) in:

Mad Creek (44.7453, –122.3898);
North Santiam River (44.7510, –122.2821);
Rock Creek (44.7077, –122.4171);
Snake Creek (44.7477, –122.4905).

(ii) Little North Santiam River Watershed 1709000505.

Outlet(s) = Little North Santiam River (Lat 44.7852, Long –122.6079)

Upstream to endpoint(s) in:

Elkhorn Creek (44.8134, –122.3561);
Little North Santiam River (44.8390, –122.3364);
Little Sinker Creek (44.8191, –122.4111);
Sinker Creek (44.8166, –122.4174).

(iii) Lower North Santiam River Watershed 1709000506.

Outlet(s) = Santiam River (Lat 44.7504, Long –123.1421)

Upstream to endpoint(s) in:

Bear Branch (44.7559, –122.7974);
Cold Creek (44.7522, –122.8848);
Morgan Creek (44.7500, –123.0376);
North Santiam River (44.7852, –122.6079);
Salem Ditch (44.8000, –122.8120);
Smallman Creek (44.7300, –122.9098);
Stout Creek (44.7930, –122.6177);
Trask Creek (44.7725, –122.6152);
Unnamed (44.7672, –123.0517);
Valentine Creek (44.8013, –122.7176).

(5) South Santiam Subbasin 17090006—

(i) Hamilton Creek/South Santiam River Watershed 1709000601.

Outlet(s) = South Santiam River (Lat 44.6869, Long –123.0052)

Upstream to endpoint(s) in:

Hamilton Creek (44.5037, –122.7667);
McDowell Creek (44.4580, –122.7128);
Mill Creek (44.6750, –122.9721);
Noble Creek (44.4519, –122.7976);
South Santiam River (44.4163, –122.6693);
Spring Branch (44.6821, –122.9811);
Unnamed (44.6703, –122.9870);
Unnamed (44.6801, –122.9786).

(ii) Crabtree Creek Watershed 1709000602.

Outlet(s) = Crabtree Creek (Lat 44.6756, Long –122.9557)

Upstream to endpoint(s) in:

Bald Peter Creek (44.5682, –122.5825);

Beaver Creek (44.6271, –122.8504);
Crabtree Creek (44.6058, –122.5405);
Roaring River (44.6251, –122.7283);
South Fork Crabtree Creek (44.5741, –122.5744).

(iii) Thomas Creek Watershed 1709000603.
Outlet(s) = Thomas Creek (Lat 44.6778, Long –122.9654)
Upstream to endpoint(s) in:
Jordan Creek (44.7531, –122.6595);
Mill Creek (44.7055, –122.7842);
Neal Creek (44.7101, –122.6912);
South Fork Neal Creek (44.7033, –122.7078);
Thomas Creek (44.6776, –122.4650).

(iv) South Santiam River Watershed 1709000606.
Outlet(s) = South Santiam River (Lat 44.3977, Long –122.4491)
Upstream to endpoint(s) in:
Falls Creek (44.4007, –122.3828);
South Santiam River (44.3980, –122.2610).

(v) South Santiam River/Foster Reservoir Watershed 1709000607.
Outlet(s) = South Santiam River (Lat 44.4163, Long –122.6693)
Upstream to endpoint(s) in:
Middle Santiam River (44.4498, –122.5479);
South Santiam River (44.3977, –122.4491).

(vi) Wiley Creek Watershed 1709000608.
Outlet(s) = Wiley Creek (Lat 44.4140, Long –122.6752)
Upstream to endpoint(s) in:
Little Wiley Creek (44.3673, –122.5916);
Wiley Creek (44.3488, –122.5900).

(6) Middle Willamette Subbasin 17090007—

(i) Mill Creek/Willamette River Watershed 1709000701.
Outlet(s) = Mill Creek (Lat 44.9520, Long –123.0381)
Upstream to endpoint(s) in:
Mill Creek (44.8255, –122.8226).

(ii) Rickreall Creek Watershed 1709000702.
Outlet(s) = Willamette River (Lat 44.9288, Long –123.1124)
Upstream to endpoint(s) in:
Willamette River (44.7504, –123.1421).

(iii) Willamette River/Chehalem Creek Watershed 1709000703.
Outlet(s) = Willamette River (Lat 45.2552, Long –122.8806)
Upstream to endpoint(s) in:
Willamette River (44.9288, –123.1124).

(iv) Abernethy Creek Watershed 1709000704.
Outlet(s) = Willamette River (Lat 45.3719, Long –122.6071)
Upstream to endpoint(s) in:
Willamette River (45.2552, –122.8806).

(7) Molalla/Pudding Subbasin 17090009—

(i) Butte Creek/Pudding River Watershed 1709000902.

Outlet(s) = Pudding River (Lat 45.1907, Long –122.7527)
Upstream to endpoint(s) in:
Pudding River (45.0740, –122.8525).
(ii) Senecal Creek/Mill Creek Watershed 1709000904.
Outlet(s) = Pudding River (Lat 45.2843, Long –122.7149)
Upstream to endpoint(s) in:
Pudding River (45.1907, –122.7527).
(iii) Upper Molalla River Watershed 1709000905.
Outlet(s) = Molalla River (Lat 45.1196, Long –122.5342)
Upstream to endpoint(s) in:
Molalla River (44.9124, –122.3228);
North Fork Molalla River (45.0872, –122.3849);
Table Rock Fork Molalla River (44.9876, –122.2741).
(iv) Lower Molalla River Watershed 1709000906.
Outlet(s) = Molalla River (Lat 45.2979, Long –122.7141)
Upstream to endpoint(s) in:
Gribble Creek (45. 2146, –122.6988);
Milk Creek (45.2278, –122.5670);
Molalla River (45.1196, –122.5342).
(8) Clackamas Subbasin 17090011—
(i) Collawash River Watershed 1709001101.
Outlet(s) = Collawash River (Lat 45.0321, Long –122.0600)
Upstream to endpoint(s) in:
Blister Creek (44.9594, –122.1590);
Collawash River (44.9507, –122.0350);
Hot Springs Fk Collawash River (44.9385, –122.1721);
Nohorn Creek (44.9442, –122.1957).
(ii) Upper Clackamas River 1709001102.
Outlet(s) = Clackamas River (Lat 45.0321, Long –122.0600)
Upstream to endpoint(s) in:
Cabin Creek (45.0087, –121.8958);
Clackamas River (44.8966, –121.8800);
Cub Creek (44.8969, –121.8876);
Granite Creek (45.0184, –121.9885);
Hunter Creek (44.9086, –121.8929);
Last Creek (44.9715, –121.8547);
Lowe Creek (44.9487, –121.8983);
Pot Creek (45.0149, –121.9084);
Unnamed (44.9469, –121.8691);
Wall Creek (44.9555, –121.8843).
(iii) Oak Grove Fork Clackamas River Watershed 1709001103.
Outlet(s) = Oak Grove Fork Clackamas River (Lat 45.0746, Long –122.0520)
Upstream to endpoint(s) in:
Oak Grove Fork Clackamas River (45.0822, –121.9859).
(iv) Middle Clackamas River Watershed 1709001104.

Outlet(s) = Clackamas River (Lat 45.2440, Long –122.2798)
Upstream to endpoint(s) in:
Clackamas River (45.0321, –122.0600);
Fish Creek (45.0962, –122.1683);
North Fork Clackamas River (45.2361, –122.2186);
Roaring River (45.1773, –122.0650);
South Fork Clackamas River (45.1939, –122.2257);
Tag Creek (45.0607, –122.0512);
Tar Creek (45.0494, –122.0570).

(v) Lower Clackamas River Watershed 1709001106.
Outlet(s) = Clackamas River (Lat 45.3719, Long –122.6071)
Upstream to endpoint(s) in:
Clackamas River (45.2440, –122.2798);
Clear Creek (45.3568, –122.4781);
Deep Creek (45.3937, –122.4095);
Richardson Creek (45.3971, –122.4712).

(9) Lower Willamette/Columbia River Corridor—Lower Willamette/Columbia River Corridor.
Outlet(s) = Columbia River (Lat 46.2485, Long –124.0782)
Upstream to endpoint(s) in:
Willamette River (45.3719, –122.6071).

(M) Upper Columbia River Spring Chinook Salmon (Oncorhynchus tshawytscha). Critical habitat is to include the areas defined in the following subbasins:

(1) Chief Joseph Subbasin 17020005— Upper Columbia/Swamp Creek Watershed 1702000505.
Outlet(s) = Columbia River (Lat 47.8077, Long –119.9754)
Upstream to endpoint(s) in:
Columbia River (48.0502, –119.8942).

(2) Methow Subbasin 17020008—

(i) Lost River Watershed 1702000801
Outlet(s) = Lost River Gorge (Lat 48.6501, Long –120.5103)
Upstream to endpoint(s) in:
Eureka Creek (48.7020, –120.4986);
Lost River Gorge (48.7324, –120.4475).

(ii) Upper Methow River Watershed 1702000802.
Outlet(s) = Methow River (Lat 48.6015, Long –120.4376)
Upstream to endpoint(s) in:
Early Winters Creek (48.5999, –120.5840);
Methow River (48.6417, –120.6150);
Rattlesnake Creek (48.6523, –120.5733);
Robinson Creek (48.6680, –120.5394);
South Fork Trout Creek (48.6448, –120.6030).

(iii) Upper Chewuch River Watershed 1702000803.
Outlet(s) = Chewuch River (Lat 48.7501, Long –120.1356)
Upstream to endpoint(s) in:

Andrews Creek (48.7855, –120.1087);
Chewuch River (48.8614, –120.0288);
Dog Creek (48.8218, –120.0151);
Lake Creek (48.8258, –120.1996);
Thirtymile Creek (48.8109, –120.0199).

(iv) Lower Chewuch River Watershed 1702000804.

Outlet(s) = Chewuch River (Lat 48.4751, Lat –120.1790)
Upstream to endpoint(s) in:

Boulder Creek (48.5797, –120.1538);
Chewuch River (48.7501, –120.1356);
Cub Creek (48.5513, –120.1899);
Eightmile Creek (48.6071, –120.1775);
Lake Creek (48.4926, –120.1629);
Twentymile Creek (48.7029, –120.1117).

(v) Twisp River Watershed 1702000805.

Outlet(s) = Twisp River (Lat 48.3682, Long –120.1176)
Upstream to endpoint(s) in:

Buttermilk Creek (48.3528, –120.3239);
Eagle Creek (48.3584, –120.3914);
North Creek (48.4587, –120.5595);
Poorman Creek (48.3674, –120.1997);
South Creek (48.4330, –120.5431);
Twisp River (48.4615, –120.5764);
War Creek (48.3649, –120.4030).

(vi) Middle Methow River Watershed 1702000806.

Outlet(s) = Methow River (Lat 48.2495, Long –120.1156)
Upstream to endpoint(s) in:

Bear Creek (48.4527, –120.1423);
Goat Creek (48.5888, –120.3705);
Little Boulder Creek (48.5700, –120.3797);
Methow River (48.6015, –120.4376);
Wolf Creek (48.4776, –120.2840)
Unnamed (48.4896, –120.2116).

(vii) Lower Methow River Watershed 1702000807.

Outlet(s) = Methow River (Lat 48.0502, Long –119.8942)
Upstream to endpoint(s) in:

Methow River (48.2495, –120.1156).

(3) Upper Columbia/Entiat Subbasin 17020010—

(i) Entiat River Watershed 1702001001.

Outlet(s) = Entiat River (Lat 47.6585, Long –120.2194)
Upstream to endpoint(s) in:

Entiat River (47.9855, –120.5749);
Hornet Creek (47.7714, –120.4403);
Mad River (47.7804, –120.4403);
Tillicum Creek (47.7295, –120.4304).

(ii) Lake Entiat Watershed 1702001002.

Outlet(s) = Columbia River (Lat 47.3438, Long –120.0929)
Upstream to endpoint(s) in:
Columbia River (47.8077, –119.9754).

(4) Wenatchee Subbasin 17020011—

(i) White River Watershed 1702001101.
Outlet(s) = White River (Lat 47.8088, Long –120.7159)
Upstream to endpoint(s) in:
Little Wenatchee River (47.8526, –120.9541);
Napeequa River (47.9285, –120.8829);
Panther Creek (47.9355, –120.9482);
White River (47.9535, –120.9380).

(ii) Chiwawa River Watershed 1702001102.
Outlet(s) = Chiwawa River (Lat 47.7880, Long –120.6589)
Upstream to endpoint(s) in:
Alder Creek (47.8483, –120.6587);
Chikamin Creek (47.9785, –120.7194);
Chiwawa River (48.1048, –120.8773);
Goose Creek (47.8392, –120.6461);
Minnow Creek (47.9137, –120.7182);
Phelps Creek (48.0794, –120.8400);
Unnamed (48.0366, –120.7615).

(iii) Nason/Tumwater Watershed 1702001103.
Outlet(s) = Wenatchee River (Lat 47.5801, Long –120.6660)
Upstream to endpoint(s) in:
Chiwaukum Creek (47.7039, –120.7791);
Nason Creek (47.7769, –120.9103);
Skinney Creek (47.6894, –120.7351).

(iv) Icicle/Chumstick Watershed 1702001104.
Outlet(s) = Wenatchee River (Lat 47.5575, Long –120.5729)
Upstream to endpoint(s) in:
Wenatchee River (47.5801, –120.6660).

(v) Lower Wenatchee River Watershed 1702001105.
Outlet(s) = Wenatchee River (Lat 47.4553, Long –120.3185)
Upstream to endpoint(s) in:
Wenatchee River (47.5575, –120.5729).

(5) Columbia River Corridor— Columbia River Corridor
Outlet(s) = Columbia River (Lat 46.2485, Long –124.0782)
Upstream to endpoint(s) in:
Columbia River (47.3438, –120.0929).

(N) Hood Canal Summer-run Chum Salmon (Oncorhynchus keta). Critical habitat is designated to include the areas defined in the following subbasins:

(1) Skokomoish Subbasin 17110017— Skokomish River 1711001701.
Outlet(s) = Skokomish River (Lat 47.3543, Long –123.1122)

Unnamed (47.3420, –123.1092)

Unnamed (47.3471, –123.1275)
Unnamed (47.3509. –123.1101)
Upstream to endpoint(s) in:
Mussel Sheel Creek (47.3039, –123.1590);
Skokomish (47.3199, –123.2198);
Unnamed (47.3209, –123.2211).
(2) Hood Canal Subbasin 17110018—
(i) Lower West Hood Canal Frontal Watershed 1711001802.
Outlet(s)= Eagle Creek (Lat 47.4849, Long –123.0766);
Finch Creek (47.4067, –123.1377);
Fulton Creek (47.6183, –122.9736);
Jorsted Creek (47.5263, –123.0489);
Lilliwaup Creek (47.4689, –123.1136);
Unnamed (47.4576, –123.1117)
Upstream to endpoint(s) in:
Eagle Creek (47.4905, –123.0830);
Finch Creek (47.4076, –123.1586);
Fulton Creek (47.6275, –122.9805);
Jorsted Creek (47.5246, –123.0649);
Lilliwaup Creek (47.4704, –123.1166);
Unnamed (47.4585, –123.1186).
(ii) Hamma Hamma River Watershed 1711001803.
Outlet(s) = Hamma Hamma River (Lat 47.5471, Long –123.0440)
Upstream to endpoint(s) in:
Hamma Hamma River (47.5547, –123.0623);
John Creek (47.5369, –123.0619).
(iii) Duckabush River Watershed 1711001804.
Outlet(s) = Duckabush River (Lat 47.6502, Long –122.9348)
Upstream to endpoint(s) in:
Duckabush River (47.6654, –122.9728).
(iv) Dosewallips River Watershed 1711001805.
Outlet(s) = Dosewallips River (Lat 47.6880, Long –122.8949)
Upstream to endpoint(s) in:
Dosewallips River (47.7157, –122.9396).
(v) Big Quilcene River Watershed 1711001806.
Outlet(s) = Big Quilcene River (Lat 47.8188, Long –122.8605)
Upstream to endpoint(s) in:
Big Quilcene River (47.8102, –122.9119).
(vi) Upper West Hood Canal Frontal Watershed 1711001807.
Outlet(s) = Little Quilcene River (Lat 47.8266; Long –122.8608)
Upstream to endpoint(s) in:
Little Quilcene River (47.8374, –122.8854).
(vii) West Kitsap Watershed 1711001808.
Outlet(s) = Anderson Creek (Lat 47.5670, Long –122.9664);
Big Beef Creek (47.6521, –122.7823);
Dewatto River (47.4538, –123.0474);

Little Anderson Creek (47.6653, –122.7554);
Tahuya River (47.3767, –123.0355);
Union River (47.4484, –122.8368);
Unnamed (47.3767, –123.0372);
Unnamed (47.4537, –123.0474)

Upstream to endpoint(s) in:

Anderson Creek (47.5596, –122.9354);
Bear Creek (47.4980, –122.8074);
Big Beef Creek (47.6385, –122.7868);
Dewatto River (47.4937, –122.9914);
East Fork Union River (47.5056, –122.7897);
Hazel Creek (47.5170, –122.7945);
Little Anderson Creek (47.6606, –122.7543);
North East Fork Union River (47.4954, –122.7819);
Tahuya River (47.4510, –122.9597);
Union River (47.5273, –122.7846);
Unnamed (47.4492, –122.9229);
Unnamed (47.4527, –122.8294);
Unnamed (47.4553, –122.8301);
Unnamed (47.4594, –122.8396);
Unnamed (47.4700, –122.8300);
Unnamed (47.4852, –122.8313);
Unnamed (47.4966, –122.8393);
Unnamed (47.4971, –122.8315);
Unnamed (47.6600, –122.7559);
Unnamed (47.6642, –122.7534).

(3) Puget Sound Subbasin 17110019— Port Ludlow/Chimacum Creek Watershed 1711001908.

Outlet(s) = Chimacum Creek (Lat 48.0507, Long –122.7832)

Upstream to endpoint(s) in:

Chimacum Creek (47.9743, –122.7764).

(4) Dungeness/Elwha Subbasin 17110020—

(i) Discovery Bay Watershed 1711002001.

Outlet(s) = Salmon Creek (Lat 47.9895, Long –122.8879);
Snow Creek (47.9900, –122.8834)

Upstream to endpoint(s) in:

Salmon Creek (47.9775, –122.9191);
Snow Creek (47.9638, –122.8827).

(ii) Sequim Bay Watershed 1711002002.

Outlet(s) = Jimmycomelately Creek (Lat 48.0235, Long –123.0039)

Upstream to endpoint(s) in:

Jimmycomelately Creek (48.0125, –123.0026).

(iii) Dungeness River Watershed 1711002003.

Outlet(s) = Dungeness River (Lat 48.1506, Long –123.1311);
Unnamed (48.1537, –123.1267)

Upstream to endpoint(s) in:
Dungeness River (48.0258, –123.1358);
Matriotti Creek (48.1369, –123.1488);
Unnamed (48.1167, –123.1403);
Unnamed (48.1514, –123.1216).

(5) Nearshore Marine Areas—

Except as provided in paragraph (e) of this section, critical habitat includes all nearshore marine areas (including areas adjacent to islands) of Hood Canal and the Strait of Juan de Fuca (to Dungeness Bay) from the line of extreme high tide out to a depth of 30 meters.

(O) Columbia River Chum Salmon (Oncorhynchus keta). Critical habitat is designated to include the areas defined in the following subbasins:

(1) Middle Columbia/Hood Subbasin 17070105—

(i) White Salmon River Watershed 1707010509.
Outlet(s) = White Salmon River (Lat 45.7267, Long –121.5209)
Upstream to endpoint(s) in:
White Salmon River (45.7677, –121.5374).

(ii) Middle Columbia/Grays Creek Watershed 1707010512.
Outlet(s) = Columbia River (Lat 45.7074, Long –121.7965)
Upstream to endpoint(s) in:
Columbia River (45.7267, –121.5209).

(iii) Middle Columbia/Eagle Creek 1707010513.
Outlet(s) = Columbia River (Lat 45.6453, Long –121.9395)
Upstream to endpoint(s) in:
Columbia River (45.7074, –121.7965).

(2) Lower Columbia/Sandy Subbasin 17080001—

(i) Washougal River Watershed 1708000106.
Outlet(s) = Unnamed (Lat 45.5812, Long –122.4077);
Washougal River (45.5795, –122.4023)
Upstream to endpoint(s) in:
Lacamas Creek (45.5972, –122.3933);
Little Washougal River (45.6210, –122.3750);
Unnamed (45.5861, –122.4083);
Washougal River (45.6232, –122.2738).

(ii) Columbia Gorge Tributaries Watershed 1708000107.
Outlet(s) = Columbia River (Lat 45.5709, Long –122.4020)
Upstream to endpoint(s) in:
Columbia River (45.6453, –121.9395);
Duncan Creek (45.6136, –122.0539);
Gibbons Creek (45.5710, –122.3147);
Greenleaf Creek (45.6548, –121.9569);
Hamilton Creek (45.6535, –121.9879);
Hardy Creek (45.6354, –121.9987);
Indian Mary Creek (45.6066, –122.0716);
Lawton Creek (45.5746, –122.2501);

Unnamed (45.5673, –122.3033);
Unnamed (45.6017, –122.1106);
Unnamed (45.6017, –122.1087);
Unnamed (45.6483, –121.9725);
Unnamed (45.6509, –121.9502);
Walton Creek (45.5757, –122.2618).
(iii) Salmon Creek Watershed 1708000109.
Outlet(s) = Lake River (Lat 45.8437, Long –122.7800);
Love Creek (45.5976, –122.5443);
Unnamed (45.5867, –122.5015);
Unnamed (45.5919, –122.5241);
Unnamed (45.5952, –122.5366)
Upstream to endpoint(s) in:
Love Creek (45.5981, –122.5444);
Salmon Creek (45.7089, –122.6480);
Unnamed (45.5873, –122.5015);
Unnamed (45.5924, –122.5242);
Unnamed (45.5955, –122.5360).
(3) Lewis Subbasin 17080002—
(i) East Fork Lewis River Watershed 1708000205.
Outlet(s) = East Fork Lewis River (Lat 45.8664, Long –122.7189);

Gee Creek (45.8462, –122.7803)
Upstream to endpoint(s) in:
Brezee Creek (45.8622, –122.6667);
East Fork Lewis River (45.8395, –122.4463);
Gee Creek (45.8264, –122.7458);
Lockwood Creek (45.8578, –122.6259);
Mason Creek (45.8410, –122.5919);
McCormick Creek (45.8521, –122.6907);
Riley Creek (45.8663, –122.6349);
Unnamed (45.8076, –122.5878);
Unnamed (45.8076, –122.6286);
Unnamed (45.8090, –122.6089);
Unnamed (45.8111, –122.5860);
Unnamed (45.8149, –122.5654);
Unnamed (45.8201, –122.5991);
Unnamed (45.8241, –122.6380);
Unnamed (45.8280, –122.6431);
Unnamed (45.8292, –122.6040);
Unnamed (45.8389, –122.6456);
Unnamed (45.8439, –122.6478);
Unnamed (45.8439, –122.6605).
(ii) Lower Lewis River Watershed 1708000206.
Outlet(s) = Lewis River (Lat 45.8519, Long –122.7806)
Upstream to endpoint(s) in:

Cedar Creek (45.9383, –122.5818);
Colvin Creek (45.9400, –122.6081);
Houghton Creek (45.9395, –122.6478);
Johnson Creek (45.9385, –122.6261);
Lewis River (45.9570, –122.5550);
Ross Creek (45.9340, –122.7076).

(4) Lower Columbia/Clatskanie Subbasin 17080003—

(i) Kalama River Watershed 1708000301.

Outlet(s) = Kalama River (Lat 46.0340, Long –122.8696)

Upstream to endpoint(s) in:

Kalama River (46.0449, –122.8034).

(ii) Germany/Abernathy Watershed 1708000304.

Outlet(s) = Abernethy Creek (Lat 46.1908, Long –123.1661);

Germany Creek (46.1895, –123.1244);
Mill Creek (46.1888, –123.1745)

Upstream to endpoint(s) in:

Abernethy Creek (46.2263, –123.1467);
Germany Creek (46.2221, –123.1353);
Mill Creek (46.1932, –123.1834).

(iii) Skamokawa/Elochoman Watershed 1708000305.

Outlet(s) = Elochoman River (Lat 46.2269, Long –123.4039);

Jim Crow Creek (46.2662, –123.5511);
Skamokawa Creek (46.2677, –123.4562);
Unnamed (46.2243, –123.3975)

Upstream to endpoint(s) in:

Beaver Creek (46.2262, –123.3239);
Brooks Slough (46.2502, –123.4094);
Clear Creek (46.2611, –123.2996);
Duck Creek (46.2517, –123.3159);
Eggman Creek (46.3248, –123.4951);
Elochoman River (46.2615, –123.2965);
Indian Jack Slough (46.2371, –123.3955);
Jim Crow Creek (46.2891, –123.5553);
Kelly Creek (46.3109, –123.4797);
Left Fork Skamokawa Creek (46.3331, –123.4610);
Quarry Creek (46.3292, –123.4241);
Skamokawa Creek (46.3277, –123.4236);
Unnamed (46.2338, –123.3282);
Unnamed (46.3293, –123.4534);
West Fork Skamokawa Creek (46.3119, –123.4889);
West Valley Creek (46.2981, –123.4698);
Wilson Creek (46.3006, –123.3787).

(5) Lower Cowlitz Subbasin 17080005—

(i) Jackson Prairie Watershed 1708000503.

Outlet(s) = Cowlitz River (Lat 46.3678, Long –122.9337)
Upstream to endpoint(s) in:
Bear Creek (46.4544, –122.9187);
Blue Creek (46.4885, –122.7253);
Coon Creek (46.4272, –122.9109);
Cowlitz River (46.5033, –122.5871);
Lacamas Creek (46.5564, –122.6878);
Mill Creek (46.5025, –122.8017);
Salmon Creek (46.4130, –122.8165);
Skook Creek (46.4708, –122.7594);
Unnamed (46.4191, –122.8205);
Unnamed (46.4205, –122.8662);
Unnamed (46.4280, –122.8380);
Unnamed (46.4707, –122.7713);
Unnamed (46.4885, –122.8068);
Unnamed (46.5076, –122.6675);
Unnamed (46.5311, –122.8194);
Unnamed (46.5432, –122.7466).

(ii) South Fork Toutle River Watershed 1708000506.
Outlet(s) = South Fork Toutle River (Lat 46.3282, Long –122.7215)
Upstream to endpoint(s) in:
Johnson Creek (46.3102, –122.6444);
South Fork Toutle River (46.2817, –122.6420).

(iii) East Willapa Watershed 1708000507.
Outlet(s) = Cowlitz River (Lat 46.2660, Long –122.9154)
Upstream to endpoint(s) in:
Arkansas Creek (46.3032, –122.9801);
Cowlitz River (46.3678, –122.9337);
Delameter Creek (46.2598, –122.9679);
Hill Creek (46.3704, –122.9267);
McMurphy Creek (46.4082, –122.9520);
Monahan Creek (46.2636, –122.9727);
North Fork Toutle River (46.3669, –122.5859);
Olequa Creek (46.4324, –122.9688);
Unnamed (46.2606, –122.9551);
Unnamed (46.2642, –122.9291);
Unnamed (46.2689, –122.9589);
Unnamed (46.2880, –122.9051);
Unnamed (46.2892, –122.9626);
Unnamed (46.3294, –122.9085);
Unnamed (46.3371, –122.8922);
Unnamed (46.3491, –122.7052);
Unnamed (46.3571, –122.7684);
Unnamed (46.3587, –122.7478);
Unnamed (46.3683, –122.7503);

Unnamed (46.3814, –122.6091);
Wyant Creek (46.3314, –122.6768).
(iv) Coweeman Watershed 1708000508.
Outlet(s) = Cowlitz River (Lat 46.0977, Long –122.9141);
Owl Creek (46.0768, –122.8679)
Upstream to endpoint(s) in:
Baird Creek (46.1789, –122.5822);
Butler Creek (46.1491, –122.5170);
Cowlitz River (46.2660, –122.9154);
Goble Creek (46.1074, –122.7068);
Leckler Creek (46.2164, –122.9325);
Mulholland Creek (46.2004, –122.6484);
Nineteen Creek (46.1593, –122.6095);
North Fork Goble Creek (46.1208, –122.7691);
Owl Creek (46.0914, –122.8692);
Salmon Creek (46.2547, –122.8839);
Sandy Bend Creek (46.2318, –122.9143);
Skipper Creek (46.1625, –122.5915);
Turner Creek (46.1167, –122.8150);
Unnamed (46.0719, –122.8607);
Unnamed (46.0767, –122.8604);
Unnamed (46.0897, –122.7355);
Unnamed (46.1295, –122.8993);
Unnamed (46.1369, –122.8034);
Unnamed (46.1441, –122.5816);
Unnamed (46.1478, –122.8649);
Unnamed (46.1516, –122.8749);
Unnamed (46.1558, –122.7803);
Unnamed (46.1727, –122.7716);
Unnamed (46.1753, –122.7657);
Unnamed (46.1940, –122.7068);
Unnamed (46.2021, –122.6941);
Unnamed (46.2416, –122.8869).
(6) Lower Columbia Subbasin 17080006—
(i) Big Creek Watershed 1708000602.
Outlet(s) = Big Creek (Lat 46.1848, Long –123.5943)
Upstream to endpoint(s) in:
Big Creek (46.1476, –123.5820);
Little Creek (46.1510, –123.6007).
(ii) Grays Bay Watershed 1708000603.
Outlet(s) = Deep River (Lat 46.3035, Long –123.7092);
Grays River (46.3035, –123.6867);
Unnamed (46.2419, –123.8842);
Unnamed (46.3026, –123.9702)
Upstream to endpoint(s) in:
Alder Creek (46.4279, –123.4621);

Blaney Creek (46.3957, –123.4607);
Campbell Creek (46.3435, –123.7087);
Chinook River (46.2685, –123.9233);
Deep River (46.3480, –123.6865);
East Fork Grays River (46.4424, –123.4120);
Fossil Creek (46.3612, –123.5217);
Grays River (46.4628, –123.4602);
Johnson Creek (46.4544, –123.4732);
Kessel Creek (46.3336, –123.5850);
King Creek (46.3444, –123.5774);
Lassila Creek (46.3343, –123.7108);
Mitchell Creek (46.4512, –123.4269);
South Fork Grays River (46.3836, –123.4592);
Thadbar Creek (46.3331, –123.6092);
Unnamed (46.2502, –123.8833);
Unnamed (46.2847, –123.9402);
Unnamed (46.2901, –123.9368);
Unnamed (46.3605, –123.5228);
Unnamed (46.3838, –123.5454);
Unnamed (46.4328, –123.4444);
West Fork Grays River (46.3942, –123.5611).

(7) Lower Columbia River Corridor— Lower Columbia River Corridor
Outlet(s) = Columbia River (Lat 46.2485, Long –124.0782)
Upstream to endpoint(s) in:
Columbia River (45.5709, –122.4020).

(P) Ozette Lake Sockeye Salmon (Oncorhynchus nerka). Critical habitat is designated to include the areas defined in the following subbasin:

(1) Hoh/Quillayute Subbasin 17100101—
(i) Ozette Lake Watershed 1710010102.
Outlet(s) = Ozette River (Lat 48.1818, Long –124.7076)
Upstream to endpoints in:
Big River (48.1844, –124.4987);
Coal Creek (48.1631, –124.6612);
East Branch Umbrella Creek (48.1835, –124.5659);
North Fork Crooked Creek (48.1020, –124.5507);
Ozette River (48.0370, –124.6218);
South Fork Crooked Creek (48.0897, –124.5597);
Umbrella Creek (48.2127, –124.5787);
Unnamed (48.1771, –124.5967);
Unnamed (48.1740, –124.6005);
Unnamed (48.1649, –124.5208).

(Q) Upper Columbia River Steelhead (Oncorhynchus mykiss). Critical habitat is designated to include the areas defined in the following subbasins:

(1) Chief Joseph Subbasin 17020005— Upper Columbia/Swamp Creek Watershed 1702000505.

Outlet(s) = Columbia River (Lat 47.8077, Long –119.9754)
Upstream to endpoint(s) in:
Columbia River (48.0828, –119.7062).

(2) Okanogan Subbasin 17020006—

(i) Upper Okanogan River Watershed 1702000601.

Outlet(s) = Okanogan River (Lat 48.7350, Long –119.4280)
Upstream to endpoint(s) in:
Antoine Creek (48.7474, –119.3655);
Ninemile Creek (48.9755, –119.3834);
Okanogan River (49.0002, –119.4409);
Similkameen River (48.9345, –119.4411);
Tomasket Creek (48.9502, –119.3618);
Whitestone Creek (48.7773, –119.4170).

(ii) Okanogan River/Bonaparte Creek Watershed 1702000602.

Outlet(s) = Okanogan River (Lat 48.5612, Long –119.4863)
Upstream to endpoint(s) in:
Aeneas Creek (48.6629, –119.4953);
Bonaparte Creek (48.6824, –119.3947);
Okanogan River (48.7350, –119.4280);
Tunk Creek (48.5644, –119.4718).

(iii) Salmon Creek Watershed 1702000603.

Outlet(s) = Salmon Creek (Lat 48.3593, Long –119.5805)
Upstream to endpoint(s) in:
Salmon Creek (48.5374, –119.7465).

(iv) Okanogan River/Omak Creek Watershed 1702000604.

Outlet(s) = Okanogan River (Lat 48.3593, Long –119.5805)
Upstream to endpoint(s) in:
Okanogan River (48.5612, –119.4863);
Omak Creek (48.3698, –119.4365);
Unnamed (48.3802, –119.4915).

(v) Lower Okanogan River Watershed 1702000605.

Outlet(s) = Okanogan River (Lat 48.0976, Long –119.7352)
Upstream to endpoint(s) in:
Chiliwist Creek (48.2643, –119.7304);
Loup Loup Creek (48.3080, –119.7128);
Okanogan River (48.3593, –119.5805).

(3) Similkameen Subbasin 17020007—Lower Similkameen River Watershed 1702000704.

Outlet(s) = Similkameen River (Lat 48.9345, Long –119.4411)
Upstream to endpoint(s) in:
Similkameen River (48.9657, –119.5009).

(4) Methow Subbasin 17020008—

(i) Lost River Watershed 1702000801.

Outlet(s) = Lost River Gorge (Lat 48.6501, Long –120.5103)

Upstream to endpoint(s) in:
Lost River Gorge (48.7324, –120.4475).
(ii) Upper Methow River Watershed 1702000802.
Outlet(s) = Methow River (Lat 48.6015, Long –120.4376)
Upstream to endpoint(s) in:
Early Winters Creek (48.5889, –120.4711);
Methow River (48.6597, –120.5368).
(iii) Upper Chewuch River Watershed 1702000803.
Outlet(s) = Chewuch River (Lat 48.7501, Long –120.1356)
Upstream to endpoint(s) in:
Andrews Creek (48.7855, –120.1087);
Chewuch River (48.8614, –120.0288);
Lake Creek (48.8258, –120.1996).
(iv) Lower Chewuch River Watershed 1702000804.
Outlet(s) = Chewuch River (Lat 48.4751, Long –120.1790)
Upstream to endpoint(s) in:
Boulder Creek (48.5804, –120.1521);
Chewuch River (48.7501, –120.1356);
Eightmile Creek (48.6167, –120.1975);
Twentymile Creek (48.7025, –120.1087).
(v) Twisp River Watershed 1702000805.
Outlet(s) = Twisp River (Lat 48.3682, Long –120.1176)
Upstream to endpoint(s) in:
Buttermilk Creek 48.3414, –120.3034);
Eagle Creek (48.3579, –120.3953);
Little Bridge Creek (48.4289, –120.3552);
South Creek (48.4329, –120.5434);
Twisp River (48.4545, –120.5621);
War Creek (48.3626, –120.4106).
(vi) Middle Methow River Watershed 1702000806.
Outlet(s) = Methow River (Lat 48.2495, Long –120.1156)
Upstream to endpoint(s) in:
Goat Creek (48.6101, –120.3692);
Hancock Creek (48.5338, –120.3310);
Little Boulder Creek (48.5569, –120.3847);
Methow River (48.6015, –120.4376);
North Fork Beaver Creek (48.4340, –120.0228);
Wolf Creek (48.4777, –120.2844).
(vii) Lower Methow River Watershed 1702000807.
Outlet(s) = Methow River (Lat 48.0502, Long –119.8942)
Upstream to endpoint(s) in:
Black Canyon Creek (48.0721, –120.0168);
Foggy Dew Creek (48.1869, –120.2344);
Gold Creek (48.2113, –120.2021);
Libby Creek (48.2548, –120.1653);
Methow River (48.2495, –120.1156);

South Fork Gold Creek (48.1468, –120.1650).
(5) Upper Columbia/Entiat Subbasin 17020010—
(i) Entiat River Watershed 1702001001.
Outlet(s) = Entiat River (Lat 47.6585, Long –120.2194)
Upstream to endpoint(s) in:
Entiat River (47.9855, –120.5749);
Mad River (47.8254, –120.5301);
Potato Creek (47.7944, –120.3889);
Roaring Creek (47.6795, –120.4163);
Stormy Creek (47.8246, –120.4125);
Tamarack Creek (47.6699, –120.4041);
Tillicum Creek (47.7295, –120.4303).
(ii) Lake Entiat Watershed 1702001002.
Outlet(s) = Columbia River (Lat 47.3539, Long –120.1105)
Upstream to endpoint(s) in:
Columbia River (47.8077, –119.9754).
(iii) Columbia River/Lynch Coulee Watershed 1702001003.
Outlet(s) = Columbia River (Lat 47.0494, Long –120.0241)
Upstream to endpoint(s) in:
Brushy Creek (47.1316, –120.1493);
Colockum Creek (47.2919, –120.1592);
Columbia River (47.3539, –120.1105);
Lynch Coulee (47.2320, –119.9943);
Quilomene Creek (47.1105, –120.0379);
Tarpiscan Creek (47.2264, –120.0922);
Tekison Creek (47.1816, –120.0206).
(iv) Columbia River/Sand Hollow Watershed 1702001004.
Outlet(s) = Columbia River (Lat 46.8159, Long –119.9255)
Upstream to endpoint(s) in:
Columbia River (47.0494, –120.0241);
Sand Hollow (46.9296, –119.9365);
Whiskey Dick Creek (47.0302, –120.0331).
(6) Wenatchee Subbasin 17020011—
(i) White River Watershed 1702001101.
Outlet(s) = White River (Lat 47.8088, Long –120.7159)
Upstream to endpoint(s) in:
Little Wenatchee River (47.8526, –120.9541);
Napeequa River (47.9359, –120.8712);
Panther Creek (47.9375, –120.9408);
White River (47.9535, –120.9380).
(ii) Chiwawa River Watershed 1702001102.
Outlet(s) = Chiwawa River (Lat 47.7880, Long –120.6589)
Upstream to endpoint(s) in:
Alder Creek (47.8565, –120.6564);
Alpine Creek (48.0823, –120.8683);
Buck Creek (48.1045, –120.8815);

Chikamin Creek (47.9111, –120.7165);
Chiwawa River (48.1140, –120.8775);
Clear Creek (47.8016, –120.6210);
James Creek (48.0748, –120.8598);
Phelps Creek (48.0743, –120.8484);
Unnamed (47.9727, –120.7878).

(iii) Nason/Tumwater Watershed 1702001103.

Outlet(s) = Wenatchee River (Lat 47.5801, Long –120.6660)
Upstream to endpoint(s) in:
Beaver Creek (47.7649, –120.6553);
Chiwaukum Creek (47.7038, –120.7788);
Coulter Creek (47.7594, –120.7969);
Gill Creek (47.7716, –120.8237);
Kahler Creek (47.7691, –120.7558);
Mill Creek (47.7744, –121.0117);
Nason Creek (47.7825, –121.0464);
Roaring Creek (47.7572, –120.8203);
Skinney Creek (47.7247, –120.7370).

(iv) Icicle/Chumstick Watershed 1702001104.

Outlet(s) = Wenatchee River (Lat 47.5575, Long –120.5729)
Upstream to endpoint(s) in:
Chumstick Creek (47.6785, –120.6385);
Derby Canyon (47.6036, –120.5623);
Eagle Creek (47.6342, –120.6261);
Icicle Creek (47.6460, –120.9833);
Wenatchee River (47.5801, –120.6660).

(v) Lower Wenatchee River Watershed 1702001105.

Outlet(s) = Wenatchee River (Lat 47.4553, Long –120.3185)
Upstream to endpoint(s) in:
Brender Creek (47.5214, –120.4844);
Ingalls Creek (47.4612, –120.6776);
King Canyon (47.3522, –120.4423);
Mill Creek (47.5139, –120.6724);
Mission Creek (47.3289, –120.4771);
Peshastin Creek (47.4380, –120.6590);
Sand Creek (47.4321, –120.5307);
Wenatchee River (47.5575, –120.5729).

(7) Lower Crab Subbasin 17020015— Lower Crab Creek Watershed 1702001509.

Outlet(s) = Lower Crab Creek (Lat 46.8159, Long –119.9255)
Upstream to endpoint(s) in:
Hayes Creek (46.8821, –119.2703);
Lower Crab Creek (46.9028, –119.2785);
Unnamed (46.8157, –119.4326);
Unnamed (46.8243, –119.4429);
Unnamed (46.8353, –119.3750);

Unnamed (46.8658, –119.3757);
Unnamed (46.8770, –119.5863).

(8) Upper Columbia/Priest Rapids Subbasin 17020016—

(i) Yakima River/ Hanson Creek Watershed 1702001604.
Outlet(s) = Columbia River (Lat 46.7159, Long –119.5294)
Upstream to endpoint(s) in:
Columbia River (46.8159, –119.9255).

(ii) Middle Columbia/Priest Rapids Watershed 1702001605.
Outlet(s) = Columbia River (Lat 46.5091, Long –119.2661)
Upstream to endpoint(s) in:
Columbia River (46.7159, –119.5294).

(iii) Columbia River/Zintel Canyon Watershed 1702001606.
Outlet(s) = Columbia River (Lat 46.2534, Long –119.2268)
Upstream to endpoint(s) in:
Columbia River (46.5091, –119.2661).

(9) Columbia River Corridor— Columbia River Corridor
Outlet(s) = Columbia River (Lat 46.2485, Long –124.0782)
Upstream to endpoint(s) in:
Columbia River (46.2534, –119.2268).

(R) Snake River Basin Steelhead (Oncorhynchus mykiss). Critical habitat is designated to include the areas defined in the following subbasins:

(1) Hells Canyon Subbasin 17060101—

(i) Snake River/Granite Creek Watershed 1706010101.
Outlet(s) = Snake River (Lat 45.467, Long –116.554)
Upstream to endpoint(s) in:
Battle Creek (45.307, –116.697);
Bernard Creek (45.387, –116.569);
Brush Creek (45.275, –116.657);
Bull Creek (45.329, –116.673);
Deep Creek (45.237, –116.674);
Devils Farm Creek (45.301, –116.611);
Granite Creek (45.277, –116.630);
Hells Canyon (45.254, –116.698);
Lightning Creek (45.440, –116.500);
Little Granite Creek (45.335, –116.636);
North Fork Battle Creek (45.316, –116.687);
Rattlesnake Creek (45.457, –116.610);
Rough Creek (45.397, –116.638);
Rush Creek (45.468, –116.596);
Saddle Creek (45.375, –116.721);
Sheep Creek (45.406, –116.523);
Sluice Creek (45.445, –116.622);
Snake River (45.243, –116.700);
Stud Creek (45.267, –116.693);
Three Creek (45.353, –116.610);

Unnamed (45.468, –116.610);
Unnamed (45.4787, –116.4799);
Wild Sheep Creek (45.326, –116.676).
(ii) Snake River/Getta Creek Watershed 1706010102.
Outlet(s) = Snake River (Lat 45.747, Long –116.543)
Upstream to endpoint(s) in:
Big Canyon Creek (45.689, –116.467);
Corral Creek (45.588, –116.433);
Cove Creek (45.553, –116.574);
Durham Creek (45.595, –116.472);
Getta Creek (45.736, –116.421);
Highrange Creek (45.738, –116.518);
Indian Creek (45.744, –116.449);
Jones Creek (45.703, –116.526);
Kirby Creek (45.575, –116.454);
Kirkwood Creek (45.548, –116.457);
Klopton Creek (45.627, –116.434);
Kurry Creek (45.656, –116.426);
Lookout Creek (45.713, –116.542);
Lost Valley Creek (45.550, –116.482);
Pleasant Valley Creek (45.647, –116.492);
Salt Creek (45.576, –116.554);
SCreek (45.491, –116.574);
Snake River (45.468, –116.554);
Somers Creek (45.645, –116.553);
Temperance Creek (45.537, –116.571);
Tryon Creek (45.694, –116.540);
Two Corral Creek (45.561, –116.526);
Unnamed (45.5817, –116.5098);
West Creek (45.664, –116.453);
West Fork West Creek (45.669, –116.463).
(iii) Snake River/Divide Creek Watershed 1706010104.
Outlet(s) = Snake River (Lat 45.857 Long –116.794)
Upstream to endpoint(s) in:
Divide Creek (45.859, –116.741);
Dry Creek (45.842, –116.598);
Snake River (45.747, –116.543);
Unnamed (45.7599, –116.6456);
Wolf Creek (45.776, –116.567).
(2) Imnaha River Subbasin 17060102—
(i) Upper Imnaha River Watershed 1706010201.
Outlet(s) = Imnaha River (Lat 45.232, Long –116.844)
Upstream to endpoint(s) in:
Crazyman Creek (45.190, –116.811);
Dry Creek (45.123, –116.867);
Gumboot Creek (45.147, –116.968);

Mahogany Creek (45.201, –116.905);
North Fork Dry Creek (45.143, –116.850);
North Fork Gumboot Creek (45.184, –116.928);
North Fork Imnaha River (45.118, –117.129);
Skookum Creek (45.117, –116.938);
South Fork Imnaha River (45.111, –117.230);
Unnamed (45.188, –116.923);
Unnamed (45.208, –116.890).

(ii) Middle Imnaha River Watershed 1706010202.
Outlet(s) = Imnaha River (Lat 45.557, Long –116.834)
Upstream to endpoint(s) in:
Freezeout Creek (45.352, –116.761);
Grouse Creek (45.179, –116.976);
Imnaha River (45.232, –116.844);
Morgan Creek (45.261, –116.948);
Rich Creek (45.243, –116.869);
Road Creek (45.279, –116.932);
Shadow Canyon (45.295, –116.860);
Summit Creek (45.228, –116.793);
Unnamed (45.203, –116.978);
Unnamed (45.203, –116.943);
Unnamed (45.250, –116.923).

(iii) Big Sheep Creek Watershed 1706010203.
Outlet(s) = Big Sheep Creek (Lat 45.520, Long –116.859)
Upstream to endpoint(s) in:
Big Sheep Creek (45.171, –117.086);
Carrol Creek (45.240, –117.063);
Griffith Creek (45.273, –117.061);
Lick Creek (45.133, –117.056);
Marr Creek (45.299, –116.949);
North Fork Carrol Creek (45.295, –116.993);
South Fork Squaw Creek (45.354, –116.872);
Tyee Creek (45.188, –116.991);
Unnamed (45.164, –117.023);
Unnamed (45.239, –117.045);
Unnamed (45.297, –116.940).

(iv) Little Sheep Creek Watershed 1706010204.
Outlet(s) = Big Sheep Creek (Lat 45.557, Long –116.834)
Upstream to endpoint(s) in:
Bear Gulch (45.379, –116.955);
Big Sheep Creek (45.520, –116.859);
Camp Creek (45.544, –116.959);
Canal Creek (45.256, –117.103);
Devils Gulch (45.428, –116.962);
Downey Gulch (45.405, –116.958);
Ferguson Creek (45.267, –117.106);

Lightning Creek (45.475, –117.020);
Little Sheep Creek (45.236, –117.083);
McCully Creek (45.295, –117.107);
Redmont Creek (45.250, –117.099);
South Fork Lightning Creek (45.473, –117.019);
Summit Creek (45.390, –116.930);
Threebuck Creek (45.395, –117.012);
Trail Creek (45.563, –116.898).

(v) Lower Imnaha River Watershed 1706010205.

Outlet(s) = Imnaha River (Lat 45.817, Long –116.764)

Upstream to endpoint(s) in:

Corral Creek (45.708, –116.815);
Cottonwood Creek (45.659, –116.865);
Cow Creek (45.573, –116.628);
Dodson Fork (45.725, –116.821);
East Fork Fence Creek (45.652, –116.855);
Fence Creek (45.655, –116.875);
Horse Creek (45.421, –116.725);
Imnaha River (45.557, –116.834);
Lightning Creek (45.447, –116.682);
Prong (45.589, –116.592);
Pumpkin Creek (45.517, –116.758);
Sleepy Creek (45.604, –116.666);
Stubblefield Fork (45.711, –116.815);
Tulley Creek (45.743, –116.766).

(3) Lower Snake/Asotin Subbasin 17060103—

(i) Snake River/Rogersburg Watershed 1706010301.

Outlet(s) = Snake River (Lat 46.080, Long –116.978)

Upstream to endpoint(s) in:

Cache Creek (45.976, –116.928);
Cave Gulch (46.023, –116.840);
Cook Creek (45.901, –116.865);
Corral Creek (46.055, –116.875);
Cottonwood Creek (45.944, –116.860);
Garden Creek (45.972, –116.903);
Snake River (45.857, –116.794).

(ii) Asotin River Watershed 1706010302.

Outlet(s) = Asotin Creek (Lat 46.345, Long –117.053)

Upstream to endpoint(s) in:

Ayers Gulch (46.278, –117.094);
Charley Creek (46.271, –117.460);
Coombs Canyon (46.128, –117.276);
George Creek (46.144, –117.303);
Hefflefinger Gulch (46.151, –117.231);
Huber Gulch (46.155, –117.188);
Kelly Creek (46.251, –117.114);

Lick Creek (46.260, –117.358);
Middle Branch North Fork Asotin Creek (46.195, –117.439);
Nims Gulch (46.178, –117.121);
North Fork Asotin Creek (46.207, –117.478);
Pintler Creek (46.194, –117.153);
South Fork Asotin Creek (46.174, –117.341);
South Fork North Fork Asotin Creek (46.192, –117.425).

(iii) Snake River/Captain John Creek Watershed 1706010303.

Outlet(s) = Snake River (Lat 46.428, Long –117.038)

Upstream to endpoint(s) in:

Captain John Creek (46.145, –116.821);
Couse Creek (46.157, –117.032);
Edeburn Gulch (46.142, –117.008);
Mill Creek (46.157, –117.078);
Redbird Creek (46.220, –116.898);
Snake River (46.080, –116.978);
South Fork Captain John Creek (46.123, –116.864);
Tammany Creek (46.362, –117.052);
Tenmile Canyon (46.284, –116.976);
Tenmile Creek (46.123, –117.086);
Unnamed (46.119, –117.100);
Unnamed (46.124, –117.111).

(4) Upper Grande Ronde River Subbasin 17060104—

(i) Upper Grande Ronde River Watershed 1706010401.

Outlet(s) = Grande Ronde River (Lat 45.264, Long –118.376)

Upstream to endpoint(s) in:

Chicken Creek (44.987, –118.378);
Clear Creek (45.014, –118.329);
Dry Creek (45.052, –118.380);
East Fork Grande Ronde River (45.060, –118.237);
East Sheep Creek (44.987, –118.425);
Fly Creek (45.125, –118.596);
Grande Ronde River (44.998, –118.273);
Limber Jim Creek (45.107, –118.270);
Little Clear Creek (45.038, –118.300);
Little Fly Creek (45.062, –118.504);
Lookout Creek (45.065, –118.543);
Muir Creek (45.066, –118.297);
North Fork Limber Jim Creek (45.125, –118.308);
Sheep Creek (45.016, –118.507);
South Fork Limber Jim Creek (45.088, –118.304);
Squaw Creek (45.103, –118.554);
Umapine Creek (45.116, –118.571);
Unnamed (45.042, –118.269);
Unnamed (45.045, –118.417);

West Chicken Creek (45.025, –118.404);
Winter Canyon (45.215, –118.361).
(ii) Meadow Creek Watershed 1706010402.
Outlet(s) = Meadow Creek (Lat 45.264, Long –118.376)
Upstream to endpoint(s) in:
Battle Creek (45.216, –118.507);
Bear Creek (45.210, –118.577);
Burnt Corral Creek (45.159, –118.524);
Dark Canyon (45.382, –118.394);
East Burnt Corral Creek (45.173, –118.498);
Ensign Creek (45.361, –118.554);
Little Dark Canyon (45.322, –118.418);
Marley Creek (45.177, –118.476);
McCoy Creek (45.322, –118.628);
McIntyre Creek (45.345, –118.459);
Meadow Creek (45.286, –118.716);
Peet Creek (45.233, –118.611);
Smith Creek (45.295, –118.594);
Sullivan Gulch (45.200, –118.515);
Syrup Creek (45.296, –118.543);
Tybow Canyon (45.214, –118.467);
Unnamed (45.206, –118.552);
Unnamed (45.275, –118.695);
Unnamed (45.295, –118.718);
Unnamed (45.330, –118.551);
Waucup Creek (45.243, –118.660).
(iii) Grande Ronde River/Beaver Creek Watershed 1706010403.
Outlet(s) = Grande Ronde River (Lat 45.347, Long –118.221)
Upstream to endpoint(s) in:
Bear Creek (45.283, –118.270);
Beaver Creek (45.146, –118.206);
Dry Beaver Creek (45.168, –118.316);
East Fork Rock Creek (45.166, –118.111);
Grande Ronde River (45.264, –118.376);
Graves Creek (45.245, –118.161);
Hoodoo Creek (45.154, –118.259);
Jordan Creek (45.162, –118.187);
Little Beaver Creek (45.185, –118.333);
Little Whiskey Creek (45.209, –118.178);
Rock Creek (45.172, –118.139);
Sheep Creek (45.281, –118.130);
South Fork Spring Creek (45.346, –118.363);
Spring Creek (45.396, –118.372);
Unnamed (45.167, –118.144);
Unnamed (45.227, –118.262);
Unnamed (45.231, –118.279);

Unnamed (45.232, –118.091);
Unnamed (45.240, –118.257);
Watermelon Creek (45.195, –118.277);
Whiskey Creek (45.198, –118.181).

(iv) Grande Ronde River/Five Points Creek Watershed 1706010404.
Outlet(s) = Grande Ronde River (Lat 45.408, Long –117.930)
Upstream to endpoint(s) in:
California Gulch (45.406, –118.335);
Conley Creek (45.406, –118.084);
Dobbin Ditch (45.377, –118.017);
Dry Creek (45.426, –118.379);
Fiddlers Hell (45.443, –118.145);
Five Points Creek (45.482, –118.143);
Grande Ronde River (45.347, –118.221);
Little John Day Creek (45.430, –118.192);
Middle Fork Five Points Creek (45.485, –118.129);
Mt Emily Creek (45.465, –118.125);
Pelican Creek (45.438, –118.318);
Tie Creek (45.420, –118.129);
Unnamed (45.385, –118.043);
Unnamed (45.423, –118.243).

(v) Catherine Creek Watershed 1706010405.
Outlet(s) = Catherine Creek (Lat 45.219, Long –117.915)
Upstream to endpoint(s) in:
Buck Creek (45.132, –117.606);
Camp Creek (45.100, –117.596);
Collins Creek (45.100, –117.531);
Corral Creek (45.113, –117.575);
Little Catherine Creek (45.148, –117.716);
Middle Fork Catherine Creek (45.155, –117.567);
Milk Creek (45.092, –117.717);
North Fork Catherine Creek (45.221, –117.610);
Pole Creek (45.123, –117.544);
Prong Creek (45.096, –117.565);
SPass Creek (45.115, –117.528);
Scout Creek (45.105, –117.644);
South Fork Catherine Creek (45.116, –117.503);
Unnamed (45.104, –117.685).

(vi) Ladd Creek Watershed 1706010406.
Outlet(s) = Ladd Creek (Lat 45.282, Long –117.936)
Upstream to endpoint(s) in:
Catherine Creek (45.219, –117.915);
Ladd Creek (45.215, –118.024);
Little Creek (45.210, –117.784);
Mill Creek (45.263, –118.083);
Unnamed (45.259, –118.039).

(vii) Grande Ronde River/Mill Creek Watershed 1706010407.
  Outlet(s) = Grande Ronde River (Lat 45.408, Long –117.930)
  Upstream to endpoint(s) in:
    Catherine Creek (45.282, –117.936);
    McAlister Slough (45.315, –117.973);
    Mill Creek (45.278, –117.728);
    Unnamed (45.297, –117.806).
(viii) Phillips Creek/Willow Creek Watershed 1706010408.
  Outlet(s) = Willow Creek (Lat 45.492, Long –117.931)
  Upstream to endpoint(s) in:
    Dry Creek (45.640, –118.114);
    End Creek (45.4622, –118.0316);
    Finley Creek (45.625, –118.099);
    Fir Creek (45.5171, –118.0568);
    Little Dry Creek (45.5348, –118.0393);
    McDonald Creek (45.5348, –118.0393);
    Mill Creek (45.568, –118.025);
    Slide Creek (45.422, –118.028);
    Smith Creek (45.5256, –118.0537);
    Unnamed (45.525, –118.014).
(ix) Grande Ronde River/Indian Creek Watershed 1706010409.
  Outlet(s) = Grande Ronde River (Lat 45.560, Long –117.910)
  Upstream to endpoint(s) in:
    Camp Creek (45.386, –117.720);
    Clark Creek (45.409, –117.728);
    East Fork Indian Creek (45.363, –117.737);
    Grande Ronde River (45.408, –117.930);
    Indian Creek (45.332, –117.717);
    Little Indian Creek (45.375, –117.785);
    Middle Fork Clark Creek (45.462, –117.764);
    North Fork Clark Creek (45.502, –117.733);
    North Fork Indian Creek (45.419, –117.787);
    Unnamed (45.375, –117.739);
    Unnamed (45.476, –117.757).
(x) Lookingglass Creek Watershed 1706010410.
  Outlet(s) = Lookingglass Creek (Lat 45.707, Long –117.841)
  Upstream to endpoint(s) in:
    Buzzard Creek (45.845, –117.939);
    Eagle Creek (45.723, –118.005);
    Jarboe Creek (45.776, –117.855);
    Little Lookingglass Creek (45.848, –117.901);
    Lookingglass Creek (45.777, –118.070);
    Mottet Creek (45.827, –117.958);
    Unnamed (45.835, –117.869);
    Unnamed (45.844, –117.893).
(xi) Grande Ronde River/Cabin Creek Watershed 1706010411.

Outlet(s) = Grande Ronde River (Lat 45.726, Long –117.784)
Upstream to endpoint(s) in:
Buck Creek (45.662, –117.919);
Duncan Canyon (45.654, –117.776);
East Phillips Creek (45.669, –118.066);
Gordon Creek (45.665, –118.001);
Grande Ronde River (45.560, –117.910);
Little Phillips Creek (45.668, –118.036);
North Fork Cabin Creek (45.721, –117.929);
Pedro Creek (45.676, –118.051);
Phillips Creek (45.666, –118.089);
Rysdam Canyon (45.633, –117.812);
South Fork Cabin Creek (45.698, –117.963);
Unnamed (45.661, –117.930);
Unnamed (45.672, –117.941);
Unnamed (45.682, –117.974);
Unnamed (45.695, –117.927);
Unnamed (45.707, –117.916).
(5) Wallowa River Subbasin 17060105—
(i) Upper Wallowa River Watershed 1706010501.
Outlet(s) = Wallowa River (Lat 45.427, Long –117.310)
Upstream to endpoint(s) in:
Hurricane Creek (45.337, –117.291);
Little Hurricane Creek (45.407, –117.276);
Prairie Creek (45.394, –117.189);
Spring Creek (45.406, –117.287);
Trout Creek (45.455, –117.281);
Unnamed (45.387, –117.215);
Unnamed (45.392, –117.214);
Unnamed (45.411, –117.264);
Unnamed (45.412, –117.156);
Unnamed (45.424, –117.313);
Wallowa River (45.335, –117.222).
(ii) Lostine River Watershed 1706010502.
Outlet(s) = Lostine River (Lat 45.552, Long –117.489)
Upstream to endpoint(s) in:
Lostine River (45.245, –117.375);
Silver Creek (45.394, –117.420).
(iii) Middle Wallowa River Watershed 1706010503.
Outlet(s) = Wallowa River (Lat 45.584, Long –117.540)
Upstream to endpoint(s) in:
Middle Fork Whisky Creek (45.590, –117.342);
North Fork Whisky Creek (45.614, –117.331);
Parsnip Creek (45.533, –117.419);
South Fork Whisky Creek (45.590, –117.413);
Straight Whisky Creek (45.622, –117.396);

Wallowa River (45.427, –117.310);
Whisky Creek (45.608, –117.397).
(iv) Bear Creek Watershed 1706010504.
Outlet(s) = Bear Creek (Lat 45.584, Long –117.540)
Upstream to endpoint(s) in:
Bear Creek (45.347,–117.500);
Doc Creek (45.449, –117.572);
Fox Creek (45.447, –117.562);
Goat Creek (45.413, –117.519);
Little Bear Creek (45.456, –117.500).
(v) Minam River Watershed 1706010505.
Outlet(s) = Minam River (Lat 45.621, Long –117.720)
Upstream to endpoint(s) in:
Cougar Creek (45.517, –117.672);
Elk Creek (45.157, –117.480);
Little Minam River (45.338, –117.643);
Minam River (45.149, –117.392);
Murphy Creek (45.414, –117.644);
North Minam River (45.275, –117.520);
Patrick Creek (45.426, –117.645);
Squaw Creek (45.576, –117.706);
Trout Creek (45.471, –117.652).
(vi) Lower Wallowa River Watershed 1706010506.
Outlet(s) = Wallowa River (Lat 45.726, Long –117.784)
Upstream to endpoint(s) in:
Deer Creek (45.452, –117.606);
Dry Creek (45.650, –117.439);
Fisher Creek (45.666, –117.750);
Howard Creek (45.735, –117.695);
Reagin Gulch (45.670, –117.559);
Rock Creek (45.679, –117.620);
Sage Creek (45.486, –117.590);
Tamarack Canyon (45.656, –117.518);
Unnamed (45.618, –117.629);
Unnamed (45.654, –117.442);
Unnamed (45.678, –117.556);
Wallowa River (45.584, –117.540);
Water Canyon (45.589, –117.614);
Wise Creek (45.671, –117.705).
(6) Lower Grande Ronde Subbasin 17060106—
(i) Grande Ronde River/ Rondowa Watershed 1706010601.
Outlet(s) = Grande Ronde River (Lat 45.896, Long –117.493)
Upstream to endpoint(s) in:
Alder Creek (45.844, –117.750);
Bear Creek (45.885, –117.752);
Clear Creek (45.775, –117.714);

Deep Creek (45.817, –117.651);
East Grossman Creek (45.819, –117.625);
Elbow Creek (45.927, –117.630);
Grande Ronde River (45.726, –117.784);
Grossman Creek (45.732, –117.614);
Meadow Creek (45.825, –117.760);
Sheep Creek (45.756, –117.797);
Sickfoot Creek (45.842, –117.567);
Unnamed (45.746, –117.656).

(ii) Grande Ronde River/Mud Creek Watershed 1706010602.

Outlet(s) = Grande Ronde River (Lat 45.946, Long –117.450)
Upstream to endpoint(s) in:
Bishop Creek (45.747, –117.555);
Bobcat Creek (45.853, –117.370);
Buck Creek (45.758, –117.298);
Burnt Creek (45.769, –117.283);
Courtney Creek (45.857, –117.314);
Grande Ronde River (45.896, –117.493);
Little Courtney Canyon (45.903, –117.385);
McAllister Creek (45.683, –117.361);
McCubbin Creek (45.700, –117.294);
Mud Creek (45.633, –117.291);
Unnamed (45.867, –117.329);
Shamrock Creek (45.828, –117.335);
Simmons Draw (45.730, –117.514);
Sled Creek (45.730, –117.278);
Teepee Creek (45.694, –117.349);
Tope Creek (45.634, –117.330);
Unnamed (45.710, –117.283);
Unnamed (45.856, –117.312);
Wallupa Creek (45.765, –117.528);
Wildcat Creek (45.732, –117.489).

(iii) Wenaha River Watershed 1706010603.

Outlet(s) = Wenaha River (Lat 45.946, Long –117.450)
Upstream to endpoint(s) in:
Beaver Creek (46.002, –117.815);
Crooked Creek (46.046, –117.624);
First Creek (46.071, –117.519);
Melton Creek (46.060, –117.566);
Milk Creek (45.973, –117.902);
North Fork Wenaha River (46.064, –117.912);
Rock Creek (45.999, –117.766);
Second Creek (46.065, –117.595);
Slick Ear Creek (45.983, –117.784);
South Fork Wenaha River (45.872, –117.897);
Third Creek (46.089, –117.627);

Weller Creek (45.989, –117.648);
West Fork Butte Creek (46.064, –117.759).
(iv) Chesnimnus Creek Watershed 1706010604.
Outlet(s) = Chesnimnus Creek (Lat 45.715, Long –117.155)
Upstream to endpoint(s) in:
Alder Creek (45.702, –116.997);
Billy Creek (45.815, –117.032);
Butte Creek (45.641, –117.096);
Chesnimnus Creek (45.718, –116.906);
Deadman Gulch (45.659, –117.049);
Devils Run Creek (45.775, –116.882);
Doe Creek (45.751, –117.029);
Dry Salmon Creek (45.663, –117.051);
East Fork Peavine Creek (45.830, –117.061);
Gooseberry Creek (45.681, –117.110);
McCarty Gulch (45.749, –117.064);
Peavine Creek (45.795, –117.084);
Pine Creek (45.673, –117.029);
Poison Creek (45.791, –116.979);
Salmon Creek (45.662, –117.038);
South Fork Chesnimnus Creek (45.743, –116.861);
Sterling Gulch (45.712, –117.000);
Summit Creek (45.794, –116.947);
Telephone Gulch (45.767, –117.076);
TNT Gulch (45.754, –116.919);
Unnamed (45.694, –117.013);
Unnamed (45.709, –116.878);
Unnamed (45.724, –116.867);
Unnamed (45.742, –117.090);
Unnamed (45.825, –117.004);
Unnamed (45.838, –117.009);
Unnamed (45.846, –117.029);
West Fork Peavine Creek (45.805, –117.100).
(v) Upper Joseph Creek Watershed 1706010605.
Outlet(s) = Joseph Creek (Lat 45.823, Long –117.231)
Upstream to endpoint(s) in:
Alford Gulch (45.729, –117.165);
Cougar Creek (45.806, –117.150);
Crow Creek (45.536, –117.115);
Davis Creek (45.658, –117.257);
Elk Creek (45.598, –117.167);
Gould Gulch (45.657, –117.181);
Little Elk Creek (45.694, –117.199);
Sumac Creek (45.753, –117.148);
Swamp Creek (45.543, –117.218);
Unnamed (45.597, –117.141).

(vi) Lower Joseph Creek Watershed 1706010606.
Outlet(s) = Joseph Creek (Lat 46.053, Long –117.005)
Upstream to endpoint(s) in:
Basin Creek (45.910, –117.057);
Broady Creek (45.882, –117.076);
Cottonwood Creek (45.832, –116.950);
Horse Creek (45.945, –116.962);
Joseph Creek (45.823, –117.231);
Peavine Creek (45.879, –117.162);
Rush Creek (45.899, –117.150);
Tamarack Creek (45.964, –117.127);
Unnamed (45.826, –116.957);
West Fork Broady Creek (45.862, –117.102).
(vii) Lower Grande Ronde River/ Menatchee Creek Watershed 1706010607.
Outlet(s) = Grande Ronde River (Lat 46.080, Long –116.978)
Upstream to endpoint(s) in:
Bear Creek (45.973, –117.455);
Buford Creek (45.975, –117.276);
Cottonwood Creek (46.071, –117.301);
Cougar Creek (46.049, –117.327);
Deer Creek (45.992, –117.191);
East Bear Creek (45.960, –117.307);
Grande Ronde River (45.946, –117.450);
Grouse Creek (46.031, –117.460);
Menatchee Creek (46.018, –117.371);
Rattlesnake Creek (46.079, –117.204);
Shumaker Creek (46.049, –117.117);
West Bear Creek (45.951, –117.337);
West Branch Rattlesnake Creek (46.086, –117.258).
(7) Lower Snake/Tucannon Subbasin 17060107—
(i) Alpowa Creek Watershed 1706010701.
Outlet(s) = Alpowa Creek (Lat 46.422, Long –117.203)
Upstream to endpoint(s) in:
Kidwell Gulch (46.338, –117.480);
Page Creek (46.402, –117.210);
Pow Wah Kee Creek (46.389, –117.288).
(ii) Snake River/Steptoe Canyon Watershed 1706010702.
Outlet(s) = Snake River (Lat 46.660, Long –117.433)
Upstream to endpoint(s) in:
Offield Canyon (46.648, –117.420);
Snake River (46.428, –117.038);
Steptoe Canyon (46.455, –117.192);
Truax Canyon (46.565, –117.348);
Wawawai Canyon (46.636, –117.375).
(iii) Deadman Creek Watershed 1706010703.

Outlet(s) = Deadman Creek (Lat 46.626, Long –117.799)
Upstream to endpoint(s) in:
Deadman Gulch (46.574, –117.565);
Lynn Gulch (46.628, –117.597);
North Deadman Creek (46.578, –117.457);
North Meadow Creek (46.517, –117.489);
South Meadow Creek (46.507, –117.508).

(iv) Upper Tucannon River Watershed 1706010706.
Outlet(s) = Tucannon River (Lat 46.509, Long –117.995)
Upstream to endpoint(s) in:
Cummings Creek (46.235, –117.610);
Little Tucannon River (46.221, –117.758);
Meadow Creek (46.163, –117.728);
Panjab Creek (46.171, –117.709);
Sheep Creek (46.196, –117.623);
Tucannon River (46.168, –117.559);
Tumalum Creek (46.315, –117.585).

(v) Lower Tucannon River Watershed 1706010707.
Outlet(s) = Tucannon River (Lat 46.558, Long –118.174)
Upstream to endpoint(s) in:
Kellogg Creek (46.430, –118.067);
Smith Hollow (46.463, –118.017);
Tucannon River (46.509, –117.995).

(vi) Snake River/Penawawa Creek Watershed 1706010708.
Outlet(s) = Snake River (Lat 46.589, Long –118.215)
Upstream to endpoint(s) in:
Almota Creek (46.706, –117.363);
Little Almota Creek (46.715, –117.465);
Penawawa Creek (46.728, –117.625);
Snake River (46.660, –117.433);
Unnamed (46.698, –117.381).

(8) Upper Salmon Subbasin 17060201—

(i) Salmon River/Challis Watershed 1706020101.
Outlet(s) = Salmon River (Lat 44.692, Long –114.049)
Upstream to endpoint(s) in:
Challis Creek (44.563, –114.246);
Salmon River (44.470, –114.192).

(ii) Salmon River/Bayhorse Creek Watershed 1706020104.
Outlet(s) = Salmon River (Lat 44.470, Long –114.192)
Upstream to endpoint(s) in:
Bayhorse Creek (44.395, –114.308);
Salmon River (44.268, –114.326).

(iii) East Fork Salmon River/ McDonald Creek Watershed 1706020105.
Outlet(s) = East Fork Salmon River (Lat 44.268, Long –114.326)
Upstream to endpoint(s) in:
Big Lake Creek (44.165, –114.394);

East Fork Salmon River (44.147, –114.378);
McDonald Creek (44.091, –114.318);
Pine Creek (44.136, –114.367).
(iv) Herd Creek Watershed 1706020108.
Outlet(s) = Herd Creek (Lat 44.154, Long –114.300)
Upstream to endpoint(s) in:
East Fork Herd Creek (44.037, –114.203);
East Pass Creek (44.009, –114.369);
Lake Creek (44.103, –114.194);
Taylor Creek (44.067, –114.317);
West Fork Herd Creek (44.032, –114.248).
(v) East Fork Salmon River/Big Boulder Creek Watershed 1706020109.
Outlet(s) = East Fork Salmon River (Lat 44.147, Long –114.378)
Upstream to endpoint(s) in:
Big Boulder Creek (44.131, –114.518);
East Fork Salmon River (44.039, –114.461);
Little Boulder Creek (44.065, –114.542).
(vi) Upper East Fork Salmon River Watershed 1706020110.
Outlet(s) = East Fork Salmon River (Lat 44.039, Long –114.461)
Upstream to endpoint(s) in:
Bowery Creek (44.0316, –114.4587);
South Fork East Fork Salmon River (43.902, –114.562);
West Fork East Fork Salmon River (43.929, –114.575);
West Pass Creek (43.922, –114.446).
(vii) Germania Creek Watershed 1706020111.
Outlet(s) = Germania Creek (Lat 44.039, Long –114.461)
Upstream to endpoint(s) in:
Germania Creek (44.003, –114.532).
(viii) Salmon River/Kinnikinic Creek Watershed 1706020112.
Outlet(s) = Salmon River (Lat 44.268, Long –114.326)
Upstream to endpoint(s) in:
Kinnikinic Creek (44.2667, –144.4026);
Salmon River (44.249, –114.454).
(ix) Salmon River/Slate Creek Watershed 1706020113.
Outlet(s) = Salmon River (Lat 44.249, Long –114.454)
Upstream to endpoint(s) in:
Holman Creek (44.250, –114.529);
Salmon River (44.254, –114.675);
Silver Rule Creek (44.198, –114.588);
Slate Creek (44.168, –114.626);
Thompson Creek (44.318, –114.588).
(x) Warm Springs Creek Watershed 1706020114.
Outlet(s) = Warm Springs Creek (Lat 44.254, Long –114.675)
Upstream to endpoint(s) in:
Warm Springs Creek (44.151, –114.718).
(xi) Salmon River/Big Casino Creek Watershed 1706020115.

Outlet(s) = Salmon River (Lat 44.254, Long –114.675)
Upstream to endpoint(s) in:
Big Casino Creek (44.216, –114.830);
Little Casino Creek (44.224, –114.861);
Lower Harden Creek (44.274, –114.778);
Nip Tuck Creek (44.234, –114.929);
Salmon River (44.169, –114.898);
Upper Harden Creek (44.272, –114.791).

(xii) Salmon River/Fisher Creek Watershed 1706020117.
Outlet(s) = Salmon River (Lat 44.169, Long –114.898)
Upstream to endpoint(s) in:
Decker Creek (44.072, –114.879);
Gold Creek (44.114, –114.846);
Huckleberry Creek (44.061, –114.875);
Salmon River (44.032, –114.836);
Williams Creek (44.096, –114.852).

(xiii) Salmon River/Fourth of July Creek Watershed 1706020118.
Outlet(s) = Salmon River (Lat 44.032, Long –114.836)
Upstream to endpoint(s) in:
Champion Creek (44.019, –114.825);
Fourth of July Creek (44.035, –114.784);
Hell Roaring Creek (44.0268, –114.9252);
Salmon River (44.004, –114.836);
Unnamed (44.017, –114.879).

(xiv) Upper Salmon River Watershed 1706020119.
Outlet(s) = Salmon River (Lat 44.004, Long –114.836)
Upstream to endpoint(s) in:
Beaver Creek (43.919, –114.813);
Camp Creek (43.876, –114.738);
Frenchman Creek (43.822, –114.792);
Pole Creek (43.940, –114.686);
Salmon River (43.837, –114.759);
Smiley Creek (43.829, –114.823);
Twin Creek (43.935, –114.723);
Unnamed (43.843, –114.742);
Unnamed (43.990, –114.803).

(xv) Alturas Lake Creek Watershed 1706020120.
Outlet(s) = Alturas Lake Creek (Lat 44.004, Long –114.836)
Upstream to endpoint(s) in:
Alpine Creek (43.905, –114.923);
Alturas Lake Creek (43.895, –114.910);
Cabin Creek (43.937, –114.856);
Pettit Lake Creek (43.961, –114.916);
Unnamed (43.952, –114.858);
Vat Creek (43.967, –114.871);
Yellowbelly Creek (43.995, –114.847).

(xvi) Redfish Lake Creek Watershed 1706020121.
    Outlet(s) = Redfish Lake Creek (Lat 44.169, Long –114.898)
    Upstream to endpoint(s) in:
        Fishhook Creek (44.137, –114.966);
        Redfish Lake Creek (44.097, –114.959).
(xvii) Valley Creek/Iron Creek Watershed 1706020122.
    Outlet(s) = Valley Creek (Lat 44.225, Long –114.927)
    Upstream to endpoint(s) in:
        Crooked Creek (44.214, –115.034);
        Goat Creek (44.179, –115.008);
        Iron Creek (44.191, –115.025);
        Job Creek (44.242, –115.027);
        Meadow Creek (44.190, –114.961);
        Park Creek (44.281, –115.036);
        Stanley Creek (44.276, –114.938);
        Valley Creek (44.291, –115.018).
(xviii) Upper Valley Creek Watershed 1706020123.
    Outlet(s) = Valley Creek (Lat 44.291, Long –115.018);
        Stanley Lake Creek (44.2535, –115.0040)
    Upstream to endpoint(s) in:
        East Fork Valley Creek (44.347, –114.999);
        Elk Creek (44.227, –115.145);
        Hanna Creek (44.314, –115.041);
        Meadow Creek (44.291, –115.119);
        Stanley Lake Creek (44.248, –115.045);
        Trap Creek (44.311, –115.121);
        Valley Creek (44.392, –114.980).
(xix) Basin Creek Watershed 1706020124.
    Outlet(s) = Basin Creek (Lat 44.264, Long –114.817)
    Upstream to endpoint(s) in:
        Basin Creek (44.361, –114.902);
        East Basin Creek (44.314, –114.823).
(xx) Yankee Fork/Jordan Creek Watershed 1706020125.
    Outlet(s) = Yankee Fork (Lat 44.270, Long –114.734)
    Upstream to endpoint(s) in:
        Eightmile Creek (44.448, –114.639);
        Fivemile Creek (44.355, –114.615);
        Jordan Creek (44.457, –114.752);
        Ramey Creek (44.355, –114.641);
        Sevenmile Creek (44.423, –114.608);
        Sixmile Creek (44.394, –114.585);
        Yankee Fork (44.426, –114.619).
(xxi) West Fork Yankee Fork Watershed 1706020126.
    Outlet(s) = West Fork Yankee Fork (Lat 44.351, Long –114.727)
    Upstream to endpoint(s) in:
        Cabin Creek (44.428, –114.881);

        - Deadwood Creek (44.356, –114.834);
        - Lightning Creek (44.466, –114.787);
        - Sawmill Creek (44.341, –114.765);
        - West Fork Yankee Fork (44.386, –114.919).
- (xxii) Upper Yankee Fork Watershed 1706020127.
    - Outlet(s) = Yankee Fork (Lat 44.426, Long –114.619)
    - Upstream to endpoint(s) in:
        - Elevenmile Creek (44.436, –114.544);
        - McKay Creek (44.475, –114.491);
        - Ninemile Creek (44.439, –114.590);
        - Tenmile Creek (44.484, –114.646);
        - Twelvemile Creek (44.497, –114.614);
        - Yankee Fork (44.510, –114.588).
- (xxiii) Squaw Creek Watershed 1706020128.
    - Outlet(s) = Squaw Creek (Lat 44.249, Long –114.454)
    - Upstream to endpoint(s) in:
        - Cash Creek (44.353, –114.473);
        - Cinnabar Creek (44.359, –114.503);
        - Squaw Creek (44.420, –114.489).
- (xxiv) Garden Creek Watershed 1706020129.
    - Outlet(s) = Garden Creek (Lat 44.511, Long –114.203)
    - Upstream to endpoint(s) in:
        - Garden Creek (44.468, –114.325).
- (xxv) Challis Creek/Mill Creek Watershed 1706020130.
    - Outlet(s) = Challis Creek (Lat 44.563, Long –114.246)
    - Upstream to endpoint(s) in:
        - Challis Creek (44.573, –114.309);
        - Darling Creek (44.572, –114.252).
- (xxvi) Morgan Creek Watershed 1706020132.
    - Outlet(s) = Morgan Creek (Lat 44.612, Long –114.168)
    - Upstream to endpoint(s) in:
        - Blowfly Creek (44.714, –114.326);
        - Corral Creek (44.8045, –114.2239);
        - Lick Creek (44.7371, –114.2948);
        - Morgan Creek (44.8029, –114.2561);
        - Van Horn Creek (44.7614, –114.2680);
        - West Fork Morgan Creek (44.710, –114.335).

(9) Pahsimeroi Subbasin 17060202—

- (i) Lower Pahsimeroi River Watershed 1706020201.
    - Outlet(s) = Pahsimeroi River (Lat 44.692, Long –114.049)
    - Upstream to endpoint(s) in:
        - Pahsimeroi River (44.559, –113.900);
        - Patterson Creek (44.561, –113.897).
- (ii) Paterson Creek Watershed 1706020203.
    - Outlet(s) = Patterson Creek (Lat 44.534, Long –113.837)
    - Upstream to endpoint(s) in:

Patterson Creek (44.566, –113.670).

(10) Middle Salmon-Panther Subbasin 17060203—

(i) Salmon River/Colson Creek Watershed 1706020301.

Outlet(s) = Salmon River (Lat 45.297, Long –114.591)

Upstream to endpoint(s) in:

Colson Creek (45.307, –114.531);
Owl Creek (45.340, –114.462);
Salmon River (45.316, –114.405).

(ii) Owl Creek Watershed 1706020302.

Outlet(s) = Owl Creek (Lat 45.340, Long –114.462)

Upstream to endpoint(s) in:

East Fork Owl Creek (45.367, –114.430);
Owl Creek (45.382, –114.469).

(iii) Salmon River/Pine Creek Watershed 1706020303.

Outlet(s) = Salmon River (Lat 45.316, Long –114.405)

Upstream to endpoint(s) in:

Boulder Creek (45.385, –114.297);
Pine Creek (45.307, –114.186);
Salmon River (45.399, –114.168);
Spring Creek (45.421, –114.278);
Squaw Creek (45.449, –114.215).

(iv) Indian Creek Watershed 1706020304.

Outlet(s) = Indian Creek (Lat 45.400, Long –114.167)

Upstream to endpoint(s) in:

Indian Creek (45.523, –114.151);
McConn Creek (45.519, –114.185);
West Fork Indian Creek (45.481, –114.168).

(v) Salmon River/Moose Creek Watershed 1706020305.

Outlet(s) = Salmon River (Lat 45.399, Long –114.168)

Upstream to endpoint(s) in:

Dump Creek (45.369, –114.035);
Fourth of July Creek (45.417, –113.857);
Little Fourth of July Creek (45.396, –113.912);
Moose Creek (45.346, –114.080);
Salmon River (45.320, –113.909);
Wagonhammer Creek (45.395, –113.945).

(vi) North Fork Salmon River Watershed 1706020306.

Outlet(s) = North Fork Salmon River (Lat 45.405, Long –113.994)

Upstream to endpoint(s) in:

Anderson Creek (45.577, –113.918);
Dahlonega Creek (45.559, –113.845);
Ditch Creek (45.534, –113.994);
Hughes Creek (45.541, –114.069);
Hull Creek (45.471, –114.016);
Moose Creek (45.674, –113.951);
Pierce Creek (45.640, –113.937);

Sheep Creek (45.502, –113.889);
Smithy Creek (45.575, –113.889);
Threemile Creek (45.577, –113.866);
Twin Creek (45.591, –114.081).

(vii) Salmon River/Tower Creek Watershed 1706020307.
Outlet(s) = Salmon River (Lat 45.320, Long –113.909)
Upstream to endpoint(s) in:
Salmon River (45.250, –113.899);
Tower Creek (45.367, –113.857);
Wallace Creek (45.2645, –113.9035).

(viii) Carmen Creek Watershed 1706020308.
Outlet(s) = Carmen Creek (Lat 45.250, Long –113.899)
Upstream to endpoint(s) in:
Carmen Creek (45.316, –113.800);
Freeman Creek (45.269, –113.752).

(ix) Salmon River/Jesse Creek Watershed 1706020309.
Outlet(s) = Salmon River (Lat 45.250, Long –113.899)
Upstream to endpoint(s) in:
Salmon River (45.109, –113.901);
Unnamed (45.180, –113.930).

(x) Salmon River/Williams Creek Watershed 1706020310.
Outlet(s) = Salmon River (Lat 45.109, Long –113.901)
Upstream to endpoint(s) in:
Salmon River (45.011, –113.932);
Williams Creek (45.081, –113.935).

(xi) Salmon River/Twelvemile Creek Watershed 1706020311.
Outlet(s) = Salmon River (Lat 45.011, Long –113.932)
Upstream to endpoint(s) in:
Lake Creek (45.015, –113.959);
Salmon River (44.896, –113.963);
Twelvemile Creek (45.011, –113.927).

(xii) Salmon River/Cow Creek Watershed 1706020312.
Outlet(s) = Salmon River (Lat 44.896, Long –113.963)
Upstream to endpoint(s) in:
Cow Creek (44.730, –113.940);
McKim Creek (44.810, –114.008);
Poison Creek (44.876, –113.934);
Salmon River (44.692, –114.049);
Warm Spring Creek (44.913, –113.914).

(xiii) Hat Creek Watershed 1706020313.
Outlet(s) = Hat Creek (Lat 44.795, Long –114.001)
Upstream to endpoint(s) in:
Hat Creek (44.785, –114.040).

(xiv) Iron Creek Watershed 1706020314.
Outlet(s) = Iron Creek (Lat 44.887, Long –113.968)
Upstream to endpoint(s) in:

Iron Creek (44.921, –114.124).

(xv) Upper Panther Creek Watershed 1706020315.

Outlet(s) = Panther Creek (Lat 45.022, Long –114.313)

Upstream to endpoint(s) in:

Cabin Creek (44.957, –114.365);
Opal Creek (44.901, –114.307);
Panther Creek (44.887, –114.305);
Porphyry Creek (45.034, –114.388).

(xvi) Moyer Creek Watershed 1706020316.

Outlet(s) = Moyer Creek (Lat 45.024, Long –114.311)

Upstream to endpoint(s) in:

Moyer Creek (44.949, –114.265);
South Fork Moyer Creek (44.944, –114.305).

(xvii) Panther Creek/Woodtick Creek Watershed 1706020317.

Outlet(s) = Panther Creek (Lat 45.079, Long –114.251)

Upstream to endpoint(s) in:

Copper Creek (45.060, –114.258);
Fawn Creek (45.073, –114.247);
Musgrove Creek (45.054, –114.368);
Panther Creek (45.022, –114.313);
Woodtick Creek (45.008, –114.235).

(xviii) Deep Creek Watershed 1706020318.

Outlet(s) = Deep Creek (Lat 45.126, Long –114.215)

Upstream to endpoint(s) in:

Deep Creek (45.108, –114.179).

(xix) Panther Creek/Spring Creek Watershed 1706020320.

Outlet(s) = Panther Creek (45.176, Long –114.314)

Upstream to endpoint(s) in:

Little Deer Creek (45.156, –114.298);
Panther Creek (45.079, –114.251);
Spring Creek (45.088, –114.223).

(xx) Big Deer Creek Watershed 1706020321.

Outlet(s) = Big Deer Creek (Lat 45.1763, Long –114.3138)

Upstream to endpoint(s) in:

Big Deer Creek (45.1695, –114.3256).

(xxi) Panther Creek/Trail Creek Watershed 1706020322.

Outlet(s) = Panther Creek (Lat 45.316, Long –114.405)

Upstream to endpoint(s) in:

Beaver Creek (45.2816, –114.2744);
Garden Creek (45.2959, –114.4293);
Trail Creek (45.2318, –114.2663);
Panther Creek (45.176, –114.314).

(xxii) Clear Creek Watershed 1706020323.

Outlet(s) = Clear Creek (Lat 45.295, Long –114.351)

Upstream to endpoint(s) in:

Clear Creek (45.210, –114.485).

(11) Lemhi Subbasin 17060204—
(i) Lemhi River/Bohannon Creek Watershed 1706020401.
Outlet(s) = Lemhi River (Lat 45.188, Long –113.889)
Upstream to endpoint(s) in:
Bohannon Creek (45.189, –113.692);
Lemhi River (45.098, –113.720).
(ii) Lemhi River/Whimpey Creek Watershed 1706020402.
Outlet(s) = Lemhi River (Lat 45.098, Long –113.720)
Upstream to endpoint(s) in:
Lemhi River (45.032, –113.662);
Wimpey Creek (45.131, –113.678);
Withington Creek (45.058, –113.750).
(iii) Lemhi River/Kenney Creek Watershed 1706020403.
Outlet(s) = Lemhi River (Lat 45.032, Long –113.662)
Upstream to endpoint(s) in:
Kenney Creek (45.087, –113.551);
Lemhi River (44.940, –113.639).
(iv) Lemhi River/McDevitt Creek Watershed 1706020405.
Outlet(s) = Lemhi River (Lat 44.940, Long –113.639)
Upstream to endpoint(s) in:
Lemhi River (44.870, –113.626).
(v) Lemhi River/Yearian Creek Watershed 1706020406.
Outlet(s) = Lemhi River (Lat 44.867, Long –113.626)
Upstream to endpoint(s) in:
Lemhi River (44.778, –113.535).
(vi) Peterson Creek Watershed 1706020407.
Outlet(s) = Lemhi River (Lat 44.778, Long –113.535)
Upstream to endpoint(s) in:
Lemhi River (44.739, –113.459).
(vii) Big Eight Mile Creek Watershed 1706020408.
Outlet(s) = Lemhi River (Lat 44.739, Long –113.459)
Upstream to endpoint(s) in:
Lemhi River (44.692, –113.366).
(viii) Canyon Creek Watershed 1706020409.
Outlet(s) = Lemhi River (Lat 44.692, Long –113.366)
Upstream to endpoint(s) in:
Lemhi River (44.682, –113.355).
(ix) Texas Creek Watershed 1706020412.
Outlet(s) = Texas Creek (Lat 44.6822, Long –113.3545)
Upstream to endpoint(s) in:
Purcell Creek (44.5726, –113.3459);
Texas Creek (44.5348, –113.3018).
(x) Hayden Creek Watershed 1706020414.
Outlet(s) = Hayden Creek (Lat 44.870, Long –113.626)
Upstream to endpoint(s) in:
Bear Valley Creek (44.796, –113.790);

East Fork Hayden Creek (44.708, –113.661);
Hayden Creek (44.726, –113.769);
Kadletz Creek (44.761, –113.767);
West Fork Hayden Creek (44.706, –113.768);
Wright Creek (44.759, –113.794).

(12) Upper Middle Fork Salmon Subbasin 17060205—

(i) Lower Loon Creek Watershed 1706020501.
Outlet(s) = Loon Creek (Lat 44.808, Long –114.811)
Upstream to endpoint(s) in:
Cabin Creek (44.742, –114.708);
Loon Creek (44.552, –114.849).

(ii) Warm Springs Watershed 1706020502.
Outlet(s) = Warm Spring Creek (Lat 44.653, Long –114.736)
Upstream to endpoint(s) in:
Trapper Creek (44.504, –114.617);
Warm Spring Creek (44.609, –114.481).

(iii) Upper Loon Creek Watershed 1706020503.
Outlet(s) = Loon Creek (Lat 44.552, Long –114.849)
Upstream to endpoint(s) in:
Cottonwood Creek (44.593, –114.679);
East Fork Mayfield Creek (44.494, –114.700);
Loon Creek (44.469, –114.923);
Pioneer Creek (44.466, –114.873);
South Fork Cottonwood Creek (44.563, –114.780);
Trail Creek (44.506, –114.959);
West Fork Mayfield Creek (44.473, –114.730).

(iv) Little Loon Creek Watershed 1706020504.
Outlet(s) = Little Loon Creek (Lat 44.731, Long –114.940)
Upstream to endpoint(s) in:
Little Loon Creek (44.615, –114.963).

(v) Rapid River Watershed 1706020505.
Outlet(s) = Rapid River (Lat 44.680, Long –115.152)
Upstream to endpoint(s) in:
Float Creek (44.546, –115.148);
North Fork Sheep Creek (44.656, –114.997);
Rapid River (44.551, –115.007);
South Fork Sheep Creek (44.628, –114.988);
Vanity Creek (44.500, –115.072).

(vi) Marsh Creek Watershed 1706020506.
Outlet(s) = Marsh Creek (Lat 44.449, Long –115.230)
Upstream to endpoint(s) in:
Asher Creek (44.374, –115.126);
Banner Creek (44.291, –115.187);
Bear Creek (44.490, –115.098);
Beaver Creek (44.494, –114.964);
Camp Creek (44.384, –115.144);

Cape Horn Creek (44.333, –115.287);
Knapp Creek (44.424, –114.915);
Marsh Creek (44.329, –115.091);
Swamp Creek (44.300, –115.175);
Winnemucca Creek (44.479, –114.972).

(vii) Middle Fork Salmon River/ Soldier Creek Watershed 1706020507.

Outlet(s) = Middle Fork Salmon River (Lat 44.680, Long –115.152)

Upstream to endpoint(s) in:

Boundary Creek (44.507, –115.328);
Dagger Creek (44.498, –115.307);
Elkhorn Creek (44.582, –115.369);
Greyhound Creek (44.626, –115.158);
Middle Fork Salmon River (44.449, –115.230);
Soldier Creek (44.528, –115.201).

(viii) Bear Valley Creek Watershed 1706020508.

Outlet(s) = Bear Valley Creek (Lat 44.449, Long –115.230)

Upstream to endpoint(s) in:

Ayers Creek (44.454, –115.330);
Bear Valley Creek (44.236, –115.499);
Bearskin Creek (44.331, –115.528);
Cache Creek (44.286, –115.409);
Cold Creek (44.371, –115.317);
Cook Creek (44.389, –115.438);
East Fork Elk Creek (44.481, –115.359);
Fir Creek (44.354, –115.296);
Little Beaver Creek (44.415, –115.504);
Little East Fork Elk Creek (44.479, –115.407);
Mace Creek (44.289, –115.443);
North Fork Elk Creek (44.527, –115.458);
Poker Creek (44.444, –115.345);
Pole Creek (44.361, –115.366);
Porter Creek (44.466, –115.529);
Sack Creek (44.320, –115.351);
Sheep Trail Creek (44.360, –115.451);
West Fork Elk Creek (44.485, –115.499);
Wyoming Creek (44.362, –115.335).

(ix) Sulphur Creek Watershed 1706020509.

Outlet(s) = Sulphur Creek (Lat 44.555, Long –115.297)

Upstream to endpoint(s) in:

Blue Moon Creek (44.572, –115.364);
Full Moon Creek (44.535, –115.400);
Honeymoon Creek (44.605, –115.399);
North Fork Sulphur Creek (44.583, –115.467);
Sulphur Creek (44.510, –115.518).

(x) Pistol Creek Watershed 1706020510.

Outlet(s) = Pistol Creek (Lat 44.724, Long –115.149)
Upstream to endpoint(s) in:
Little Pistol Creek (44.721, –115.404);
Luger Creek (44.636, –115.386);
Pistol Creek (44.644, –115.442).

(xi) Indian Creek Watershed 1706020511.
Outlet(s) = Indian Creek (Lat 44.770, Long –115.089)
Upstream to endpoint(s) in:
Big Chief Creek (44.817, –115.368);
Indian Creek (44.803, –115.383);
Little Indian Creek (44.879, –115.226).

(xii) Upper Marble Creek Watershed 1706020512.
Outlet(s) = Marble Creek (Lat 44.797, Long –114.971)
Upstream to endpoint(s) in:
Big Cottonwood Creek (44.879, –115.206);
Canyon Creek (44.822, –114.943);
Cornish Creek (44.933, –115.127);
Dynamite Creek (44.871, –115.207);
Marble Creek (44.983, –115.079);
Trail Creek (44.917, –114.930).

(xiii) Middle Fork Salmon River/ Lower Marble Creek Watershed 1706020513.
Outlet(s) = Middle Fork Salmon River (Lat 44.808, Long –114.811)
Upstream to endpoint(s) in:
Marble Creek (44.797, –114.971);
Middle Fork Salmon River (44.680, –115.152).

(13) Lower Middle Fork Salmon Subbasin 17060206—

(i) Lower Middle Fork Salmon River Watershed 1706020601.
Outlet(s) = Middle Fork Salmon River (Lat 45.297, Long –114.591)
Upstream to endpoint(s) in:
Middle Fork Salmon River (45.095, –114.732);
Roaring Creek (45.186, –114.574);
Stoddard Creek (45.244, –114.702).

(ii) Wilson Creek Watershed 1706020602.
Outlet(s) = Wilson Creek (Lat 45.033, Long –114.723)
Upstream to endpoint(s) in:
Wilson Creek (45.032, –114.659).

(iii) Middle Fork Salmon River/Brush Creek Watershed 1706020603.
Outlet(s) = Middle Fork Salmon River (Lat 45.095, Long –114.732)
Upstream to endpoint(s) in:
Brush Creek (44.955, –114.733);
Middle Fork Salmon River (44.958, –114.747).

(iv) Yellow Jacket Creek Watershed 1706020604.

Outlet(s) = Yellowjacket Creek (Lat 44.892, Long –114.644)
Upstream to endpoint(s) in:
Beagle Creek (44.993, –114.466);
Hoodoo Creek (44.993, –114.568);
Lake Creek (44.967, –114.603);
Little Jacket Creek (44.931, –114.505);
Meadow Creek (44.984, –114.481);
Shovel Creek (45.006, –114.463);
Trail Creek (44.939, –114.461);
Yellowjacket Creek (45.050, –114.480).

(v) Silver Creek Watershed 1706020605.
Outlet(s) = Silver Creek (Lat 44.830, Long –114.501)
Upstream to endpoint(s) in:
Silver Creek (44.856, –114.458).

(vi) Upper Camas Creek Watershed 1706020606.
Outlet(s) = Camas Creek (Lat 44.830, Long –114.501)
Upstream to endpoint(s) in:
Castle Creek (44.825, –114.415);
Fly Creek (44.703, –114.509);
Furnace Creek (44.767, –114.421);
J Fell Creek (44.669, –114.459);
South Fork Camas Creek (44.731, –114.553);
Spider Creek (44.688, –114.495);
White Goat Creek (44.731, –114.460).

(vii) West Fork Camas Creek Watershed 1706020607.
Outlet(s) = West Fork Camas Creek (Lat 44.831, Long –114.504)
Upstream to endpoint(s) in:
Flume Creek (44.806, –114.526);
Martindale Creek (44.822, –114.560);
West Fork Camas Creek (44.795, –114.595).

(viii) Lower Camas Creek Watershed 1706020608.
Outlet(s) = Camas Creek (Lat 44.892, Long –114.722)
Upstream to endpoint(s) in:
Camas Creek (44.830, –114.501);
Duck Creek (44.852, –114.521);
Woodtick Creek (44.870, –114.636).

(ix) Middle Fork Salmon River/Sheep Creek Watershed 1706020609.
Outlet(s) = Middle Fork Salmon River (Lat 44.955, Long –114.733)
Upstream to endpoint(s) in:
Middle Fork Salmon River (44.808, –114.811);
Sheep Creek (44.923, –114.873).

(x) Rush Creek Watershed 1706020610.
Outlet(s) = Rush Creek (Lat 45.105, Long –114.861)
Upstream to endpoint(s) in:
Rush Creek (44.958, –114.992);

South Fork Rush Creek (45.013, –114.972);
Two Point Creek (45.027, –114.947).

(xi) Monumental Creek Watershed 1706020611.
Outlet(s) = Monumental Creek (Lat 45.160, Long –115.129)
Upstream to endpoint(s) in:
Monumental Creek (44.952, –115.179);
Snowslide Creek (45.055, –115.266);
West Fork Monumental Creek (45.011, –115.244).

(xii) Big Creek/Little Marble Creek Watershed 1706020612.
Outlet(s) = Big Creek (Lat 45.163, Long –115.128)
Upstream to endpoint(s) in:
Big Creek (45.153, –115.297);
Little Marble Creek (45.062, –115.276).

(xiii) Upper Big Creek Watershed 1706020613.
Outlet(s) = Big Creek (Lat 45.153, Long –115.297)
Upstream to endpoint(s) in:
Big Creek (45.075, –115.342);
Jacobs Ladder Creek (45.063, –115.322);
Middle Fork Smith Creek (45.166, –115.411);
Smith Creek (45.170, –115.380);
Unnamed (45.129, –115.422).

(xiv) Beaver Creek Watershed 1706020614.
Outlet(s) = Beaver Creek (Lat 45.163, Long –115.242)
Upstream to endpoint(s) in:
Beaver Creek (45.242, –115.314);
Coin Creek (45.218, –115.328);
HCreek (45.266, –115.270).

(xv) Big Ramey Creek Watershed 1706020615.
Outlet(s) = Big Ramey Creek (Lat 45.177, Long –115.159)
Upstream to endpoint(s) in:
Big Ramey Creek (45.279, –115.243).

(xvi) Big Creek/Crooked Creek Watershed 1706020616.
Outlet(s) = Big Creek (Lat 45.127, Long –114.935)
Upstream to endpoint(s) in:
Big Creek (45.163, –115.128);
Cave Creek (45.219, –114.916);
Coxey Creek (45.181, –115.022);
East Fork Crooked Creek (45.250, –114.975);
Fawn Creek (45.125, –115.032);
West Fork Crooked Creek (45.251, –115.117).

(xvii) Lower Big Creek Watershed 1706020617.
Outlet(s) = Big Creek (Lat 45.095, Long –114.732)
Upstream to endpoint(s) in:
Big Creek (45.127, –114.935);
Cabin Creek (45.195, –114.837);
Canyon Creek (45.087, –114.997);

Cliff Creek (45.127, –114.857);
Cougar Creek (45.138, –114.813);
Pioneer Creek (45.066, –114.842).
(14) Middle Salmon-Chamberlain Subbasin 17060207—
(i) Salmon River/ Fall Creek Watershed 1706020701.
Outlet(s) = Salmon River (Lat 45.426, Long –116.025)
Upstream to endpoint(s) in:
Carey Creek (45.4242, –115.9343);
Fall Creek (45.4153, –115.9755);
Salmon River (45.455, –115.941).
(ii) Wind River Watershed 1706020702.
Outlet(s) = Wind River (Lat 45.4553, Long –115.9411)
Upstream to endpoint(s) in:
Wind River (45.4657, –115.9394).
(iii) Salmon River/California Creek Watershed 1706020703.
Outlet(s) = Salmon River (Lat 45.455, Long –115.941)
Upstream to endpoint(s) in:
Bear Creek (45.435, –115.852);
Bull Creek (45.482, –115.716);
California Creek (45.341, –115.850);
Cottontail Creek (45.388, –115.752);
Maxwell Creek (45.392, –115.841);
Salmon River (45.434, –115.666).
(iv) Sheep Creek Watershed 1706020704.
Outlet(s) = Sheep Creek (Lat 45.468, Long –115.810)
Upstream to endpoint(s) in:
East Fork Sheep Creek (45.546, –115.769);
Meadow Creek (45.544, –115.792);
Plummer Creek (45.531, –115.807);
Porcupine Creek (45.506, –115.817);
Sheep Creek (45.591, –115.705).
(v) Crooked Creek Watershed 1706020705.
Outlet(s) = Crooked Creek (Lat 45.434, Long –115.666)
Upstream to endpoint(s) in:
Arlington Creek (45.491, –115.678);
Crooked Creek (45.515, –115.554);
Lake Creek (45.616, –115.686).
(vi) Salmon River/Rabbit Creek Watershed 1706020706.
Outlet(s) = Salmon River (Lat 45.434, Long –115.666)
Upstream to endpoint(s) in:
Indian Creek (45.409, –115.608);
Rabbit Creek (45.416, –115.667);
Salmon River (45.378, –115.512).
(vii) Salmon River/Trout Creek Watershed 1706020708.
Outlet(s) = Salmon River (Lat 45.378, Long –115.512)
Upstream to endpoint(s) in:

Big Blowout Creek (45.468, –115.432);
Big Elkhorn Creek (45.521, –115.331);
Fivemile Creek (45.391, –115.452);
Jersey Creek (45.494, –115.531);
Little Fivemile Creek (45.416, –115.425);
Little Mallard Creek (45.538, –115.317);
Rhett Creek (45.483, –115.410);
Richardson Creek (45.499, –115.265);
Salmon River (45.567, –115.191);
Trout Creek (45.396, –115.315).

(viii) Bargamin Creek Watershed 1706020709.

Outlet(s) = Bargamin Creek (Lat 45.567, Long –115.191)

Upstream to endpoint(s) in:

Bargamin Creek (45.706, –115.046);
Cache Creek (45.691, –115.180);
Porcupine Creek (45.725, –115.128);
Prospector Creek (45.688, –115.153);
Rainey Creek (45.617, –115.210);
Salt Creek (45.643, –115.189).

(ix) Salmon River/Rattlesnake Creek Watershed 1706020710.

Outlet(s) = Salmon River (Lat 45.567, Long –115.191)

Upstream to endpoint(s) in:

Rattlesnake Creek (45.560, –115.143);
Salmon River (45.511, –115.041).

(x) Sabe Creek Watershed 1706020711.

Outlet(s) = Sabe Creek (Lat 45.507, Long –115.024)

Upstream to endpoint(s) in:

Center Creek (45.573, –115.040);
Hamilton Creek (45.544, –114.826).

(xi) Salmon River/Hot Springs Creek Watershed 1706020712.

Outlet(s) = Salmon River (Lat 45.511, Long –115.041)

Upstream to endpoint(s) in:

Big Harrington Creek (45.498, –114.895);
Hot Springs Creek (45.465, –115.135);
Salmon River (45.454, –114.931).

(xii) Salmon River/Disappointment Creek Watershed 1706020713.

Outlet(s) = Salmon River (Lat 45.454, Long –114.931)

Upstream to endpoint(s) in:

Salmon River (45.395, –114.732).

(xiii) Horse Creek Watershed 1706020714.

Outlet(s) = Horse Creek (Lat 45.395, Long –114.732)

Upstream to endpoint(s) in:

East Fork Reynolds Creek (45.541, –114.493);
Horse Creek (45.498, –114.421);
Reynolds Creek (45.555, –114.558);
West Horse Creek (45.494, –114.754).

(xiv) Salmon River/Kitchen Creek Watershed 1706020715.
Outlet(s) = Salmon River (Lat 45.395, Long –114.732)
Upstream to endpoint(s) in:
Corn Creek (45.370, –114.681);
Kitchen Creek (45.295, –114.752);
Salmon River (45.297, –114.591).

(xv) Cottonwood Creek Watershed 1706020716.
Outlet(s) = Cottonwood Creek (Lat 45.394, Long –114.802)
Upstream to endpoint(s) in:
Cottonwood Creek (45.354, –114.823).

(xvi) Lower Chamberlain/McCalla Creek Watershed 1706020717.
Outlet(s) = Chamberlain Creek (Lat 45.454, Long –114.931)
Upstream to endpoint(s) in:
McCalla Creek (45.321, –115.115);
Unnamed (45.433, –114.935);
Whimstick Creek (45.241, –115.053).

(xvii) Upper Chamberlain Creek Watershed 1706020718.
Outlet(s) = Chamberlain Creek (Lat 45.414, Long –114.981)
Upstream to endpoint(s) in:
Flossie Creek (45.384, –115.248);
Lodgepole Creek (45.305, –115.254);
Moose Creek (45.283, –115.292);
South Fork Chamberlain Creek (45.288, –115.342).

(xviii) Warren Creek Watershed 1706020719.
Outlet(s) = Warren Creek (Lat 45.397, Long –115.592)
Upstream to endpoint(s) in:
Richardson Creek (45.372, –115.625);
Slaughter Creek (45.269, –115.648);
Steamboat Creek (45.259, –115.722);
Warren Creek (45.248, –115.653).

(15) South Fork Salmon Subbasin 17060208—

(i) Lower South Fork Salmon River Watershed 1706020801.
Outlet(s) = South Fork Salmon River (Lat 45.378, Long –115.512)
Upstream to endpoint(s) in:
Big Buck Creek (45.253, –115.554);
Pony Creek (45.209, –115.663);
Porphyry Creek (45.255, –115.462);
Smith Creek (45.265, –115.550);
South Fork Salmon River (45.156, –115.585).

(ii) South Fork Salmon River/Sheep Creek Watershed 1706020802.
Outlet(s) = South Fork Salmon River (Lat 45.156, Long –115.585)
Upstream to endpoint(s) in:
Bear Creek (45.124, –115.643);
Contux Creek (45.155, –115.620);
Deer Creek (45.162, –115.606);
Elk Creek (45.149, –115.506);

Sheep Creek (45.039, –115.583);
South Fork Salmon River (45.025, –115.706).
(iii) Lower East Fork South Fork Salmon River Watershed 1706020803.
Outlet(s) = East Fork South Fork Salmon River (Lat 45.015, Long –115.713)
Upstream to endpoint(s) in:
Caton Creek (44.900, –115.584);
East Fork South Fork Salmon River (44.963, –115.501);
Loosum Creek (44.918, –115.529);
Parks Creek (44.969, –115.530).
(iv) Upper East Fork South Fork Salmon River Watershed 1706020804.
Outlet(s) = East Fork South Fork Salmon River (Lat 44.963, Long –115.501)
Upstream to endpoint(s) in:
East Fork South Fork Salmon River (44.934, –115.336);
Profile Creek (45.035, –115.409);
Quartz Creek (45.048, –115.496);
Salt Creek (44.962, –115.329);
Sugar Creek (44.975, –115.245);
Tamarack Creek (44.995, –115.318).
(v) Lower Johnson Creek Watershed 1706020805.
Outlet(s) = Johnson Creek (Lat 44.963, Long –115.501)
Upstream to endpoint(s) in:
Johnson Creek (44.803, –115.518);
Riordan Creek (44.898, –115.472);
Trapper Creek (44.829, –115.508).
(vi) Burntlog Creek Watershed 1706020806.
Outlet(s) = Burntlog Creek (Lat 44.803, Long –115.518)
Upstream to endpoint(s) in:
Burntlog Creek (44.718, –115.419).
(vii) Upper Johnson Creek Watershed 1706020807.
Outlet(s) = Johnson Creek (Lat 44.803, Long –115.518)
Upstream to endpoint(s) in:
Boulder Creek (44.565, –115.595);
Johnson Creek (44.550, –115.590);
Landmark Creek (44.630, –115.574);
Rock Creek (44.600, –115.592);
SCreek (44.609, –115.413);
Whiskey Creek (44.563, –115.486).
(viii) Upper South Fork Salmon River Watershed 1706020808.
Outlet(s) = South Fork Salmon River (Lat 44.652, Long –115.703)
Upstream to endpoint(s) in:
Bear Creek (44.607, –115.600);
Camp Creek (44.605, –115.633);
Curtis Creek (44.593, –115.752);
Lodgepole Creek (44.576, –115.610);

Mormon Creek (44.499, –115.654);
Rice Creek (44.510, –115.644);
South Fork Salmon River (44.480, –115.688);
Tyndall Creek (44.568, –115.736).

(ix) South Fork Salmon River/Cabin Creek Watershed 1706020809.
Outlet(s) = South Fork Salmon River (Lat 44.759, Long –115.684)
Upstream to endpoint(s) in:
Cabin Creek (44.713, –115.638);
Dollar Creek (44.759, –115.751);
North Fork Dollar Creek (44.755, –115.745);
Six-Bit Creek (44.684, –115.724);
South Fork Salmon River (44.652, –115.703);
Two-bit Creek (44.655, –115.747);
Warm Lake Creek (44.653, –115.662).

(x) South Fork Salmon River/ Blackmare Creek Watershed 1706020810.
Outlet(s) = South Fork Salmon River (Lat 44.898, Long –115.715)
Upstream to endpoint(s) in:
Blackmare Creek (44.809, –115.795);
Camp Creek (44.889, –115.691);
Cougar Creek (44.823, –115.804);
Phoebe Creek (44.910, –115.705);
South Fork Salmon River (44.759, –115.684).

(xii) Buckhorn Creek Watershed 1706020811.
Outlet(s) = Buckhorn Creek (Lat 44.922, Long –115.736)
Upstream to endpoint(s) in:
Buckhorn Creek (44.881, –115.856);
Little Buckhorn Creek (44.902, –115.756);
West Fork Buckhorn Creek (44.909, –115.832).

(xiii) South Fork Salmon River/Fitsum Creek Watershed 1706020812.
Outlet(s) = South Fork Salmon River (Lat 45.025, Long –115.706)
Upstream to endpoint(s) in:
Fitsum Creek (44.996, –115.784);
North Fork Fitsum Creek (44.992, –115.870);
South Fork Fitsum Creek (44.981, –115.768);
South Fork Salmon River (44.898, –115.715).

(xiv) Lower Secesh River Watershed 1706020813.
Outlet(s) = Secesh River (Lat 45.025, Long –115.706)
Upstream to endpoint(s) in:
Cly Creek (45.031, –115.911);
Hum Creek (45.070, –115.903);
Lick Creek (45.049, –115.906);
Secesh River (45.183, –115.821);
Split Creek (45.109, –115.805);
Zena Creek (45.057, –115.732).

(xv) Middle Secesh River Watershed 1706020814.
Outlet(s) = Secesh River (Lat 45.183, Long –115.821)

Upstream to endpoint(s) in:
Grouse Creek (45.289, –115.835);
Secesh River (45.257, –115.895);
Victor Creek (45.186, –115.831).
(xiv) Upper Secesh River Watershed 1706020815.
Outlet(s) = Secesh River (Lat 45.257, Long –115.895)
Upstream to endpoint(s) in:
Lake Creek (45.374, –115.867);
Threemile Creek (45.334, –115.891).
(16) Lower Salmon Subbasin 17060209—
(i) Salmon River/China Creek Watershed 1706020901.
Outlet(s) = Salmon River (Lat 45.857, Long –116.794)
Upstream to endpoint(s) in:
China Creek (46.004, –116.817);
Flynn Creek (45.911, –116.714);
Salmon River (45.999, –116.695);
Wapshilla Creek (45.945, –116.766).
(ii) Eagle Creek Watershed 1706020902.
Outlet(s) = Eagle Creek (Lat 45.997, Long –116.700)
Upstream to endpoint(s) in:
Eagle Creek (46.057, –116.814).
(iii) Deer Creek Watershed 1706020903.
Outlet(s) = Deer Creek (Lat 45.999, Long –116.695)
Upstream to endpoint(s) in:
Deer Creek (46.051, –116.702).
(iv) Salmon River/Cottonwood Creek Watershed 1706020904.
Outlet(s) = Salmon River (Lat 45.999, Long –116.695)
Upstream to endpoint(s) in:
Billy Creek (45.990, –116.643);
Cottonwood Creek (45.932, –116.598);
Maloney Creek (46.068, –116.625);
Salmon River (46.038, –116.625);
West Fork Maloney Creek (46.061, –116.632).
(v) Salmon River/Deep Creek Watershed 1706020905.
Outlet(s) = Salmon River (Lat 46.038, Long –116.625)
Upstream to endpoint(s) in:
Burnt Creek (45.966, –116.548);
Deep Creek (46.005, –116.547);
Round Spring Creek (45.972, –116.501);
Salmon River (45.911, –116.410);
Telcher Creek (45.978, –116.443).
(vi) Rock Creek Watershed 1706020906.
Outlet(s) = Rock Creek (Lat 45.905, Long –116.396)
Upstream to endpoint(s) in:
Grave Creek (45.978, –116.359);
Johns Creek (45.930, –116.245);

Rock Creek (45.919, –116.245).

(vii) Salmon River/Hammer Creek Watershed 1706020907.

Outlet(s) = Salmon River (Lat 45.911, Long –116.410)

Upstream to endpoint(s) in:

Salmon River (45.752, –116.322).

(viii) White Bird Creek Watershed 1706020908

White Bird Creek (Lat 45.752, Long –116.322)

Upstream to endpoint(s) in:

Asbestos Creek (45.722, –116.050);
Cabin Creek (45.842, –116.110);
Chapman Creek (45.841, –116.216);
Cold Springs Creek (45.716, –116.037);
Fish Creek (45.865, –116.084);
Jungle Creek (45.739, –116.063);
Little White Bird Creek (45.740, –116.087);
North Fork White Bird Creek (45.797, –116.089);
Pinnacle Creek (45.779, –116.086);
South Fork White Bird Creek (45.772, –116.028);
Twin Cabins Creek (45.782, –116.048);
Unnamed (45.809, –116.086);
Unnamed (45.841, –116.114);
Unnamed (45.858, –116.105).

(ix) Salmon River/McKinzie Creek Watershed 1706020909.

Outlet(s) = Salmon River (Lat 45.752, Long –116.322)

Upstream to endpoint(s) in:

Deer Creek (45.706, –116.332);
McKinzie Creek (45.676, –116.260);
Salmon River (45.640, –116.284);
Sotin Creek (45.725, –116.341).

(x) Skookumchuck Creek Watershed 1706020910.

Outlet(s) = Skookumchuck Creek (Lat 45.700, Long –116.317)

Upstream to endpoint(s) in:

North Fork Skookumchuck Creek (45.728, –116.114);
South Fork Skookumchuck Creek (45.711, –116.197).

(xi) Slate Creek Watershed 1706020911.

Outlet(s) = Slate Creek (Lat 45.640, Long –116.284)

Upstream to endpoint(s) in:

Deadhorse Creek (45.603, –116.093);
Little Slate Creek (45.587, –116.075);
North Fork Slate Creek (45.671, –116.095);
Slate Creek (45.634, –116.000);
Slide Creek (45.662, –116.146);
Unnamed (45.5959, –116.1061);
Waterspout Creek (45.631, –116.115).

(xii) Salmon River/John Day Creek Watershed 1706020912.

Outlet(s) = Salmon River (Lat 45.640, Long –116.284)

Upstream to endpoint(s) in:
China Creek (45.547, –116.310);
Cow Creek (45.539, –116.330);
East Fork John Day Creek (45.575, –116.221);
Fiddle Creek (45.495, –116.269);
John Day Creek (45.564, –116.220);
Race Creek (45.437, –116.316);
South Fork Race Creek (45.440, –116.403);
West Fork Race Creek (45.464, –116.352).
(xiii) Salmon River/Lake Creek Watershed 1706020913.
Outlet(s) = Salmon River (Lat 45.437, Long –116.316)
Upstream to endpoint(s) in:
Allison Creek (45.507, –116.156);
Berg Creek (45.426, –116.244);
Lake Creek (45.294, –116.219);
Salmon River (45.418, –116.162);
West Fork Allison Creek (45.457, –116.184);
West Fork Lake Creek (45.370, –116.241).
(xiv) Salmon River/Van Creek Watershed 1706020914.
Outlet(s) = Salmon River (Lat 45.418, Long –116.162)
Upstream to endpoint(s) in:
Robbins Creek (45.430, –116.026);
Salmon River (45.426, –116.025);
Van Creek (45.431, –116.138).
(xv) French Creek Watershed 1706020915.
Outlet(s) = French Creek (Lat 45.425, Long –116.030)
Upstream to endpoint(s) in:
French Creek (45.375, –116.040).
(xvi) Partridge Creek Watershed 1706020916.
Outlet(s) = Elkhorn Creek (Lat 45.4043, Long –116.0941);
Partridge Creek (45.408, –116.126)
Upstream to endpoint(s) in:
Elkhorn Creek (45.369, –116.092);
Partridge Creek (45.369, –116.146).
(17) Little Salmon Subbasin 17060210—
(i) Lower Little Salmon River Watershed 1706021001.
Outlet(s) = Little Salmon River (Lat 45.417, Long –116.313)
Upstream to endpoint(s) in:
Denny Creek (45.306, –116.359);
Elk Creek (45.218, –116.311);
Hat Creek (45.313, –116.354);
Little Salmon River (45.204, –116.310);
Lockwood Creek (45.254, –116.366);
North Fork Squaw Creek (45.4234, –116.4320);
Papoose Creek (45.4078, –116.3920);
Rattlesnake Creek (45.268, –116.339);

Sheep Creek (45.344, –116.336);
South Fork Squaw Creek (45.4093, –116.4356).

(ii) Little Salmon River/Hard Creek Watershed 1706021002.

Outlet(s) = Little Salmon River (Lat 45.204, Long –116.310)

Upstream to endpoint(s) in:

Bascum Canyon (45.145, –116.248);
Hard Creek (45.125, –116.239);
Little Salmon River (45.123, –116.298);
Trail Creek (45.164, –116.338).

(iii) Hazard Creek Watershed 1706021003.

Outlet(s) = Hazard Creek (Lat 45.183, Long –116.283)

Upstream to endpoint(s) in:

Hazard Creek (45.201, –116.248).

(iv) Boulder Creek Watershed 1706021006.

Outlet(s) = Boulder Creek (Lat 45.204, Long –116.310)

Upstream to endpoint(s) in:

Ant Basin Creek (45.128, –116.447);
Boulder Creek (45.103, –116.479);
Bull Horn Creek (45.159, –116.407);
Pollock Creek (45.168, –116.395);
Pony Creek (45.190, –116.374);
Squirrel Creek (45.198, –116.368);
Star Creek (45.152, –116.418);
Unnamed (45.095, –116.461);
Unnamed (45.116, –116.455);
Yellow Jacket Creek (45.141, –116.426).

(v) Rapid River Watershed 1706021007.

Outlet(s) = Rapid River (Lat 45.375, Long –116.355)

Upstream to endpoint(s) in:

Granite Fork Lake Fork Rapid River (45.179, –116.526);
Paradise Creek (45.223, –116.550);
Rapid River (45.157, –116.489);
Shingle Creek (45.369, –116.409);
West Fork Rapid River (45.306, –116.425).

(18) Upper Selway Subbasin 17060301—

(i) Selway River/Pettibone Creek Watershed 1706030101.

Outlet(s) = Selway River (Lat 46.122, Long –114.935)

Upstream to endpoint(s) in:

Ditch Creek (46.022, –114.900);
Elk Creek (45.987, –114.872);
Pettibone Creek (46.105, –114.745);
Selway River (45.962, –114.828).

(ii) Bear Creek Watershed 1706030102.

Outlet(s) = Bear Creek (Lat 46.019, Long –114.844)

Upstream to endpoint(s) in:

Bear Creek (46.104, –114.588);

        - Brushy Fork Creek (45.978, –114.602);
        - Cub Creek (46.021, –114.662);
        - Granite Creek (46.102, –114.619);
        - Paradise Creek (46.036, –114.710);
        - Wahoo Creek (46.104, –114.633).
- (iii) Selway River/Gardner Creek Watershed 1706030103.
    - Outlet(s) = Selway River (Lat 45.962, Long –114.828)
    - Upstream to endpoint(s) in:
        - Bad Luck Creek (45.899, –114.752);
        - Crooked Creek (45.865, –114.764);
        - Gardner Creek (45.937, –114.772);
        - Magruder Creek (45.702, –114.795);
        - North Star Creek (45.950, –114.806);
        - Selway River (45.707, –114.719);
        - Sheep Creek (45.821, –114.741);
        - Snake Creek (45.855, –114.728).
- (iv) White Cap Creek Watershed 1706030104.
    - Outlet(s) = White Cap Creek (Lat 45.860, Long –114.744)
    - Upstream to endpoint(s) in:
        - Barefoot Creek (45.886, –114.639);
        - Canyon Creek (45.878, –114.422);
        - Cedar Creek (45.895, –114.668);
        - Cooper Creek (45.861, –114.557);
        - Elk Creek (45.928, –114.574);
        - Fox Creek (45.898, –114.597);
        - Granite Creek (45.931, –114.506);
        - Lookout Creek (45.959, –114.626);
        - Paloma Creek (45.918, –114.592);
        - Peach Creek (45.868, –114.607);
        - South Fork Lookout Creek (45.929, –114.649);
        - Unnamed (45.855, –114.557);
        - White Cap Creek (45.947, –114.534).
- (v) Indian Creek Watershed 1706030105.
    - Outlet(s) = Indian Creek (Lat 45.792, Long –114.764)
    - Upstream to endpoint(s) in:
        - Indian Creek (45.786, –114.581);
        - Jack Creek (45.789, –114.681);
        - Saddle Gulch (45.766, –114.641);
        - Schofield Creek (45.818, –114.586).
- (vi) Upper Selway River Watershed 1706030106.
    - Outlet(s) = Selway River (Lat 45.707, Long –114.719)
    - Upstream to endpoint(s) in:
        - Cayuse Creek (45.752, –114.572);
        - Deep Creek (45.703, –114.517);
        - French Creek (45.609, –114.561);
        - Gabe Creek (45.714, –114.666);

Hells Half Acre Creek (45.689, –114.708);
Lazy Creek (45.670, –114.553);
Line Creek (45.590, –114.585);
Mist Creek (45.561, –114.629);
Pete Creek (45.720, –114.557);
Selway River (45.502, –114.702);
Slow Gulch Creek (45.678, –114.520);
Storm Creek (45.641, –114.596);
Surprise Creek (45.533, –114.672);
Swet Creek (45.516, –114.804);
Three Lakes Creek (45.620, –114.803);
Unnamed (45.569, –114.642);
Vance Creek (45.681, –114.594);
Wilkerson Creek (45.561, –114.601).
(vii) Little Clearwater River Watershed 1706030107.
Outlet(s) = Little Clearwater River (Lat 45.754, Long –114.775)
Upstream to endpoint(s) in:
Burnt Knob Creek (45.697, –114.950);
FCreek (45.644, –114.847);
Little Clearwater River (45.740, –114.949);
Lonely Creek (45.727, –114.865);
Salamander Creek (45.655, –114.883);
Short Creek (45.759, –114.859);
Throng Creek (45.736, –114.904).
(viii) Running Creek Watershed 1706030108.
Outlet(s) = Running Creek (Lat 45.919, Long –114.832)
Upstream to endpoint(s) in:
Eagle Creek (45.844, –114.886);
Lynx Creek (45.794, –114.993);
Running Creek (45.910, –115.027);
South Fork Running Creek (45.820, –115.024).
(ix) Goat Creek Watershed 1706030109.
Outlet(s) = Goat Creek (Lat 45.962, Long –114.828)
Upstream to endpoint(s) in:
Goat Creek (45.940, –115.038).
(19) Lower Selway Subbasin 17060302—
(i) Selway River/Goddard Creek Watershed 1706030201.
Outlet(s) = Selway River (Lat 46.140, Long –115.599)
Upstream to endpoint(s) in:
Boyd Creek (46.092, –115.431);
Glover Creek (46.082, –115.361);
Goddard Creek (46.059, –115.610);
Johnson Creek (46.139, –115.514);
Rackliff Creek (46.110, –115.494);
Selway River (46.046, –115.295).
(ii) Gedney Creek Watershed 1706030202.

Outlet(s) = Gedney Creek (Lat 46.056, Long –115.313)
Upstream to endpoint(s) in:
Gedney Creek (46.111, –115.268).

(iii) Selway River/Three Links Creek Watershed 1706030203.
Outlet(s) = Selway River (Lat 46.046, Long –115.295)
Upstream to endpoint(s) in:
Mink Creek (46.041, –115.087);
Otter Creek (46.042, –115.216);
Pinchot Creek (46.120, –115.108);
Selway River (46.098, –115.071);
Three Links Creek (46.143, –115.093).

(iv) Upper Three Links Creek Watershed 1706030204.
Outlet(s) = Three Links Creek (Lat 46.143, Long –115.093)
Upstream to endpoint(s) in:
Three Links Creek (46.155, –115.100).

(v) Rhoda Creek Watershed 1706030205.
Outlet(s) = Rhoda Creek (Lat 46.234, Long –114.960)
Upstream to endpoint(s) in:
Lizard Creek (46.220, –115.136);
Rhoda Creek (46.252, –115.164);
Wounded Doe Creek (46.299, –115.078).

(vi) North Fork Moose Creek Watershed 1706030207.
Outlet(s) = North Fork Moose Creek (Lat 46.165, Long –114.897)
Upstream to endpoint(s) in:
North Fork Moose Creek (46.305, –114.853);
West Moose Creek (46.322, –114.970).

(vii) East Fork Moose Creek/Trout Creek Watershed 1706030208.
Outlet(s) = Selway River (Lat 46.098, Long –115.071)
Upstream to endpoint(s) in:
Double Creek (46.230, –114.837);
East Fork Moose Creek (46.204, –114.722);
Elbow Creek (46.200, –114.716);
Fitting Creek (46.231, –114.861);
Maple Creek (46.218, –114.785);
Monument Creek (46.189, –114.728);
Selway River (46.122, –114.935);
Trout Creek (46.141, –114.861).

(viii) Upper East Fork Moose Creek Watershed 1706030209.
Outlet(s) = East Fork Moose Creek (Lat 46.204, Long –114.722)
Upstream to endpoint(s) in:
Cedar Creek (46.291, –114.708);
East Fork Moose Creek (46.253, –114.700).

(ix) Marten Creek Watershed 1706030210.
Outlet(s) = Marten Creek (Lat 46.099, Long –115.052)
Upstream to endpoint(s) in:
Marten Creek (45.988, –115.029).

(x) Upper Meadow Creek Watershed 1706030211.
Outlet(s) = Meadow Creek (Lat 45.88043738, Long –115.1034371)
Upstream to endpoint(s) in:
Butter Creek (45.804, –115.149);
Meadow Creek (45.698, –115.217);
Three Prong Creek (45.790, –115.062).
(xi) Middle Meadow Creek Watershed 1706030212.
Outlet(s) = Meadow Creek (Lat 45.88157325, Long –115.2178401)
Upstream to endpoint(s) in:
East Fork Meadow Creek (45.868, –115.067);
Meadow Creek (45.880, –115.103);
Sable Creek (45.853, –115.219);
Schwar Creek (45.905, –115.108);
Simmons Creek (45.856, –115.247).
(xii) Lower Meadow Creek Watershed 1706030213.
Outlet(s) = Meadow Creek (Lat 46.04563958, Long –115.2953459)
Upstream to endpoint(s) in:
Buck Lake Creek (45.992, –115.084);
Butte Creek (45.878, –115.248);
Fivemile Creek (45.953, –115.310);
Little Boulder Creek (45.935, –115.293);
Meadow Creek (45.882, –115.218).
(xiii) O’Hara Creek Watershed 1706030214.
Outlet(s) = OHara Creek (Lat 46.08603027, Long –115.5170987)
Upstream to endpoint(s) in:
East Fork OHara Creek (45.995, –115.521);
West Fork O’Hara Creek (45.995, –115.543).
(20) Lochsa Subbasin 17060303—
(i) Lower Lochsa River Watershed 1706030301.
Outlet(s) = Lochsa River (Lat 46.14004554, Long –115.5986467)
Upstream to endpoint(s) in:
Canyon Creek (46.227, –115.580);
Coolwater Creek (46.215, –115.464);
Deadman Creek (46.262, –115.517);
East Fork Deadman Creek (46.275, –115.505);
Fire Creek (46.203, –115.411);
Kerr Creek (46.162, –115.579);
Lochsa River (46.338, –115.314);
Nut Creek (46.180, –115.601);
Pete King Creek (46.182, –115.697);
Placer Creek (46.196, –115.631);
South Fork Canyon Creek (46.211, –115.556);
Split Creek (46.207, –115.364);

Walde Creek (46.193, –115.662).
(ii) Fish Creek Watershed 1706030302.
Outlet(s) = Fish Creek (Lat 46.33337703, Long –115.3449332)
Upstream to endpoint(s) in:
Alder Creek (46.319, –115.460);
Ceanothus Creek (46.341, –115.470);
Fish Creek (46.341, –115.575);
Frenchman Creek (46.330, –115.544);
Gass Creek (46.390, –115.511);
Ham Creek (46.391, –115.365);
Hungery Creek (46.377, –115.542);
Myrtle Creek (46.343, –115.569);
Poker Creek (46.346, –115.447);
Willow Creek (46.396, –115.369).
(iii) Lochsa River/Stanley Creek Watershed 1706030303.
Outlet(s) = Lochsa River (Lat 46.33815653, Long –115.3141495)
Upstream to endpoint(s) in:
Bald Mountain Creek (46.406, –115.254);
Dutch Creek (46.377, –115.211);
Eagle Mountain Creek (46.428, –115.130);
Indian Grave Creek (46.472, –115.103);
Indian Meadow Creek (46.450, –115.060);
Lochsa River (46.466, –114.985);
Lost Creek (46.432, –115.116);
Sherman Creek (46.352, –115.320);
Stanley Creek (46.387, –115.144);
Unnamed (46.453, –115.028);
Unnamed (46.460, –115.006);
Unnamed (46.502, –115.050);
Weir Creek (46.490, –115.035).
(iv) Lochsa River/Squaw Creek Watershed 1706030304.
Outlet(s) = Lochsa River (Lat 46.4656626, Long –114.9848623)
Upstream to endpoint(s) in:
Badger Creek (46.535, –114.833);
Bear Mtn. Creek (46.471, –114.962);
Cliff Creek (46.482, –114.708);
Colgate Creek (46.455, –114.914);
Doe Creek (46.534, –114.914);
East Fork Papoose Creek (46.555, –114.743);
Jay Creek (46.513, –114.739);
Lochsa River (46.508, –114.681);
Postoffice Creek (46.529, –114.948);
Squaw Creek (46.567, –114.859);
Unnamed (46.463, –114.923);
Wendover Creek (46.521, –114.788);
West Fork Papoose Creek (46.576, –114.758);

West Fork Postoffice Creek (46.493, –114.985);
West Fork Squaw Creek (46.545, –114.884).

(v) Lower Crooked Fork Watershed 1706030305.

Outlet(s) = Crooked Fork Lochsa River (Lat 46.50828495, Long –114.680785)

Upstream to endpoint(s) in:

Crooked Fork Lochsa River (46.578, –114.612).

(vi) Upper Crooked Fork Watershed 1706030306.

Outlet(s) = Crooked Fork Lochsa River (Lat 46.57831788, Long –114.6115072)

Upstream to endpoint(s) in:

Boulder Creek (46.636, –114.703);
Crooked Fork Lochsa River (46.653, –114.670);
Haskell Creek (46.605, –114.596);
Shotgun Creek (46.601, –114.667).

(vii) Brushy Fork Watershed 1706030307.

Outlet(s) = Brushy Fork (Lat 46.57831788, Long –114.6115072)

Upstream to endpoint(s) in:

Brushy Fork (46.619, –114.450);
Pack Creek (46.580, –114.588);
Spruce Creek (46.609, –114.433).

(viii) Lower White Sands Creek Watershed 1706030308.

Outlet(s) = White Sands Creek (Lat 46.50828495, Long –114.680785)

Upstream to endpoint(s) in:

Beaver Creek (46.509, –114.619);
Cabin Creek (46.518, –114.641);
Walton Creek (46.500, –114.673);
White Sands Creek (46.433, –114.540).

(ix) Storm Creek Watershed 1706030309.

Outlet(s) = Storm Creek (Lat 46.46307502, Long –114.5482819)

Upstream to endpoint(s) in:

Maud Creek (46.495, –114.511);
Storm Creek (46.540, –114.424).

(x) Upper White Sands Creek Watershed 1706030310.

Outlet(s) = White Sands Creek (Lat 46.4330966, Long –114.5395027)

Upstream to endpoint(s) in:

Big FCreek (46.401, –114.475);
Big SCreek (46.407, –114.534);
Colt Creek (46.403, –114.726);
White Sands Creek (46.422, –114.462).

(xi) Warm Springs Creek Watershed 1706030311.

Outlet(s) = Warm Springs Creek (Lat 46.4733796, Long –114.8872254)

Upstream to endpoint(s) in:

Cooperation Creek (46.453, –114.866);
Warm Springs Creek (46.426, –114.868).

(xii) Fish Lake Creek Watershed 1706030312.

Outlet(s) = Fish Lake Creek (Lat 46.46336343, Long –114.9957028)

Upstream to endpoint(s) in:

Fish Lake Creek (46.405, –115.000);
Heslip Creek (46.393, –115.027);
Sponge Creek (46.384, –115.048).

(xiii) Boulder Creek Watershed 1706030313.

Outlet(s) = Boulder Creek (Lat 46.33815653, Long –115.3141495)

Upstream to endpoint(s) in:

Boulder Creek (46.320, –115.199).

(xiv) Old Man Creek Watershed 1706030314.

Outlet(s) = Old Man Creek (Lat 46.2524595, Long –115.3988563)

Upstream to endpoint(s) in:

Old Man Creek (46.256, –115.343).

(21) Middle Fork Clearwater Subbasin 17060304—

(i) Middle Fork Clearwater River/Maggie Creek Watershed 1706030401.

Outlet(s) = Middle Fork Clearwater River (Lat 46.1459, Long –115.9797)

Upstream to endpoint(s) in:

Maggie Creek (46.195, –115.801);
Middle Fork Clearwater River (46.140, –115.599).

(ii) Clear Creek Watershed 1706030402.

Outlet(s) = Clear Creek (Lat 46.1349, Long –115.9515)

Upstream to endpoint(s) in:

Browns Spring Creek (46.067, –115.658);
Clear Creek (46.056, –115.659);
Kay Creek (46.005, –115.725);
Middle Fork Clear Creek (46.030, –115.739);
Pine Knob Creek (46.093, –115.702);
South Fork Clear Creek (45.941, –115.769);
West Fork Clear Creek (46.013, –115.821).

(22) South Fork Clearwater Subbasin 17060305—

(i) Lower South Fork Clearwater River Watershed 1706030501.

Outlet(s) = South Fork Clearwater River (Lat 46.1459, Long –115.9797)

Upstream to endpoint(s) in:

Butcher Creek (45.945, –116.064);
Castle Creek (45.834, –115.966);
Earthquake Creek (45.853, –116.005);
Green Creek (45.957, –115.937);
Lightning Creek (45.936, –115.946);
Mill Creek (45.934, –116.010);
Rabbit Creek (46.028, –115.877);

Sally Ann Creek (46.019, –115.893);
Schwartz Creek (45.914, –116.000);
South Fork Clearwater River (45.830, –115.931);
Wall Creek (45.998, –115.926).

(ii) South Fork Clearwater River/ Meadow Creek Watershed 1706030502.

Outlet(s) = South Fork Clearwater River (Lat 45.8299, Long –115.9312)

Upstream to endpoint(s) in:

Covert Creek (45.890, –115.933);
North Meadow Creek (45.923, –115.890);
South Fork Clearwater River (45.824, –115.889);
Storm Creek (45.952, –115.848);
Whitman Creek (45.914, –115.919).

(iii) South Fork Clearwater River/ Peasley Creek Watershed 1706030503.

Outlet(s) = South Fork Clearwater River (Lat 45.8239, Long –115.8892)

Upstream to endpoint(s) in:

South Fork Clearwater River (45.795, –115.763).

(iv) South Fork Clearwater River/ Leggett Creek Watershed 1706030504.

Outlet(s) = South Fork Clearwater River (Lat 45.7952, Long –115.7628)

Upstream to endpoint(s) in:

Allison Creek (45.832, –115.588);
Buckhorn Creek (45.807, –115.658);
Fall Creek (45.833, –115.696);
Leggett Creek (45.862, –115.685);
Maurice Creek (45.856, –115.514);
Moose Creek (45.835, –115.578);
Rabbit Creek (45.822, –115.603);
Santiam Creek (45.811, –115.624);
South Fork Clearwater River (45.808, –115.474);
Twentymile Creek (45.791, –115.765);
Whiskey Creek (45.869, –115.544).

(v) Newsome Creek Watershed 1706030505.

Outlet(s) = Newsome Creek (Lat 45.8284, Long –115.6147)

Upstream to endpoint(s) in:

Baldy Creek (45.944, –115.681);
Bear Creek (45.887, –115.580);
Beaver Creek (45.943, –115.568);
Haysfork Creek (45.953, –115.678);
Mule Creek (45.985, –115.606);
Newsome Creek (45.972, –115.654);
Nuggett Creek (45.897, –115.600);
Pilot Creek (45.939, –115.716);
Sawmill Creek (45.904, –115.701);
Sing Lee Creek (45.898, –115.677);

West Fork Newsome Creek (45.880, –115.661).
(vi) American River Watershed 1706030506.
Outlet(s) = American River (Lat 45.8082, Long –115.4740)
Upstream to endpoint(s) in:
American River (45.996, –115.445);
Big Elk Creek (45.902, –115.513);
Box Sing Creek (45.850, –115.386);
Buffalo Gulch (45.873, –115.522);
East Fork American River (45.905, –115.381);
Flint Creek (45.913, –115.423);
Kirks Fork American River (45.842, –115.385);
Lick Creek (45.945, –115.477);
Little Elk Creek (45.894, –115.476);
Monroe Creek (45.871, –115.495);
Unnamed (45.884, –115.510);
West Fork American River (45.934, –115.510);
West Fork Big Elk Creek (45.883, –115.515).
(vii) Red River Watershed 1706030507.
Outlet(s) = Red River (Lat 45.8082, Long –115.4740)
Upstream to endpoint(s) in:
Bridge Creek (45.814, –115.163);
Campbell Creek (45.792, –115.486);
Dawson Creek (45.728, –115.393);
Deadwood Creek (45.794, –115.471);
Ditch Creek (45.7941, –115.2923);
Jungle Creek (45.710, –115.286);
Little Campbell Creek (45.801, –115.478);
Little Moose Creek (45.710, –115.399);
Moose Butte Creek (45.695, –115.365);
Otterson Creek (45.803, –115.222);
Red Horse Creek (45.822, –115.355);
Red River (45.788, –115.174);
Siegel Creek (45.800, –115.323);
Soda Creek (45.741, –115.257);
South Fork Red River (45.646, –115.407);
Trail Creek (45.784, –115.265);
Trapper Creek (45.672, –115.311);
Unnamed (45.788, –115.199);
West Fork Red River (45.662, –115.447).
(viii) Crooked River Watershed 1706030508.
Outlet(s) = Crooked River (Lat 45.8241, Long –115.5291)
Upstream to endpoint(s) in:
American Creek (45.7159, –115.9679);
East Fork Crooked River (45.655, –115.562);
East Fork Relief Creek (45.7363, –115.4511);
Fivemile Creek (45.721, –115.568);

Quartz Creek (45.702, –115.536);
Relief Creek (45.712, –115.472);
Silver Creek (45.713, –115.535);
Trout Creek (45.6876, –115.9463);
West Fork Crooked River (45.666, –115.596).
(ix) Ten Mile Creek Watershed 1706030509.
Outlet(s) = Tenmile Creek (Lat 45.8064, Long –115.6833)
Upstream to endpoint(s) in:
Mackey Creek (45.754, –115.683);
Morgan Creek (45.731, –115.672);
Sixmile Creek (45.762, –115.641);
Tenmile Creek (45.694, –115.694);
Williams Creek (45.703, –115.636).
(x) John's Creek Watershed 1706030510.
Outlet(s) = Johns Creek (Lat 45.8239, Long –115.8892)
Upstream to endpoint(s) in:
American Creek (45.750, –115.961);
Frank Brown Creek (45.708, –115.785);
Gospel Creek (45.637, –115.915);
Johns Creek (45.665, –115.827);
Trout Creek (45.750, –115.909);
West Fork Gospel Creek (45.657, –115.949).
(xi) Mill Creek Watershed 1706030511.
Outlet(s) = Mill Creek (Lat 45.8299, Long –115.9312)
Upstream to endpoint(s) in:
Adams Creek (45.6556, –116.0408);
Camp Creek (45.6613, –115.9820);
Corral Creek (45.6719, –115.9779);
Hunt Creek (45.6768, –115.9640);
Mill Creek (45.641, –116.008);
Unnamed (45.6964, –115.9641).
(xii) Cottonwood Creek Watershed 1706030513.
Outlet(s) = Cottonwood Creek (Lat 46.0810, Long –115.9764)
Upstream to endpoint(s) in:
Cottonwood Creek (46.0503, –116.1109);
Red Rock Creek (46.0807, –116.1579).
(23) Clearwater Subbasin 17060306—
(i) Lower Clearwater River Watershed 1706030601.
Outlet(s) = Clearwater River (Lat 46.4281, Long –117.0380)
Upstream to endpoint(s) in:
Clearwater River (46.447, –116.837).
(ii) Clearwater River/Lower Potlatch River Watershed 1706030602.
Outlet(s) = Clearwater River (Lat 46.4467, Long –116.8366)
Upstream to endpoint(s) in:
Catholic Creek (46.489, –116.841);
Clearwater River (46.474, –116.765);

Howard Gulch (46.4976, –116.7791);
Little Potlatch Creek (46.6322, –116.8320);
Potlatch River (46.523, –116.728).

(iii) Potlatch River/Middle Potlatch Creek Watershed 1706030603.
Outlet(s) = Potlatch River (Lat 46.5231, Long –116.7284)
Upstream to endpoint(s) in:
Middle Potlatch Creek (46.669, –116.796);
Potlatch River (46.583, –116.700).

(iv) Lower Big Bear Creek Watershed 1706030604.
Outlet(s) = Big Bear Creek (Lat 46.6180, Long –116.6439)
Upstream to endpoint(s) in:
Big Bear Creek (46.7145, –116.6632);
Little Bear Creek (46.7360, –116.7010),
West Fork Little Bear Creek (46.7413, –116.7789).

(v) Upper Big Bear Creek 1706030605.
Outlet(s) = Big Bear Creek (Lat 46.7145, Long –116.6632)
Upstream to endpoint(s) in:
East Fork Big Bear Creek (46.8141, –116.5984).

(vi) Potlatch River/Pine Creek Watershed 1706030606.
Outlet(s) = Potlatch River (Lat 46.5830, Long –116.6998)
Upstream to endpoint(s) in:
Boulder Creek (46.711, –116.450);
Leopold Creek (46.6547, –116.4407);
Pine Creek (46.706, –116.554);
Potlatch River (46.699, –116.504).

(vii) Upper Potlatch River Watershed 1706030607.
Outlet(s) = Potlatch River (Lat 46.6987, Long –116.5036)
Upstream to endpoint(s) in:
Corral Creek (46.8012, –116.4746);
East Fork Potlatch River (46.876, –116.247);
Feather Creek (46.938, –116.411);
Head Creek (46.942, –116.366);
Little Boulder Creek (46.768, –116.414);
Nat Brown Creek (46.911, –116.375);
Pasture Creek (46.940, –116.371);
Porcupine Creek (46.937, –116.379);
Potlatch River (46.941, –116.359);
Ruby Creek (46.7992, –116.3037);
Unnamed (46.8938, –116.3617);
Unnamed (46.922, –116.449);
West Fork Potlatch River (46.931, –116.458).

(viii) Clearwater River/Bedrock Creek Watershed 1706030608.
Outlet(s) = Clearwater River (Lat 46.4741, Long –116.7652)
Upstream to endpoint(s) in:
Bedrock Creek (46.5738, –116.5000);
Clearwater River (46.516, –116.590);

Louse Creek (46.5380, –116.4411);
Pine Creek (46.579, –116.615).
(ix) Clearwater River/Jack’s Creek Watershed 1706030609.
Outlet(s) = Clearwater River (Lat 46.5159, Long –116.5903)
Upstream to endpoint(s) in:
Clearwater River (46.498, –116.433);
Jacks Creek (46.435, –116.462).
(x) Big Canyon Creek Watershed 1706030610.
Outlet(s) = Big Canyon Creek (Lat 46.4984, Long –116.4326)
Upstream to endpoint(s) in:
Big Canyon Creek (46.2680, –116.5396);
Cold Springs Creek (46.2500, –116.5210);
Posthole Canyon (46.318, –116.450);
Sixmile Canyon (46.372, –116.441);
Unnamed (46.3801, –116.3750).
(xi) Little Canyon Creek Watershed 1706030611.
Outlet(s) = Little Canyon Creek (Lat 46.4681, Long –116.4172)
Upstream to endpoint(s) in:
Little Canyon Creek (46.295, –116.279).
(xii) Clearwater River/Lower Orofino Creek Watershed 1706030612.
Outlet(s) = Clearwater River (Lat 46.4984, Long –116.4326)
Upstream to endpoint(s) in:
Clearwater River (46.476, –116.254);
Orofino Creek (46.485, –116.196);
Whiskey Creek (46.5214, –116.1753).
(xiii) Jim Ford Creek Watershed 1706030614.
Outlet(s) = Jim Ford Creek (Lat 46.4394, Long –116.2115)
Upstream to endpoint(s) in:
Jim Ford Creek (46.3957, –115.9570).
(xiv) Lower Lolo Creek Watershed 1706030615.
Outlet(s) = Lolo Creek (Lat 46.3718, Long –116.1697)
Upstream to endpoint(s) in:
Big Creek (46.392, –116.118);
Lolo Creek (46.284, –115.882)
Schmidt Creek (46.3617, –116.0426).
(xv) Middle Lolo Creek Watershed 1706030616.
Outlet(s) = Lolo Creek (Lat 46.2844, Long –115.8818)
Upstream to endpoint(s) in:
Crocker Creek (46.254, –115.859);
Lolo Creek (46.381, –115.708);
Mud Creek (46.274, –115.759);
Nevada Creek (46.322, –115.735);
Pete Charlie Creek (46.289, –115.823);
Yakus Creek (46.238, –115.763).
(xvi) Musselshell Creek Watershed 1706030617.
Outlet(s) = Jim Brown Creek (Lat 46.3098, Long –115.7531)

Upstream to endpoint(s) in:
Gold Creek (46.376, –115.735);
Jim Brown Creek (46.357, –115.790);
Musselshell Creek (46.394, –115.744).
(xvii) Upper Lolo Creek Watershed 1706030618.
Outlet(s) = Lolo Creek (Lat 46.3815, Long –115.7078)
Upstream to endpoint(s) in:
Camp Creek (46.416, –115.624);
Lolo Creek (46.425, –115.648);
Max Creek (46.384, –115.679);
Relaskon Creek (46.394, –115.647);
Siberia Creek (46.384, –115.707);
Yoosa Creek (46.408, –115.589).
(xviii) Eldorado Creek Watershed 1706030619.
Outlet(s) = Eldorado Creek (Lat 46.2947, Long –115.7500)
Upstream to endpoint(s) in:
Cedar Creek (46.298, –115.711);
Dollar Creek (46.301, –115.640);
Eldorado Creek (46.300, –115.645);
Four Bit Creek (46.294, –115.644).
(xix) Clearwater River/Fivemile Creek Watershed 1706030620.
Outlet(s) = Clearwater River (Lat 46.4759, Long –116.2543)
Upstream to endpoint(s) in:
Clearwater River (46.350, –116.154);
Fivemile Creek (46.3473, –116.1859).
(xx) Clearwater River/Sixmile Creek Watershed 1706030621.
Outlet(s) = Clearwater River (Lat 46.3500, Long –116.1541)
Upstream to endpoint(s) in:
Clearwater River (46.257, –116.067);
Sixmile Creek (46.269, –116.213).
(xxi) Clearwater River/Tom Taha Creek Watershed 1706030622.
Outlet(s) = Clearwater River (Lat 46.2565, Long –116.067)
Upstream to endpoint(s) in:
Clearwater River (46.146, –115.980);
Tom Taha Creek (46.244, –115.993).
(xxii) Lower Lawyer Creek Watershed 1706030623.
Outlet(s) = Lawyer Creek (Lat 46.2257, Long –116.0116)
Upstream to endpoint(s) in:
Lawyer Creek (46.155, –116.190)
Sevenmile Creek (46.1498, –116.0838).
(xxiii) Middle Lawyer Creek Watershed 1706030624.
Outlet(s) = Lawyer Creek (Lat 46.1546, Long –116.1899)
Upstream to endpoint(s) in:
Lawyer Creek (46.188, –116.380).
(xxiv) Cottonwood Creek Watershed 1706030627.
Outlet(s) = Cottonwood Creek (Lat 46.5023, Long –116.7127)

Upstream to endpoint(s) in:
Cottonwood Creek (46.387, –116.622)
Coyote Creek (46.4622, –116.6377)
Magpie Creek (46.4814, –116.6643).
(xxv) Upper Lapwai Creek Watershed 1706030628.
Outlet(s) = Lapwai Creek (Lat 46.3674, Long –116.7352)
Upstream to endpoint(s) in:
Lapwai Creek (46.2961, –116.5955);
Unnamed (46.3346, –116.5794).
(xxvi) Mission Creek Watershed 1706030629.
Outlet(s) = Mission Creek (Lat 46.3674, Long –116.73525)
Upstream to endpoint(s) in:
Mission Creek (46.2724, –116.6949);
Rock Creek (46.3048, –116.6250).
(xxvii) Upper Sweetwater Creek Watershed 1706030630.
Outlet(s) = Webb Creek (Lat 46.3310, Long –116.8369)
Upstream to endpoint(s) in:
Sweetwater Creek (46.2751, –116.8513);
Webb Creek (46.2338, –116.7500).
(xxviii) Lower Sweetwater Creek Watershed 1706030631.
Outlet(s) = Lapwai Creek (Lat 46.4512, Long –116.8182)
Upstream to endpoint(s) in:
Lapwai Creek (46.364, –116.750);
Sweetwater Creek (46.331, –116.837);
Tom Beall Creek (46.4240, –116.7822).

(24) Lower Snake/Columbia River Corridor—Lower Snake/Columbia River Corridor.

Outlet(s) = Columbia River mouth (Lat 46.2485, Long –124.0782)
Upstream to endpoint at the confluence of the Palouse River (46.589, –117.215).

(S) Middle Columbia River Steelhead (Oncorhynchus mykiss). Critical habitat is designated to include the areas defined in the following subbasins:

(1) Upper Yakima Subbasin 17030001—
(i) Upper Yakima River Watershed 1703000101.
Outlet(s) = Yakima River (Lat 47.1770, Long –120.9964)
Upstream to endpoint(s) in:
Big Creek (47.1951, –121.1181);
Cabin Creek (47.2140, –121.2400);
Cle Elum River (47.2457, –121.0729);
Kachess River (47.2645, –121.2062);
Little Creek (47.2002, –121.0842);
Peterson Creek (47.1765, –121.0592);
Tucker Creek (47.2202, –121.1639);
Yakima River (47.3219, –121.3371).
(ii) Teanaway River Watershed 1703000102.

Outlet(s) = Yakima River (Lat 47.1673, Long –120.8338)
Upstream to endpoint(s) in:
Bear Creek (47.3684, –120.7902);
DeRoux Creek (47.4202, –120.9477);
Dickey Creek (47.2880, –120.8322);
Indian Creek (47.3216, –120.8145);
Jack Creek (47.3414, –120.8130);
Jungle Creek (47.3453, –120.8951);
Mason Creek (47.2528, –120.7889);
Middle Creek (47.2973, –120.8204);
Middle Fork Teanaway River (47.3750, –120.9800);
Standup Creek (47.3764, –120.8362);
Tillman Creek (47.1698, –120.9798);
Unnamed (47.2809, –120.8995);
West Fork Teanaway River (47.3040, –121.0179);
Yakima River (47.1770, –120.9964).
(iii) Middle Upper Yakima River Watershed 1703000103.
Outlet(s) = Yakima River (Lat 46.8987, Long –120.5035)
Upstream to endpoint(s) in:
Badger Creek (46.9305, –120.4805);
Coleman Creek (46.9636, –120.4764);
Cooke Creek (46.9738, –120.4381);
Dry Creek (47.0366, –120.6122);
First Creek (47.2082, –120.6732);
Iron Creek (47.3495, –120.7032);
Manastash Creek (46.9657, –120.7347);
Naneum Creek (46.9561, –120.4987);
North Fork Taneum Creek (47.1224, –121.0396);
Reecer Creek (47.0066, –120.5817);
South Fork Taneum Creek (47.0962, –120.9713);
Swauk Creek (47.3274, –120.6586);
Unnamed (46.9799, –120.5407);
Unnamed (47.0000, –120.5524);
Unnamed (47.0193, –120.5676);
Williams Creek (47.2638, –120.6513);
Wilson Creek (46.9931, –120.5497);
Yakima River (47.1673, –120.8338).
(iv) Umtanum/Wenas Watershed 1703000104.
Outlet(s) = Yakima River (Lat 46.6309, Long –120.5130)
Upstream to endpoint(s) in:
Burbank Creek (46.7663, –120.4238);
Lmuma Creek (46.8224, –120.4510);
Umtanum Creek (46.8928, –120.6130);
Wenas Creek (46.7087, –120.5179);
Yakima River (46.8987, –120.5035).
(2) Naches Subbasin 17030002—

(i) Little Naches River Watershed 1703000201.
Outlet(s) = Little Naches River (Lat 46.9854, Long –121.0915)
Upstream to endpoint(s) in:
American River (46.9008, –121.4194);
Barton Creek (46.8645, –121.2869);
Bear Creek (47.0793, –121.2415);
Blowout Creek (47.0946, –121.3046);
Crow Creek (47.0147, –121.3241);
Goat Creek (46.9193, –121.2269);
Kettle Creek (46.9360, –121.3262);
Mathew Creek (47.0829, –121.1944);
Miner Creek (46.9542, –121.3074);
Morse Creek (46.9053, –121.4131);
North Fork Little Naches River (47.0958, –121.3141);
Parker Creek (46.9589, –121.2900);
Pinus Creek (46.9682, –121.2766);
Quartz Creek (47.0382, –121.1128);
Scab Creek (46.8969, –121.2459);
South Fork Little Naches River (47.0574, –121.2760);
Sunrise Creek (46.9041, –121.2448);
Survey Creek (46.9435, –121.3296);
Timber Creek (46.9113, –121.3822);
Union Creek (46.9366, –121.3596);
Unnamed (46.8705, –121.2809);
Unnamed (46.8741, –121.2956);
Unnamed (46.8872, –121.2811);
Unnamed (46.8911, –121.2816);
Unnamed (46.9033, –121.4162);
Unnamed (46.9128, –121.2286);
Unnamed (46.9132, –121.4058);
Unnamed (46.9158, –121.3710);
Unnamed (46.9224, –121.2200);
Unnamed (46.9283, –121.3484);
Unnamed (46.9302, –121.2103);
Unnamed (46.9339, –121.1970);
Unnamed (46.9360, –121.3482);
Unnamed (46.9384, –121.3200);
Unnamed (46.9390, –121.1898);
Unnamed (46.9396, –121.3404);
Unnamed (46.9431, –121.3088);
Unnamed (46.9507, –121.2894);
Unnamed (47.0774, –121.3092);
Wash Creek (46.9639, –121.2810).
(ii) Naches River/Rattlesnake Creek Watershed 1703000202.
Outlet(s) = Naches River (Lat 46.7467, Long –120.7858)
Upstream to endpoint(s) in:

Glass Creek (46.8697, –121.0974);
Gold Creek (46.9219, –121.0464);
Hindoo Creek (46.7862, –121.1689);
Little Rattlesnake Creek (46.7550, –121.0543);
Lost Creek (46.9200, –121.0568);
Naches River (46.9854, –121.0915);
North Fork Rattlesnake Creek (46.8340, –121.1439);
Rattlesnake Creek (46.7316, –121.2339);
Rock Creek (46.8847, –120.9718).

(iii) Naches River/Tieton River Watershed 1703000203.

Outlet(s) = Naches River (Lat 46.6309, Long –120.5130)

Upstream to endpoint(s) in:

Naches River (46.7467, –120.7858);
Oak Creek (46.7295, –120.9348);
South Fork Cowiche Creek (46.6595, –120.7601);
Tieton River (46.6567, –121.1287);
Unnamed (46.6446, –120.5923);
Wildcat Creek (46.6715, –121.1520).

(3) Lower Yakima Subbasin 17030003—

(i) Ahtanum Creek Watershed 1703000301.

Outlet(s) = Ahtanum Creek (Lat 46.5283, Long –120.4732)

Upstream to endpoint(s) in:

Foundation Creek (46.5349, –121.0134);
Middle Fork Ahtanum Creek (46.5075, –121.0225);
Nasty Creek (46.5718, –120.9721);
North Fork Ahtanum Creek (46.5217, –121.0917);
South Fork Ahtanum Creek (46.4917, –120.9590);
Unnamed (46.5811, –120.6390).

(ii) Upper Lower Yakima River Watershed 1703000302.

Outlet(s) = Yakima River (Lat 46.5283, Long –120.4732)

Upstream to endpoint(s) in:

Unnamed (46.5460, –120.4383);
Yakima River (46.6309, –120.5130).

(iii) Upper Toppenish Creek Watershed 1703000303.

Outlet(s) = Toppenish Creek (Lat 46.3767, Long –120.6172)

Upstream to endpoint(s) in:

Agency Creek (46.3619, –120.9646);
Branch Creek (46.2958, –120.9969);
North Fork Simcoe Creek (46.4548, –120.9307);
North Fork Toppenish Creek (46.3217, –120.9985);
Old Maid Canyon (46.4210, –120.9349);
South Fork Toppenish Creek (46.2422, –121.0885);
Toppenish Creek (46.3180, –121.1387);
Unnamed (46.3758, –120.9336);
Unnamed (46.4555, –120.8436);
Wahtum Creek (46.3942, –120.9146);

Willy Dick Canyon (46.2952, –120.9021).
(iv) Lower Toppenish Creek Watershed 1703000304.
Outlet(s) = Yakima River (Lat 46.3246, Long –120.1671)
Upstream to endpoint(s) in:
Toppenish Creek (46.3767, –120.6172);
Unnamed (46.3224, –120.4464);
Unnamed (46.3363, –120.5891);
Unnamed (46.3364, –120.2288);
Unnamed (46.3679, –120.2801);
Unnamed (46.4107, –120.5582);
Unnamed (46.4379, –120.4258);
Yakima River (46.5283, –120.4732).
(v) Satus Creek Watershed 1703000305.
Outlet(s) = Satus Creek (Lat 46.2893, Long –120.1972)
Upstream to endpoint(s) in:
Bull Creek (46.0314, –120.5147);
Kusshi Creek (46.0994, –120.6094);
Logy Creek (46.1357, –120.6389);
Mule Dry Creek (46.0959, –120.3186);
North Fork Dry Creek (46.1779, –120.7669);
Satus Creek (46.0185, –120.7268);
Unnamed (46.0883, –120.5278);
Wilson Charley Canyon (46.0419, –120.6479).
(vi) Yakima River/Spring Creek Watershed 1703000306.
Outlet(s) = Yakima River (Lat 46.3361, Long –119.4817)
Upstream to endpoint(s) in:
Corral Creek (46.2971, –119.5302);
Satus Creek (46.2893, –120.1972);
Snipes Creek (46.2419, –119.6802);
Spring Creek (46.2359, –119.6952);
Unnamed (46.2169, –120.0189);
Unnamed (46.2426, –120.0993);
Unnamed (46.2598, –120.1322);
Unnamed (46.2514, –120.0190);
Yakima River (46.3246, –120.1671).
(vii) Yakima River/Cold Creek Watershed 1703000307.
Outlet(s) = Yakima River (Lat 46.2534, Long –119.2268)
Upstream to endpoint(s) in:
Yakima River (46.3361, –119.4817).
(4) Middle Columbia/Lake Wallula Subbasin 17070101—
(i) Upper Lake Wallula Watershed 1707010101.
Outlet(s) = Columbia River (Lat 46.0594, Long –118.9445)
Upstream to endpoint(s) in:
Columbia River (46.1776, –119.0183).
(ii) Lower Lake Wallula Watershed 1707010102.
Outlet(s) = Columbia River (Lat 45.9376, Long –119.2969)

Upstream to endpoint(s) in:
Columbia River (46.0594, –118.9445).

(iii) Glade Creek Watershed 1707010105.
Outlet(s) = Glade Creek (Lat 45.8895, Long –119.6809)
Upstream to endpoint(s) in:
Glade Creek (45.8978, –119.6962).

(iv) Upper Lake Umatilla Watershed 1707010106.
Outlet(s) = Columbia River (Lat 45.8895, Long –119.6809)
Upstream to endpoint(s) in:
Columbia River (45.9376, –119.2969).

(v) Middle Lake Umatilla Watershed 1707010109.
Outlet(s) = Columbia River (Lat 45.8318, Long –119.9069)
Upstream to endpoint(s) in:
Columbia River (45.8895, –119.6809).

(vi) Alder Creek Watershed 1707010110.
Outlet(s) = Alder Creek (Lat 45.8298, Long –119.9277)
Upstream to endpoint(s) in:
Alder Creek (45.8668, –119.9224).

(vii) Pine Creek Watershed 1707010111.
Outlet(s) = Pine Creek (Lat 45.7843, Long –120.0823)
Upstream to endpoint(s) in:
Pine Creek (45.8234, –120.1396).

(viii) Wood Gulch Watershed 1707010112.
Outlet(s) = Wood Creek (Lat 45.7443, Long –120.1930)
Upstream to endpoint(s) in:
Big Horn Canyon (45.8322, –120.2467);
Wood Gulch (45.8386, –120.3006).

(ix) Rock Creek Watershed 1707010113.
Outlet(s) = Rock Creek (Lat 45.6995, Long –120.4597)
Upstream to endpoint(s) in:
Rock Creek (45.8835, –120.5557);
Squaw Creek (45.8399, –120.4935).

(x) Lower Lake Umatilla Watershed 1707010114.
Outlet(s) = Columbia River (Lat 45.7168, Long –120.6927)
Upstream to endpoint(s) in:
Chapman Creek (45.7293, –120.3148);
Columbia River (45.8318, –119.9069).

(5) Walla Walla Subbasin 17070102—

(i) Upper Walla Walla River Watershed 1707010201.
Outlet(s) = Walla Walla River (Lat 45.9104, Long –118.3696)
Upstream to endpoint(s) in:
Bear Creek (45.8528, –118.0991);
Big Meadow Canyon (45.900, –118.1116);
Burnt Cabin Gulch (45.8056, –118.0593);
Couse Creek (45.8035, –118.2032);
Elbow Creek (45.7999, –118.1462);

Kees Canyon (45.8262, –118.0927);
Little Meadow Canyon (45.9094, –118.1333);
North Fork Walla Walla River (45.9342, –118.0169);
Reser Creek (45.8840, –117.9950);
Rodgers Gulch (45.8513, –118.0839);
Skiphorton Creek (45.8892, –118.0255);
South Fork Walla Walla River (45.9512, –117.9647);
Swede Canyon (45.8506, –118.0640);
Table Creek (45.8540, –118.0546);
Unnamed (45.8026, –118.1412);
Unnamed (45.8547, –117.9915);
Unnamed (45.8787–118.0387);
Unnamed (45.8868, –117.9629);
Unnamed (45.9095, –117.9621).

(ii) Mill Creek Watershed 1707010202.
Outlet(s) = Mill Creek (Lat 46.0391, Long –118.4779)
Upstream to endpoint(s) in:
Blue Creek (46.0188, –118.0519);
Broken Creek (45.9745, –117.9899);
Cold Creek (46.0540, –118.4097);
Deadman Creek (46.0421, –117.9503);
Doan Creek (46.0437, –118.4353);
Green Fork (46.0298, –117.9389);
Henry Canyon (45.9554, –118.1104);
Low Creek (45.9649, –117.9980);
Mill Creek (46.0112, –117.9406);
North Fork Mill Creek (46.0322, –117.9937);
Paradise Creek (46.0005, –117.9900);
Tiger Creek (45.9588, –118.0253);
Unnamed (46.0253, –117.9320);
Unnamed (46.0383, –117.9463);
Webb Creek (45.9800, –118.0875).

(iii) Upper Touchet River Watershed 1707010203.
Outlet(s) = Touchet River (Lat 46.3196, Long –117.9841)
Upstream to endpoint(s) in:
Burnt Fork (46.0838, –117.9311);
Coates Creek (46.1585, –117.8431);
Green Fork (46.0737, –117.9712);
Griffin Fork (46.1100, –117.9336);
Ireland Gulch (46.1894, –117.8070);
Jim Creek (46.2156, –117.7959);
Lewis Creek (46.1855, –117.7791);
North Fork Touchet River (46.0938, –117.8460);
North Patit Creek (46.3418, –117.7538);
Robinson Fork (46.1200, –117.9006);
Rodgers Gulch (46.2813, –117.8411);

Spangler Creek (46.1156, –117.7934);
Unnamed (46.1049, –117.9351);
Unnamed (46.1061, –117.9544);
Unnamed (46.1206, –117.9386);
Unnamed (46.1334, –117.9512);
Unnamed (46.1604, –117.9018);
Unnamed (46.2900, –117.7339);
Weidman Gulch (46.2359, –117.8067);
West Patit Creek (46.2940, –117.7164);
Whitney Creek (46.1348, –117.8491);
Wolf Fork (46.1035, –117.8797).

(iv) Middle Touchet River Watershed 1707010204.

Outlet(s) = Touchet River (Lat 46.2952, Long –118.3320)
Upstream to endpoint(s) in:
North Fork Coppei Creek (46.1384, –118.0181);
South Fork Coppei Creek (46.1302, –118.0608);
Touchet River (46.3196, –117.9841);
Whisky Creek (46.2438, –118.0785).

(v) Lower Touchet River Watershed 1707010207.

Outlet(s) = Touchet River (Lat 46.0340, Long –118.6828)
Upstream to endpoint(s) in:
Touchet River (46.2952, –118.3320).

(vi) Cottonwood Creek Watershed 1707010208.

Outlet(s) = Walla Walla River (Lat 46.0391, Long –118.4779)
Upstream to endpoint(s) in:
Birch Creek (45.9489, –118.2541);
Caldwell Creek (46.0493, –118.3022);
East Little Walla Walla River (46.0009, –118.4069);
Garrison Creek (46.0753, –118.2726);
Middle Fork Cottonwood Creek (45.9566, –118.1776);
North Fork Cottonwood Creek (45.9738, –118.1533);
Reser Creek (46.0370, –118.3085);
Russell Creek (46.0424, –118.2488);
South Fork Cottonwood Creek (45.9252, –118.1798);
Stone Creek (46.0618, –118.3081);
Unnamed (45.9525, –118.2513);
Unnamed (46.0022, –118.4070);
Walla Walla River (45.9104, –118.3696);
Yellowhawk Creek (46.0753, –118.2726).

(vii) Dry Creek Watershed 1707010210.

Outlet(s) = Dry Creek (Lat 46.0507, Long –118.5932)
Upstream to endpoint(s) in:
Dry Creek (46.0725, –118.0268);
Mud Creek (46.1414, –118.1313);
South Fork Dry Creek (46.0751, –118.0514);
Unnamed (46.1122, –118.1141).

(viii) Lower Walla Walla River Watershed 1707010211.
Outlet(s) = Walla Walla River (Lat 46.0594, Long –118.9445)
Upstream to endpoint(s) in:
Walla Walla River (46.0391, –118.4779).
(6) Umatilla Subbasin 17070103—
(i) Upper Umatilla River Watershed 1707010301.
Outlet(s) = Umatilla River (Lat 45.7024, Long –118.3593)
Upstream to endpoint(s) in:
Bear Creek (45.7595, –118.1942);
Bobsled Creek (45.7268, –118.2503);
Buck Creek (45.7081, –118.1059);
East Fork Coyote Creek (45.7553, –118.1263);
Johnson Creek #4 (45.7239, –118.0797);
Lake Creek #2 (45.7040, –118.1297);
Lick Creek (45.7400, –118.1880);
North Fork Umatilla River (45.7193, –118.0244);
Rock Creek (45.7629, –118.2377);
Ryan Creek (45.6362, –118.2963);
Shimmiehorn Creek (45.6184, –118.1908);
South Fork Umatilla River (45.6292, –118.2424);
Spring Creek #2 (45.6288, –118.1525);
Swamp Creek (45.6978, –118.1356);
Thomas Creek (45.6546, –118.1435);
Unnamed (45.6548, –118.1371);
Unnamed (45.6737, –118.1616);
Unnamed (45.6938, –118.3036);
Unnamed (45.7060, –118.2123);
Unnamed (45.7200, –118.3092);
Unnamed (45.7241, –118.3197);
Unnamed (45.7281, –118.1604);
Unnamed (45.7282, –118.3372);
Unnamed (45.7419, –118.1586);
West Fork Coyote Creek (45.7713, –118.1513);
Woodward Creek (45.7484, –118.0760).
(ii) Meacham Creek Watershed 1707010302.
Outlet(s) = Meacham Creek (Lat 45.7024, Long –118.3593)
Upstream to endpoint(s) in:
Bear Creek #3 (45.4882, –118.1993);
Beaver Creek (45.4940, –118.4411);
Boston Canyon (45.6594, –118.3344);
Butcher Creek (45.4558, –118.3737);
Camp Creek (45.5895, –118.2800);
Duncan Canyon (45.5674, –118.3244);
East Meacham Creek (45.4570, –118.2212);
Hoskins Creek (45.5188, –118.2059);
Line Creek (45.6303, –118.3291);

Meacham Creek (45.4364, –118.3963);
North Fork Meacham Creek (45.5767, –118.1721);
Owsley Creek (45.4349, –118.2434);
Pot Creek (45.5036, –118.1438);
Sheep Creek (45.5121, –118.3945);
Twomile Creek (45.5085, –118.4579);
Unnamed (45.4540, –118.2192);
Unnamed (45.5585, –118.2064);
Unnamed (45.6019, –118.2971);
Unnamed (45.6774, –118.3415).
(iii) Umatilla River/Mission Creek Watershed 1707010303.
Outlet(s) = Umatilla River (Lat 45.6559, Long –118.8804)
Upstream to endpoint(s) in:
Bachelor Canyon (45.6368, –118.3890);
Buckaroo Creek (45.6062, –118.5000);
Coonskin Creek (45.6556, –118.5239);
Cottonwood Creek (45.6122, –118.5704);
Little Squaw Creek (45.5969, –118.4095);
Mission Creek (45.6256, –118.6133);
Moonshine Creek (45.6166, –118.5392);
Patawa Creek (45.6424, –118.7125);
Red Elk Canyon (45.6773, –118.4431);
Saddle Hollow (45.7067, –118.3968);
South Patawa Creek (45.6250, –118.6919);
Squaw Creek (45.5584, –118.4389);
Stage Gulch (45.6533, –118.4481);
Thorn Hollow Creek (45.6957, –118.4530);
Umatilla River (45.7024, –118.3593);
Unnamed (45.5649, –118.4221);
Unnamed (45.6092, –118.7603);
Unnamed (45.6100, –118.4046);
Unnamed (45.6571, –118.7473);
Unnamed (45.6599, –118.4641);
Unnamed (45.6599, –118.4711);
Unnamed (45.6676, –118.6176);
Unnamed (45.6688, –118.5575);
Unnamed (45.6745, –118.5859).
(iv) McKay Creek Watershed 1707010305.
Outlet(s) = McKay Creek (Lat 45.6685, Long –118.8400)
Upstream to endpoint(s) in:
McKay Creek (45.6077, –118.7917).
(v) Birch Creek Watershed 1707010306.
Outlet(s) = Birch Creek (Lat 45.6559, Long –118.8804)
Upstream to endpoint(s) in:
Bear Creek (45.2730, –118.8939);
Bridge Creek (45.3603, –118.9039);

California Gulch (45.3950, –118.8149);
Dark Canyon (45.3119, –118.7572);
East Birch Creek (45.3676, –118.6085);
Johnson Creek #2 (45.3931, –118.7518);
Little Pearson Creek (45.3852, –118.7415);
Merle Gulch (45.3450, –118.8136);
Owings Creek (45.3864, –118.9600);
Pearson Creek (45.2901, –118.7985);
South Canyon #2 (45.3444, –118.6949);
Unnamed (45.2703, –118.7624);
Unnamed (45.3016, –118.7705);
Unnamed (45.3232, –118.7264);
Unnamed (45.3470, –118.7984);
Unnamed (45.3476, –118.6703);
Unnamed (45.3511, –118.6328);
Unnamed (45.4628, –118.7491);
West Birch Creek (45.2973, –118.8341);
Willow Spring Canyon (45.3426, –118.9833).

(vi) Umatilla River/Alkali Canyon Watershed 1707010307.
Outlet(s) = Umatilla River (Lat 45.7831, Long –119.2372)
Upstream to endpoint(s) in:
Umatilla River (45.6559, –118.8804).

(vii) Lower Umatilla River Watershed 1707010313.
Outlet(s) = Umatilla River (Lat 45.9247, Long –119.3575)
Upstream to endpoint(s) in:
Umatilla River (45.7831, –119.2372);
Unnamed (45.8202, –119.3305).

(7) Middle Columbia/Hood Subbasin 17070105—

(i) Upper Middle Columbia/ Hood Watershed 1707010501.
Outlet(s) = Columbia River (Lat 45.6426, Long –120.9142)
Upstream to endpoint(s) in:
Columbia River (45.7168, –120.6927);
Frank Fulton Canyon (45.6244, –120.8258);
Spanish Hollow Creek (45.6469, –120.8069);
Unnamed (45.6404, –120.8654).

(ii) Fifteenmile Creek Watershed 1707010502.
Outlet(s) = Fifteenmile Creek (Lat 45.6197, Long –121.1265)
Upstream to endpoint(s) in:
Cedar Creek (45.3713, –121.4153);
Dry Creek (45.4918, –121.0479);
Fifteenmile Creek (45.3658, –121.4390);
Ramsey Creek (45.3979, –121.4454);
Unnamed (45.3768, –121.4410).

(iii) Fivemile Creek Watershed 1707010503.
Outlet(s) = Eightmile Creek (Lat 45.6064, Long –121.0854)
Upstream to endpoint(s) in:

Eightmile Creek (45.3944, –121.4983);
Middle Fork Fivemile Creek (45.4502, –121.4324);
South Fork Fivemile Creek (45.4622, –121.3641).
(iv) Middle Columbia/Mill Creek Watershed 1707010504.
Outlet(s) = Columbia River (Lat 45.6920, Long –121.2937)
Upstream to endpoint(s) in:
Brown Creek (45.5911, –121.2729);
Chenoweth Creek (45.6119, –121.2658);
Columbia River (45.6426, –120.9142);
North Fork Mill Creek (45.4999, –121.4537);
South Fork Mill Creek (45.5187, –121.3367);
Threemile Creek (45.5598, –121.1747).
(v) Mosier Creek Watershed 1707010505.
Outlet(s) = Mosier Creek (Lat 45.6950, Long –121.3996)
Upstream to endpoint(s) in:
Mosier Creek (45.6826, –121.3896);
Rock Creek (45.6649, –121.4352).
(vi) White Salmon River Watershed 1707010509.
Outlet(s) = White Salmon River (Lat 45.7267, Long –121.5209)
Upstream to endpoint(s) in:
Unnamed (45.7395, –121.5500);
White Salmon River (45.7676, –121.5374).
(vii) Middle Columbia/Grays Creek Watershed 1707010512.
Outlet(s) = Columbia River (Lat 45.7070, Long –121.7943)
Upstream to endpoint(s) in:
Catherine Creek (45.7448, –121.4206);
Columbia River (45.6920, –121.2937);
Dog Creek (45.7200, –121.6804);
East Fork Major Creek (45.8005, –121.3449);
Hanson Creek (45.7472, –121.3143);
Jewett Creek (45.7524, –121.4704);
Rowena Creek (45.6940, –121.3122);
Unnamed (45.7238, –121.7227);
Unnamed (45.7248, –121.7322);
Unnamed (45.7303, –121.3095);
Unnamed (45.7316, –121.3094);
Unnamed (45.7445, –121.3309);
Unnamed (45.7486, –121.3203);
Unnamed (45.7530, –121.4697);
Unnamed (45.7632, –121.4795);
Unnamed (45.7954, –121.3863);
Unnamed (45.8003, –121.4062);
West Fork Major Creek (45.8117, –121.3929).
(8) Klickitat Subbasin 17070106—
(i) Upper Klickitat River Watershed 1707010601.
Outlet(s) = Klickitat River (Lat 46.1263, Long –121.2881)

Upstream to endpoint(s) in:
    Cedar Creek (46.2122, –121.2042);
    Coyote Creek (46.4640, –121.1839);
    Cuitin Creek (46.4602, –121.1662);
    Diamond Fork (46.4794, –121.2284);
    Huckleberry Creek (46.4273, –121.3720);
    Klickitat River (46.4439, –121.3756);
    McCreedy Creek (46.3319, –121.2529);
    Piscoe Creek (46.3708, –121.1436);
    Surveyors Creek (46.2181, –121.1838);
    Unnamed (46.4476, –121.2575);
    Unnamed (46.4585, –121.2565);
    West Fork Klickitat River (46.2757, –121.3267).

(ii) Middle Klickitat River Watershed 1707010602.

Outlet(s) = Klickitat River (Lat 45.9858, Long –121.1233)

Upstream to endpoint(s) in:
    Bear Creek (46.0770, –121.2262);
    Klickitat River (46.1263, –121.2881);
    Outlet Creek (46.0178, –121.1740);
    Summit Creek (46.0035, –121.0918);
    Trout Creek (46.1166, –121.1968);
    White Creek (46.1084, –121.0730).

(iii) Little Klickitat River Watershed 1707010603.

Outlet(s) = Little Klickitat River (Lat 45.8452, Long –121.0625)

Upstream to endpoint(s) in:
    Blockhouse Creek (45.8188, –120.9813);
    Butler Creek (45.9287, –120.7005);
    Canyon Creek (45.8833, –121.0504);
    East Prong Little Klickitat River (45.9279, –120.6832);
    Mill Creek (45.8374, –121.0001);
    Unnamed (45.8162, –120.9288);
    West Prong Little Klickitat River (45.9251, –120.7202).

(iv) Lower Klickitat River Watershed 1707010604.

Outlet(s) = Klickitat River (Lat 45.6920, Long –121.2937)

Upstream to endpoint(s) in:
    Dead Canyon (45.9473, –121.1734);
    Dillacort Canyon (45.7349, –121.1904);
    Klickitat River (45.9858, –121.1233);
    Logging Camp Canyon (45.7872, –121.2260);
    Snyder Canyon (45.8431, –121.2152);
    Swale Creek (45.7218, –121.0475);
    Wheeler Canyon (45.7946, –121.1615).

(9) Upper John Day Subbasin 17070201—

(i) Middle South Fork John Day Watershed 1707020103.

Outlet(s) = South Fork John Day River (Lat 44.1918, Long –119.5261)

Upstream to endpoint(s) in:
Blue Creek (44.2183, –119.3679);
Corral Creek (44.1688, –119.3573);
North Fork Deer Creek (44.2034, –119.3009);
South Fork Deer Creek (44.1550, –119.3457);
South Fork John Day River (44.1822, –119.5243)
Unnamed (44.1824, –119.4210);
Vester Creek (44.1794, –1193872).

(ii) Murderers Creek Watershed 1707020104.
Outlet(s) = Murderers Creek (Lat 44.3146, Long –119.5383)
Upstream to endpoint(s) in:
Bark Cabin Creek (44.2481, –119.3967);
Basin Creek (44.2700, –119.1711);
Cabin Creek (44.3420, –119.4403);
Charlie Mack Creek (44.2708, –119.2344);
Crazy Creek (44.2421, –119.4282);
Dans Creek (44.2500, –119.2774);
Duncan Creek (44.3219, –119.3555);
Lemon Creek (44.2528, –119.2500);
Miner Creek (44.3237, –119.2416);
Orange Creek (44.2524, –119.2613);
Oregon Mine Creek (44.2816, –119.2945);
South Fork Murderers Creek (44.2318, –119.3221);
Sugar Creek (44.2914, –119.2326);
Tennessee Creek (44.3041, –119.3029);
Thorn Creek (44.3113, –119.3157);
Todd Creek (44.3291, –119.3976);
Unnamed (44.3133, –119.3533);
Unnamed (44.3250, –119.3476);
White Creek (44.2747, –119.1866).

(iii) Lower South Fork John Day Watershed 1707020105.
Outlet(s) = South Fork John Day River (Lat 44.4740, Long –119.5344)
Upstream to endpoint(s) in:
Cougar Gulch (44.2279, –119.4898);
Frazier Creek (44.2200, –119.5745);
Jackass Creek (44.3564, –119.4958);
North Fork Wind Creek (44.3019, –119.6632);
Payten Creek (44.3692, –119.6185);
Smoky Creek (44.3893, –119.4791);
South Fork Black Canyon Creek (44.3789, –119.7293);
South Fork John Day River (44.1918, –119.5261);
South Fork Wind Creek (44.2169, –119.6192);
South Prong Creek (44.3093, –119.6558);
Squaw Creek (44.3000, –119.6143);
Unnamed (44.2306, –119.6095);

Unnamed (44.2358, –119.6013);
Unnamed (44.3052, –119.6332);
Wind Creek (44.2793, –119.6515).
(iv) Upper John Day River Watershed 1707020106.
Outlet(s) = John Day River (Lat 44.4534, Long –118.6711)
Upstream to endpoint(s) in:
Bogue Gulch (44.3697, –118.5200);
Call Creek (44.2973, –118.5169);
Crescent Creek (44.2721, –118.5473);
Dads Creek (44.5140, –118.6463);
Dans Creek (44.4989, –118.5920);
Deardorff Creek (44.3665, –118.4596);
Eureka Gulch (44.4801, –118.5912);
Graham Creek (44.3611, –118.6084);
Isham Creek (44.4649, –118.5626);
Jeff Davis Creek (44.4813, –118.6370);
John Day River (44.2503, –118.5256);
Mossy Gulch (44.4641, –118.5211);
North Reynolds Creek (44.4525, –118.4886);
Rail Creek #2 (44.3413, –118.5017);
Reynolds Creek (44.4185, –118.4507);
Roberts Creek (44.3060, –118.5815);
Thompson Creek (44.3581, –118.5395);
Unnamed (44.2710, –118.5412).
(v) Canyon Creek Watershed 1707020107.
Outlet(s) = Canyon Creek (Lat 44.4225, Long –118.9584)
Upstream to endpoint(s) in:
Berry Creek (44.3084, –118.8791);
Brookling Creek (44.3042, –118.8363);
Canyon Creek (44.2368, –118.7775);
Crazy Creek #2 (44.2165, –118.7751);
East Brookling Creek (44.3029, –118.8082);
East Fork Canyon Creek (44.2865, –118.7939);
Middle Fork Canyon Creek (44.2885, –118.7500);
Skin Shin Creek (44.3036, –118.8488);
Tamarack Creek #2 (44.2965, –118.8611);
Unnamed (44.2500, –118.8298);
Unnamed (44.2717, –118.7500);
Unnamed (44.2814, –118.7620);
Vance Creek (44.2929, –118.9989);
Wall Creek (44.2543, –118.8308).
(vi) Strawberry Creek Watershed 1707020108.
Outlet(s) = John Day River (Lat 44.4225, Long –118.9584)
Upstream to endpoint(s) in:
Bear Creek (44.5434, –118.7508);
Dixie Creek (44.5814, –118.7257);

Dog Creek (44.3635, –118.8890);
Grub Creek (44.5189, –118.8050);
Hall Creek (44.5479, –118.7894);
Indian Creek #3 (44.3092, –118.7438);
John Day River (44.4534, –118.6711);
Little Pine Creek (44.3771, –118.9103);
Onion Creek (44.3151, –118.6972);
Overholt Creek (44.3385, –118.7196);
Pine Creek (44.3468, –118.8345);
Slide Creek (44.2988, –118.6583);
Standard Creek (44.5648, –118.6468);
Strawberry Creek (44.3128, –118.6772);
West Fork Little Indian Creek (44.3632, –118.7918).
(vii) Beech Creek Watershed 1707020109.
Outlet(s) = Beech Creek (Lat 44.4116, Long –119.1151)
Upstream to endpoint(s) in:
Bear Creek (44.5268, –119.1002);
Beech Creek (44.5682, –119.1170);
Clear Creek (44.5522, –118.9942);
Cottonwood Creek (44.5758, –119.0694);
East Fork Beech Creek (44.5248, –118.9023);
Ennis Creek (44.5409, –119.0207);
Hog Creek (44.5484, –119.0379);
Little Beech Creek (44.4676, –118.9733);
McClellan Creek #2 (44.5570, –118.9490);
Tinker Creek (44.5550, –118.8892);
Unnamed (44.5349, –119.0827).
(viii) Laycock Creek Watershed 1707020110.
Outlet(s) = John Day River (Lat 44.4155, Long –119.2230)
Upstream to endpoint(s) in:
Birch Creek #2 (44.4353, –119.2148);
East Fork Dry Creek (44.4896, –119.1817);
Fall Creek #2 (44.3551, –119.0420);
Hanscombe Creek (44.3040, –119.0513);
Harper Creek (44.3485, –119.1259);
Ingle Creek (44.3154, –119.1153);
John Day River (44.4225, –118.9584);
Laycock Creek (44.3118, –119.0842);
McClellan Creek (44.3510, –119.2004);
Moon Creek (44.3483, –119.2389);
Riley Creek (44.3450, –119.1664).
(ix) Fields Creek Watershed 1707020111.
Outlet(s) = John Day River (Lat 44.4740, Long –119.5344)
Upstream to endpoint(s) in:
Belshaw Creek (44.5460, –119.2025);
Bridge Creek (44.4062, –119.4180);

Buck Cabin Creek (44.3412, –119.3313);
Cummings Creek (44.5043, –119.3250);
Fields Creek (44.3260, –119.2828);
Flat Creek (44.3930, –119.4386);
John Day River (44.4155, –119.2230);
Marks Creek (44.5162, –119.3886);
Wickiup Creek (44.3713, –119.3239);
Widows Creek (44.3752, –119.3819);
Wiley Creek (44.4752, –119.3784).

(x) Upper Middle John Day Watershed 1707020112.

Outlet(s) = John Day River (Lat 44.5289, Long –119.6320)

Upstream to endpoint(s) in:

Back Creek (44.4164, –119.6858);
Battle Creek (44.4658, –119.5863);
Cottonwood Creek (44.3863, –119.7376);
Cougar Creek (44.4031, –119.7056);
East Fork Cottonwood Creek (44.3846, –119.6177);
Ferris Creek (44.5446, –119.5250);
Franks Creek (44.5067, –119.4903);
John Day River (44.4740, –119.5344);
Rattlesnake Creek (44.4673, –119.6953);
Unnamed (44.3827, –119.6479);
Unnamed (44.3961, –119.7403);
Unnamed (44.4082, –119.6916).

(xi) Mountain Creek Watershed 1707020113.

Outlet(s) = Mountain Creek (Lat 44.5214, Long –119.7138)

Upstream to endpoint(s) in:

Badger Creek (44.4491, –120.1186);
Fopiano Creek (44.5899, –119.9429);
Fort Creek (44.4656, –119.9253);
Fry Creek (44.4647, –119.9940);
Keeton Creek (44.4632, –120.0195);
Mac Creek (44.4739, –119.9359);
Milk Creek (44.4649, –120.1526);
Unnamed (44.4700, –119.9427);
Unnamed (44.4703, –120.0328);
Unnamed (44.4703, –120.0597);
Unnamed (44.4827, –119.8970);
Willow Creek (44.6027, –119.8746).

(xii) Rock Creek Watershed 1707020114.

Outlet(s) = Rock Creek (Lat 44.5289, Long –119.6320)

Upstream to endpoint(s) in:

Baldy Creek (44.3906, –119.7651);
Bear Creek (44.3676, –119.8401);
Fir Tree Creek (44.3902, –119.7893);
First Creek (44.4086, –119.8120);

Fred Creek (44.4602, –119.8549);
Little Windy Creek (44.3751, –119.7595);
Pine Hollow #2 (44.5007, –119.8559);
Rock Creek (44.3509, –119.7636);
Second Creek (44.3984, –119.8075);
Unnamed (44.4000, –119.8501);
Unnamed (44.4232, –119.7271);
West Fork Birch Creek (44.4365, –119.7500).

(xiii) John Day River/Johnson Creek Watershed 1707020115.

Outlet(s) = John Day River (Lat 44.7554, Long –119.6382)

Upstream to endpoint(s) in:

Buckhorn Creek (44.6137, –119.7382);
Burnt Corral Creek (44.6987, –119.5733);
Frank Creek (44.6262, –119.7177);
Indian Creek (44.5925, –119.7636);
John Day River (44.5289, –119.6320);
Johnny Creek (44.6126, –119.5534);
Johnson Creek (44.6766, –119.7363).

(10) North Fork John Day Subbasin 17070202—

(i) Upper North Fork John Day River Watershed 1707020201.

Outlet(s) = North Fork John Day River (Lat 44.8661, Long –118.5605)

Upstream to endpoint(s) in:

Baldy Creek (44.8687, –118.3172);
Bear Gulch (44.8978, –118.5400);
Bull Creek (44.8790, –118.2753);
Crane Creek (44.8715, –118.3539);
Crawfish Creek (44.9424, –118.2608);
Cunningham Creek (44.9172, –118.2478);
Davis Creek (44.9645, –118.4156);
First Gulch (44.8831, –118.5588);
Hoodoo Creek (44.9763, –118.3673);
Long Meadow Creek (44.9490, –118.2932);
McCarty Gulch (44.9131, –118.5114);
Middle Trail Creek (44.9513, –118.3185);
North Fork John Day River (44.8691, –118.2392);
North Trail Creek (44.9675, –118.3219);
South Trail Creek (44.9434, –118.2930);
Trout Creek (44.9666, –118.4656);
Unnamed (44.8576, –118.3169);
Unnamed (44.8845, –118.3421);
Unnamed (44.9221, –118.5000);
Unnamed (44.9405, –118.4093);
Unnamed (44.9471, –118.4797);
Wagner Gulch (44.9390, –118.5148).

(ii) Granite Creek Watershed 1707020202.

Outlet(s) = Granite Creek (Lat 44.8661, Long –118.5605)
Upstream to endpoint(s) in:
Beaver Creek (44.7425, –118.3940);
Boulder Creek (44.8368, –118.3631);
Boundary Creek (44.8106, –118.3420);
Bull Run Creek (44.7534, –118.3154);
Corral Creek #2 (44.8186, –118.3565);
Deep Creek #2 (44.8017, –118.3200);
East Ten Cent Creek (44.8584, –118.4253);
Granite Creek (44.8578, –118.3736);
Lake Creek (44.7875, –118.5929);
Lick Creek (44.8503, –118.5065);
Lightning Creek (44.7256, –118.5011);
Lost Creek (44.7620, –118.5822);
North Fork Ruby Creek (44.7898, –118.5073);
Olive Creek (44.7191, –118.4677);
Rabbit Creek (44.7819, –118.5616);
Ruby Creek (44.7797, –118.5237);
South Fork Beaver Creek (44.7432, –118.4272);
Squaw Creek #5 (44.8552, –118.4705);
Unnamed (44.8427, –118.4233);
West Fork Clear Creek (44.7490, –118.5440);
West Ten Cent Creek (44.8709, –118.4377);
Wolesy Creek (44.7687, –118.5540).

(iii) North Fork John Day River/Big Creek Watershed 1707020203.
Outlet(s) = North Fork John Day River (Lat 44.9976, Long –118.9444)
Upstream to endpoint(s) in:
Backout Creek (44.8560, –118.6289);
Basin Creek (44.9081, –118.6671);
Big Creek (45.0115, –118.6041);
Bismark Creek (44.9548, –118.7020);
Corral Creek (44.9592, –118.6368);
Cougar Creek (44.9288, –118.6653);
Meadow Creek (44.9856, –118.4664);
North Fork John Day River (44.8661, –118.5605);
Oregon Gulch (44.8694, –118.6119);
Oriental Creek (45.0000, –118.7255);
Otter Creek (44.9634, –118.7567);
Paradise Creek (44.9168, –118.5850);
Raspberry Creek (44.9638, –118.7356);
Ryder Creek (44.9341, –118.5943);
Silver Creek (44.9077, –118.5580);
Simpson Creek (44.9383, –118.6794);
South Fork Meadow Creek (44.9303, –118.5481);
South Martin Creek (44.9479, –118.5281);

Trough Creek (44.9960, –118.8499);
Unnamed (44.8594, –118.6432);
Unnamed (44.9073, –118.5690);
Unnamed (45.0031, –118.7060);
Unnamed (45.0267, –118.7635);
Unnamed (45.0413, –118.8089);
White Creek (45.0000, –118.5617);
Winom Creek (44.9822, –118.6766).

(iv) Desolation Creek Watershed 1707020204.

Outlet(s) = Desolation Creek (Lat 44.9977, Long –118.9352)

Upstream to endpoint(s) in:

Battle Creek (44.8895, –118.7010);
Beeman Creek (44.8230, –118.7498);
Bruin Creek (44.8936, –118.7600);
Howard Creek (44.8513, –118.7004);
Junkens Creek (44.8482, –118.7994);
Kelsay Creek (44.9203, –118.6899);
Little Kelsay Creek (44.9127, –118.7124);
North Fork Desolation Creek (44.7791, –118.6231);
Park Creek (44.9109, –118.7839);
Peep Creek (44.9488, –118.8069);
South Fork Desolation Creek (44.7890, –118.6732);
Sponge Creek (44.8577, –118.7165);
Starveout Creek (44.8994, –118.8220);
Unnamed (44.8709, –118.7130);
Unnamed (44.9058, –118.7689);
Unnamed (44.9163, –118.8384);
Unnamed (44.9203, –118.8315);
Unnamed (44.9521, –118.8141);
Unnamed (44.9735, –118.8707).

(v) Upper Camas Creek Watershed 1707020205.

Outlet(s) = Camas Creek (Lat 45.1576, Long –118.8411)

Upstream to endpoint(s) in:

Bear Wallow Creek (45.2501, –118.7502);
Bowman Creek (45.2281, –118.7028);
Butcherknife Creek (45.1495, –118.6913);
Camas Creek (45.1751, –118.5548);
Dry Camas Creek (45.1582, –118.5846);
Frazier Creek (45.1196, –118.6152);
Hidaway Creek (45.0807, –118.5788);
Lane Creek (45.2429, –118.7749);
Line Creek (45.1067, –118.6562);
North Fork Cable Creek (45.0535, –118.6569);
Rancheria Creek (45.2144, –118.6552);
Salsbury Creek (45.2022, –118.6206);
South Fork Cable Creek (45.0077, –118.6942);

Unnamed (45.0508, –118.6536);
Unnamed (45.0579, –118.6705);
Unnamed (45.0636, –118.6198);
Unnamed (45.0638, –118.5908);
Unnamed (45.0823, –118.6579);
Unnamed (45.1369, –118.6771);
Unnamed (45.1513, –118.5966);
Unnamed (45.1854, –118.6842);
Unnamed (45.1891, –118.6110);
Unnamed (45.2429, –118.7575);
Warm Spring Creek (45.1386, –118.6561).

(vi) Lower Camas Creek Watershed 1707020206.

Outlet(s) = Camas Creek (Lat 45.0101, Long –118.9950)

Upstream to endpoint(s) in:

Bridge Creek (45.0395, –118.8633);
Camas Creek (45.1576, –118.8411);
Cooper Creek (45.2133, –118.9881);
Deerlick Creek (45.1489, –119.0229);
Dry Fivemile Creek (45.1313, –119.0898);
Fivemile Creek (45.1804, –119.2259);
Middle Fork Wilkins Creek (45.1193, –119.0439);
North Fork Owens Creek (45.1872, –118.9705);
Owens Creek (45.2562, –118.8305);
Silver Creek (45.1066, –119.1268);
Snipe Creek (45.2502, –118.9707);
South Fork Wilkins Creek (45.1078, –119.0312);
Sugarbowl Creek (45.1986, –119.0999);
Taylor Creek (45.1482, –119.1820);
Tribble Creek (45.1713, –119.1617);
Unnamed (45.0797, –118.7878);
Unnamed (45.1198, –118.8514);
Unnamed (45.1993, –118.9062);
Unnamed (45.2000, –118.8236);
Unnamed (45.2141, –118.8079);
Unnamed (45.1773, –119.0753);
Unnamed (45.2062, –119.0717);
Wilkins Creek (45.1239, –119.0094).

(vii) North Fork John Day River/ Potamus Creek Watershed 1707020207.

Outlet(s) = North Fork John Day River (Lat 44.8832. Long –119.4090)

Upstream to endpoint(s) in:

Buckaroo Creek (45.0245, –119.1187);
Butcher Bill Creek (45.1290, –119.3197);
Cabin Creek (44.9650, –119.3628);
Deep Creek (45.0977, –119.2021);
Deerhorn Creek (45.0513, –119.0542);

Ditch Creek (45.1584, –119.3153);
East Fork Meadow Brook Creek (44.9634, –118.9575);
Ellis Creek (45.1197, –119.2167);
Graves Creek (44.9927, –119.3171);
Hinton Creek (44.9650, –119.0025);
Hunter Creek (45.0114, –119.0896);
Jericho Creek (45.0361, –119.0829);
Little Potamus Creek (45.0462, –119.2579);
Mallory Creek (45.1030, –119.3112);
Martin Creek (45.1217, –119.3538);
Matlock Creek (45.0762, –119.1837);
No Name Creek (45.0730, –119.1459);
North Fork John Day River (44.9976, –118.9444);
Pole Creek (45.1666, –119.2533);
Rush Creek (45.0498, –119.1219);
Skull Creek (44.9726, –119.2035);
Smith Creek (44.9443, –118.9687);
Stalder Creek (45.0655, –119.2844);
Stony Creek (45.0424, –119.1489);
West Fork Meadow Brook (44.9428, –119.0319);
Wickiup Creek (45.0256, –119.2776);
Wilson Creek (45.1372, –119.2673).

(viii) Wall Creek Watershed 1707020208.

Outlet(s) = Big Wall Creek (Lat 44.8832, Long –119.4090)

Upstream to endpoint(s) in:

Alder Creek (45.1049, –119.4170);
Bacon Creek (45.0137, –119.4800);
Bear Creek (45.0551, –119.4170);
Big Wall Creek (44.9369, –119.6055);
Bull Prairie Creek (44.9753, –119.6604);
Colvin Creek (44.9835, –119.6911);
East Fork Alder Creek (45.1028, –119.3929);
East Fork Indian Creek (44.9009, –119.4918);
Happy Jack Creek (44.8997, –119.5730);
Hog Creek (45.0507, –119.4821);
Indian Creek (44.8810, –119.5260);
Johnson Creek (45.0097, –119.6282);
Little Bear Creek (45.0433, –119.4084);
Little Wall Creek (45.0271, –119.5235);
Little Wilson Creek (44.8979, –119.5531);
Lovlett Creek (44.9675, –119.5105);
Skookum Creek (45.0894, –119.4725);
South Fork Big Wall Creek (44.9315, –119.6167);
Swale Creek (45.1162, –119.3836);
Three Trough Creek (44.9927, –119.5318);
Two Spring Creek (45.0251, –119.3938);

Unnamed (44.9000, –119.6213);
Unnamed (44.9830, –119.7364);
Unnamed (44.9883, –119.7248);
Unnamed (45.0922, –119.4374);
Unnamed (45.1079, –119.4359);
Willow Spring Creek (44.9467, –119.5921);
Wilson Creek (44.9861, –119.6623).

(ix) Cottonwood Creek Watershed 1707020209.

Outlet(s) = Cottonwood Creek (Lat 44.8141, Long –119.4183)

Upstream to endpoint(s) in:

BecK Creek (44.5795, –119.2664);
Board Creek (44.5841, –119.3763);
Boulder Creek (44.5876, –119.3006);
Camp Creek #3 (44.6606, –119.3283);
Cougar Creek #2 (44.6230, –119.4133);
Day Creek (44.5946, –119.0235);
Donaldson Creek (44.5919, –119.3480);
Dunning Creek (44.6416, –119.0628);
Fox Creek (44.6163, –119.0078);
Indian Creek #3 (44.6794, –119.2196);
McHaley Creek (44.5845, –119.2234);
Mill Creek (44.6080, –119.0878);
Mine Creek (44.5938, –119.1756);
Murphy Creek (44.6062, –119.1114);
Smith Creek (44.6627, –119.0808);
Squaw Creek #3 (44.5715, –119.4069);
Unnamed (44.6176, –119.0806).

(x) Lower North Fork John Day River Watershed 1707020210.

Outlet(s) = North Fork John Day River (Lat 44.7554, Long –119.6382)

Upstream to endpoint(s) in:

East Fork Deer Creek (44.7033, –119.2753);
Gilmore Creek (44.6744, –119.4875);
North Fork John Day River (44.8832, –119.4090);
Rudio Creek (44.6254, –119.5026);
Straight Creek (44.6759, –119.4687);
West Fork Deer Creek (44.6985, –119.3372).

(11) Middle Fork John Day Subbasin 17070203—

(i) Upper Middle Fork John Day River Watershed 1707020301.

Outlet(s) = Middle Fork John Day River (Lat 44.5946, Long –118.5163)

Upstream to endpoint(s) in:

Bridge Creek (44.5326, –118.5746);
Clear Creek (44.4692, –118.4615);
Crawford Creek (44.6381, –118.3887);
Dry Fork Clear Creek (44.5339, –118.4484);

Fly Creek (44.6108, –118.3810);
Idaho Creek (44.6113, –118.3856);
Middle Fork John Day River (44.5847, –118.4286);
Mill Creek (44.6106, –118.4809);
North Fork Bridge Creek (44.5479, –118.5663);
North Fork Summit Creek (44.5878, –118.3560);
Squaw Creek (44.5303, –118.4089);
Summit Creek (44.5831, –118.3585).

(ii) Camp Creek Watershed 1707020302.

Outlet(s) = Middle Fork John Day River (Lat 44.6934, Long –118.7947)

Upstream to endpoint(s) in:

Badger Creek (44.7102, –118.6738);
Balance Creek (44.6756, –118.7661);
Beaver Creek (44.6918, –118.6467);
Bennett Creek (44.6095, –118.6432);
Big Boulder Creek (44.7332, –118.6889);
Blue Gulch (44.6952, –118.5220);
Butte Creek (44.5913, –118.6481);
Camp Creek (44.5692, –118.8041);
Caribou Creek (44.6581, –118.5543);
Charlie Creek (44.5829, –118.8277);
Cottonwood Creek (44.6616, –118.8919);
Cougar Creek (44.6014, –118.8261);
Coxie Creek (44.5596, –118.8457);
Coyote Creek (44.7040, –118.7436);
Davis Creek (44.5720, –118.6026);
Deerhorn Creek (44.5984, –118.5879);
Dry Creek (44.6722, –118.6962);
Eagle Creek (44.5715, –118.8269);
Granite Boulder Creek (44.6860, –118.6039);
Lemon Creek (44.6933, –118.6169);
Lick Creek (44.6102, –118.7504);
Little Boulder Creek (44.6661, –118.5807);
Little Butte Creek (44.6093, –118.6188);
Middle Fork John Day River (44.5946, –118.5163);
Myrtle Creek (44.7336, –118.7187);
Placer Gulch (44.5670, –118.5593);
Ragged Creek (44.6366, –118.7048);
Ruby Creek (44.6050, –118.6897);
Sulphur Creek (44.6119, –118.6672);
Sunshine Creek (44.6424, –118.7437);
Tincup Creek (44.6489, –118.6320);
Trail Creek (44.6249, –118.8469);
Unnamed (44.5535, –118.8139);
Unnamed (44.5697, –118.5975);

Unnamed (44.6041, –118.6051);
Unnamed (44.6471, –118.6869);
Unnamed (44.6559, –118.5777);
Vincent Creek (44.6663, –118.5345);
Vinegar Creek (44.6861, –118.5378);
West Fork Lick Creek (44.6021, –118.7891);
Whiskey Creek (44.6776, –118.8659);
Windlass Creek (44.6653, –118.6030);
Wray Creek (44.6978, –118.6588).

(iii) Big Creek Watershed 1707020303.

Outlet(s) = Middle Fork John Day River (Lat 44.8363, Long –119.0306)

Upstream to endpoint(s) in:

Barnes Creek (44.8911, –118.9974);
Bear Creek (44.7068, –118.8742);
Big Creek (44.7726, –118.6831);
Deadwood Creek (44.7645, –118.7499);
Deep Creek (44.7448, –118.7591);
East Fork Big Creek (44.7923, –118.7783);
Elk Creek (44.7167, –118.7721);
Granite Creek (44.8893, –119.0103);
Huckleberry Creek (44.8045, –118.8605);
Indian Creek (44.8037, –118.7498);
Lick Creek (44.8302, –118.9613);
Little Indian Creek (44.8743, –118.8862);
Lost Creek (44.7906, –118.7970);
Middle Fork John Day River (44.6934, –118.7947);
Mosquito Creek (44.7504, –118.8021);
North Fork Elk Creek (44.7281, –118.7624);
Onion Gulch (44.7622, –118.7846);
Pizer Creek (44.7805, –118.8102);
Slide Creek (44.6950, –118.9124);
Swamp Gulch (44.7606, –118.7641);
Unnamed (44.8249, –118.8718);
Unnamed (44.8594, –118.9018).

(iv) Long Creek Watershed 1707020304.

Outlet(s) = Long Creek (Lat 44.8878, Long –119.2338)

Upstream to endpoint(s) in:

Basin Creek (44.7458, –119.2452);
Everett Creek (44.7106, –119.1063);
Jonas Creek (44.6307, –118.9118);
Long Creek (44.6076, –118.9402);
Pass Creek (44.7681, –119.0414);
Paul Creek (44.7243, –119.1304);
Pine Creek (44.8125, –119.0859);
South Fork Long Creek (44.6360, –118.9756).

(v) Lower Middle Fork John Day River Watershed 1707020305.

Outlet(s) = Middle Fork John Day River (Lat 44.9168, Long –119.3004)

Upstream to endpoint(s) in:

Middle Fork John Day River (44.8363, –119.0306).

(12) Lower John Day Subbasin 17070204—

(i) Lower John Day River/ Kahler Creek 1707020401.

Outlet(s) = John Day River (Lat 44.8080, Long –119.9585)

Upstream to endpoint(s) in:

Alder Creek (44.9575, –119.8621);
Camp Creek (44.9005, –119.9505);
East Bologna Canyon (44.8484, –119.5842);
Henry Creek (44.9609, –119.7683);
Horseshoe Creek (44.7076, –119.9465);
Kahler Creek (44.9109, –119.7030);
Lake Creek (44.9012, –119.9806);
Left Hand Creek (44.7693, –119.7613);
Parrish Creek (44.7207, –119.8369);
Tamarack Butte #2 (44.6867, –119.7898);
Tamarack Creek (44.9107, –119.7026);
Unnamed (44.9334, –119.9164);
Unnamed (44.9385, –119.9088);
Unnamed (44.9451, –119.8932);
Unnamed (44.9491, –119.8696);
Unnamed (44.9546, –119.8739);
Unnamed (44.9557, –119.7561);
West Bologna Canyon (44.8338, –119.6422);
Wheeler Creek (44.9483, –119.8447);
William Creek (44.7458, –119.9027).

(ii) Lower John Day River/Service Creek Watershed 1707020402.

Outlet(s) = John Day River (Lat 44.7368, Long –120.3054)

Upstream to endpoint(s) in:

Big Service Creek (44.9286, –120.0428);
Girds Creek (44.6681, –120.1234);
John Day River (44.8080, –119.9585);
Rowe Creek (44.8043, –120.1751);
Service Creek (44.8951, –120.0892);
Shoofly Creek (44.6510, –120.0207).

(iii) Bridge Creek Watershed 1707020403.

Outlet(s) = Bridge Creek (Lat 44.7368, Long –120.3054)

Upstream to endpoint(s) in:

Bear Creek (44.5585, –120.4198);
Bridge Creek (44.4721, –120.2009);
Carroll Creek (44.5460, –120.3322);
Dodds Creek (44.5329, –120.3867);
Gable Creek (44.5186, –120.2384);

Johnson Creek #2 (44.5193, –120.0949);
Slide Creek (44.4956, –120.3023);
Thompson Creek (44.5270, –120.2489);
West Branch Bridge Creek (44.4911, –120.3098).
(iv) Lower John Day River/Muddy Creek Watershed 1707020404.
Outlet(s) = John Day River (Lat 44.9062, Long –120.4460)
Upstream to endpoint(s) in:
Cherry Creek (44.6344, –120.4543);
Clubfoot Hollow (44.8865, –120.1929);
Cove Creek (44.9299, –120.3791);
Dry Creek (44.6771, –120.5367);
John Day River (44.7368, –120.3054);
Little Muddy Creek (44.7371, –120.5575);
Muddy Creek (44.7491, –120.5071);
Pine Creek (44.8931, –120.1797);
Robinson Canyon (44.8807, –120.2678);
Steers Canyon (44.9247, –120.2013).
(v) Lower John Day River/Clarno Watershed 1707020405.
Outlet(s) = John Day River (Lat 45.1626, Long –120.4681)
Upstream to endpoint(s) in:
Pine Creek (44.9062, –120.4460);
Sorefoot Creek (44.9428, –120.5481).
(vi) Butte Creek Watershed 1707020406.
Outlet(s) = Butte Creek (Lat 45.0574, Long –120.4831)
Upstream to endpoint(s) in:
Butte Creek (44.9266, –120.1142);
Cottonwood Creek (44.9816, –120.2136);
Deep Creek (45.0166, –120.4165);
Hunt Canyon (45.1050, –120.2838);
Straw Fork (44.9536, –120.1024);
Unnamed (45.0952, –120.2928);
West Fork Butte Creek (44.9883, –120.3332).
(vii) Pine Hollow Watershed 1707020407.
Outlet(s) = Pine Hollow (Lat 45.1531, Long –120.4757)
Upstream to endpoint(s) in:
Big Pine Hollow (44.9968, –120.7342);
Brush Canyon (45.0255, –120.6329);
Eakin Canyon (45.1608, –120.5863);
Hannafin Canyon (45.1522, –120.6158);
Long Hollow Creek (44.9922, –120.5565);
West Little Pine Hollow (44.9921, –120.7324).
(viii) Thirtymile Creek Watershed 1707020408.
Outlet(s) = Thirtymile Creek (Lat 45.1626, Long –120.4681)
Upstream to endpoint(s) in:
Condon Canyon (45.1870, –120.1829);
Dry Fork Thirtymile Creek (45.1858, –120.1338);

East Fork Thirtymile Creek (45.1575, –120.0556);
Lost Valley Creek (45.1062, –119.9916);
Patill Canyon (45.1252, –120.1870);
Thirtymile Creek (44.9852, –120.0375);
Unnamed (44.9753, –120.0469);
Wehrli Canyon (45.1539, –120.2137).

(ix) Lower John Day River/Ferry Canyon Watershed 1707020409.
Outlet(s) = John Day River (Lat 45.3801, Long –120.5117)
Upstream to endpoint(s) in:
Ferry Canyon (45.3424, –120.4388);
Jackknife Creek (45.2490, –120.6106);
John Day River (45.1626, –120.4681);
Lamberson Canyon (45.3099, –120.4147);
Little Ferry Canyon (45.3827, –120.5913).

(x) Lower John Day River/Scott Canyon Watershed 1707020410.
Outlet(s) = John Day River (Lat 45.5769, Long –120.4041)
Upstream to endpoint(s) in:
Cottonwood Canyon (45.4143, –120.4490);
Cottonwood Canyon (45.4898, –120.5118);
Dry Fork Hay Creek (45.3093, –120.1612);
John Day River (45.3801, –120.5117);
Scott Canyon (45.4124, –120.1957);
Unnamed (45.3407, –120.2299).

(xi) Upper Rock Creek Watershed 1707020411.
Outlet(s) = Rock Creek (Lat 45.2190, Long –119.9597)
Upstream to endpoint(s) in:
Allen Canyon (45.1092, –119.5976);
Allen Spring Canyon (45.0471, –119.6468);
Board Creek (45.1120, –119.5390);
Brown Creek (45.0365, –119.8296);
Buckhorn Creek (45.0272, –119.9186);
Chapin Creek (45.0538, –119.6727);
Davidson Canyon (45.0515, –119.5952);
Hahn Canyon (45.1491, –119.8320);
Harris Canyon (45.0762, –119.5856);
Hollywood Creek (45.0964, –119.5174);
Indian Creek (45.0481, –119.6476);
John Z Canyon (45.0829, –119.6058);
Juniper Creek (45.0504, –119.7730);
Middle Fork Rock Creek (45.0818, –119.7404);
Rock Creek (45.0361, –119.5989);
Stahl Canyon (45.0071, –119.8683);
Tree Root Canyon (45.0626, –119.6314);
Tupper Creek (45.0903, –119.4999);
Unnamed (45.0293, –119.5907);
Unnamed (45.0698, –119.5329);

Unnamed (45.0714, –119.5227);

West Fork Juniper Creek (45.0192, –119.7786).

(xii) Lower Rock Creek Watershed 1707020412.

Outlet(s) = Rock Creek (Lat 45.5769, Long –120.4041)

Upstream to endpoint(s) in:

Dry Creek (45.3238, –119.9709);

Rock Creek (45.2190, –119.9597);

Sixmile Canyon (45.2448, –120.0283);

South Fork Rock Creek (45.2770, –120.1232).

(xiii) Grass Valley Canyon Watershed 1707020413.

Outlet(s) = Grass Valley Canyon (Lat 45.5974, Long –120.4232)

Upstream to endpoint(s) in:

Grass Valley Canyon (45.4071, –120.7226);

Hay Canyon (45.5104, –120.6085);

Rosebush Creek (45.3395, –120.7159).

(xiv) Lower John Day River/McDonald Ferry Watershed 1707020414.

Outlet(s) = John Day River (Lat 45.7389, Long –120.6520)

Upstream to endpoint(s) in:

John Day River (45.5769, –120.4041).

(13) Lower Deschutes Subbasin 17070306—

(i) Upper Deschutes River Watershed 1707030603.

Outlet(s) = Deschutes River (Lat 44.8579, Long –121.0668)

Upstream to endpoint(s) in:

Deschutes River (44.7243, –121.2465);

Shitike Creek (44.7655, –121.5835);

Unnamed (44.7934, –121.3715).

(ii) Mill Creek Watershed 1707030604.

Outlet(s) = Mill Creek (Lat 44.8792, Long –121.3711)

Upstream to endpoint(s) in:

Boulder Creek (44.8261, –121.4924);

Mill Creek (44.8343, –121.6737);

Unnamed (44.8330, –121.6756).

(iii) Beaver Creek Watershed 1707030605.

Outlet(s) = Beaver Creek (Lat 44.8730, Long –121.3405)

Upstream to endpoint(s) in:

Beaver Butte Creek (45.0786, –121.5746);

Beaver Creek (45.1306, –121.6468);

Indian Creek (45.0835, –121.5113).

(iv) Warm Springs River Watershed 1707030606.

Outlet(s) = Warm Springs River (Lat 44.8579, Long –121.0668)

Upstream to endpoint(s) in:

Badger Creek #2 (44.9352, –121.5569);

South Fork Warm Springs River (44.9268, –121.6995);

Warm Springs River (44.9812, –121.7976).

(v) Middle Deschutes River Watershed 1707030607.

Outlet(s) = Deschutes River (Lat 45.2642, Long –121.0232)

Upstream to endpoint(s) in:
Cove Creek (44.9673, –121.0430);
Deschutes River (44.8579, –121.0668);
Eagle Creek (44.9999, –121.1688);
Nena Creek (45.1030, –121.1653);
Oak Creek (44.9336, –121.0981);
Paquet Gulch (45.0676, –121.2911);
Skookum Creek (44.9171, –121.1251);
Stag Canyon (45.1249, –121.0563);
Unnamed (45.0186, –121.0464);
Unnamed (45.0930, –121.1511);
Wapinitia Creek (45.1177, –121.3025).
(vi) Bakeoven Creek Watershed 1707030608.
Outlet(s) = Bakeoven Creek (Lat 45.1748, Long –121.0728)
Upstream to endpoint(s) in:
Bakeoven Creek (45.1261, –120.9398);
Booten Creek (45.1434, –121.0131);
Cottonwood Creek (45.0036, –120.8720);
Deep Creek (44.9723, –120.9480);
Robin Creek (45.1209, –120.9652);
Trail Hollow Creek (45.1481, –121.0423).
(vii) Buck Hollow Creek Watershed 1707030611.
Outlet(s) = Buck Hollow Creek (Lat 45.2642, Long –121.0232)
Upstream to endpoint(s) in:
Buck Hollow Creek (45.0663, –120.7095);
Finnegan Creek (45.2231, –120.8472);
Macken Canyon (45.1093, –120.7011);
Thorn Hollow (45.0450, –120.7386).
(viii) Lower Deschutes River Watershed 1707030612.
Outlet(s) = Deschutes River (Lat 45.6426, Long –120.9142)
Upstream to endpoint(s) in:
Bull Run Canyon (45.4480, –120.8655);
Deschutes River (45.2642, –121.0232);
Fall Canyon (45.5222, –120.8538);
Ferry Canyon (45.3854, –120.9373);
Jones Canyon (45.3011, –120.9404);
Macks Canyon (45.3659, –120.8524);
Oak Canyon (45.3460, –120.9960);
Sixteen Canyon (45.4050, –120.8529).
(14) Trout Subbasin 17070307—
(i) Upper Trout Creek Watershed 1707030701.
Outlet(s) = Trout Creek (Lat 44.8229, Long –120.9193)
Upstream to endpoint(s) in:
Amity Creek (44.6447, –120.5854);
Auger Creek (44.5539, –120.5381);
Beaver Creek (44.6390, –120.7034);

Big Log Creek (44.5436, –120.6997);
Big Whetstone Creek (44.6761, –120.7645);
Board Hollow (44.6064, –120.7405);
Cartwright Creek (44.5404, –120.6535);
Clover Creek (44.6523, –120.7358);
Dutchman Creek (44.5320, –120.6704);
Foley Creek (44.5861, –120.6801);
Little Trout Creek (44.7816, –120.7237);
Opal Creek (44.5792, –120.5446);
Potlid Creek (44.5366, –120.6207);
Trout Creek (44.5286, –120.5805);
Tub Springs Canyon (44.8155, –120.7888);
Unnamed (44.5428, –120.5848);
Unnamed (44.6043, –120.7403);
Unnamed (44.6510, –120.7337).

(ii) Antelope Creek Watershed 1707030702.
Antelope Creek (Lat 44.8229, Long –120.9193)
Upstream to endpoint(s) in:
Antelope Creek (44.8564, –120.8574);
Boot Creek (44.9086, –120.8864);
Pole Creek (44.9023, –120.9108);
Ward Creek (44.9513, –120.8341).

(iii) Lower Trout Creek Watershed 1707030705.
Outlet(s) = Trout Creek (Lat 44.8214, Long –121.0876)
Upstream to endpoint(s) in:
Brocher Creek (44.8357, –121.0330);
Hay Creek (44.7824, –120.9652);
Trout Creek (44.8229, –120.9193).

(15) Upper Columbia/Priest Rapids Subbasin 17020016—Columbia River/ Zintel Canyon Watershed 1702001606.
Outlet(s) = Columbia River (Lat 46.1776, Long –119.0183)
Upstream to endpoint(s) in:
Columbia River (46.2534, –119.2268).

(16) Columbia River Corridor- Columbia River Corridor
Outlet(s) = Columbia River (Lat 46.2485, Long –124.0782)
Upstream to endpoint(s) in:
Columbia River (45.7070, –121.7943).

(T) Lower Columbia River Steelhead (Oncorhynchus mykiss). Critical habitat is designated to include the areas defined in the following subbasins:

(1) Middle Columbia/Hood Subbasin 17070105—

(i) East Fork Hood River Watershed 1707010506.
Outlet(s) = Hood River (Lat 45.6050, Long –121.6323)
Upstream to endpoint(s) in:
Baldwin Creek (45.5618, –121.5585);
Bear Creek (45.4894, –121.6516);

Cat Creek (45.4708, –121.5591);
Clark Creek (45.3335, –121.6420);
Coe Branch (45.4342, –121.6673);
Cold Spring Creek (45.4020, –121.5873);
Culvert Creek (45.3770, –121.5660);
Dog River (45.4404, –121.5623);
East Fork Hood River (45.3172, –121.6390);
Eliot Branch, Middle Fork Hood River (45.4534, –121.6362);
Emil Creek (45.5223, –121.5886);
Evans Creek (45.4872, –121.5894);
Graham Creek (45.5463, –121.5639);
Meadows Creek (45.3195, –121.6279);
Newton Creek (45.3370, –121.6261);
Pinnacle Creek (45.4595, –121.6568);
Pocket Creek (45.3025, –121.5969);
Polallie Creek (45.4132, –121.5826);
Tony Creek (45.5254, –121.6584);
Unnamed (45.3470, –121.5843);
Unnamed (45.4661, –121.5627);
Unnamed (45.5208, –121.6198);
Unnamed (45.5445, –121.5738).

(ii) West Fork Hood River Watershed 1707010507.
Outlet(s) = West Fork Hood River (Lat 45.6050, Long –121.6323)
Upstream to endpoint(s) in:
Divers Creek (45.5457, –121.7447);
Elk Creek (45.4294, –121.7884);
Green Point Creek (45.5915, –121.6981);
Indian Creek (45.5375, –121.7857);
Jones Creek (45.4673, –121.8020);
Lake Branch (45.5083, –121.8485);
McGee Creek (45.4120, –121.7598);
No Name Creek (45.5347, –121.7929);
Red Hill Creek (45.4720, –121.7705);
Unnamed (45.5502, –121.7014).

(iii) Hood River Watershed 1707010508.
Outlet(s) = Hood River (Lat 45.7237, Long –121.5049)
Upstream to endpoint(s) in:
Hood River (45.6050, –121.6323);
Lenz Creek (45.6291, –121.5220);
Neal Creek (45.5787, –121.4875);
West Fork Neal Creek (45.5751, –121.5215);
Whiskey Creek (45.6827, –121.5064).

(iv) Wind River Watershed 1707010511.
Outlet(s) = Wind River (Lat 45.7067, Long –121.7929)
Upstream to endpoint(s) in:

Bear Creek (45.7619, –121.8295);
Big Hollow Creek (45.9408, –122.0075);
Bourbon Creek (45.9246, –121.9982);
Brush Creek (45.7720, –121.7528);
Cedar Creek (45.8388, –121.7956);
Compass Creek (45.8372, –122.0633);
Crater Creek (45.8637, –122.0639);
Dry Creek (45.9551, –121.9924);
East Fork Trout Creek (45.8503, –122.0096);
Eightmile Creek (45.8616, –121.8966);
Falls Creek (45.9107, –121.9151);
Hollis Creek (45.8524, –121.9304);
Jimmy Creek (45.7886, –121.8409);
Layout Creek (45.8096, –122.0475);
Little Wind River (45.7763, –121.7222);
Martha Creek (45.7846, –121.9482);
Mouse Creek (45.8415, –121.8428);
Ninemile Creek (45.8942, –121.9023);
Oldman Creek (45.9856, –121.9369);
Panther Creek (45.8605, –121.8422);
Pass Creek (45.8555, –122.0133);
Planting Creek (45.8071, –122.0010);
Proverbial Creek (45.9816, –121.9654);
Tenmile Creek (45.8760, –121.8694);
Trapper Creek (45.9113, –122.0470);
Trout Creek (45.8679, –122.0477);
Unnamed (45.7862, –121.9097);
Unnamed (45.8008, –121.9881);
Unnamed (45.8025, –121.9678);
Unnamed (45.8142, –122.0204);
Unnamed (45.8149, –122.0532);
Unnamed (45.8161, –121.8437);
Unnamed (45.8206, –121.8111);
Unnamed (45.8218, –121.9470);
Unnamed (45.8242, –122.0295);
Unnamed (45.8427, –121.9180);
Unnamed (45.8509, –121.9190);
Unnamed (45.8529, –122.0406);
Unnamed (45.8551, –122.0638);
Unnamed (45.8610, –121.9635);
Unnamed (45.8637, –122.0625);
Unnamed (45.8640, –121.9764);
Unnamed (45.8682, –121.9714);
Unnamed (45.8940, –122.0348);
Unnamed (45.8965, –122.0035);
Unnamed (45.9652, –121.9517);

Unnamed (45.9798, –121.8873);
Unnamed (45.9844, –121.9171);
Wind River (45.9964, –121.9000).
(v) Middle Columbia/Grays Creek Watershed 1707010512.
Outlet(s) = Columbia River (Lat 45.7070, Long –121.7943)
Upstream to endpoint(s) in:
Columbia River (45.7237, –121.5049).
(vi) Middle Columbia/Eagle Creek Watershed 1707010513.
Outlet(s) = Columbia River (Lat 45.6453, Long –121.9395)
Upstream to endpoint(s) in:
Columbia River (45.7070, –121.7943).
(2) Lower Columbia/Sandy Subbasin 17080001—
(i) Salmon River Watershed 17080001.
Outlet(s) = Salmon River (Lat 45.3768, Long –122.0293)
Upstream to endpoint(s) in:
Bighorn Creek (45.2582, –121.9204);
Boulder Creek (45.3027, –122.0209);
Cheeney Creek (45.2919, –121.9710);
Copper Creek (45.2454, –121.9051);
Mack Hall Creek (45.2391, –121.9508);
Salmon River (45.2511, –121.9025);
South Fork Salmon River (45.2500, –121.9770);
Unnamed (45.2576, –121.9068);
Unnamed (45.2600, –121.9093);
Unnamed (45.2633, –121.9153);
Unnamed (45.2646, –121.9175);
Unnamed (45.2708, –121.9246);
Unnamed (45.2946, –121.9388);
Unnamed (45.3161, –121.9565);
Unnamed (45.3225, –121.9609);
Unnamed (45.3254, –121.9582);
Unnamed (45.3277, –121.9635);
Unnamed (45.3336, –121.9538);
Unnamed (45.3383, –121.9768);
Unnamed (45.3398, –121.9954).
(ii) Zigzag River Watershed 1708000102.
Outlet(s) = Zigzag River (Lat 45.3489, Long –121.9442)
Upstream to endpoint(s) in:
Camp Creek (45.3070, –121.7921);
Cool Creek (45.2867, –121.8849);
Devil Canyon (45.3186, –121.8587);
Henry Creek (45.3241, –121.8869);
Lady Creek (45.3199, –121.8225);
Little Zigzag Canyon (45.3138, –121.8035);
Still Creek (45.3167, –121.7228);
Unnamed (45.2647, –121.8342);

Unnamed (45.2706, –121.8194);
Unnamed (45.2793, –121.8529);
Unnamed (45.2801, –121.8537);
Wind Creek (45.2961, –121.8515);
Zigzag River (45.3270, –121.7786).
(iii) Upper Sandy River Watershed 1708000103.
Outlet(s) = Sandy River (Lat 45.3489, Long –121.9442)
Upstream to endpoint(s) in:
Cast Creek (45.3794, –121.8538);
Clear Creek (45.3998, –121.8936);
Clear Fork (45.4256, –121.8006);
Horseshoe Creek (45.3664, –121.8680);
Little Clear Creek (45.3854, –121.9190);
Lost Creek (45.3670, –121.8091);
Muddy Fork (45.3920, –121.7577);
Sandy River (45.3719, –121.7560);
Unnamed (45.3813, –121.8954);
Unnamed (45.3904, –121.7979);
Unnamed (45.4090, –121.8056);
Unnamed (45.4164, –121.8342).
(iv) Middle Sandy River Watershed 1708000104.
Outlet(s) = Sandy River (Lat 45.4464, Long –122.2459)
Upstream to endpoint(s) in:
Alder Creek (45.3459, –122.0875);
Bear Creek #2 (45.3368, –121.9265);
Cedar Creek (45.4046, –122.2513);
Hackett Creek (45.3525, –121.9504);
North Boulder Creek (45.3900, –122.0037);
Sandy River (45.3489, –121.9442);
Unnamed (45.3469, –122.0673);
Unnamed (45.3699, –122.0764);
Unnamed (45.3808, –122.0325);
Unnamed (45.3864, –122.0355);
Whisky Creek (45.3744, –122.1202).
(v) Washougal River Watershed 1708000106.
Outlet(s) = Unnamed (Lat 45.5812, Long –122.4077);
Washougal River (45.5795, –122.4023)
Upstream to endpoint(s) in:
Bear Creek (45.7732, –122.1468);
Bluebird Creek (45.7486, –122.1717);
Cougar Creek (45.6514, –122.2677);
Dougan Creek (45.7080, –122.1817);
East Fork Little Washougal River (45.6722, –122.2827);
Grouse Creek (45.7574, –122.1352);
Hagen Creek (45.7154, –122.2518);
Jackson Creek (45.6755, –122.2530);

Jones Creek (45.6913, –122.2870);
Lacamas Creek (45.5972, –122.3933);
Little Washougal River (45.7006, –122.3212);
Lookout Creek (45.7806, –122.1006);
Meander Creek (45.7708, –122.0848);
Prospector Creek (45.7590, –122.0890);
Silver Creek (45.7343, –122.1694);
Stebbins Creek (45.7285, –122.0683);
Texas Creek (45.6946, –122.1873);
Timber Creek (45.7236, –122.1001);
Unnamed (45.5873, –122.4121);
Unnamed (45.6002, –122.3312);
Unnamed (45.6132, –122.3238);
Unnamed (45.6177, –122.2425);
Unnamed (45.6206, –122.3449);
Unnamed (45.6213, –122.2807);
Unnamed (45.6243, –122.2283);
Unnamed (45.6251, –122.3419);
Unnamed (45.6279, –122.2549);
Unnamed (45.6297, –122.2463);
Unnamed (45.6321, –122.2753);
Unnamed (45.6328, –122.2574);
Unnamed (45.6382, –122.2915);
Unnamed (45.6477, –122.3665);
Unnamed (45.6487, –122.3336);
Unnamed (45.6507, –122.1562);
Unnamed (45.6531, –122.2739);
Unnamed (45.6594, –122.2062);
Unnamed (45.6622, –122.3015);
Unnamed (45.6625, –122.3446);
Unnamed (45.6675, –122.3415);
Unnamed (45.6694, –122.1553);
Unnamed (45.6703, –122.3399);
Unnamed (45.6721, –122.1725);
Unnamed (45.6749, –122.3370);
Unnamed (45.6798, –122.2905);
Unnamed (45.6835, –122.3336);
Unnamed (45.6836, –122.1146);
Unnamed (45.6871, –122.2996);
Unnamed (45.6934, –122.1063);
Unnamed (45.6949, –122.3305);
Unnamed (45.6959, –122.3149);
Unnamed (45.6965, –122.0837);
Unnamed (45.7074, –122.1566);
Unnamed (45.7080, –122.2600);
Unnamed (45.7092, –122.2510);

Unnamed (45.7179, –122.0744);
Unnamed (45.7201, –122.1360);
Unnamed (45.7249, –122.1067);
Unnamed (45.7285, –122.1965);
Unnamed (45.7303, –122.1126);
Unnamed (45.7458, –122.1328);
Unnamed (45.7476, –122.0518);
Unnamed (45.7482, –122.1594);
Unnamed (45.7624, –122.1308);
Unnamed (45.7841, –122.1211);
Washougal River (45.7798, –122.1403);
West Fork Washougal River (45.7382, –122.2173);
Wildboy Creek (45.6712, –122.2172);
Winkler Creek (45.6377, –122.2588).

(vi) Columbia Gorge Tributaries Watershed 1708000107.

Outlet(s) = Columbia River (Lat 45.5710, Long –122.4021)
Upstream to endpoint(s) in:
Columbia River (45.6453, –121.9395).

(vii) Lower Sandy River Watershed 1708000108.

Outlet(s) = Sandy River (Lat 45.5679, Long –122.4023)
Upstream to endpoint(s) in:
Beaver Creek (45.4959, –122.3643);
Big Creek (45.5068, –122.2966);
Buck Creek (45.4985, –122.2671);
Gordon Creek (45.5021, –122.1805);
Kelly Creek (45.5134, –122.3953);
Sandy River (45.4464, –122.2459);
Smith Creek (45.5136, –122.3339);
Trout Creek (45.4819, –122.2769);
Unnamed (45.4889, –122.3513);
Unnamed (45.5557, –122.3715);
Unnamed (45.5600, –122.3650).

(3) Lewis Subbasin 17080002—

(i) East Fork Lewis River Watershed 1708000205.

Outlet(s) = Allen Creek (Lat 45.8641, Long –122.7499);
East Fork Lewis River (45.8664, –122.7189);
Gee Creek (45.8462, –122.7803)
Upstream to endpoint(s) in:
Allen Creek (45.8279, –122.6968);
Anaconda Creek (45.8208, –122.2652);
Basket Creek (45.8327, –122.4579);
Big Tree Creek (45.8572, –122.3728);
Brezee Creek (45.8625, –122.6637);
Cedar Creek (45.7226, –122.3290);
Cold Creek (45.7493, –122.3252);
Copper Creek (45.8177, –122.2637);

Coyote Creek (45.7554, –122.2641);
East Fork Lewis River (45.8380, –122.0948);
Gee Creek (45.7920, –122.6679);
Green Fork (45.8462, –122.1274);
Grouse Creek (45.7214, –122.2709);
King Creek (45.7802, –122.2552);
Little Creek (45.8417, –122.1779);
Lockwood Creek (45.8986, –122.5953);
Mason Creek (45.8661, –122.5430);
McCormick Creek (45.8521, –122.6907);
McKinley Creek (45.8026, –122.1797);
Niccolls Creek (45.8148, –122.3093);
Poison Gulch (45.7898, –122.1617);
Riley Creek (45.8936, –122.6175);
Rock Creek (45.7375, –122.2571);
Roger Creek (45.8183, –122.3426);
Slide Creek (45.8477, –122.2090);
Unnamed (45.7212, –122.3389);
Unnamed (45.7623, –122.2727);
Unnamed (45.7697, –122.3157);
Unnamed (45.7726, –122.6651);
Unnamed (45.7770, –122.3539);
Unnamed (45.7802, –122.6068);
Unnamed (45.7858, –122.3283);
Unnamed (45.7916, –122.3780);
Unnamed (45.7919, –122.2780);
Unnamed (45.7961, –122.1312);
Unnamed (45.7980, –122.5650);
Unnamed (45.8033, –122.6667);
Unnamed (45.8038, –122.3545);
Unnamed (45.8075, –122.1120);
Unnamed (45.8076, –122.6285);
Unnamed (45.8079, –122.2942);
Unnamed (45.8146, –122.4818);
Unnamed (45.8147, –122.3144);
Unnamed (45.8149, –122.5653);
Unnamed (45.8172, –122.5742);
Unnamed (45.8207, –122.4916);
Unnamed (45.8230, –122.7069);
Unnamed (45.8242, –122.6390);
Unnamed (45.8292, –122.6040);
Unnamed (45.8306, –122.3769);
Unnamed (45.8353, –122.4842);
Unnamed (45.8363, –122.1252);
Unnamed (45.8368, –122.6498);
Unnamed (45.8381, –122.4685);

Unnamed (45.8427, –122.3708);
Unnamed (45.8432, –122.1480);
Unnamed (45.8434, –122.2292);
Unnamed (45.8439, –122.6478);
Unnamed (45.8471, –122.7486);
Unnamed (45.8475, –122.6486);
Unnamed (45.8484, –122.4401);
Unnamed (45.8498, –122.7300);
Unnamed (45.8502, –122.5228);
Unnamed (45.8513, –122.1323);
Unnamed (45.8537, –122.5973);
Unnamed (45.8600, –122.6112);
Unnamed (45.8604, –122.3831);
Unnamed (45.8606, –122.3981);
Unnamed (45.8662, –122.5772);
Unnamed (45.8667, –122.5744);
Unnamed (45.8689, –122.4227);
Unnamed (45.8698, –122.6777);
Unnamed (45.8756, –122.4795);
Unnamed (45.8813, –122.4772);
Unnamed (45.8899, –122.6256);
Unnamed (45.8986, –122.5742);
Unnamed (45.8988, –122.6123);
Unnamed (45.9055, –122.5187);
Yacolt Creek (45.8761, –122.4220).

(ii) Lower Lewis River Watershed 1708000206.

Outlet(s) = Lewis River (Lat 45.8519, Long –122.7806)

Upstream to endpoint(s) in:

Bitter Creek (45.9133, –122.4593);
Brush Creek (45.9280, –122.4674);
Cedar Creek (45.9019, –122.3655);
Chelatchie Creek (45.9357, –122.3784);
Colvin Creek (45.9400, –122.6081);
Houghton Creek (45.9559, –122.6348);
John Creek (45.9291, –122.4964);
Johnson Creek (45.9536, –122.6183);
Lewis River (45.9570, –122.5550);
Pup Creek (45.9486, –122.5245);
Robinson Creek (45.9362, –122.7243);
Ross Creek (45.9536, –122.7043);
Staples Creek (45.9423, –122.6665);
Unnamed (45.8696, –122.7658);
Unnamed (45.8878, –122.3688);
Unnamed (45.8928, –122.4209);
Unnamed (45.8940, –122.4371);
Unnamed (45.9001, –122.7226);

Unnamed (45.9136, –122.6836);
Unnamed (45.9141, –122.5565);
Unnamed (45.9172, –122.3591);
Unnamed (45.9202, –122.5339);
Unnamed (45.9203, –122.4557);
Unnamed (45.9245, –122.3731);
Unnamed (45.9258, –122.5964);
Unnamed (45.9294, –122.6225);
Unnamed (45.9396, –122.4097);
Unnamed (45.9417, –122.7035);
Unnamed (45.9436, –122.6417);
Unnamed (45.9438, –122.6190);
Unnamed (45.9446, –122.6437);
Unnamed (45.9457, –122.3926);
Unnamed (45.9474, –122.6695);
Unnamed (45.9549, –122.6967).

(4) Lower Columbia/Clatskanie Subbasin 17080003—Kalama River Watershed 1708000301.

Outlet(s) = Burris Creek (Lat 45.8926, Long –122.7892);
Bybee Creek (45.9667, –122.8150);
Kalama River (46.0340, –122.8695);
Mill Creek (45.9579, –122.8030);
Schoolhouse Creek (45.9785, –122.8282);
Unnamed (46.0001, –122.8438);
Unnamed (46.0075, –122.8455)
Upstream to endpoint(s) in:
Arnold Creek (46.0206, –122.5638);
Bear Creek (46.0951, –122.5772);
Burris Creek (45.9506, –122.7428);
Bush Creek (46.0828, –122.4611);
Bybee Creek (45.9695, –122.8135);
Canyon Creek (45.9540, –122.7925);
Cedar Creek (46.0333, –122.8110);
Dee Creek (45.9953, –122.6525);
Elk Creek (46.1154, –122.4796);
Hatchery Creek (46.0673, –122.7548);
Indian Creek (46.0516, –122.7502);
Jacks Creek (46.0400, –122.5014);
Kalama River (46.1109, –122.3579);
Knowlton Creek (46.0245, –122.6454);
Langdon Creek (46.1137, –122.4364);
Little Kalama River (45.9745, –122.6604);
Lost Creek (46.0692, –122.5292);
Mill Creek (45.9741, –122.7756);
North Fork Elk Creek (46.1086, –122.5284);
North Fork Kalama River (46.1550, –122.4007);

Schoolhouse Creek (45.9810, –122.8217);
Spencer Creek (46.0253, –122.8285);
Summers Creek (46.0357, –122.6529);
Unnamed (45.9034, –122.7792);
Unnamed (45.9423, –122.7761);
Unnamed (45.9683, –122.7751);
Unnamed (45.9772, –122.6534);
Unnamed (45.9820, –122.7123);
Unnamed (45.9830, –122.8249);
Unnamed (45.9957, –122.6742);
Unnamed (46.0023, –122.8001);
Unnamed (46.0034, –122.8330);
Unnamed (46.0059, –122.7350);
Unnamed (46.0064, –122.7377);
Unnamed (46.0238, –122.5834);
Unnamed (46.0257, –122.5913);
Unnamed (46.0389, –122.6305);
Unnamed (46.0437, –122.5713);
Unnamed (46.0440, –122.8548);
Unnamed (46.0462, –122.5097);
Unnamed (46.0473, –122.7668);
Unnamed (46.0611, –122.5514);
Unnamed (46.0618, –122.4290);
Unnamed (46.0634, –122.5630);
Unnamed (46.0645, –122.3953);
Unnamed (46.0861, –122.6708);
Unnamed (46.0882, –122.5729);
Unnamed (46.0982, –122.4887);
Unnamed (46.0986, –122.6384);
Unnamed (46.0998, –122.6089);
Unnamed (46.1031, –122.3851);
Unnamed (46.1076, –122.5965);
Unnamed (46.1086, –122.4399);
Unnamed (46.1088, –122.3440);
Unnamed (46.1124, –122.6411);
Unnamed (46.1153, –122.5646);
Unnamed (46.1159, –122.5728);
Unnamed (46.1169, –122.3397);
Unnamed (46.1242, –122.5932);
Unnamed (46.1244, –122.4255);
Unnamed (46.1355, –122.4413);
Unnamed (46.1451, –122.4279);
Unnamed (46.1543, –122.4131);
Unnamed (46.1559, –122.4254);
Wild Horse Creek (46.1018, –122.6755);
Wolf Creek (46.0523, –122.4334).

(5) Upper Cowlitz Subbasin 17080004—
(i) Headwaters Cowlitz River Watershed 1708000401.
Outlet(s) = Cowlitz River (Lat 46.6580, Long –121.6032)
Upstream to endpoint(s) in:
Clear Fork Cowlitz River (46.6846, –121.5668);
Muddy Fork Cowlitz River (46.6973, –121.6177);
Ohanapecosh River (46.6909, –121.5809);
Purcell Creek (46.6722, –121.5877).
(ii) Upper Cowlitz River Watershed 1708000402.
Outlet(s) = Cowlitz River (Lat 46.5742, Long –121.7059)
Upstream to endpoint(s) in:
Butter Creek (46.6451, –121.6749);
Coal Creek (46.6438, –121.6108);
Cowlitz River (46.6580, –121.6032);
Hall Creek (46.6044, –121.6609);
Johnson Creek (46.5546, –121.6373);
Lake Creek (46.6227, –121.6093);
Skate Creek (46.6850, –121.8052);
Unnamed (46.6930, –121.8024).
(iii) Cowlitz Valley Frontal Watershed 1708000403.
Outlet(s) = Cowlitz River (Lat 46.4765, Long –122.0952)
Upstream to endpoint(s) in:
Burton Creek (46.5423, –121.7505);
Cowlitz River (46.5742, –121.7059);
Davis Creek (46.5410, –121.8084);
Kilborn Creek (46.5081, –121.8007);
Oliver Creek (46.5450, –121.9928);
Peters Creek (46.5386, –121.9830);
Siler Creek (46.4931, –121.9085);
Silver Creek (46.5909, –121.9253);
Smith Creek (46.5620, –121.6923);
Unnamed (46.4913, –122.0820);
Unnamed (46.5657, –122.0489);
Willame Creek (46.5805, –121.7319).
(iv) Upper Cispus River Watershed 1708000404.
Outlet(s) = Cispus River (Lat 46.4449, Long –121.7954)
Upstream to endpoint(s) in:
Cispus River (46.3450, –121.6833);
East Canyon Creek (46.3472, –121.7028);
North Fork Cispus River (46.4362, –121.6479);
Timonium Creek (46.4318, –121.6548);
Twin Creek (46.3748, –121.7297);
Yozoo Creek (46.4363, –121.6637).
(v) Lower Cispus River Watershed 1708000405.
Outlet(s) = Cispus River (Lat 46.4765, Long –122.0952)
Upstream to endpoint(s) in:

Ames Creek (46.4654, –121.9233);
Camp Creek (46.4513, –121.8301);
Cispus River (46.4449, –121.7954);
Covell Creek (46.4331, –121.8516);
Crystal Creek (46.4454, –122.0234);
Greenhorn Creek (46.4217, –121.9042);
Iron Creek (46.3887, –121.9702);
McCoy Creek (46.3891, –121.8190);
Quartz Creek (46.4250, –122.0519);
Unnamed (46.4633, –121.9548);
Woods Creek (46.4741, –121.9473);
Yellowjacket Creek (46.3869, –121.8342).

(6) Cowlitz Subbasin 17080005—

(i) Riffe Reservoir Watershed 1708000502.

Outlet(s) = Cowlitz River (Lat 46.5033, Long –122.5870)
Upstream to endpoint(s) in:
Cowlitz River (46.4765, –122.0952).

(ii) Jackson Prairie Watershed 1708000503.

Outlet(s) = Cowlitz River (Lat 46.3678, Long –122.9337)
Upstream to endpoint(s) in:
Bear Creek (46.4538, –122.9192);
Blue Creek (46.4885, –122.7253);
Brights Creek (46.5015, –122.6247);
Cedar Creek (46.4110, –122.7316);
Coon Creek (46.4371, –122.9065);
Cougar Creek (46.3937, –122.7945);
Cowlitz River (46.5033, –122.5870);
Foster Creek (46.4073, –122.8897);
Hopkey Creek (46.4587, –122.5533);
Jones Creek (46.5125, –122.6825);
Lacamas Creek (46.5246, –122.7923);
Little Salmon Creek (46.4402, –122.7458);
Mill Creek (46.5024, –122.8013);
Mill Creek (46.5175, –122.6209);
Otter Creek (46.4801, –122.7000);
Pin Creek (46.4133, –122.8321);
Rapid Creek (46.4320, –122.5465);
Skook Creek (46.5031, –122.7561);
Unnamed (46.3838, –122.7243);
Unnamed (46.3841, –122.6789);
Unnamed (46.3849, –122.7043);
Unnamed (46.3857, –122.9224);
Unnamed (46.3881, –122.6949);
Unnamed (46.3900, –122.7368);
Unnamed (46.3998, –122.8974);
Unnamed (46.4001, –122.7437);

Unnamed (46.4015, –122.7327);
Unnamed (46.4097, –122.5887);
Unnamed (46.4102, –122.6787);
Unnamed (46.4106, –122.7075);
Unnamed (46.4115, –122.9091);
Unnamed (46.4117, –122.7554);
Unnamed (46.4143, –122.7823);
Unnamed (46.4174, –122.6365);
Unnamed (46.4241, –122.8170);
Unnamed (46.4269, –122.6124);
Unnamed (46.4291, –122.6418);
Unnamed (46.4293, –122.8354);
Unnamed (46.4412, –122.5192);
Unnamed (46.4454, –122.8662);
Unnamed (46.4496, –122.5281);
Unnamed (46.4514, –122.8699);
Unnamed (46.4703, –122.7959);
Unnamed (46.4708, –122.7713);
Unnamed (46.4729, –122.6850);
Unnamed (46.4886, –122.8067);
Unnamed (46.5172, –122.6534);
Unnamed (46.5312, –122.8196).

(iii) North Fork Toutle River Watershed 1708000504.

Outlet(s) = North Fork Toutle River (Lat 46.3669, Long –122.5859)

Upstream to endpoint(s) in:

Alder Creek (46.2813, –122.4964);
Bear Creek (46.3085, –122.3504);
Coldwater Creek (46.2884, –122.2675);
Cow Creek (46.3287, –122.4616);
Hoffstadt Creek (46.3211, –122.3324);
Maratta Creek (46.2925, –122.2845);
Unnamed (46.3050, –122.5416);
Unnamed (46.3346, –122.5460);
Unnamed (46.3394, –122.3314).

(iv) Green River Watershed 1708000505.

Outlet(s) = Green River (Lat 46.3718, Long –122.5847)

Upstream to endpoint(s) in:

Beaver Creek (46.4056, –122.5671);
Cascade Creek (46.3924, –122.3529);
Devils Creek (46.4017, –122.4089);
Elk Creek (46.4178, –122.2477);
Green River (46.3857, –122.1815);
Jim Creek (46.3885, –122.5256);
Miners Creek (46.3483, –122.1932);
Shultz Creek (46.3684, –122.2848);

Tradedollar Creek (46.3769, –122.2411);
Unnamed (46.3271, –122.2978);
Unnamed (46.3467, –122.2092);
Unnamed (46.3602, –122.3257);
Unnamed (46.3655, –122.4774);
Unnamed (46.3683, –122.3454);
Unnamed (46.3695, –122.4132);
Unnamed (46.3697, –122.4705);
Unnamed (46.3707, –122.5175);
Unnamed (46.3734, –122.3883);
Unnamed (46.3817, –122.2348);
Unnamed (46.3844, –122.4335);
Unnamed (46.3876, –122.4870);
Unnamed (46.3931, –122.3726);
Unnamed (46.4023, –122.5543);
Unnamed (46.4060, –122.5415);
Unnamed (46.4087, –122.5061);
Unnamed (46.4106, –122.4300);
Unnamed (46.4143, –122.4463);
Unnamed (46.4173, –122.2910);
Unnamed (46.4196, –122.2850);
Unnamed (46.4226, –122.3029);
Unnamed (46.4285, –122.2662).

(v) South Fork Toutle River Watershed 1708000506.

Outlet(s) = South Fork Toutle River (Lat 46.3282, Long –122.7215)

Upstream to endpoint(s) in:

Bear Creek (46.2219, –122.4620);
Big Wolf Creek (46.2259, –122.5662);
Disappointment Creek (46.2138, –122.3080);
Eighteen Creek (46.2453, –122.5989);
Harrington Creek (46.2508, –122.4126);
Johnson Creek (46.3047, –122.5923);
Sheep Canyon (46.2066, –122.2672);
South Fork Toutle River (46.2137, –122.2347);
Studebaker Creek (46.2825, –122.6805);
Thirteen Creek (46.2374, –122.6230);
Trouble Creek (46.1999, –122.3774);
Twenty Creek (46.2508, –122.5738);
Unnamed (46.1858, –122.2983);
Unnamed (46.1953, –122.2881);
Unnamed (46.2068, –122.3301);
Unnamed (46.2075, –122.3267);
Unnamed (46.2082, –122.2591);
Unnamed (46.2107, –122.4301);
Unnamed (46.2115, –122.2786);

Unnamed (46.2117, –122.2378);
Unnamed (46.2121, –122.5188);
Unnamed (46.2157, –122.3467);
Unnamed (46.2215, –122.5318);
Unnamed (46.2234, –122.3265);
Unnamed (46.2265, –122.3906);
Unnamed (46.2271, –122.3367);
Unnamed (46.2277, –122.3719);
Unnamed (46.2309, –122.3828);
Unnamed (46.2357, –122.4802);
Unnamed (46.2365, –122.4402);
Unnamed (46.2424, –122.4860);
Unnamed (46.2444, –122.5427);
Unnamed (46.2457, –122.6283);
Unnamed (46.2523, –122.5147);
Unnamed (46.2587, –122.5333);
Unnamed (46.2591, –122.5240);
Unnamed (46.2608, –122.5493);
Unnamed (46.2618, –122.5705);
Unnamed (46.2693, –122.5763);
Unnamed (46.2707, –122.6094);
Unnamed (46.2932, –122.5890);
Unnamed (46.2969, –122.6718);
Unnamed (46.2976, –122.6129);
Unnamed (46.3035, –122.5952);
Unnamed (46.3128, –122.7032);
Unnamed (46.3217, –122.6473);
Whitten Creek (46.2328, –122.4944).

(vi) East Willapa Watershed 1708000507.

Outlet(s) = Cowlitz River (Lat 46.2660, Long –122.9154)
Upstream to endpoint(s) in:

Arkansas Creek (46.3345, –123.0567);
Baxter Creek (46.3367, –122.9841);
Brim Creek (46.4446, –123.0395);
Campbell Creek (46.3436, –123.0700);
Cline Creek (46.3397, –122.8550);
Cowlitz River (46.3678, –122.9337);
Delameter Creek (46.2705, –123.0143);
Ferrier Creek (46.4646, –122.9374);
Hemlock Creek (46.2586.–122.7270);
Hill Creek (46.3861, –122.8864);
King Creek (46.5304, –123.0203);
McMurphy Creek (46.4113, –122.9469);
Monahan Creek (46.3041, –123.0614);
North Fork Brim Creek (46.4627, –123.0222);
North Fork Toutle River (46.3669, –122.5859);

Owens Creek (46.3994, –123.0457);
Rock Creek (46.3479, –122.8144);
Rock Creek (46.3531, –122.9368);
Snow Creek (46.4486, –122.9805);
Stankey Creek (46.3259, –122.8266);
Stillwater Creek (46.3583, –123.1144);
Sucker Creek (46.2600, –122.7684);
Tucker Creek (46.2565, –123.0162);
Unnamed (46.2413, –122.9887);
Unnamed (46.2480, –123.0169);
Unnamed (46.2480, –122.7759);
Unnamed (46.2517, –123.0173);
Unnamed (46.2606, –122.9549);
Unnamed (46.2629, –123.0188);
Unnamed (46.2663, –122.9804);
Unnamed (46.2709, –122.7687);
Unnamed (46.2711, –122.8159);
Unnamed (46.2840, –122.8128);
Unnamed (46.2878, –123.0286);
Unnamed (46.2883, –122.9051);
Unnamed (46.2892, –122.9625);
Unnamed (46.2900, –122.8124);
Unnamed (46.3030, –123.0645);
Unnamed (46.3092, –122.9826);
Unnamed (46.3160, –122.7783);
Unnamed (46.3161, –123.0123);
Unnamed (46.3173, –122.8950);
Unnamed (46.3229, –122.8152);
Unnamed (46.3245, –122.8609);
Unnamed (46.3248, –123.0292);
Unnamed (46.3252, –122.9238);
Unnamed (46.3294, –122.9084);
Unnamed (46.3309, –123.0046);
Unnamed (46.3316, –122.8257);
Unnamed (46.3346, –123.0167);
Unnamed (46.3378, –122.9398);
Unnamed (46.3393, –122.9402);
Unnamed (46.3415, –122.9208);
Unnamed (46.3456, –122.6405);
Unnamed (46.3472, –122.9457);
Unnamed (46.3488, –123.0519);
Unnamed (46.3510, –123.0079);
Unnamed (46.3511, –122.7678);
Unnamed (46.3584, –122.7902);
Unnamed (46.3585, –123.0369);
Unnamed (46.3586, –122.7477);

Unnamed (46.3599, –123.0992);
Unnamed (46.3623, –122.6910);
Unnamed (46.3665, –122.6334);
Unnamed (46.3667, –122.8953);
Unnamed (46.3683, –122.8930);
Unnamed (46.3683, –122.7502);
Unnamed (46.3718, –122.6202);
Unnamed (46.3720, –123.0933);
Unnamed (46.3748, –122.6167);
Unnamed (46.3818, –122.8822);
Unnamed (46.3824, –122.6090);
Unnamed (46.3942, –122.9794);
Unnamed (46.4015, –123.0272);
Unnamed (46.4045, –123.0194);
Unnamed (46.4177, –122.9611);
Unnamed (46.4200, –123.0403);
Unnamed (46.4286, –123.0467);
Unnamed (46.4362, –123.0451);
Unnamed (46.4379, –122.9985);
Unnamed (46.4571, –122.9604);
Unnamed (46.4606, –123.0166);
Unnamed (46.4724, –122.9989);
Unnamed (46.4907, –122.9352);
Unnamed (46.5074, –122.8877);
Unnamed (46.5089, –122.9291);
Unnamed (46.5228, –122.8539);
Unnamed (46.5336, –122.9793);
Unnamed (46.5371, –122.8214);
Unnamed (46.5439, –122.8538);
Whittle Creek (46.3122, –122.9501);
Wyant Creek (46.3381, –122.6117).
(vii) Coweeman River Watershed 1708000508.
Outlet(s) = Cowlitz River (Lat 46.0977, Long –122.9141);
Owl Creek (46.0771, –122.8676)
Upstream to endpoint(s) in:
Baird Creek (46.1942, –122.5483);
Coweeman River (46.1505, –122.5172);
Cowlitz River (46.2660, –122.9154);
Goble Creek (46.1103, –122.6789);
Hill Creek (46.1784, –122.5990);
Leckler Creek (46.2317, –122.9470);
Little Baird Creek (46.1905, –122.5709);
Martin Creek (46.1394, –122.5519);
Mulholland Creek (46.2013, –122.6450);
Nineteen Creek (46.1437, –122.6146);
North Fork Goble Creek (46.1363, –122.6769);

Nye Creek (46.1219, –122.8040);
O’Neil Creek (46.1760, –122.5422);
Ostrander Creek (46.2103, –122.7623);
Owl Creek (46.0913, –122.8644);
Salmon Creek (46.2547, –122.8839);
Sandy Bend Creek (46.2319, –122.9140);
Skipper Creek (46.1639, –122.5887);
South Fork Ostrander Creek (46.1875, –122.8240);
Turner Creek (46.1167, –122.8149);
Unnamed (46.0719, –122.8607);
Unnamed (46.0767, –122.8605);
Unnamed (46.0824, –122.7200);
Unnamed (46.0843, –122.7195);
Unnamed (46.1185, –122.7253);
Unnamed (46.1289, –122.8968);
Unnamed (46.1390, –122.5709);
Unnamed (46.1430, –122.8125);
Unnamed (46.1433, –122.8084);
Unnamed (46.1478, –122.8649);
Unnamed (46.1546, –122.6376);
Unnamed (46.1562, –122.7808);
Unnamed (46.1579, –122.6476);
Unnamed (46.1582, –122.5332);
Unnamed (46.1605, –122.6681);
Unnamed (46.1620, –122.5885);
Unnamed (46.1671, –122.6284);
Unnamed (46.1688, –122.9215);
Unnamed (46.1724, –122.6118);
Unnamed (46.1735, –122.8282);
Unnamed (46.1750, –122.8428);
Unnamed (46.1750, –122.7557);
Unnamed (46.1797, –122.7746);
Unnamed (46.1803, –122.7801);
Unnamed (46.1811, –122.7631);
Unnamed (46.1814, –122.7656);
Unnamed (46.1840, –122.8191);
Unnamed (46.1955, –122.9082);
Unnamed (46.1966, –122.5542);
Unnamed (46.1971, –122.7118);
Unnamed (46.2014, –122.8241);
Unnamed (46.2021, –122.6941);
Unnamed (46.2027, –122.5593);
Unnamed (46.2172, –122.9516);
Unnamed (46.2192, –122.6663);
Unnamed (46.2199, –122.8375);
Unnamed (46.2208, –122.8887);

Unnamed (46.2231, –122.9509);
Unnamed (46.2257, –122.7667);
Unnamed (46.2261, –122.8023);
Unnamed (46.2379, –122.8859);
Unnamed (46.2430, –122.8842).
(7) Clackamas Subbasin 17090011—
(i) Collawash River Watershed 1709001101.
Outlet(s) = Collawash River (Lat 45.0321, Long –122.0600)
Upstream to endpoint(s) in:
Blister Creek (44.9594, –122.1590);
Dickey Creek (44.9335, –122.0469);
East Fork Collawash River (44.8789, –121.9850);
Elk Lake Creek (44.8886, –122.0128);
Fan Creek (44.9926, –122.0735);
Farm Creek (44.9620, –122.0604);
Hot Springs Fork Collawash River (44.9005, –122.1616);
Hugh Creek (44.9226, –122.1978);
Pansy Creek (44.9463, –122.1420);
Skin Creek (44.9477, –122.2015);
Thunder Creek (44.9740, –122.1230).
(ii) Upper Clackamas River Watershed 1709001102.
Outlet(s) = Clackamas River (Lat 45.0321, Long –122.0600)
Upstream to endpoint(s) in:
Berry Creek (44.8291, –121.9176);
Cabin Creek (45.0087, –121.8958);
Clackamas River (44.8723, –121.8470);
Cub Creek (44.8288, –121.8863);
Fawn Creek (44.9089, –121.9226);
Hunter Creek (44.8926, –121.9285);
Kansas Creek (44.9820, –121.8999);
Last Creek (44.9759, –121.8424);
Lost Creek (45.0180, –121.9070);
Lowe Creek (44.9636, –121.9457);
Pinhead Creek (44.9421, –121.8359);
Pot Creek (45.0201, –121.9014);
Rhododendron Creek (44.9358, –121.9154);
Sisi Creek (44.9110, –121.8875);
Unnamed (44.8286, –121.9225);
Unnamed (44.8343, –121.8778);
Unnamed (44.8944, –121.9028);
Unnamed (44.9355, –121.8735);
Unnamed (44.9661, –121.8894);
Unnamed (44.9687, –121.8920);
Unnamed (45.0000, –121.8910).
(iii) Oak Grove Fork Clackamas River Watershed 1709001103.

Outlet(s) = Oak Grove Fork Clackamas River (Lat 45.0746, Long –122.0520)
Upstream to endpoint(s) in:
Oak Grove Fork Clackamas River (45.0823, –121.9861);
Pint Creek (45.0834, –122.0355).

(iv) Middle Clackamas River Watershed 1709001104.
Outlet(s) = Clackamas River (Lat 45.2440, Long –122.2798)
Upstream to endpoint(s) in:
Big Creek (45.0694, –122.0848);
Calico Creek (45.0682, –122.1627);
Clackamas River (45.0321, –122.0600);
Cripple Creek (45.1149, –122.0618);
Fish Creek (45.0634, –122.1597);
Mag Creek (45.0587, –122.0488);
North Fork Clackamas River (45.2371, –122.2181);
Pick Creek (45.0738, –122.1994);
Pup Creek (45.1451, –122.1055);
Roaring River (45.1773, –122.0650);
Sandstone Creek (45.0862, –122.0845);
Second Creek (45.1081, –122.1601);
South Fork Clackamas River (45.1912, –122.2261);
Tag Creek (45.0605, –122.0475);
Tar Creek (45.0494, –122.0569);
Third Creek (45.0977, –122.1649);
Trout Creek (45.0379, –122.0720);
Wash Creek (45.0473, –122.1893);
Whale Creek (45.1102, –122.0849).

(v) Eagle Creek Watershed 1709001105.
Outlet(s) = Eagle Creek (Lat 45.3535, Long –122.3823)
Upstream to endpoint(s) in:
Bear Creek (45.3369, –122.2331);
Currin Creek (45.3369, –122.3555);
Delph Creek (45.2587, –122.2098);
Eagle Creek (45.2766, –122.1998);
Little Eagle Creek (45.3003, –122.1682);
North Fork Eagle Creek (45.3142, –122.1135);
Trout Creek (45.3305, –122.1187).

(vi) Lower Clackamas River 1709001106.
Outlet(s) = Clackamas River (Lat 45.3719, Long –122.6071)
Upstream to endpoint(s) in:
Bargfeld Creek (45.3195, –122.4398);
Clackamas River (45.2440, –122.2798);
Clear Creek (45.2022, –122.3121);
Deep Creek (45.3421, –122.2799);
Foster Creek (45.3512, –122.4082);
Goose Creek (45.3621, –122.3549);

Little Clear Creek (45.2803, –122.4055);
Mosier Creek (45.2683, –122.4516);
North Fork Deep Creek (45.4271, –122.3094);
Richardson Creek (45.4097, –122.4484);
Rock Creek (45.4157, –122.5013);
Tickle Creek (45.3932, –122.2775);
Unnamed (45.3502, –122.4861);
Unnamed (45.3626, –122.2858);
Unnamed (45.3816, –122.3721);
Unnamed (45.4057, –122.3223);
Unnamed (45.4102, –122.2987);
Wade Creek (45.2922, –122.3237).
(8) Lower Willamette Subbasin 17090012—
(i) Johnson Creek Watershed 1709001201.
Outlet(s) = Willamette River (Lat 45.4423, Long –122.6453)
Upstream to endpoint(s) in:
Crystal Springs Creek (45.4811, –122.6381);
Crystal Springs Lake (45.4799, –122.6361);
Johnson Creek (45.4610, –122.3432);
Kellogg Creek (45.4083, –122.5925);
Kelly Creek (45.4661, –122.4655);
Mount Scott Creek (45.4306, –122.5556);
Oswego Creek (45.4105, –122.6666);
Phillips Creek (45.4328, –122.5763);
Tryon Creek (45.4472, –122.6863);
Unnamed (45.4793, –122.4165);
Willamette River (45.3719, –122.6071).
(ii) Scappoose Creek Watershed 1709001202.
Outlet(s) = Multnomah Channel (Lat 45.8577, Long –122.7919)
Upstream to endpoint(s) in:
Multnomah Channel (45.6188, –122.7921).
(iii) Columbia Slough/Willamette River Watershed 1709001203.
Outlet(s) = Willamette River (Lat 45.6530, Long –122.7646)
Upstream to endpoint(s) in:
Bybee Lake (45.6266, –122.7523);
Bybee/Smith Lakes (45.6105, –122.7285);
Columbia Slough #1 (45.6078, –122.7447);
Swan Island Basin (45.5652, –122.7120);
Unnamed (45.6253, –122.7568);
Willamette River (45.4423, –122.6453).
(9) Lower Columbia River Corridor— Lower Columbia River Corridor
Outlet(s) = Columbia River (Lat 46.2485, Long –124.0782)
Upstream to endpoint(s) in:
Columbia River (45.5710, –122.4021).

(U) Upper Willamette River Steelhead (Oncorhynchus mykiss). Critical habitat is designated to include the areas defined in the following subbasins:

(1) Upper Willamette Subbasin 17090003—
(i) Calapooia River Watershed 1709000303.
Outlet(s) = Calapooia River (Lat 44.5088, Long –123.1101)
Upstream to endpoint(s) in:
Bigs Creek (44.2883, –122.6133);
Butte Creek (44.4684, –123.0488);
Calapooia River (44.2361, –122.3664);
Hands Creek (44.2559, –122.5127);
King Creek (44.2458, –122.4452);
McKinley Creek (44.2569, –122.5621);
North Fork Calapooia River (44.2497, –122.4094);
Potts Creek (44.2581, –122.4756);
Spoon Creek (44.4379, –123.0877);
United States Creek (44.2244, –122.3825).
(ii) Oak Creek Watershed 1709000304.
Outlet(s) = Willamette River (Lat 44.7504, Long –123.1421)
Upstream to endpoint(s) in:
Calapooia River (44.5088, –123.1101);
Cox Creek (44.6417, –123.0680);
Periwinkle Creek (44.6250, –123.0814);
Truax Creek (44.6560, –123.0598).
(iii) Luckiamute River Watershed 1709000306.
Outlet(s) = Luckiamute River (Lat 44.7561, Long –123.1468)
Upstream to endpoint(s) in:
Bonner Creek (44.6735, –123.4849);
Burgett Creek (44.6367, –123.4574);
Clayton Creek (44.7749, –123.4870);
Cooper Creek (44.8417, –123.3246);
Grant Creek (44.8389, –123.4098);
Little Luckiamute River (44.8673, –123.4375);
Luckiamute River (44.7970, –123.5270);
Maxfield Creek (44.6849, –123.3427);
McTimmonds Creek (44.7622, –123.4125);
North Fork Pedee Creek (44.7866, –123.4511);
Plunkett Creek (44.6522, –123.4241);
Price Creek (44.6677, –123.3732);
Sheythe Creek (44.7683, –123.5027);
Soap Creek (44.6943, –123.2488);
South Fork Pedee Creek (44.7798, –123.4667);
Teal Creek (44.8329, –123.4582);
Unnamed (44.7562, –123.5293);
Unnamed (44.7734, –123.2027);
Unnamed (44.7902, –123.6211);
Vincent Creek (44.6380, –123.4327);

Waymire Creek (44.8725, –123.4128);
Woods Creek (44.6564, –123.3905).

(2) North Santiam Subbasin 17090005—

(i) Middle North Santiam River Watershed 1709000504.

Outlet(s) = North Santiam River (Lat 44.7852, Long –122.6079)

Upstream to endpoint(s) in:

Little Rock Creek (44.7330, –122.3927);
Mad Creek (44.7373, –122.3735);
North Santiam River (44.7512, –122.2825);
Rock Creek (44.7011, –122.4080);
Snake Creek (44.7365, –122.4870).

(ii) Little North Santiam River Watershed 1709000505.

Outlet(s) = Little North Santiam River (Lat 44.7852, Long –122.6079)

Upstream to endpoint(s) in:

Cedar Creek (44.8439, –122.2682);
Elkhorn Creek (44.8139, –122.3451);
Evans Creek (44.8412, –122.3601);
Fish Creek (44.8282, –122.3915);
Little North Santiam River (44.8534, –122.2887);
Little Sinker Creek (44.8235, –122.4163);
Sinker Creek (44.8211, –122.4210).

(iii) Lower North Santiam River Watershed 1709000506.

Outlet(s) = Santiam River (Lat 44.7504, Long –123.1421)

Upstream to endpoint(s) in:

Bear Branch (44.7602, –122.7942);
Chehulpum Creek (44.7554, –122.9898);
Cold Creek (44.7537, –122.8812);
Morgan Creek (44.7495, –123.0443);
North Santiam River (44.7852, –122.6079);
Salem Ditch (44.8000, –122.8120);
Santiam River (44.6869, –123.0052);
Smallman Creek (44.7293, –122.9139);
Stout Creek (44.8089, –122.5994);
Trask Creek (44.7725, –122.6152);
Unnamed (44.7972, –122.7328);
Valentine Creek (44.7999, –122.7311).

(3) South Santiam Subbasin 17090006—

(i) Hamilton Creek/South Santiam River Watershed 1709000601.

Outlet(s) = South Santiam River (Lat 44.6869, Long –123.0052)

Upstream to endpoint(s) in:

Albany—Santiam Canal (44.5512, –122.9032);
Hamilton Creek (44.5392, –122.7018);
Johnson Creek (44.4548, –122.7080);
McDowell Creek (44.4640, –122.6803);
Mill Creek (44.6628, –122.9575);

Morgan Creek (44.4557, –122.7058);
Noble Creek (44.4513, –122.7974);
South Santiam River (44.4163, –122.6693).
(ii) Crabtree Creek Watershed 1709000602.
Outlet(s) = Crabtree Creek (Lat 44.6756, Long –122.9557)
Upstream to endpoint(s) in:
Bald Barney Creek (44.5469, –122.5959);
Bald Peter Creek (44.5325, –122.6024);
Beaver Creek (44.6337, –122.8537);
Camp Creek (44.5628, –122.5768);
Crabtree Creek (44.6208, –122.5055);
Cruiser Creek (44.5543, –122.5831);
Green Mountain Creek (44.5777, –122.6258);
Roaring River (44.6281, –122.7148);
Rock Creek (44.5883, –122.6000);
South Fork Crabtree Creek (44.5648, –122.5441);
White Rock Creek (44.6050, –122.5209).
(iii) Thomas Creek Watershed 1709000603.
Outlet(s) = Thomas Creek (Lat 44.6778, Long –122.9654)
Upstream to endpoint(s) in:
Criminal Creek (44.7122, –122.5709);
Ella Creek (44.6815, –122.5228);
Hortense Creek (44.6756, –122.5017);
Jordan Creek (44.7527, –122.6519);
Mill Creek (44.7060, –122.7849);
Neal Creek (44.6923, –122.6484);
South Fork Neal Creek (44.7016, –122.7049);
Thomas Creek (44.6776, –122.4650);
West Fork Ella Creek (44.6805, –122.5288).
(iv) South Santiam River Watershed 1709000606.
Outlet(s) = South Santiam River (Lat 44.3977, Long –122.4473)
Upstream to endpoint(s) in:
Canyon Creek (44.3074, –122.3300);
Falls Creek (44.4007, –122.3828);
Harter Creek (44.4166, –122.2605);
Keith Creek (44.4093, –122.2847);
Moose Creek (44.4388, –122.3671)
Owl Creek (44.2999, –122.3686);
Shuttle Camp Creek (44.4336, –122.2597);
Soda Fork South Santiam River (44.4410, –122.2466);
South Santiam River (44.3980, –122.2610);
Trout Creek (44.3993, –122.3464);
Two Girls Creek (44.3248, –122.3346).
(v) South Santiam River/Foster Reservoir Watershed 1709000607.
Outlet(s) = South Santiam River (Lat 44.4163, Long –122.6693)
Upstream to endpoint(s) in:

        Lewis Creek (44.4387, –122.6223);
        Middle Santiam River (44.4498, –122.5479);
        South Santiam River (44.3977, –122.4473).
    (vi) Wiley Creek Watershed 1709000608.
      Outlet(s) = Wiley Creek (Lat 44.4140, Long –122.6752)
      Upstream to endpoint(s) in:
        Farmers Creek (44.3383, –122.5812);
        Jackson Creek (44.3669, –122.6344);
        Little Wiley Creek (44.3633, –122.5228);
        Unnamed (44.3001, –122.4579);
        Unnamed (44.3121, –122.5197);
        Unnamed (44.3455, –122.5934);
        Unnamed (44.3565, –122.6051);
        Wiley Creek (44.2981, –122.4318).
(4) Middle Willamette Subbasin 17090007—
    (i) Mill Creek/Willamette River Watershed 1709000701.
      Outlet(s) = Mill Creek (Lat 44.9520, Long –123.0381)
      Upstream to endpoint(s) in:
        Mill Creek (44.8268, –122.8249).
    (ii) Rickreall Creek Watershed 1709000702.
      Outlet(s) = Willamette River (Lat 44.9288, Long –123.1124)
      Upstream to endpoint(s) in:
        Willamette River (44.7504, –123.1421).
    (iii) Willamette River/Chehalem Creek Watershed 1709000703.
      Outlet(s) = Willamette River (Lat 45.2552, Long –122.8806)
      Upstream to endpoint(s) in:
        Willamette River (44.9288, –123.1124).
    (iv) Abernethy Creek Watershed 1709000704.
      Outlet(s) = Willamette River (Lat 45.3540, Long –122.6186)
      Upstream to endpoint(s) in:
        Willamette River (45.2552, –122.8806).
(5) Yamhill Subbasin 17090008—
    (i) Upper South Yamhill River Watershed 1709000801.
      Outlet(s) = South Yamhill River (Lat 45.0784, Long –123.4753)
      Upstream to endpoint(s) in:
        Agency Creek (45.1799, –123.6976);
        Cedar Creek (45.0892, –123.6969);
        Cockerham Creek (45.0584, –123.5077);
        Cosper Creek (45.1497, –123.6178);
        Cow Creek (45.0410, –123.6165);
        Crooked Creek (45.0964, –123.6611);
        Doane Creek (45.0449, –123.4929);
        Ead Creek (45.1214, –123.6969);
        Elmer Creek (45.0794, –123.6714);
        Gold Creek (45.0108, –123.5496);
        Jackass Creek (45.0589, –123.6495);

Joe Creek (45.1216, –123.6216);
Joe Day Creek (45.0285, –123.6660);
Kitten Creek (45.1110, –123.7266);
Klees Creek (45.0784, –123.5496);
Lady Creek (45.0404, –123.5269);
Little Rowell Creek (45.0235, –123.5792);
Mule Tail Creek (45.0190, –123.5547);
Pierce Creek (45.1152, –123.7203);
Rock Creek (45.0130, –123.6344);
Rogue River (45.0613, –123.6550);
Rowell Creek (45.0187, –123.5699);
Unnamed (45.0318, –123.5421);
Unnamed (45.0390, –123.4620);
Unnamed (45.0431, –123.5541);
Unnamed (45.0438, –123.4721);
Unnamed (45.0493, –123.6044);
Unnamed (45.0599, –123.4661);
Unnamed (45.0945, –123.6110);
Unnamed (45.0994, –123.6276);
Unnamed (45.1151, –123.6566);
Unnamed (45.1164, –123.6717);
Unnamed (45.1412, –123.6705);
West Fork Agency Creek (45.1575, –123.7032);
Wind River (45.1367, –123.6392);
Yoncalla Creek (45.1345, –123.6614).

(ii) Mill Creek/South Yamhill River Watershed 1709000803.
Outlet(s) = Mill Creek (Lat 45.0908, Long –123.4434)
Upstream to endpoint(s) in:
Mill Creek (45.0048, –123.4184).

(iii) Lower South Yamhill River Watershed 1709000804.
Outlet(s) = South Yamhill River (Lat 45.1616, Long –123.2190)
Upstream to endpoint(s) in:
South Yamhill River (45.0784, –123.4753).

(iv) Yamhill River Watershed 1709000807.
Outlet(s) = Yamhill River (Lat 45.2301, Long –122.9950)
Upstream to endpoint(s) in:
South Yamhill River (45.1616, –123.2190).

(6) Molalla/Pudding Subbasin 17090009-

(i) Abiqua Creek/Pudding River Watershed 1709000901.
Outlet(s) = Pudding River (Lat 45.0740, Long –122.8525)
Upstream to endpoint(s) in :
Abiqua Creek (44.9264, –122.5666);
Little Abiqua Creek (44.9252, –122.6204);
Little Pudding River (45.0435, –122.8965);
Powers Creek (44.9552, –122.6796);
Pudding (44.9998, –122.8412);

Silver Creek (44.8981, –122.6799).

(ii) Butte Creek/Pudding River Watershed 1709000902.

Outlet(s) = Pudding River (Lat 45.1907, Long –122.7527)

Upstream to endpoint(s) in:

Pudding River (45.0740, –122.8525).

(iii) Rock Creek/Pudding River Watershed 1709000903.

Outlet(s) = Rock Creek (Lat 45.1907, Long –122.7527)

Upstream to endpoint(s) in:

Rock Creek (45.0876, –122.5916).

(iv) Senecal Creek/Mill Creek Watershed 1709000904.

Outlet(s) = Pudding River (Lat 45.2843, Long –122.7149)

Upstream to endpoint(s) in:

Pudding River (45.1907, –122.7527).

(v) Upper Molalla River Watershed 1709000905.

Outlet(s) = Molalla River (Lat 45.1196, Long –122.5342)

Upstream to endpoint(s) in:

Camp Creek (44.9630, –122.2928);
Cedar Creek (45.0957, –122.5257);
Copper Creek (44.8877, –122.3704);
Cougar Creek (45.0421, –122.3145);
Dead Horse Canyon Creek (45.0852, –122.3146);
Gawley Creek (44.9320, –122.4304);
Lost Creek (44.9913, –122.2444);
Lukens Creek (45.0498, –122.2421);
Molalla River (44.9124, –122.3228);
North Fork Molalla River (45.0131, –122.2986);
Pine Creek (45.0153, –122.4560);
Table Rock Fork Molalla River (44.9731, –122.2629);
Trout Creek (45.0577, –122.4657).

(vi) Lower Molalla River Watershed 1709000906.

Outlet(s) = Molalla River (Lat 45.2979, Long –122.7141)

Upstream to endpoint(s) in:

Buckner Creek (45.2382, –122.5399);
Canyon Creek (45.1317, –122.3858);
Cedar Creek (45.2037, –122.5327);
Gribble Creek (45.2004, –122.6867);
Jackson Creek (45.1822, –122.3898);
Milk Creek (45.2036, –122.3761);
Molalla River (45.1196, –122.5342);
Woodcock Creek (45.1508, –122.5075).

(7) Tualatin Subbasin 17090010— Gales Creek Watershed 1709001002.

Outlet(s) = Tualatin River (Lat 45.5019, Long –122.9946)

Upstream to endpoint(s) in:

Bateman Creek (45.6350, –123.2966);
Beaver Creek (45.6902, –123.2889);
Clear Creek (45.5705, –123.2567);

Gales Creek (45.6428, –123.3576);
Iler Creek (45.5900, –123.2582);
North Fork Gales Creek (45.6680, –123.3394);
Roaring Creek (45.5620, –123.2574);
Roderick Creek (45.5382, –123.2013);
South Fork Gales Creek (45.6059, –123.2978);
Tualatin River (45.4917, –123.1012).

(8) Lower Willamette/Columbia River Corridor—Lower Willamette/Columbia River Corridor.

Outlet(s) = Columbia River (Lat 46.2485, Long –124.0782)
Upstream to endpoint(s) in:
Willamette River (45.3540, –122.6186).

(V) Oregon Coast Coho Salmon (Oncorhynchus kisutch). Critical habitat is designated to include the areas defined in the following subbasins:

(1) Necanicum Subbasin 17100201- Necanicum River Watershed 1710020101.
Outlet(s) =
Arch Cape Creek (Lat 45.8035, Long-123.9656);
Asbury Creek (45.815,-123.9624);
Ecola Creek (45.8959,-123.9649);
Necanicum River (46.0113,-123.9264);
Short Sand Creek (45.7595,-123.9641)
Upstream to endpoint(s) in:
Arch Cape Creek (45.8044,-123.9404);
Asbury Creek (45.8150,-123.9584);
Beerman Creek (45.9557,-123.8749);
Bergsvik Creek (45.8704,-123.7650);
Brandis Creek (45.8894,-123.8529);
Charlie Creek (45.9164,-123.7606);
Circle Creek (45.9248,-123.9436);
Circle Creek Trib A (45.9335,-123.9457);
North Fork Ecola Creek (45.8705,-123.9070);
West Fork Ecola Creek (45.8565,-123.9424);
Grindy Creek (45.9179,-123.7390);
Hawley Creek (45.9259,-123.8864);
Joe Creek (45.8747,-123.7503);
Johnson Creek (45.8885,-123.8816);
Klootchie Creek (45.9450,-123.8413);
Klootchie Creek Trib A (45.9250,-123.8447);
Lindsley Creek (45.9198,-123.8339);
Little Humbug Creek (45.9235,-123.7653);
Little Joe Creek (45.8781,-123.7852);
Little Muddy Creek (45.9551,-123.9559);
Mail Creek (45.8887,-123.8655);
Meyer Creek (45.9279,-123.9135);
Mill Creek (46.0245,-123.8905);

Mill Creek Trib 1 (46.0142,-123.8967);
Neacoxie Creek (46.0245,-123.9157);
Neawanna Creek (45.9810,-123.8809);
Necanicum River (45.9197,-123.7106);
North Fork Necanicum River (45.9308,-123.7986);
North Fork Necanicum River Trib A (45.9398,-123.8109);
South Fork Necanicum River (45.8760,-123.8122);
Shangrila Creek (45.9706,-123.8778);
Short Sand Creek (45.7763,-123.9406);
Thompson Creek (46.0108,-123.8951);
Tolovana Creek (45.8581,-123.9370);
Unnamed (45.8648,-123.9371);
Unnamed (45.8821,-123.9318);
Unnamed (45.8881,-123.7436);
Unnamed (45.8883,-123.9366);
Unnamed (45.8906,-123.7460);
Unnamed (45.8912,-123.9433);
Unnamed (45.8950,-123.8715);
Unnamed (45.9026,-123.9540);
Unnamed (45.9046,-123.9578);
Unnamed (45.9050,-123.9585);
Unnamed (45.9143,-123.8656);
Unnamed (45.9161,-123.9000);
Unnamed (45.9210,-123.8668);
Unnamed (45.9273,-123.8499);
Unnamed (45.9292,-123.8900);
Unnamed (45.9443,-123.9038);
Unnamed (45.9850,-123.8999);
Unnamed (46.0018,-123.8998);
Volmer Creek (45.9049,-123.9139);
Warner Creek (45.8887,-123.7801);
Williamson Creek (45.9522,-123.9060).
(2) Nehalem Subbasin 17100202-
(i) Upper Nehalem River Watershed 1710020201.
Outlet(s) = Nehalem River (Lat 45.9019, Long -123.1442)
Upstream to endpoint(s) in:
Bear Creek (45.7781,-123.4252);
Bear Creek (45.8556,-123.2205);
Beaver Creek (45.7624,-123.2073);
Beaver Creek Trib A (45.8071,-123.2143);
Beaver Creek Trib B (45.7711,-123.2318);
Carlson Creek (45.7173,-123.3425);
Castor Creek (45.7103,-123.2698);
Cedar Creek (45.8528,-123.2928);
Clear Creek, Lower North Fork (45.8229,-123.3111);
Clear Creek (45.8239,-123.3531);

Coal Creek Trib B (45.8149,-123.1174);
Coal Creek (45.7978,-123.1293);
Coon Creek (45.8211,-123.1446);
Dell Creek (45.7919,-123.1559);
Derby Creek (45.7225,-123.3857);
Dog Creek (45.8957,-123.0741);
Elk Creek (45.8256,-123.1290);
Fall Creek (45.8626,-123.3247);
Ginger Creek (45.8520,-123.3511);
Ivy Creek (45.8938,-123.3160);
Jim George Creek (45.8009,-123.1041);
Kenusky Creek (45.8859,-123.0422);
Kist Creek (45.7826,-123.2507);
Lousignont CreeK (45.7424,-123.3722);
Lousignont Creek, North Fork (45.7463,-123.3576);
Martin Creek (45.8474,-123.4025);
Maynard Creek (45.8556,-123.3038);
Military Creek (45.8233,-123.4812);
Nehalem River (45.7269,-123.4159);
Nehalem River, East Fork (45.8324,-123.0502);
Olson Creek (45.8129,-123.3853);
Pebble Creek (45.7661,-123.1357);
Pebble Creek, West Fork (45.7664,-123.1899);
Robinson Creek (45.7363,-123.2512);
Rock Creek (45.8135,-123.5201);
Rock Creek, North Fork (45.8616,-123.4560);
Rock Creek, South Fork (45.7598,-123.4249);
Rock Creek Trib C (45.7957,-123.4882);
South Fork Rock Creek Trib A (45.7753,-123.4586);
South Fork Nehalem River (45.7073,-123.4017);
Selder Creek (45.8975,-123.3806);
South Fork Clear Creek (45.8141,-123.3484);
South Prong Clear Creek (45.7832,-123.2975);
Step Creek (45.6824,-123.3348);
Swamp Creek (45.8217,-123.2004);
Unnamed (45.7270,-123.3419);
Unnamed (45.8095,-123.0908);
Unnamed (45.7558,-123.2630);
Unnamed (45.7938,-123.3847);
Unnamed (45.7943,-123.4059);
Unnamed (45.8197,-123.0679);
Unnamed (45.8477,-123.0734);
Unnamed (45.8817,-123.1266);
Unnamed (45.8890,-123.3817);
Unnamed (45.9019,-123.1346);
Weed Creek (45.8707,-123.4049);

Wolf Creek, South Fork (45.7989,-123.4028);
Wolf Creek (45.7768,-123.3556).

(ii) Middle Nehalem River Watershed 1710020202.
Outlet(s) = Nehalem River (Lat 45.9838, Long -123.4214)
Upstream to endpoint(s) in:

Adams Creek (46.0263,-123.2869);
Archibald Creek (45.9218,-123.0829);
Beaver Creek (46.0554,-123.2985);
Boxler Creek (46.0486,-123.3521);
Calvin Creek (45.9514,-123.2976);
Cedar Creek (45.9752,-123.1143);
Cook Creek (45.9212,-123.1087);
Cow Creek (46.0500,-123.4326);
Crooked Creek (45.9043,-123.2689);
Deep Creek (45.9461,-123.3719);
Deep Creek Trib A (45.9127,-123.3794);
Deep Creek Trib B (45.9314,-123.3809);
Deer Creek (45.9033,-123.3142);
Eastman Creek (46.0100,-123.2262);
Fall Creek (45.9438,-123.2012);
Fishhawk Creek (46.0596,-123.3857);
Fishhawk Creek, North Fork (46.0907,-123.3675);
Fishhawk Creek, Trib C (46.0808,-123.3692);
Ford Creek (46.0570,-123.2872);
Gus Creek (45.9828,-123.1453);
Johnson Creek (46.0021,-123.2133);
Lane Creek (45.9448,-123.3253);
Little Deer Creek (45.9378,-123.2780);
Lousignont Creek (46.0342,-123.4186);
Lundgren Creek (46.0240,-123.2092);
McCoon Creek (46.0665,-123.3043);
Messing Creek (46.0339,-123.2260);
Nehalem River (45.9019,-123.1442);
Northrup Creek (46.0672,-123.4377);
Oak Ranch Creek (45.9085,-123.0834);
Sager Creek (45.9388,-123.4020);
Unnamed (45.9039,-123.2044);
Unnamed (45.9067,-123.0595);
Unnamed (45.9488,-123.2220);
Unnamed (45.9629,-123.3845);
Unnamed (45.9999,-123.1732);
Unnamed (46.0088,-123.4508);
Unnamed (46.0208,-123.4588);
Unnamed (46.0236,-123.2381);
Unnamed (46.0308,-123.3135);
Unnamed (46.0325,-123.4650);

Unnamed (46.0390,-123.3648);
Unnamed (46.0776,-123.3274);
Unnamed (46.0792,-123.3409);
Unnamed (46.0345,-123.2956);
Warner Creek (46.0312,-123.3817);
Wrong Way Creek (46.0789,-123.3142).

(iii) Lower Nehalem River Watershed 1710020203.
Outlet(s) = Nehalem River (Lat 45.7507, Long -123.6530)
Upstream to endpoint(s) in:

Alder Creek (45.9069,-123.5907);
Beaver Creek (45.8949,-123.6764);
Big Creek (45.8655,-123.6476);
Bull Heifer Creek (45.9908,-123.5322);
Buster Creek (45.9306,-123.4165);
Cedar Creek (45.8931,-123.6029);
Cow Creek (45.8587,-123.5206);
Crawford Creek (45.9699,-123.4725);
Cronin Creek, Middle Fork (45.7719,-123.5747);
Cronin Creek, North Fork (45.7795,-123.6064);
Cronin Creek, South Fork (45.7456,-123.5596);
Destruction Creek (45.8750,-123.6571);
East Humbug Creek (45.9454,-123.6358);
Fishhawk Creek (45.9666,-123.5895);
Fishhawk Creek (46.0224,-123.5374);
George Creek (45.8461,-123.6226);
George Creek (45.9118,-123.5766);
Gilmore Creek (45.9609,-123.5372);
Hamilton Creek (46.0034,-123.5881);
Klines Creek (45.8703,-123.4908);
Larsen Creek (45.8757,-123.5847);
Little Fishhawk Creek (45.9256,-123.5501);
Little Rock Creek (45.8886,-123.4558);
McClure Creek (45.8560,-123.6227);
Moores Creek (45.8801,-123.5178);
Nehalem River (45.9838,-123.4214);
Quartz Creek (45.8414,-123.5184);
Spruce Run Creek (45.8103,-123.6028);
Squaw Creek (45.9814,-123.4529);
Stanley Creek (45.8861,-123.4352);
Strum Creek (45.9321,-123.4275);
Trailover Creek (46.0129,-123.4976);
Unnamed (45.8083,-123.6280);
Unnamed (45.8682,-123.6168);
Unnamed (45.9078,-123.6630);
Unnamed (45.9207,-123.4534);
Unnamed (45.9405,-123.6338);

Unnamed (45.9725,-123.5544);
West Humbug Creek (45.9402,-123.6726);
Walker Creek (45.9266,-123.4423);
Walker Creek (46.0391,-123.5142);
West Brook (45.9757,-123.4638).

(iv) Salmonberry River Watershed 1710020204.
Outlet(s) = Salmonberry River (Lat 45.7507, Long -123.6530)
Upstream to endpoint(s) in:

Pennoyer Creek (45.7190,-123.4366);
Salmonberry River (45.7248,-123.4436);
Salmonberry River, North Fork (45.7181,-123.5204);
Wolf Creek (45.6956,-123.4485).

(v) North Fork of Nehalem River Watershed 1710020205.
Outlet(s) = Nehalem River, North Fork (Lat 45.7317, Long -123.8765)
Upstream to endpoint(s) in:

Acey Creek (45.7823,-123.8292);
Anderson Creek (45.7643,-123.9073);
Big Rackheap Creek (45.7546,-123.8145);
Boykin Creek (45.8030,-123.8595);
Buchanan Creek (45.8270,-123.7901);
Coal Creek (45.7897,-123.8676);
Coal Creek, West Fork (45.7753,-123.8871);
Cougar Creek (45.8064,-123.8090);
Fall Creek (45.7842,-123.8547);
Fall Creek (45.8226,-123.7054);
Gods Valley Creek (45.7689,-123.7793);
Grassy Lake Creek (45.7988,-123.8193);
Gravel Creek (45.7361,-123.8126);
Henderson Creek (45.7932,-123.8548);
Jack Horner Creek (45.8531,-123.7837);
Lost Creek (45.7909,-123.7195);
Nehalem River, Little North Fork (45.9101,-123.6972);
Nehalem River, North Fork (45.8623,-123.7463);
Nehalem River, North Fork, Trib R (45.8287,-123.6625);
Nehalem River, North Fork, Trib T (45.8492,-123.6796);
Rackheap Creek (45.7677,-123.8008);
Sally Creek (45.8294,-123.7468);
Soapstone Creek (45.8498,-123.7469);
Soapstone Creek, Trib A (45.8591,-123.7616);
Sweethome Creek (45.7699,-123.6616);
Unnamed (45.7457,-123.8490);
Unnamed (45.7716,-123.7691);
Unnamed (45.7730,-123.7789);
Unnamed (45.7736,-123.7607);
Unnamed (45.7738,-123.7534);
Unnamed (45.7780,-123.7434);

Unnamed (45.7784,-123.7742);
Unnamed (45.7794,-123.7315);
Unnamed (45.7824,-123.7396);
Unnamed (45.7833,-123.7680);
Unnamed (45.7841,-123.7299);
Unnamed (45.7858,-123.7660);
Unnamed (45.7898,-123.7424);
Unnamed (45.7946,-123.7365);
Unnamed (45.7966,-123.7953);
Unnamed (45.8008,-123.7349);
Unnamed (45.8193,-123.7436);
Unnamed (45.8322,-123.7789);
Unnamed (45.8359,-123.7766);
Unnamed (45.8569,-123.7235);
Unnamed (45.8629,-123.7347);
Unnamed (45.8662,-123.7444);
Unnamed (45.8962,-123.7189).

(vi) Lower Nehalem River/Cook Creek Watershed 1710020206.
Outlet(s) = Nehalem River (Lat 45.6577, Long -123.9355)
Upstream to endpoint(s) in:

Alder Creek (45.7286,-123.9091);
Anderson Creek (45.6711,-123.7470);
Bastard Creek (45.7667,-123.6943);
Bob's Creek (45.7444,-123.9038);
Cook Creek (45.6939,-123.6146);
Cook Creek, East Fork (45.6705,-123.6440);
Daniels Creek (45.6716,-123.8606);
Dry Creek (45.6449,-123.8507);
Dry Creek (45.6985,-123.7422);
East Foley Creek (45.6621,-123.8068);
Fall Creek (45.7489,-123.7778);
Foley Creek (45.6436,-123.8933);
Gallagher Slough (45.7140,-123.8657);
Hanson Creek (45.6611,-123.7179);
Harliss Creek (45.6851,-123.7249);
Helloff Creek (45.7545,-123.7603);
Hoevett Creek (45.6894,-123.6276);
Jetty Creek (45.6615,-123.9103);
Lost Creek (45.7216,-123.7164);
Neahkahnie Creek (45.7197,-123.9247);
Nehalem River (45.7507,-123.6530);
Peterson Creek (45.6975,-123.8098);
Piatt Canyon (45.6844,-123.6983);
Roy Creek (45.7174,-123.8038);
Snark Creek (45.7559,-123.6713);
Unnamed (45.6336,-123.8549);

Unnamed (45.6454,-123.8663);
Unnamed (45.6483,-123.8605);
Unnamed (45.6814,-123.8786);
Unnamed (45.7231,-123.9016).

(3) Wilson/Trask/Nestucca Subbasin 17100203-

(i) Little Nestucca River Watershed 1710020301.

Outlet(s) = Little Nestucca River (Lat 45.1827, Long -123.9543)

Upstream to endpoint(s) in:

Austin Creek (45.1080,-123.8748);
Austin Creek, West Fork (45.1074,-123.8894);
Baxter Creek (45.1149,-123.7705);
Bear Creek (45.1310,-123.8500);
Bowers Creek (45.1393,-123.9198);
Cedar Creek (45.0971,-123.8094);
Fall Creek (45.1474,-123.8767);
Hiack Creek (45.0759,-123.8042);
Kautz Creek (45.0776,-123.8317);
Kellow Creek (45.1271,-123.9072);
Little Nestucca River (45.0730,-123.7825);
Little Nestucca River, South Fork (45.0754,-123.8393);
Louie Creek (45.1277,-123.7869);
McKnight Creek (45.1124,-123.8363);
Small Creek (45.1151,-123.8227);
Sourgrass Creek (45.0917,-123.7623);
Sourgrass Creek, Trib A (45.1109,-123.7664);
Squaw Creek (45.1169,-123.8938);
Stillwell Creek (45.0919,-123.8141);
Unname (45.1169,-123.7974).

(ii) Nestucca River Watershed 1710020302.

Outlet(s) = Nestucca Bay (Lat 45.1607, Long -123.9678)

Upstream to endpoint(s) in:

Alder Creek (45.1436,-123.7998);
Alder Creek (45.2436,-123.7364);
Bays Creek (45.3197,-123.7240);
Bear Creek (45.3188,-123.6022);
Bear Creek (45.3345,-123.7898);
Beulah Creek (45.2074,-123.6747);
Bible Creek (45.2331,-123.5868);
Boulder Creek (45.2530,-123.7525);
Buck Creek (45.1455,-123.7734);
Cedar Creek (45.3288,-123.4531);
Clarence Creek (45.2649,-123.6395);
Clear Creek (45.1725,-123.8660);
Crazy Creek (45.1636,-123.7595);
Dahl Fork (45.2306,-123.7076);
East Beaver Creek (45.3579,-123.6877);

East Creek (45.3134,-123.6348);
Elk Creek (45.3134,-123.5645);
Elk Creek, Trib A (45.2926,-123.5381);
Elk Creek, Trib B (45.2981,-123.5471);
Fan Creek (45.2975,-123.4994);
Farmer Creek (45.2593,-123.9074);
Foland Creek (45.2508,-123.7890);
Foland Creek, West Fork (45.2519,-123.8025);
George Creek (45.2329,-123.8291);
Ginger Creek (45.3283,-123.4680);
Hartney Creek (45.2192,-123.8632);
Horn Creek (45.2556,-123.9212);
Lawrence Creek (45.1861,-123.7852);
Limestone Creek (45.2472,-123.7169);
Mina Creek (45.2444,-123.6197);
Moon Creek (45.3293,-123.6762);
North Beaver Creek (45.3497,-123.8961);
Nestucca River (45.3093,-123.4077);
Niagara Creek (45.1898,-123.6637);
Pheasant Creek (45.2121,-123.6366);
Pollard Creek (45.1951,-123.7958);
Powder Creek (45.2305,-123.6974);
Saling Creek (45.2691,-123.8474);
Sanders Creek (45.2254,-123.8959);
Slick Rock Creek (45.2683,-123.6106);
Swab Creek (45.2889,-123.7656);
Testament Creek (45.2513,-123.5488);
Three Rivers (45.1785,-123.7557);
Tiger Creek (45.3405,-123.8029);
Tiger Creek, Trib A (45.3346,-123.8547);
Tony Creek (45.2575,-123.7735);
Turpy Creek (45.2537,-123.7620);
Unnamed (45.1924,-123.8202);
Unnamed (45.2290,-123.9398);
Unnamed (45.3018,-123.4636);
Unnamed (45.3102,-123.6628);
Unnamed (45.3148,-123.6616);
Unnamed (45.3158,-123.8679);
Unnamed (45.3292,-123.8872);
Walker Creek (45.2914,-123.4207);
West Beaver Creek (45.3109,-123.8840);
West Creek (45.2899,-123.8514);
Wildcat Creek (45.3164,-123.8187);
Wolfe Creek (45.3113,-123.7658);
Woods Creek (45.1691,-123.8070).
(iii) Tillamook River Watershed 1710020303.

Outlet(s) = Tillamook River (Lat 45.4682, Long -123.8802)
Upstream to endpoint(s) in:
Bear Creek (45.4213,-123.8885);
Beaver Creek (45.4032,-123.8861);
Bewley Creek (45.3637,-123.8965);
Esther Creek (45.4464,-123.9017);
Fawcett Creek (45.3824,-123.7210);
Joe Creek (45.3754,-123.8257);
Killam Creek (45.4087,-123.7276);
Mills Creek (45.3461,-123.7915);
Munson Creek (45.3626,-123.7681);
Simmons Creek (45.3605,-123.7364);
Sutton Creek (45.4049,-123.8568);
Tillamook River (45.3595,-123.9115);
Tomlinson Creek (45.4587,-123.8868);
Unnamed (45.3660,-123.8313);
Unnamed (45.3602,-123.8466);
Unnamed (45.3654,-123.9050);
Unnamed (45.3987,-123.7105);
Unnamed (45.4083,-123.8160);
Unnamed (45.4478, 123.8670);
Unnamed (45.3950,-123.7348).
(iv) Trask River Watershed 1710020304.
Outlet(s) = Trask River (Lat 45.4682, Long -123.8802)
Upstream to endpoint(s) in:
Bales Creek (45.3712,-123.5786);
Bark Shanty Creek (45.4232,-123.5550);
Bear Creek (45.4192,-123.7408);
Bill Creek (45.3713,-123.6386);
Blue Bus Creek (45.4148,-123.5949);
Boundry Creek (45.3493,-123.5470);
Clear Creek #1 (45.4638,-123.5571);
Clear Creek #2 (45.5025,-123.4683);
Cruiser Creek (45.4201,-123.4753);
Dougherty Slough (45.4684,-123.7888);
East Fork of South Fork Trask River (45.3563,-123.4752);
Edwards Creek (45.3832,-123.6676);
Elkhorn Creek, Trib C (45.4080,-123.4440);
Elkhorn Creek (45.3928,-123.4709);
Gold Creek (45.4326,-123.7218);
Green Creek (45.4510,-123.7361);
Hatchery Creek (45.4485,-123.6623);
Headquarters Camp Creek (45.3317,-123.5072);
Hoquarten Slough (45.4597,-123.8480);
Joyce Creek (45.3881,-123.6386);
Michael Creek (45.4799,-123.5119);

Mill Creek (45.4100,-123.7450);
Miller Creek (45.3582,-123.5666);
Pigeon Creek (45.3910,-123.5656);
Rawe Creek (45.4395,-123.6351);
Rock Creek (45.3515,-123.5074);
Samson Creek (45.4662,-123.6439);
Scotch Creek (45.4015,-123.5873);
Steampot Creek (45.3875,-123.5425);
Stretch Creek (45.3483,-123.5382);
Summit Creek (45.3481,-123.6054);
Summit Creek, South Fork (45.3473,-123.6145);
Trask River, North Fork, Middle Fork (45.4472,-123.3945);
Trask River, North Fork, North Fork (45.5275,-123.4177);
Trask River, South Fork (45.3538,-123.6445);
Trib A (45.3766,-123.5191);
Trib B (45.3776,-123.4988);
Unnamed (45.3639,-123.6054);
Unnamed (45.4105,-123.7741);
Unnamed (45.4201,-123.6320);
Unnamed (45.4220,-123.7654).

(v) Wilson River Watershed 1710020305.
Outlet(s) = Wilson River (Lat 45.4816, Long -123.8708)
Upstream to endpoint(s) in:

Beaver Creek (45.4894,-123.7933);
Ben Smith Creek (45.5772,-123.5072);
Cedar Creek (45.5869,-123.6228);
Cedar Creek, North Fork (45.6066,-123.6151);
Deo Creek (45.6000,-123.3716);
Drift Creek (45.6466,-123.3944);
Elk Creek (45.6550,-123.4620);
Elk Creek, West Fork (45.6208,-123.4717);
Elliott Creek (45.5997,-123.3925);
Fall Creek (45.4936,-123.5616);
Fox Creek (45.5102,-123.5869);
Hatchery Creek (45.4835,-123.7074);
Hughey Creek (45.4540,-123.7526);
Idiot Creek (45.6252,-123.4296);
Jones Creek (45.6028,-123.5702);
Jordan Creek (45.5610,-123.4557);
Jordan Creek, South Fork (45.5099,-123.5279);
Kansas Creek (45.4861,-123.6434);
Morris Creek (45.6457,-123.5409);
Tuffy Creek (45.5787,-123.4702);
Unnamed (45.4809,-123.8362);
Unnamed (45.5758,-123.5226);
Unnamed (45.5942,-123.4259);

Unnamed (45.6002,-123.5939);
Unnamed (45.6151,-123.4385);
White Creek (45.5181,-123.7223);
Wilson River, Devil's Lake Fork (45.6008,-123.3301);
Wilson River, North Fork (45.6679,-123.5138);
Wilson River, North Fork, Little (45.5283,-123.6771);
Wilson River, North Fork, West Fork (45.6330,-123.5879);
Wilson River, North Fork, West Fork, North Fork (45.6495,-123.5779);
Wilson River, South Fork (45.5567,-123.3965);
Wolf Creek (45.5683,-123.6129).

(vi) Kilchis River Watershed 1710020306.
Outlet(s) = Kilchis River (Lat 45.4927, Long -123.8615)
Upstream to endpoint(s) in:
Clear Creek (45.5000,-123.7647);
Coal Creek (45.5004,-123.8085);
Company Creek (45.5892,-123.7370);
French Creek (45.6318,-123.6926);
Kilchis River, Little South Fork (45.5668,-123.7178);
Kilchis River, North Fork (45.6044,-123.6504);
Kilchis River, South Fork (45.5875,-123.6944);
Mapes Creek (45.5229,-123.8382);
Murphy Creek (45.5320,-123.8341);
Myrtle Creek (45.5296,-123.8156);
Sam Downs Creek (45.5533,-123.7144);
Schroeder Creek (45.6469,-123.7064);
Unnamed (45.5625,-123.7593).

(vii) Miami River Watershed 1710020307.
Outlet(s) = Miami River (Lat 45.5597, Long -123.8904)
Upstream to endpoint(s) in:
Diamond Creek (45.6158,-123.8184);
Hobson Creek (45.5738,-123.8970);
Illingsworth Creek (45.5547,-123.8693);
Miami River (45.6362,-123.7533);
Miami River, Trib S (45.6182,-123.8004);
Miami River, Trib T (45.6546,-123.7463);
Minich Creek (45.5869,-123.8936);
Moss Creek (45.5628,-123.8319);
Peterson Creek (45.6123,-123.8996);
Prouty Creek (45.6304,-123.8435);
Stuart Creek (45.6042,-123.8442);
Unnamed (45.6317,-123.7906);
Unnamed (45.6341,-123.7900);
Waldron Creek (45.5856,-123.8483).

(viii) Tillamook Bay Watershed 1710020308.
Outlet(s) = Tillamook Bay (Lat 45.5600, Long -123.9366)

Upstream to endpoint(s) in:
Douthy Creek (45.5277,-123.8570);
Electric Creek (45.5579,-123.8925);
Hall Slough (45.4736,-123.8637);
Jacoby Creek (45.5297,-123.8665);
Kilchis River (45.4927,-123.8615);
Larson Creek (45.5366,-123.8849);
Miami River (45.5597,-123.8904);
Patterson Creek (45.5359,-123.8732);
Tillamook Bay (45.4682,-123.8802);
Vaughn Creek (45.5170,-123.8516);
Wilson River (45.4816,-123.8708).

(ix) Spring Creek/Sand Lake/ Neskowin Creek Frontal Watershed 1710020309.

Outlet(s) =
Crescent Lake (45.6360,-123.9405);
Neskowin Creek (45.1001,-123.9859);
Netarts Bay (45.4339,-123.9512);
Rover Creek (45.3290,-123.9670);
Sand Creek (45.2748,-123.9589);
Watesco Creek (45.5892,-123.9477)

Upstream to endpoint(s) in:
Andy Creek (45.2905,-123.8744);
Butte Creek (45.1159,-123.9360);
Crescent Lake (45.6320,-123.9376);
Davis Creek (45.3220,-123.9254);
Fall Creek (45.0669,-123.9679);
Hawk Creek (45.1104,-123.9436);
Jackson Creek (45.3568,-123.9611);
Jewel Creek (45.2865,-123.8905);
Jim Creek (45.0896,-123.9224);
Lewis Creek (45.0835,-123.8979);
Meadow Creek (45.0823,-123.9824);
Neskowin Creek (45.0574,-123.8812);
Prospect Creek (45.0858,-123.9321);
Reneke Creek (45.2594,-123.9434);
Rover Creek (45.3284,-123.9438);
Sand Creek (45.3448,-123.9156);
Sloan Creek (45.0718,-123.8998);
Watesco Creek (45.5909,-123.9353);
Whiskey Creek (45.3839,-123.9193).

(4) Siletz/Yaquina Subbasin 17100204-

(i) Upper Yaquina River Watershed 1710020401.

Outlet(s) = Yaquina River (Lat 44.6219, Long -123.8741)

Upstream to endpoint(s) in:
Bales Creek (44.6893,-123.7503);

Bales Creek, East Fork (44.6927,-123.7363);
Bales Creek, East Fork, Trib A (44.6827,-123.7257);
Bales Creek (44.6610,-123.8749);
Bones Creek (44.6647,-123.6762);
Bryant Creek (44.6746,-123.7139);
Buckhorn Creek (44.6676,-123.6677);
Buttermilk Creek (44.6338,-123.6827);
Buttermilk Creek, Trib A (44.6518,-123.7173);
Carlisle Creek (44.6451,-123.8847);
Cline Creek (44.6084,-123.6844);
Cook Creek (44.6909,-123.8583);
Crystal Creek (44.6500,-123.8132);
Davis Creek (44.6500,-123.6587);
Eddy Creek (44.6388,-123.7951);
Felton Creek (44.6626,-123.6502);
Haxel Creek (44.6781,-123.8046);
Hayes Creek (44.6749,-123.7749);
Humphrey Creek (44.6697,-123.6329);
Klamath Creek (44.6927,-123.8431);
Little Elk Creek (44.6234,-123.6628);
Little Elk Creek,Trib A (44.6196,-123.7583);
Little Yaquina River (44.6822,-123.6123);
Lytle Creek (44.6440,-123.5979);
Miller Creek (44.6055,-123.7030);
Oglesby Creek (44.6421,-123.7271);
Oglesby Creek, Trib A (44.6368, 123.7100);
Peterson Creek (44.6559,-123.7868);
Randall Creek (44.6721,-123.6570);
Salmon Creek (44.6087,-123.7379);
Simpson Creek (44.6775,-123.8780);
Sloop Creek (44.6654,-123.8595);
Spilde Creek (44.6636,-123.5856);
Stony Creek (44.6753,-123.7020);
Thornton Creek (44.6923,-123.8208);
Trapp Creek (44.6455,-123.8307);
Twentythree Creek (44.6887,-123.8751);
Unnamed (44.6074,-123.6738);
Unnamed (44.6076,-123.7067);
Unnamed (44.6077,-123.6633);
Unnamed (44.6123,-123.6646);
Unnamed (44.6188,-123.7237);
Unnamed (44.6202,-123.7201);
Unnamed (44.6367,-123.7444);
Unnamed (44.6415,-123.6237);
Unnamed (44.6472,-123.7793);
Unnamed (44.6493,-123.6789);

Unnamed (44.6707,-123.7908);
Unnamed (44.6715,-123.6907);
Unnamed (44.6881,-123.6089);
Unnamed (44.6908,-123.7298);
Wakefield Creek (44.6336,-123.6963);
Yaquina River (44.6894,-123.5907);
Young Creek (44.6372,-123.6027).

(ii) Big Elk Creek Watershed 1710020402.
Outlet(s) = Elk Creek (Lat 44.6219, Long -123.8741)
Upstream to endpoint(s) in:

Adams Creek (44.5206,-123.6349);
Baker Creek (44.5230,-123.6346);
Bear Creek (44.5966,-123.8299);
Beaver Creek (44.6040,-123.7999);
Beaverdam Creek (44.5083,-123.6337);
Bevens Creek (44.5635,-123.7371);
Bull Creek (44.5408,-123.8162);
Bull Creek (44.5431,-123.8142);
Bull Creek, Trib A (44.5359,-123.8276);
Cougar Creek (44.5070,-123.6482);
Cougar Creek (44.5861,-123.7563);
Deer Creek (44.6020,-123.7667);
Devils Well Creek (44.6324,-123.8438);
Dixon Creek (44.6041,-123.8659);
Elk Creek (44.5075,-123.6022);
Feagles Creek (44.4880,-123.7180);
Feagles Creek, Trib B (44.5079,-123.6909);
Feagles Creek, West Fork (44.5083,-123.7117);
Grant Creek (44.5010,-123.7363);
Harve Creek (44.5725,-123.8025);
Jackass Creek (44.5443,-123.7790);
Johnson Creek (44.5466,-123.6336);
Lake Creek (44.5587,-123.6826);
Leverage Creek (44.5536,-123.6343);
Little Creek (44.5548,-123.6980);
Little Wolf Creek (44.5590,-123.7165);
Peterson Creek (44.5576,-123.6450);
Rail Creek (44.5135,-123.6639);
Spout Creek (44.5824,-123.6561);
Sugarbowl Creek (44.5301,-123.5995);
Unnamed (44.5048,-123.7566);
Unnamed (44.5085,-123.6309);
Unnamed (44.5108,-123.6249);
Unnamed (44.5144,-123.6554);
Unnamed (44.5204,-123.6148);
Unnamed (44.5231,-123.6714);

Unnamed (44.5256,-123.6804);
Unnamed (44.5325,-123.7244);
Unnamed (44.5332,-123.7211);
Unnamed (44.5361,-123.7139);
Unnamed (44.5370,-123.7643);
Unnamed (44.5376,-123.6176);
Unnamed (44.5410,-123.8213);
Unnamed (44.5504,-123.8290);
Unnamed (44.5530,-123.8282);
Unnamed (44.5618,-123.8431);
Unnamed (44.5687,-123.8563);
Unnamed (44.5718,-123.7256);
Unnamed (44.5734,-123.6696);
Unnamed (44.5737,-123.6566);
Unnamed (44.5771,-123.7027);
Unnamed (44.5821,-123.8123);
Unnamed (44.5840,-123.6678);
Unnamed (44.5906,-123.7871);
Unnamed (44.5990,-123.7808);
Unnamed (44.5865,-123.8521);
Wolf Creek (44.5873,-123.6939);
Wolf Creek, Trib A (44.5862,-123.7188);
Wolf Creek, Trib B (44.5847,-123.7062).
(iii) Lower Yaquina River Watershed 1710020403.
Outlet(s) = Yaquina River (Lat 44.6098, Long -124.0818)
Upstream to endpoint(s) in:
Abbey Creek (44.6330,-123.8881);
Babcock Creek (44.5873,-123.9221);
Beaver Creek (44.6717,-123.9799);
Blue Creek (44.6141,-123.9936);
Boone Slough, Trib A (44.6134,-123.9769);
Depot Creek, Little (44.6935,-123.9482);
Depot Creek, Trib A (44.6837,-123.9420);
Drake Creek (44.6974,-123.9690);
East Fork Mill Creek (44.5691,-123.8834);
Flesher Slough (44.5668,-123.9803);
King Slough (44.5944,-124.0323);
Little Beaver Creek (44.6531,-123.9728);
McCaffery Slough (44.5659,-124.0180);
Mill Creek (44.5550,-123.9064);
Mill Creek, Trib A (44.5828,-123.8750);
Montgomery Creek (44.5796,-123.9286);
Nute Slough (44.6075,-123.9660);
Olalla Creek (44.6810,-123.8972);
Olalla Creek, Trib A (44.6511,-123.9034);
Parker Slough (44.5889,-124.0119);

Unnamed (44.5471,-123.9557);
Unnamed (44.5485,-123.9308);
Unnamed (44.5520,-123.9433);
Unnamed (44.5528,-123.9695);
Unnamed (44.5552,-123.9294);
Unnamed (44.5619,-123.9348);
Unnamed (44.5662,-123.8905);
Unnamed (44.5827,-123.9456);
Unnamed (44.5877,-123.8850);
Unnamed (44.6444,-123.9059);
Unnamed (44.6457,-123.9996);
Unnamed (44.6530,-123.9914);
Unnamed (44.6581,-123.8947);
Unnamed (44.6727-123.8942);
Unnamed (44.6831,-123.9940);
West Olalla Creek (44.6812,-123.9299);
West Olalla Creek, Trib A (44.6649,-123.9204);
Wessel Creek (44.6988,-123.9863);
Wright Creek (44.5506,-123.9250);
Wright Creek, Trib A (44.5658,-123.9422);
Yaquina River (44.6219,-123.8741).
(iv) Middle Siletz River Watershed 1710020405.
Outlet(s) = Siletz River (Lat 44.7375, Long -123.7917)
Upstream to endpoint(s) in:
Buck Creek, East Fork (44.8410,-123.7970);
Buck Creek, South Fork (44.8233,-123.8095);
Buck Creek, West Fork (44.8352,-123.8084);
Cerine Creek (44.7478,-123.7198);
Deer Creek (44.8245,-123.7268);
Deer Creek, Trib A (44.8178,-123.7397);
Elk Creek (44.8704,-123.7668);
Fourth of July Creek (44.8203,-123.6810);
Gunn Creek (44.7816,-123.7679);
Holman River (44.8412,-123.7707);
Mill Creek, North Fork (44.7769,-123.7361);
Mill Creek, South Fork (44.7554,-123.7276);
Palmer Creek (44.7936,-123.8344);
Siletz River (44.8629,-123.7323);
Sunshine Creek (44.7977,-123.6963);
Unnamed (44.7691,-123.7851);
Unnamed (44.7747,-123.7740);
Unnamed (44.7749,-123.7662);
Unnamed (44.8118,-123.6926);
Unnamed (44.8188,-123.6995);
Unnamed (44.8312,-123.6983);
Unnamed (44.8583,-123.7573);

Whiskey Creek (44.8123,-123.6937).

(v) Rock Creek/Siletz River Watershed 1710020406.

Outlet(s) = Rock Creek (Lat 44.7375, Long -123.7917)

Upstream to endpoint(s) in:

Beaver Creek (44.7288,-123.6773);
Big Rock Creek (44.7636,-123.6969);
Brush Creek (44.6829,-123.6582);
Cedar Creek (44.7366,-123.6586);
Fisher Creek (44.7149,-123.6359);
Little Rock Creek (44.7164,-123.6155);
Little Steere Creek (44.7219,-123.6368);
Rock Creek, Trib A (44.7414,-123.7508);
Steere Creek (44.7336,-123.6313);
Unnamed (44.7175,-123.6496);
William Creek (44.7391,-123.7277).

(vi) Lower Siletz River Watershed 1710020407.

Outlet(s) = Siletz Bay (Lat 44.9269, Long -124.0218)

Upstream to endpoint(s) in:

Anderson Creek (44.9311,-123.9508);
Bear Creek (44.8682,-123.8891);
Bentilla Creek (44.7745,-123.8555);
Butterfield Creek (44.8587,-123.9993);
Cedar Creek (44.8653,-123.8488);
Cedar Creek, Trib D (44.8606,-123.8696);
Coon Creek (44.7959,-123.8468);
Dewey Creek (44.7255,-123.9724);
Drift Creek (44.9385,-123.8211);
Erickson Creek (44.9629,-123.9490);
Euchre Creek (44.8023,-123.8687);
Fowler Creek (44.9271,-123.8440);
Gordey Creek (44.9114,-123.9724);
Hough Creek (44.8052,-123.8991);
Jaybird Creek (44.7640,-123.9733);
Long Prairie Creek (44.6970,-123.7499);
Long Tom Creek (44.7037,-123.8533);
Mann Creek (44.6987,-123.8025);
Mill Creek (44.6949,-123.8967);
Miller Creek (44.7487,-123.9733);
North Creek (44.9279,-123.8908);
North Roy Creek (44.7916,-123.9897);
Ojalla Creek (44.7489,-123.9427);
Quarry Creek (44.8989,-123.9360);
Reed Creek (44.8020,-123.8835);
Reed Creek (44.8475,-123.9267);
Roots Creek (44.8300,-123.9351);
South Roy Creek (44.7773,-123.9847);

Sam Creek (44.7086,-123.7312);
Sampson Creek (44.9089,-123.8173);
Savage Creek (44.8021,-123.8608);
Scare Creek (44.8246,-123.9954);
Schooner Creek, North Fork (44.9661,-123.8793);
Schooner Creek, South Fork (44.9401,-123.8689);
Scott Creek (44.7414,-123.8268);
Sijota Creek (44.8883,-124.0257);
Siletz River (44.7375,-123.7917);
Skunk Creek (44.8780,-123.9073);
Smith Creek (44.9294,-123.8056);
Stemple Creek (44.8405,-123.9492);
Tangerman Creek (44.7278,-123.8944);
Thayer Creek (44.7023,-123.8256);
Thompson Creek (44.7520,-123.8893);
Unnamed (44.7003,-123.7669);
Unnamed (44.8904,-123.8034);
Unnamed (44.8927,-123.8400);
Unnamed (44.7034,-123.7754);
Unnamed (44.7145,-123.8423);
Unnamed (44.7410,-123.8800);
Unnamed (44.7925,-123.9212);
Unnamed (44.8396,-123.8896);
Unnamed (44.9035,-123.8635);
Unnamed (44.9240,-123.7913);
West Fork Mill Creek (44.7119,-123.9703);
Wildcat Creek (44.8915,-123.8842).
(vii) Salmon River/Siletz/Yaquina Bay Watershed 1710020408.
Outlet(s) = Salmon River (Lat 45.0474, Long -124.0031)
Upstream to endpoint(s) in:
Alder Brook (45.0318,-123.8428);
Bear Creek (44.9785,-123.8580);
Boulder Creek (45.0428,-123.7817);
Calkins Creek (45.0508,-123.9615);
Crowley Creek (45.0540,-123.9819);
Curl Creek (45.0150,-123.9198);
Deer Creek (45.0196,-123.8091);
Frazer Creek (45.0096,-123.9576);
Gardner Creek (45.0352,-123.9024);
Indian Creek (45.0495,-123.8010);
Little Salmon River (45.0546,-123.7473);
McMullen Creek (44.9829,-123.8682);
Panther Creek (45.0208,-123.8878);
Panther Creek, North Fork (45.0305,-123.8910);
Prairie Creek (45.0535,-123.8129);
Rowdy Creek (45.0182,-123.9751);

Salmon River (45.0269,-123.7224);
Slick Rock Creek (44.9903,-123.8158);
Sulphur Creek (45.0403,-123.8216);
Telephone Creek (45.0467,-123.9348);
Toketa Creek (45.0482,-123.9088);
Trout Creek (44.9693,-123.8337);
Unnamed (44.9912,-123.8789);
Unnamed (45.0370,-123.7333);
Unnamed (45.0433,-123.7650);
Widow Creek (45.0373,-123.8530);
Widow Creek, West Fork (45.0320,-123.8643);
Willis Creek (45.0059,-123.9391).
(viii) Devils Lake/Moolack Frontal Watershed 1710020409.
Outlet(s) =
Big Creek (Lat 44.6590, Long -124.0571);
Coal Creek (44.7074,-124.0615);
D River (44.9684,-124.0172);
Fogarty Creek (44.8395,-124.0520);
Moolack Creek (44.7033,-124.0622);
North Depoe Bay Creek (44.8098,-124.0617);
Schoolhouse Creek (44.8734,-124.0401);
Spencer Creek (44.7292,-124.0582);
Wade Creek (44.7159,-124.0600)
Upstream to endpoint(s) in:
Big Creek (44.6558,-124.0427);
Coal Creek (44.7047,-124.0099);
Devils Lake (44.9997,-123.9773);
Fogarty Creek (44.8563,-124.0153);
Jeffries Creek (44.6425,-124.0315);
Moolack Creek (44.6931,-124.0150);
North Depoe Bay Creek (44.8157,-124.0510);
Rock Creek (44.9869,-123.9317);
South Depoe Bay Creek (44.7939,-124.0126);
Salmon Creek (44.8460,-124.0164);
Schoolhouse Creek (44.8634,-124.0151);
South Fork Spencer Creek (44.7323,-123.9974);
Spencer Creek, North Fork (44.7453,-124.0276);
Unnamed (44.8290,-124.0318);
Unnamed (44.9544,-123.9867);
Unnamed (44.9666,-123.9731);
Unnamed (44.9774,-123.9706);
Wade Creek (44.7166,-124.0057).
(5) Alsea Subbasin 17100205-
(i) Upper Alsea River Watershed 1710020501.
Outlet(s) = Alsea River, South Fork (Lat 44.3767, Long -123.6024)
Upstream to endpoint(s) in:

Alder Creek (44.4573,-123.5188);
Alsea River, South Fork (44.3261,-123.4891);
Baker Creek (44.4329,-123.5522);
Banton Creek (44.3317,-123.6020);
Brown Creek (44.3151,-123.6250);
Bummer Creek (44.3020,-123.5765);
Cabin Creek (44.4431,-123.5328);
Crooked Creek (44.4579,-123.5099);
Dubuque Creek (44.3436,-123.5527);
Ernest Creek (44.4234,-123.5275);
Hayden Creek (44.4062,-123.5815);
Honey Grove Creek (44.3874,-123.5078);
North Fork Alsea River (44.4527,-123.6102);
Parker Creek (44.4702,-123.5978);
Peak Creek (44.3358,-123.4933);
Record Creek (44.3254,-123.6331);
Seeley Creek (44.4051,-123.5177);
Swamp Creek (44.3007,-123.6108);
Tobe Creek (44.3273,-123.5719);
Trout Creek (44.3684,-123.5163);
Unnamed (44.3108,-123.6225);
Unnamed (44.3698,-123.5670);
Unnamed (44.4574,-123.5001);
Unnamed (44.3708,-123.5740);
Unnamed (44.3713,-123.5656);
Unnamed (44.3788,-123.5528);
Unnamed (44.4270,-123.5492);
Unnamed (44.4518,-123.6236);
Yew Creek (44.4581,-123.5373);
Zahn Creek (44.4381,-123.5425).

(ii) Five Rivers/Lobster Creek Watershed 1710020502.
Outlet(s) = Five Rivers (Lat 44.3584, Long -123.8279)
Upstream to endpoint(s) in:

Alder Creek (44.2947,-123.8105);
Bear Creek (44.2824,-123.9123);
Bear Creek (44.3588,-123.7930);
Bear Creek (44.2589,-123.6647);
Briar Creek (44.3184,-123.6602);
Buck Creek (44.2428,-123.8989);
Camp Creek (44.2685,-123.7552);
Cascade Creek (44.3193,-123.9073);
Cascade Creek, North Fork (44.3299,-123.8932);
Cedar Creek (44.2732,-123.7753);
Cherry Creek (44.3061,-123.8140);
Coal Creek (44.2881,-123.6484);
Cook Creek (44.2777,-123.6445);

Cougar Creek (44.2723,-123.8678);
Crab Creek (44.2458,-123.8750);
Crazy Creek (44.2955,-123.7927);
Crooked Creek (44.3154,-123.7986);
Elk Creek (44.3432,-123.7969);
Fendall Creek (44.2764,-123.7890);
Five Rivers (44.2080,-123.8025);
Green River (44.2286,-123.8751);
Green River, East Fork (44.2255,-123.8143);
Jasper Creek (44.2777,-123.7326);
Little Lobster Creek (44.2961,-123.6266);
Lobster Creek, East Fork (44.2552,-123.5897);
Lobster Creek, South Fork (44.2326,-123.6060);
Lobster Creek (44.2237,-123.6195);
Lord Creek (44.2411,-123.7631);
Martha Creek (44.2822,-123.6781);
Meadow Creek (44.2925,-123.6591);
Phillips Creek (44.3398,-123.7613);
Preacher Creek (44.2482,-123.7440);
Prindel Creek (44.2346,-123.7849);
Ryan Creek (44.2576,-123.7971);
Summers Creek (44.2589,-123.7627);
Swamp Creek (44.3274,-123.8407);
Unnamed (44.2845,-123.7007);
Unnamed (44.2129,-123.7919);
Unnamed (44.2262,-123.7982);
Unnamed (44.2290,-123.8559);
Unnamed (44.2327,-123.8344);
Unnamed (44.2356,-123.8178);
Unnamed (44.2447,-123.6460);
Unnamed (44.2500,-123.8074);
Unnamed (44.2511,-123.9011);
Unnamed (44.2551,-123.8733);
Unnamed (44.2614,-123.8652);
Unnamed (44.2625,-123.8635);
Unnamed (44.2694,-123.8180);
Unnamed (44.2695,-123.7429);
Unnamed (44.2696,-123.8497);
Unnamed (44.2752,-123.7616);
Unnamed (44.2760,-123.7121);
Unnamed (44.2775,-123.8895);
Unnamed (44.2802,-123.7097);
Unnamed (44.2802,-123.8608);
Unnamed (44.2823,-123.7900);
Unnamed (44.2853,-123.7537);
Unnamed (44.2895,-123.9083);

Unnamed (44.2940,-123.7358);
Unnamed (44.2954,-123.7602);
Unnamed (44.2995,-123.7760);
Unnamed (44.3024,-123.9064);
Unnamed (44.3066,-123.8838);
Unnamed (44.3070,-123.8280);
Unnamed (44.3129,-123.7763);
Unnamed (44.3214,-123.8161);
Unnamed (44.3237,-123.9020);
Unnamed (44.3252,-123.7382);
Unnamed (44.3289,-123.8354);
Unnamed (44.3336,-123.7431);
Unnamed (44.3346,-123.7721);
Wilkinson Creek (44.3296,-123.7249);
Wilson Creek (44.3085,-123.8990).

(iii) Drift Creek Watershed 1710020503.

Outlet(s) = Drift Creek (Lat 44.4157, Long -124.0043)

Upstream to endpoint(s) in:

Boulder Creek (44.4434,-123.8705);
Bush Creek (44.5315,-123.8631);
Cape Horn Creek (44.5153,-123.7844);
Cedar Creek (44.4742,-123.9699);
Cougar Creek (44.4405,-123.9144);
Deer Creek (44.5514,-123.8778);
Drift Creek (44.4688,-123.7859);
Ellen Creek (44.4415,-123.9413);
Flynn Creek (44.5498,-123.8520);
Gold Creek (44.4778,-123.8802);
Gopher Creek (44.5217,-123.7787);
Horse Creek (44.5347,-123.9072);
Lyndon Creek (44.4395,-123.9801);
Needle Branch (44.5154,-123.8537);
Nettle Creek (44.4940,-123.7845);
Slickrock Creek (44.4757,-123.9007);
Trout Creek (44.4965,-123.9113);
Trout Creek, East Fork (44.4705,-123.9290);
Unnamed (44.4995,-123.8488);
Unnamed (44.4386,-123.9200);
Unnamed (44.4409,-123.8738);
Unnamed (44.4832,-123.9570);
Unnamed (44.4868,-123.9340);
Unnamed (44.4872,-123.9518);
Unnamed (44.4875,-123.9460);
Unnamed (44.4911,-123.9227);
Unnamed (44.5187,-123.7996);
Unnamed (44.5260,-123.7848);

Unnamed (44.5263,-123.8868);
Unnamed (44.5326,-123.8453);
Unnamed (44.5387,-123.8440);
Unnamed (44.5488,-123.8694);
Unnamed (44.4624,-123.8216).

(iv) Lower Alsea River Watershed 1710020504.
Outlet(s) = Alsea River (Lat 44.4165, Long -124.0829)
Upstream to endpoint(s) in:

Alsea River (44.3767,-123.6024);
Arnold Creek (44.3922,-123.9503);
Barclay Creek (44.4055,-123.8659);
Bear Creek (44.3729,-123.9623);
Bear Creek (44.3843,-123.7704);
Beaty Creek (44.4044,-123.6043);
Benner Creek (44.3543,-123.7447);
Brush Creek (44.3826,-123.8537);
Bull Run Creek (44.4745,-123.7439);
Canal Creek (44.3322,-123.9460);
Canal Creek, East Fork (44.3454,-123.9161);
Carns Canyon (44.4027,-123.7550);
Cedar Creek (44.3875,-123.7946);
Cove Creek (44.4403,-123.7107);
Cow Creek (44.3620,-123.7510);
Darkey Creek (44.3910,-123.9927;
Digger Creek (44.3906,-123.6890);
Fall Creek (44.4527,-123.6864);
Fall Creek (44.4661,-123.6933);
George Creek (44.3556,-123.8603);
Grass Creek (44.3577,-123.8798);
Hatchery Creek (44.3952,-123.7269);
Hatchery Creek (44.4121,-123.8734);
Hoover Creek (44.3618,-123.8583);
Lake Creek (44.3345,-123.8725);
Lint Creek (44.3850,-124.0490);
Maltby Creek (44.3833,-123.6770);
Meadow Fork (44.3764,-123.8879);
Mill Creek (44.4046,-123.6436);
Minotti Creek (44.3750,-123.7718);
Nye Creek (44.4326,-123.7648);
Oxstable Creek (44.3912,-123.9603);
Phillips Creek (44.3803,-123.7780);
Red Creek (44.3722,-123.9162);
Risley Creek (44.4097,-123.9380);
Schoolhouse Creek (44.3897,-123.6545);
Scott Creek, East Fork (44.4252,-123.7897);
Scott Creek, West Fork (44.4212,-123.8225);

Skinner Creek (44.3585,-123.9374);
Skunk Creek (44.3998,-123.6912);
Slide Creek (44.3986,-123.8419);
Starr Creek (44.4477,-124.0130);
Sudan Creek (44.3817,-123.9717);
Sulmon Creek (44.3285,-123.7008);
Sulmon Creek, North Fork (44.3421,-123.6374);
Sulmon Creek, South Fork (44.3339,-123.6709);
Swede Fork (44.3852,-124.0295);
Unnamed (44.3319,-123.9318);
Unnamed (44.3356,-123.9464);
Unnamed (44.3393,-123.9360);
Unnamed (44.3413,-123.9294);
Unnamed (44.3490,-123.9058);
Unnamed (44.3548,-123.6574);
Unnamed (44.3592,-123.6363);
Unnamed (44.3597,-123.9042);
Unnamed (44.3598,-123.6563);
Unnamed (44.3598,-123.6562);
Unnamed (44.3600,-123.6514);
Unnamed (44.3656,-123.9085);
Unnamed (44.3680,-123.9629);
Unnamed (44.3794,-123.8268);
Unnamed (44.3800,-123.9134);
Unnamed (44.3814,-123.7650);
Unnamed (44.3822,-124.0555);
Unnamed (44.3823,-124.0451);
Unnamed (44.3989,-123.6050);
Unnamed (44.4051,-124.0527);
Unnamed (44.4166,-123.8149);
Unnamed (44.4537,-123.7247);
Walker Creek (44.4583,-124.0271);
Weist Creek (44.3967,-124.0256);
West Creek (44.3588,-123.9493).
(v) Beaver Creek/Waldport Bay Watershed 1710020505.
Outlet(s) =
Beaver Creek (Lat 44.5233, Long -124.0734);
Deer Creek (44.5076,-124.0807);
Thiel Creek (44.5646,-124.0709)
Upstream to endpoint(s) in:
Beaver Creek, North Fork, Trib G (44.5369,-123.9195);
Beaver Creek, South Fork (44.4816,-123.9853);
Beaver Creek, South Fork, Trib A (44.4644,-124.0332);
Bowers Creek (44.5312,-124.0117);
Bunnel Creek (44.5178,-124.0265);
Deer Creek (44.5057,-124.0721);

Elkhorn Creek (44.5013,-123.9572);
Elkhorn Creek (44.4976,-123.9685);
Lewis Creek (44.5326,-123.9532);
North Fork Beaver Creek (44.5149,-123.8988);
Oliver Creek (44.4660,-124.0471);
Peterson Creek (44.5419,-123.9738);
Pumphouse Creek (44.5278,-124.0569);
Simpson Creek (44.5255,-124.0390);
Thiel Creek (44.5408,-124.0254);
Tracy Creek (44.5411,-124.0500);
Unnamed (44.4956,-123.9751);
Unnamed (44.5189,-124.0638);
Unnamed (44.5225,-123.9313);
Unnamed (44.5256,-123.9399);
Unnamed (44.5435,-124.0221);
Unnamed (44.5461,-124.0311);
Unnamed (44.5472,-124.0591);
Unnamed (44.5482,-124.0249);
Unnamed (44.5519,-124.0279);
Unnamed (44.5592,-124.0531);
Worth Creek (44.5013,-124.0207).

(vi) Yachats River Watershed 1710020506.

Outlet(s) = Yachats River (Lat 44.3081, Long -124.1070)

Upstream to endpoint(s) in:

Axtell Creek (44.3084,-123.9915);
Beamer Creek (44.3142,-124.0124);
Bend Creek (44.2826,-124.0077);
Carson Creek (44.3160,-124.0030);
Dawson Creek (44.2892,-124.0133);
Depew Creek (44.3395,-123.9631);
Earley Creek (44.3510,-123.9885);
Fish Creek (44.3259,-123.9592);
Glines Creek (44.3436,-123.9756);
Grass Creek (44.2673,-123.9109);
Helms Creek (44.2777,-123.9954);
Keller Creek (44.2601,-123.9485);
Little Beamer Creek (44.2993,-124.0213);
Reedy Creek (44.3083,-124.0460);
South Beamer Creek (44.2852,-124.0325);
Stump Creek (44.2566,-123.9624);
Unnamed (44.2596,-123.9279);
Unnamed (44.2657,-123.9585);
Unnamed (44.2660,-123.9183);
Unnamed (44.2684,-123.9711);
Unnamed (44.2837,-123.9268);
Unnamed (44.2956,-123.9316);

Unnamed (44.3005,-123.9324);
Unnamed (44.3163,-123.9428);
Unnamed (44.3186,-123.9568);
Unnamed (44.3259,-123.9578);
Unnamed (44.3431,-123.9711);
West Fork Williamson Creek (44.3230,-124.0008);
Williamson Creek (44.3300,-124.0026);
Yachats River (44.2468,-123.9329);
Yachats River, North Fork (44.3467,-123.9972);
Yachats River, School Fork (44.3145,-123.9341).

(vii) Cummins Creek/Tenmile Creek/ Mercer Lake Frontal Watershed 1710020507.

Outlet(s) =
Berry Creek (Lat 44.0949, Long -124.1221);
Big Creek (44.1767,-124.1148);
Bob Creek (44.2448,-124.1118);
Cape Creek (44.1336,-124.1211);
Cummins Creek (44.2660,-124.1075);
Rock Creek (44.1833,-124.1149);
Sutton Creek (44.0605,-124.1269);
Tenmile Creek (44.2245,-124.1083)

Upstream to endpoint(s) in:
Bailey Creek (44.1037,-124.0530);
Berry Creek (44.0998,-124.0885);
Big Creek (44.1866,-123.9781);
Big Creek, South Fork (44.1692,-123.9688);
Big Creek, Trib A (44.1601,-124.0231);
Bob Creek (44.2346,-124.0235);
Cape Creek (44.1351,-124.0174);
Cape Creek, North Fork (44.1458,-124.0489);
Cummins Creek (44.2557,-124.0104);
Fryingpan Creek (44.1723,-124.0401);
Levage Creek (44.0745,-124.0588);
Little Cummins Creek (44.2614,-124.0851);
McKinney Creek (44.2187,-123.9985);
Mercer Creek (44.0712,-124.0796);
Mill Creek (44.2106,-124.0747);
Quarry Creek (44.0881,-124.1124);
Rath Creek (44.0747,-124.0901);
Rock Creek (44.1882,-124.0310);
Tenmile Creek (44.2143,-123.9351);
Tenmile Creek, South Fork (44.2095,-123.9607);
Unnamed (44.1771,-124.0908);
Unnamed (44.0606,-124.0805);
Unnamed (44.0624,-124.0552);
Unnamed (44.0658,-124.0802);

Unnamed (44.0690,-124.0490);
Unnamed (44.0748,-124.0478);
Unnamed (44.0814,-124.0464);
Unnamed (44.0958,-124.0559);
Unnamed (44.1283,-124.0242);
Unnamed (44.1352,-124.0941);
Unnamed (44.1712,-124.0558);
Unnamed (44.1715,-124.0636);
Unnamed (44.2011,-123.9634);
Unnamed (44.2048,-123.9971);
Unnamed (44.2146,-124.0358);
Unnamed (44.2185,-124.0270);
Unnamed (44.2209,-123.9368);
Wapiti Creek (44.1216,-124.0448);
Wildcat Creek (44.2339,-123.9632).

(viii) Big Creek/Vingie Creek Watershed 1710020508.
Outlet(s) = Big Creek (Lat 44.3742, Long -124.0896)
Upstream to endpoint(s) in:

Big Creek (44.3564,-124.0613);
Dicks Fork Big Creek (44.3627,-124.0389);
Reynolds Creek (44.3768,-124.0740);
South Fork Big Creek (44.3388,-124.0597);
Unnamed (44.3643,-124.0355);
Unnamed (44.3662,-124.0573);
Unnamed (44.3686,-124.0683).

(6) Siuslaw Subbasin 17100206-

(i) Upper Siuslaw River Watershed 1710020601.
Outlet(s) = Siuslaw River (Lat 44.0033, Long -123.6545)
Upstream to endpoint(s) in:

Bear Creek (43.8482,-123.5172);
Bear Creek, Trib A (43.8496,-123.5059);
Bierce Creek (43.8750,-123.5559);
Big Canyon Creek (43.9474,-123.6582);
Bottle Creek (43.8791,-123.3871);
Bounds Creek (43.9733,-123.7108);
Buck Creek, Trib B (43.8198,-123.3913);
Buck Creek, Trib E (43.8152,-123.4248);
Burntwood Creek (43.9230,-123.5342);
Cabin Creek (43.8970,-123.6754);
Camp Creek (43.9154,-123.4904);
Canyon Creek (43.9780,-123.6096);
Clay Creek (43.8766,-123.5721);
Collins Creek (43.8913,-123.6047);
Conger Creek (43.8968,-123.4524);
Doe Creek (43.8957,-123.3558);
Doe Hollow Creek (43.8487,-123.4603);

Dogwood Creek (43.8958,-123.3811);
Douglas Creek (43.8705,-123.2836);
Edris Creek (43.9224,-123.5531);
Esmond Creek (43.8618,-123.5772);
Esmond Creek, Trib 1 (43.9303,-123.6518);
Esmond Creek, Trib A (43.8815,-123.6646);
Farman Creek (43.8761,-123.2562);
Fawn Creek (43.8743,-123.2992);
Fawn Creek (43.9436,-123.6088);
Fryingpan Creek (43.8329,-123.4241);
Fryingpan Creek (43.8422,-123.4318);
Gardner Creek (43.8024,-123.2582);
Haight Creek (43.8406,-123.4862);
Haskins Creek (43.8785,-123.5851);
Hawley Creek (43.8599,-123.1558);
Hawley Creek, North Fork (43.8717,-123.1751);
Holland Creek (43.8775,-123.4156);
Jeans Creek (43.8616,-123.4714);
Johnson Creek (43.8822,-123.5332);
Kelly Creek (43.8338,-123.1739);
Kline Creek (43.9034,-123.6635);
Leopold Creek (43.9199,-123.6890);
Leopold Creek, Trib A (43.9283,-123.6630);
Letz Creek, Trib B (43.7900,-123.3248);
Lick Creek (43.8366,-123.2695);
Little Siuslaw Creek (43.8048,-123.3412);
Lucas Creek (43.8202,-123.2233);
Luyne Creek (43.9155,-123.5068);
Luyne Creek, Trib A (43.9179,-123.5208);
Michaels Creek (43.8624,-123.5417);
Mill Creek (43.9028,-123.6228);
Norris Creek (43.8434,-123.2006);
North Creek (43.9223,-123.5752);
North Fork Siuslaw River (43.8513,-123.2302);
Oxbow Creek (43.8384,-123.5433);
Oxbow Creek, Trib C (43.8492,-123.5465);
Pheasant Creek (43.9120,-123.4247);
Pheasant Creek, Trib 2 (43.9115,-123.4411);
Pugh Creek (43.9480,-123.5940);
Russell Creek (43.8813,-123.3425);
Russell Creek, Trib A (43.8619,-123.3498);
Sandy Creek (43.7684,-123.2441);
Sandy Creek, Trib B (43.7826,-123.2538);
Shaw Creek (43.8817,-123.3289);
Siuslaw River, East Trib (43.8723,-123.5378);
Siuslaw River, North Fork, Upper Trib (43.8483,-123.2275);

Smith Creek (43.8045,-123.3665);
South Fork Siuslaw River (43.7831,-123.1569);
Trail Creek (43.9142,-123.6241);
Tucker Creek (43.8159,-123.1604);
Unnamed (43.7796,-123.2019);
Unnamed (43.7810,-123.2818);
Unnamed (43.8278,-123.2610);
Unnamed (43.8519,-123.2773);
Unnamed (43.8559,-123.5520);
Unnamed (43.8670,-123.6022);
Unnamed (43.8876,-123.5194);
Unnamed (43.8902,-123.5609);
Unnamed (43.8963,-123.4171);
Unnamed (43.8968,-123.4731);
Unnamed (43.8992,-123.4033);
Unnamed (43.9006,-123.4637);
Unnamed (43.9030,-123.6434);
Unnamed (43.9492,-123.6924);
Unnamed (43.9519,-123.6886);
Unnamed (43.9784,-123.6815);
Unnamed (43.9656,-123.7145);
Whittaker Creek (43.9490,-123.7004);
Whittaker Creek, Trib B (43.9545,-123.7121).
(ii) Wolf Creek Watershed 1710020602.
Outlet(s) = Wolf Creek (Lat 43.9548, Long -123.6205)
Upstream to endpoint(s) in:
Bill Lewis Creek (43.9357,-123.5708);
Cabin Creek (43.9226,-123.4081);
Eames Creek (43.9790,-123.4352);
Eames Creek, Trib C (43.9506,-123.4371);
Elkhorn Creek (43.9513,-123.3934);
Fish Creek (43.9238,-123.3872);
Gall Creek (43.9865,-123.5187);
Gall Creek, Trib 1 (43.9850,-123.5285);
Grenshaw Creek (43.9676,-123.4645);
Lick Creek (43.9407,-123.5796);
Oat Creek, Trib A (43.9566,-123.5052);
Oat Creek, Trib C (43.9618,-123.4902);
Oat Creek (43.9780,-123.4761);
Panther Creek (43.9529,-123.3744);
Pittenger Creek (43.9713,-123.5434);
Saleratus Creek (43.9796,-123.5675);
Saleratus Creek, Trib A (43.9776,-123.5797);
Swamp Creek (43.9777,-123.4197);
Swing Log Creek (43.9351,-123.3339);
Unnamed (43.9035,-123.3358);

Unnamed (43.9343,-123.3648);
Unnamed (43.9617,-123.4507);
Unnamed (43.9668,-123.6041);
Unnamed (43.9693,-123.4846);
Van Curen Creek (43.9364,-123.5520);
Wolf Creek (43.9101,-123.3234).
(iii) Wildcat Creek Watershed 1710020603.
Outlet(s) = Wildcat Creek (Lat 44.0033, Long -123.6545)
Upstream to endpoint(s) in:
Bulmer Creek (44.0099,-123.5206);
Cattle Creek (44.0099,-123.5475);
Fish Creek (44.0470,-123.5383);
Fowler Creek (43.9877,-123.5918);
Haynes Creek (44.1000,-123.5578);
Kirk Creek (44.0282,-123.6270);
Knapp Creek (44.1006,-123.5801);
Miller Creek (44.0767,-123.6034);
Pataha Creek (43.9914,-123.5361);
Potato Patch Creek (43.9936,-123.5812);
Salt Creek (44.0386,-123.5021);
Shady Creek (44.0647,-123.5838);
Shultz Creek (44.0220,-123.6320);
Unnamed (43.9890,-123.5468);
Unnamed (44.0210,-123.4805);
Unnamed (44.0233,-123.4996);
Unnamed (44.0242,-123.4796);
Unnamed (44.0253,-123.4963);
Unnamed (44.0283,-123.5311);
Unnamed (44.0305,-123.5275);
Unnamed (44.0479,-123.6199);
Unnamed (44.0604,-123.5624);
Unnamed (44.0674,-123.6075);
Unnamed (44.0720,-123.5590);
Unnamed (44.0839,-123.5777);
Unnamed (44.0858,-123.5787);
Unnamed (44.0860,-123.5741);
Unnamed (44.0865,-123.5935);
Unnamed (44.0945,-123.5838);
Unnamed (44.0959,-123.5902);
Walker Creek (44.0469,-123.6312);
Walker Creek, Trib C (44.0418,-123.6048);
Wildcat Creek (43.9892,-123.4308);
Wildcat Creek, Trib ZH (43.9924,-123.4975);
Wildcat Creek, Trib ZI (44.0055,-123.4681).
(iv) Lake Creek Watershed 1710020604.
Outlet(s) = Lake Creek (Lat 44.0556, Long -123.7968)

Upstream to endpoint(s) in:
Chappell Creek (44.1158,-123.6921);
Conrad Creek (44.1883,-123.4918);
Druggs Creek (44.1996,-123.5926);
Fish Creek (44.1679,-123.5149);
Green Creek (44.1389,-123.7930);
Greenleaf Creek (44.1766,-123.6391);
Hula Creek (44.1202,-123.7087);
Johnson Creek (44.1037,-123.7327);
Lake Creek (44.2618,-123.5148);
Lamb Creek (44.1401,-123.5991);
Leaver Creek (44.0754,-123.6285);
Leibo Canyon (44.2439,-123.4648);
Little Lake Creek (44.1655,-123.6004);
McVey Creek (44.0889,-123.6875);
Nelson Creek (44.1229,-123.5558);
North Fork Fish Creek (44.1535,-123.5437);
Pontius Creek (44.1911,-123.5909);
Pope Creek (44.2118,-123.5319);
Post Creek (44.1828,-123.5259);
Stakely Canyon (44.2153,-123.4690);
Steinhauer Creek (44.1276,-123.6594);
Swamp Creek (44.2150,-123.5687);
Swartz Creek (44.2304,-123.4461);
Target Canyon (44.2318,-123.4557);
Unnamed (44.1048,-123.6540);
Unnamed (44.1176,-123.5846);
Unnamed (44.1355,-123.5473);
Unnamed (44.1355,-123.6125);
Unnamed (44.1382,-123.5539);
Unnamed (44.1464,-123.5843);
Unnamed (44.1659,-123.5658);
Unnamed (44.1725,-123.5981);
Unnamed (44.1750,-123.5914);
Unnamed (44.1770,-123.5697);
Unnamed (44.1782,-123.5419);
Unnamed (44.1798,-123.5834);
Unnamed (44.1847,-123.5862);
Unnamed (44.2042,-123.5700);
Unnamed (44.2143,-123.5873);
Unnamed (44.2258,-123.4493);
Unnamed (44.2269,-123.5478);
Unnamed (44.2328,-123.5285);
Unnamed (44.2403,-123.5358);
Unnamed (44.2431,-123.5105);
Unnamed (44.2437,-123.5739);

Unnamed (44.2461,-123.5180);
Unnamed (44.2484,-123.5501);
Unnamed (44.2500,-123.5691);
Unnamed (44.2573,-123.4736);
Unnamed (44.2670,-123.4840);
Wheeler Creek (44.1232,-123.6778).

(v) Deadwood Creek Watershed 1710020605.
Outlet(s) = Deadwood Creek (Lat 44.0949, Long -123.7594)
Upstream to endpoint(s) in:
Alpha Creek (44.1679,-123.6951);
Bear Creek (44.1685,-123.6627);
Bear Creek, South Fork (44.1467,-123.6743);
Buck Creek (44.2003,-123.6683);
Deadwood Creek (44.2580,-123.6885);
Deadwood Creek, West Fork (44.1946,-123.8023);
Deer Creek (44.1655,-123.7229);
Failor Creek (44.1597,-123.8003);
Fawn Creek (44.2356,-123.7244);
Karlstrom Creek (44.1776,-123.7133);
Misery Creek (44.1758,-123.7950);
North Fork Panther Creek (44.2346,-123.7362);
Panther Creek (44.2273,-123.7558);
Raleigh Creek (44.1354,-123.6926);
Rock Creek (44.1812,-123.6683);
Schwartz Creek (44.1306,-123.7258);
Unnamed (44.2011,-123.7273);
Unnamed (44.1806,-123.7693);
Unnamed (44.1845,-123.6824);
Unnamed (44.1918,-123.7521);
Unnamed (44.1968,-123.7664);
Unnamed (44.2094,-123.6674);
Unnamed (44.2149,-123.7639);
Unnamed (44.2451,-123.6705);
Unnamed (44.2487,-123.7137);
Unnamed (44.2500,-123.6933).

(vi) Indian Creek/Lake Creek Watershed 1710020606.
Outlet(s) = Indian Creek (Lat 44.0808, Long -123.7891)
Upstream to endpoint(s) in:
Cremo Creek (44.1424,-123.8144);
Elk Creek (44.1253,-123.8821);
Gibson Creek (44.1548,-123.8132);
Herman Creek (44.2089,-123.8220);
Indian Creek (44.2086,-123.9171);
Indian Creek, North Fork (44.2204,-123.9016);
Indian Creek, West Fork (44.2014,-123.9075);
Long Creek (44.1395,-123.8800);

Maria Creek (44.1954,-123.9219);
Pyle Creek (44.1792,-123.8623);
Rogers Creek (44.1851,-123.9397);
Smoot Creek (44.1562,-123.8449);
Taylor Creek (44.1864,-123.8115);
Unnamed (44.1643,-123.8993);
Unnamed (44.1727,-123.8154);
Unnamed (44.1795,-123.9180);
Unnamed (44.1868,-123.9002);
Unnamed (44.1905,-123.8633);
Unnamed (44.1967,-123.8872);
Unnamed (44.2088,-123.8381);
Unnamed (44.2146,-123.8528);
Unnamed (44.2176,-123.8462);
Unnamed (44.2267,-123.8912);
Velvet Creek (44.1295,-123.8087).
(vii) North Fork Siuslaw River Watershed 1710020607.
Outlet(s) = North Fork Siuslaw River (Lat 43.9719, Long -124.0783)
Upstream to endpoint(s) in:
Billie Creek (44.0971,-124.0362);
Cataract Creek (44.0854,-123.9497);
Cedar Creek (44.1534,-123.9045);
Condon Creek (44.1138,-123.9984);
Coon Creek (44.0864,-124.0318);
Deer Creek (44.1297,-123.9475);
Drew Creek (44.1239,-123.9801);
Drew Creek (44.1113,-123.9854);
Elma Creek (44.1803,-123.9434);
Hanson Creek (44.0776,-123.9328);
Haring Creek (44.0307,-124.0462);
Lawrence Creek (44.1710,-123.9504);
Lindsley Creek (44.0389,-124.0591);
McLeod Creek (44.1050,-123.8805);
Morris Creek (44.0711,-124.0308);
Porter Creek (44.1490,-123.9641);
Russell Creek (44.0680,-123.9848);
Sam Creek (44.1751,-123.9527);
Slover Creek (44.0213,-124.0531);
South Russell Creek (44.0515,-123.9840);
Taylor Creek (44.1279,-123.9052);
Uncle Creek (44.1080,-124.0174);
Unnamed (43.9900,-124.0784);
Unnamed (43.9907,-124.0759);
Unnamed (43.9953,-124.0514);
Unnamed (43.9958,-124.0623);
Unnamed (43.9999,-124.0694);

Unnamed (44.0018,-124.0596);
Unnamed (44.0050,-124.0556);
Unnamed (44.0106,-124.0650);
Unnamed (44.0135,-124.0609);
Unnamed (44.0166,-124.0371);
Unnamed (44.0194,-124.0631);
Unnamed (44.0211,-124.0663);
Unnamed (44.0258,-124.0594);
Unnamed (44.0304,-124.0129);
Unnamed (44.0327,-124.0670);
Unnamed (44.0337,-124.0070);
Unnamed (44.0342,-124.0056);
Unnamed (44.0370,-124.0391);
Unnamed (44.0419,-124.0013);
Unnamed (44.0441,-124.0321);
Unnamed (44.0579,-124.0077);
Unnamed (44.0886,-124.0192);
Unnamed (44.0892,-123.9925);
Unnamed (44.0941,-123.9131);
Unnamed (44.0976,-124.0033);
Unnamed (44.1046,-123.9032);
Unnamed (44.1476,-123.8959);
Unnamed (44.1586,-123.9150);
West Branch North Fork Siuslaw River (44.1616,-123.9616);
Wilhelm Creek (44.1408,-123.9774).

(viii) Lower Siuslaw River Watershed 1710020608.
Outlet(s) = Siuslaw River (Lat 44.0160, Long -124.1327)
Upstream to endpoint(s) in:

Barber Creek (44.0294,-123.7598);
Beech Creek (44.0588,-123.6980);
Berkshire Creek (44.0508,-123.8890);
Bernhardt Creek (43.9655,-123.9532);
Brush Creek (44.0432,-123.7798);
Brush Creek, East Fork (44.0414,-123.7782);
Cedar Creek (43.9696,-123.9304);
Cleveland Creek (44.0773,-123.8343);
Demming Creek (43.9643,-124.0313);
Dinner Creek (44.0108,-123.8069);
Divide Creek (44.0516,-123.9421);
Duncan Inlet (44.0081,-123.9921);
Hadsall Creek (43.9846,-123.8221);
Hadsall Creek, Trib D (43.9868,-123.8500);
Hadsall Creek, Trib E (43.9812,-123.8359);
Hanson Creek (44.0364,-123.9628);
Hoffman Creek (43.9808,-123.9412);
Hollenbeck Creek (44.0321,-123.8672);

Hood Creek (43.9996,-123.7995);
Karnowsky Creek (43.9847,-123.9658);
Knowles Creek (43.9492,-123.7315);
Knowles Creek, Trib L (43.9717,-123.7830);
Lawson Creek, Trib B (43.9612,-123.9659);
Meadow Creek (44.0311,-123.6490);
Munsel Creek (44.0277,-124.0788);
Old Man Creek (44.0543,-123.8022);
Pat Creek (44.0659,-123.7245);
Patterson Creek (43.9984,-124.0234);
Rice Creek (44.0075,-123.8519);
Rock Creek (44.0169,-123.6512);
South Fork Waite Creek (43.9929,-123.7105);
San Antone Creek (44.0564,-123.6515);
Shoemaker Creek (44.0669,-123.8977);
Shutte Creek (43.9939,-124.0339);
Siuslaw River (44.0033,-123.6545);
Skunk Hollow (43.9830,-124.0626);
Smith Creek (44.0393,-123.6674);
Spencer Creek (44.0676,-123.8809);
Sulphur Creek (43.9822,-123.8015);
Sweet Creek (43.9463,-123.9016);
Sweet Creek, Trib A (44.0047,-123.8907);
Sweet Creek, Trib D (43.9860,-123.8811);
Thompson Creek (44.0974,-123.8615);
Turner Creek (44.0096,-123.7607);
Unnamed (43.9301,-124.0434);
Unnamed (43.9596,-124.0337);
Unnamed (43.9303,-124.0487);
Unnamed (43.9340,-124.0529);
Unnamed (43.9367,-124.0632);
Unnamed (43.9374,-124.0442);
Unnamed (43.9481,-124.0530);
Unnamed (43.9501,-124.0622);
Unnamed (43.9507,-124.0533);
Unnamed (43.9571,-124.0658);
Unnamed (43.9576,-124.0491);
Unnamed (43.9587,-124.0988);
Unnamed (43.9601,-124.0927);
Unnamed (43.9615,-124.0527);
Unnamed (43.9618,-124.0875);
Unnamed (43.9624,-123.7499);
Unnamed (43.9662,-123.7639);
Unnamed (43.9664,-123.9252);
Unnamed (43.9718,-124.0389;
Unnamed (43.9720,-124.0075);

Unnamed (43.9751,-124.0090);
Unnamed (43.9784,-124.0191);
Unnamed (43.9796,-123.9150);
Unnamed (43.9852,-123.9802);
Unnamed (43.9878,-123.9845);
Unnamed (43.9915,-123.9732);
Unnamed (43.9938,-123.9930);
Unnamed (43.9942,-123.8547);
Unnamed (43.9943,-123.9891);
Unnamed (43.9954,-124.1185);
Unnamed (43.9956,-123.7074);
Unnamed (43.9995,-123.9825);
Unnamed (44.0023,-123.7317);
Unnamed (44.0210,-123.7874);
Unnamed (44.0240,-123.8989);
Unnamed (44.0366,-123.7363);
Unnamed (44.0506,-123.9068);
Waite Creek (43.9886,-123.7220);
Walker Creek (44.0566,-123.9129);
Wilson Creek (44.0716,-123.8792).

(7) Siltcoos Subbasin 17100207-

(i) Waohink River/Siltcoos River/ Tahkenitch Lake Frontal Watershed 1710020701.

Outlet(s) =
Siltcoos River (Lat 43.8766, Long -124.1548);
Tahkenitch Creek (43.8013,-124.1689)

Upstream to endpoint(s) in:
Alder Creek (43.8967,-124.0114);
Bear Creek (43.9198,-123.9293);
Bear Creek Trib (43.9030,-123.9881);
Bear Creek, South Fork (43.9017,-123.9555);
Bell Creek (43.8541,-123.9718);
Billy Moore Creek (43.8876,-123.9604);
Carle Creek (43.9015,-124.0210);
Carter Creek (43.9457,-124.0123);
Dismal Swamp (43.8098,-124.0871);
Elbow Lake Creek (43.7886,-124.1490);
Fiddle Creek (43.9132,-123.9164);
Fivemile Creek (43.8297,-123.9776);
Grant Creek (43.9373,-124.0278);
Harry Creek (43.8544,-124.0220);
Henderson Canyon (43.8648,-123.9654);
Henderson Creek (43.9427,-123.9704);
John Sims Creek (43.8262,-124.0792);
King Creek (43.8804,-124.0300);
Lane Creek (43.8437,-124.0765);

Leitel Creek (43.8181,-124.0200);
Mallard Creek (43.7775,-124.0852);
Maple Creek (43.9314,-123.9316);
Maple Creek, North Prong (43.9483,-123.9510);
Miles Canyon (43.8643,-124.0097);
Miller Creek (43.9265,-124.0663);
Mills Creek (43.8966,-124.0397);
Morris Creek (43.8625,-123.9541);
Perkins Creek (43.8257,-124.0448);
Rider Creek (43.9210,-123.9700);
Roache Creek (43.9087,-124.0049);
Schrum Creek (43.9194,-124.0492);
Schultz Creek (43.9245,-123.9371);
Stokes Creek (43.9161,-123.9984);
Tenmile Creek (43.9419,-123.9447);
Unnamed (43.8928,-124.0461);
Unnamed (43.7726,-124.1021);
Unnamed (43.7741,-124.1313);
Unnamed (43.7756,-124.1363);
Unnamed (43.7824,-124.1342);
Unnamed (43.7829,-124.0852);
Unnamed (43.7837,-124.0812);
Unnamed (43.7849,-124.0734);
Unnamed (43.7862,-124.0711);
Unnamed (43.7865,-124.1107);
Unnamed (43.7892,-124.1163);
Unnamed (43.7897,-124.0608);
Unnamed (43.7946,-124.0477);
Unnamed (43.7964,-124.0643);
Unnamed (43.8015,-124.0450);
Unnamed (43.8078,-124.0340);
Unnamed (43.8095,-124.1362);
Unnamed (43.8112,-124.0608);
Unnamed (43.8152,-124.0981);
Unnamed (43.8153,-124.1314);
Unnamed (43.8172,-124.0752);
Unnamed (43.8231,-124.0853);
Unnamed (43.8321,-124.0128);
Unnamed (43.8322,-124.0069);
Unnamed (43.8323,-124.1016);
Unnamed (43.8330,-124.0217);
Unnamed (43.8361,-124.1209);
Unnamed (43.8400,-123.9802);
Unnamed (43.8407,-124.1051);
Unnamed (43.8489,-124.0634);
Unnamed (43.8500,-123.9852);

Unnamed (43.8504,-124.1248);
Unnamed (43.8504,-124.0024);
Unnamed (43.8507,-124.0511);
Unnamed (43.8589,-124.1231);
Unnamed (43.8596,-124.0438);
Unnamed (43.8605,-124.1211);
Unnamed (43.8669,-124.0717);
Unnamed (43.8670,-124.0327);
Unnamed (43.8707,-124.0689);
Unnamed (43.8802,-124.0605);
Unnamed (43.8862,-124.0570);
Unnamed (43.8913,-123.9380);
Unnamed (43.8919,-124.0771);
Unnamed (43.8976,-124.0725);
Unnamed (43.9032,-124.0651);
Unnamed (43.9045,-124.0548);
Unnamed (43.9057,-124.0606);
Unnamed (43.9065,-124.0656);
Unnamed (43.9105,-124.0453);
Unnamed (43.9106,-124.0203);
Unnamed (43.9202,-124.0786);
Unnamed (43.9209,-124.0734);
Unnamed (43.9237,-124.0155);
Unnamed (43.9249,-124.0074);
Unnamed (43.9274,-124.0759);
Unnamed (43.9275,-124.0308);
Unnamed (43.9360,-124.0892);
Unnamed (43.9365,-124.0297);
Unnamed (43.9424,-124.0981);
Unnamed (43.9438,-124.0929);
Unnamed (43.9453,-124.0752);
Unnamed (43.9518,-123.9953).

(8) North Fork Umpqua Subbasin 17100301-

(i) Boulder Creek Watershed 1710030106.

Outlet(s) = Boulder Creek (Lat 43.3036, Long -122.5272)

Upstream to endpoint(s) in:

Boulder Creek (Lat 43.3138, Long -122.5247)

(ii) Middle North Umpqua Watershed 1710030107.

Outlet(s) = North Umpqua River (Lat 43.3322, Long -123.0025)

Upstream to endpoint(s) in:

Calf Creek (43.2852,-122.6229);
Copeland Creek (43.2853,-122.5325);
Deception Creek (43.2766,-122.5850);
Dry Creek (43.2967,-122.6016);
Honey Creek (43.3181,-122.9414);
Limpy Creek (43.3020,-122.6795);

North Umpqua River (43.3027,-122.4938);
Panther Creek (43.3019,-122.6801);
Steamboat Creek (43.3491,-122.7281);
Susan Creek (43.3044,-122.9058);
Williams Creek (43.3431,-122.7724).
(iii) Rock Creek/North Umpqua River Watershed 1710030110.
Outlet(s) = Rock Creek (Lat 43.3322, Long -123.0025)
Upstream to endpoint(s) in:
Conley Creek (43.3594,-122.9663);
Harrington Creek (43.4151,-122.9550);
Kelly Creek (43.3592,-122.9912);
McComas Creek (43.3536,-122.9923);
Miller Creek (43.3864,-122.9371);
Rock Creek (43.4247,-122.9055);
Rock Creek, East Fork (43.3807,-122.8270);
Rock Creek, East Fork, North Fork (43.4147,-122.8512);
Shoup Creek (43.3882,-122.9674);
Unnamed (43.3507,-122.9741);
Woodstock Creek (43.3905,-122.9258).
(iv) Little River Watershed 1710030111.
Outlet(s) = Little River (Lat 43.2978, Long -123.1012)
Upstream to endpoint(s) in:
Buck Peak Creek (43.1762,-123.0479);
Buckhorn Creek (43.2592,-123.1072);
Cavitt Creek (43.1464,-122.9758);
Copperhead Creek (43.1626,-123.0595);
Emile Creek (43.2544,-122.8849);
Evarts Creek (43.2087,-123.0133);
Jim Creek (43.2257,-123.0592);
Little River (43.2065,-122.8231);
McKay Creek (43.2092,-123.0356);
Tuttle Creek (43.1440,-122.9813);
White Rock Creek (43.1540,-123.0379);
Wolf Creek (43.2179,-122.9461).
(v) Lower North Umpqua River Watershed 1710030112.
Outlet(s) = North Umpqua River (Lat 43.2682, Long -123.4448)
Upstream to endpoint(s) in:
Bradley Creek (43.3350,-123.1025);
Clover Creek (43.2490,-123.2604);
Cooper Creek (43.3420,-123.1650);
Cooper Creek (43.3797,-123.2807);
Dixon Creek (43.2770,-123.2911);
French Creek (43.3349,-123.0801);
Huntley Creek (43.3363,-123.1340);
North Umpqua River (43.3322,-123.0025);
Oak Creek (43.2839,-123.2063);

Short Creek (43.3204,-123.3315);
Sutherlin Creek (43.3677,-123.2114);
Unnamed (43.3285,-123.2016).

(9) South Fork Umpqua Subbasin 17100302-

(i) Jackson Creek Watershed 1710030202.
Outlet(s) = Jackson Creek (Lat 42.9695, Long -122.8795)
Upstream to endpoint(s) in:
Beaver Creek (Lat 42.9084, Long -122.7924);
Jackson Creek (Lat 42.9965, Long -122.6459);
Ralph Creek (Lat 42.9744, Long -122.6976);
Squaw Creek (Lat 42.9684, Long -122.6913);
Tallow Creek (Lat 42.98814, Long -122.6965);
Whiskey Creek (Lat 42.9593, Long -122.7262);
Winters Creek (Lat 42.9380, Long -122.8271).

(ii) Middle South Umpqua River Watershed 1710030203.
Outlet(s) = South Umpqua River (Lat 42.9272, Long -122.9504)
Upstream to endpoint(s) in:
Boulder Creek (43.1056,-122.7379);
Budd Creek (43.0506,-122.8185);
Deadman Creek (43.0049,-122.8967);
Dompier Creek (42.9553,-122.9166);
Dumont Creek (43.0719,-122.8224);
Francis Creek (43.0202,-122.8231);
South Umpqua River (43.0481,-122.6998);
Sam Creek (43.0037,-122.8412);
Slick Creek (43.0986,-122.7867).

(iii) Elk Creek/South Umpqua Watershed 1710030204.
Outlet(s) = Elk Creek (Lat 42.9272, Long -122.9504)
Upstream to endpoint(s) in:
Brownie Creek (Lat 42.8304, Long -122.8746);
Callahan Creek (Lat 42.8778, Long -122.9609);
Camp Creek (Lat 42.8667, Long -122.8958);
Dixon Creek (Lat 42.8931, Long -122.9152);
Drew Creek (Lat 42.8682, Long -122.9358);
Flat Creek (Lat 42.8294, Long -122.8250);
Joe Hall Creek (Lat 42.8756, Long -122.8202);
Tom Creek (Lat 42.8389, Long -122.8959).

(iv) South Umpqua River Watershed 1710030205.
Outlet(s) = South Umpqua River (Lat 42.9476, Long -123.3368)
Upstream to endpoint(s) in:
Alder Creek (42.9109,-123.2991);
Canyon Creek (42.8798,-123.2410);
Canyon Creek, West Fork (42.8757,-123.2734);
Canyon Creek, West Fork, Trib A (42.8834,-123.2947);
Coffee Creek (42.9416,-122.9993);
Comer Brook (42.9082,-123.2908);

Days Creek (43.0539,-123.0012);
Days Creek, Trib 1 (43.0351,-123.0532);
Doe Hollow (42.9805,-123.0812);
Fate Creek (42.9943,-123.1028);
Green Gulch (43.0040,-123.1276);
Hatchet Creek (42.9251,-122.9757);
Jordan Creek (42.9224,-123.3086);
Lavadoure Creek (42.9545,-123.1049);
Lick Creek (42.9213,-123.0261);
May Creek (43.0153,-123.0725);
Morgan Creek (42.9635,-123.2409);
O'Shea Creek (42.9256,-123.2486);
Perdue Creek (43.0038,-123.1192);
Poole Creek (42.9321,-123.1106);
Poole Creek, East Fork (42.9147,-123.0956);
South Umpqua River (42.9272,-122.9504);
Shively Creek (42.8888,-123.1635);
Shively Creek, East Fork (42.8793,-123.1194);
Small Creek (42.9631,-123.2519);
St. John Creek (42.9598,-123.0514);
Stinger Gulch Creek (42.9950,-123.1851);
Stouts Creek, East Fork (42.9090,-123.0424);
Stouts Creek, West Fork (42.8531,-123.0167);
Sweat Creek (42.9293,-123.1899);
Wood Creek (43.0048,-123.1486).

(v) Middle Cow Creek Watershed 1710030207.
Outlet(s) = Cow Creek (Lat 42.8114, Long -123.5947)
Upstream to endpoint(s) in:

Bear Creek (42.8045,-123.3635);
Booth Gulch (42.7804,-123.2282);
Bull Run Creek (42.7555,-123.2366);
Clear Creek (42.8218,-123.2610);
Cow Creek (42.8487,-123.1780);
Dads Creek (42.7650,-123.5401);
East Fork Whitehorse Creek (42.7925,-123.1448);
Fortune Branch (42.8051,-123.2971);
Hogum Creek (42.7574,-123.1853);
Lawson Creek (42.7896,-123.3752);
Little Bull Run Creek (42.7532,-123.2479);
McCullough Creek (42.7951,-123.4421);
Mynatt Creek (42.8034,-123.2828);
Panther Creek (42.7409,-123.4990);
Perkins Creek (42.7331,-123.4997);
Quines Creek (42.7278,-123.2396);
Rattlesnake Creek (42.7106,-123.4774);
Riffle Creek (42.7575,-123.6260);

Section Creek (42.7300,-123.4373);
Skull Creek (42.7527,-123.5779);
Starveout Creek (42.7541,-123.1953);
Stevens Creek (42.7255,-123.4835);
Susan Creek (42.8035,-123.5762);
Swamp Creek (42.7616,-123.3518);
Tennessee Gulch (42.7265,-123.2591);
Totten Creek (42.7448,-123.4610);
Unnamed (42.7964,-123.4200);
Unnamed (42.8101,-123.3150);
Whitehorse Creek (42.7772,-123.1532);
Wildcat Creek (42.7738,-123.2378);
Windy Creek (42.8221,-123.3296);
Wood Creek (42.8141,-123.4111);
Woodford Creek (42.7458,-123.3180).

(vi) West Fork Cow Creek Watershed 1710030208.
Outlet(s) = West Fork Cow Creek (Lat 42.8118, Long -123.6006)
Upstream to endpoint(s) in:
Bear Creek (42.7662,-123.6741);
Bobby Creek (42.8199,-123.7196);
Elk Valley Creek (42.8681,-123.7133);
Elk Valley Creek, East Fork (42.8698,-123.6812);
Goat Trail Creek (42.8002,-123.6828);
Gold Mountain Creek (42.8639,-123.7787);
No Sweat Creek (42.8024,-123.7081);
Panther Creek (42.8596,-123.7506);
Slaughter Pen Creek (42.8224,-123.6565);
Sweat Creek (42.8018,-123.6995);
Walker Creek (42.8228,-123.7614);
Wallace Creek (42.8311,-123.7696);
West Fork Cow Creek (42.8329,-123.7733).

(vii) Lower Cow Creek Watershed 1710030209.
Outlet(s) = Cow Creek (Lat 42.9476, Long -123.3368)
Upstream to endpoint(s) in:
Ash Creek (42.9052,-123.3385);
Boulder Creek (42.8607,-123.5494);
Brush Creek (42.8526,-123.4369);
Buck Creek (42.8093,-123.4979);
Buck Creek (42.9347,-123.5163);
Cattle Creek (42.8751,-123.5374);
Cedar Gulch (42.8457,-123.5038);
Council Creek (42.8929,-123.4366);
Cow Creek (42.8114,-123.5947);
Darby Creek (42.8553,-123.6123);
Doe Creek (42.9333,-123.5057);
Gravel Creek (42.8596,-123.4598);

Iron Mountain Creek (42.9035,-123.5175);
Island Creek (42.8957,-123.4749);
Jerry Creek (42.9517,-123.4009);
Little Dads Creek (42.8902,-123.5655);
Martin Creek (42.8080,-123.4763);
Middle Creek, South Fork (42.8298,-123.3870);
Panther Creek (42.8417,-123.4492);
Peavine Creek (42.8275,-123.4610);
Russell Creek (42.9094,-123.3797);
Salt Creek (42.9462,-123.4830);
Shoestring Creek (42.9221,-123.3613);
Smith Creek (42.8489,-123.4765);
Smith Creek (42.9236,-123.5482);
Table Creek (42.9114,-123.5695);
Union Creek (42.8769,-123.5853);
Unnamed (42.8891,-123.4080).

(viii) Middle South Umpqua River Watershed 1710030210.
Outlet(s) = South Umpqua River (Lat 43.1172, Long -123.4273)
Upstream to endpoint(s) in:
Adams Creek (43.0724,-123.4776);
Barrett Creek (43.0145,-123.4451);
Clark Brook (43.0980,-123.2897);
East Willis Creek (43.0151,-123.3845);
Judd Creek (42.9852,-123.4060);
Kent Creek (43.0490,-123.4792);
Lane Creek (42.9704,-123.4001);
Porter Creek (43.0444,-123.4597);
Rice Creek (43.0181,-123.4779);
Richardson Creek (43.0766,-123.2881);
South Umpqua River (42.9476,-123.3368);
Squaw Creek (43.0815,-123.4688);
Van Dine Creek (43.0326,-123.3473);
West Willis Creek (43.0172,-123.4355).

(ix) Myrtle Creek Watershed 1710030211.
Outlet(s) = North Myrtle Creek (Lat 43.0231, Long -123.2951)
Upstream to endpoint(s) in:
Ben Branch Creek (43.0544,-123.1618);
Big Lick (43.0778,-123.2175);
Bilger Creek (43.1118,-123.2372);
Buck Fork Creek (43.1415,-123.0831);
Cedar Hollow (43.0096,-123.2297);
Frozen Creek (43.1089,-123.1929);
Frozen Creek, Left Fork (43.1157,-123.2306);
Harrison Young Brook (43.0610,-123.2850);
Lally Creek (43.0890,-123.0597);
Lee Creek (43.1333,-123.1477);

Letitia Creek (43.0710,-123.0907);
Little Lick (43.0492,-123.2234);
Long Wiley Creek (43.0584,-123.1067);
Louis Creek (43.1165,-123.0783);
North Myrtle Creek (43.1486,-123.1219);
Riser Creek (43.1276,-123.0703);
Rock Creek (43.0729,-123.2620);
South Myrtle Creek (43.0850,-123.0103);
School Hollow (43.0563,-123.1753);
Short Wiley Creek (43.0589,-123.1158);
Slide Creek (43.1110,-123.1078);
Unnamed (43.1138,-123.1721);
Weaver Creek (43.1102,-123.0576).
(x) Ollala Creek/Lookingglass Watershed 1710030212.
Outlet(s) = Lookingglass Creek (Lat 43.1172, Long -123.4273)
Upstream to endpoint(s) in:
Archambeau Creek (43.2070,-123.5329);
Bear Creek (43.1233,-123.6382);
Berry Creek (43.0404,-123.5543);
Bushnell Creek (43.0183,-123.5289);
Byron Creek, East Fork (43.0192,-123.4939);
Byron Creek, North Fork (43.0326,-123.4792);
Coarse Gold Creek (43.0291,-123.5742);
Flournoy Creek (43.2227,-123.5560);
Little Muley Creek (43.0950,-123.6247);
Lookingglass Creek (43.1597,-123.6015);
McNabb Creek (43.0545,-123.4984);
Muns Creek (43.0880,-123.6333);
Olalla Creek (42.9695,-123.5914);
Perron Creek (43.0960,-123.4904);
Porter Creek (43.1381,-123.5569);
Sheilds Creek (43.0640,-123.6189);
Tenmile Creek (43.1482,-123.6537);
Tenmile Creek, North Fork (43.1260,-123.6069);
Thompson Creek (42.9860,-123.5140);
Willingham Creek (42.9600,-123.5814).
(xi) Lower South Umpqua River Watershed 1710030213.
Outlet(s) = South Umpqua River (Lat 43.2682, Long -123.4448)
Upstream to endpoint(s) in:
Callahan Creek (43.2291,-123.5355);
Damotta Brook (43.2030,-123.2987);
Deer Creek, North Fork (43.2166,-123.1437);
Deer Creek, South Fork (43.1875,-123.1722);
Deer Creek, South Fork, Trib 1 (43.1576,-123.2393);
Deer Creek, South Fork, Middle Fork (43.1625,-123.1413);
Doerner Creek (43.2370,-123.5153);

Elgarose Creek (43.2747,-123.5105);
Marsters Creek (43.1584,-123.4489);
Melton Creek (43.1294,-123.2173);
Roberts Creek (43.1124,-123.2831);
South Umpqua River (43.1172,-123.4273);
Stockel Creek (43.2205,-123.4392);
Tucker Creek (43.1238,-123.2378);
Unnamed (43.2184,-123.1709);
Willow Creek (43.2543,-123.5143).

(10) Umpqua Subbasin 17100303

(i) Upper Umpqua River Watershed 1710030301.
Outlet(s) = Umpqua River
Upstream to endpoint(s) in:

Bear Creek (43.3202,-123.6118);
Bear Creek (43.5436,-123.4481);
Bottle Creek (43.4060,-123.5043);
Brads Creek (43.5852,-123.4651);
Camp Creek (43.2969,-123.5361);
Case Knife Creek (43.4288,-123.6665);
Cedar Creek (43.5360,-123.5969);
Cougar Creek (43.3524,-123.6166);
Doe Creek (43.5311,-123.4259);
Fitzpatrick Creek (43.5819,-123.6308);
Galagher Canyon (43.4708,-123.4394);
Heddin Creek (43.5909,-123.6466);
Hubbard Creek (43.2526,-123.5544);
Leonard Creek (43.4448,-123.5402);
Little Canyon Creek (43.4554,-123.4560);
Little Wolf Creek (43.4232,-123.6633);
Little Wolf Creek, Trib D (43.4052,-123.6477);
Lost Creek (43.4355,-123.4902);
Martin Creek (43.5539,-123.4633);
McGee Creek (43.5125,-123.5632);
Mehl Creek (43.5491,-123.6541);
Mill Creek (43.3178,-123.5095);
Miner Creek (43.4518,-123.6764);
Panther Canyon (43.5541,-123.3484);
Porter Creek (43.4348,-123.5530);
Rader Creek (43.5203,-123.6517);
Rader Creek, Trib A (43.4912,-123.5726);
Umpqua River (43.2682,-123.4448);
Unnamed (43.5781,-123.6170);
Unnamed (43.5630,-123.6080);
Unnamed (43.4011,-123.6474);
Unnamed (43.4119,-123.6172);
Unnamed (43.4212,-123.6398);

Unnamed (43.4640,-123.6734);
Unnamed (43.4940,-123.6166);
Unnamed (43.5765,-123.4710);
Waggoner Creek (43.5282,-123.6072);
Whiskey Camp Creek (43.4587,-123.6755);
Williams Creek (43.5952,-123.5222);
Wolf Creek (43.4707,-123.6655).
(ii) Calapooya Creek Watershed 1710030302.
Outlet(s) = Calapooya Creek (Lat 43.3658, Long -123.4674)
Upstream to endpoint(s) in:
Bachelor Creek (43.5480,-123.2062);
Banks Creek (43.3631,-123.1755);
Beaty Creek (43.4406,-123.0392);
Boyd Creek (43.4957,-123.1573);
Brome Creek (43.4016,-123.0490);
Burke Creek (43.3987,-123.4463);
Buzzard Roost Creek (43.4584,-123.0990);
Cabin Creek (43.5421,-123.3294);
Calapooya Creek, North Fork (43.4867,-123.0280);
Coon Creek (43.4218,-123.4349);
Coon Creek (43.5245,-123.0429);
Dodge Canyon Creek (43.4362,-123.4420);
Driver Valley Creek (43.4327,-123.1960);
Field Creek (43.4043,-123.0917);
Gassy Creek (43.3862,-123.1133);
Gilbreath Creek (43.4218,-123.0931);
Gossett Creek (43.4970,-123.1045);
Haney Creek (43.4763,-123.1086);
Hinkle Creek (43.4230,-123.0382);
Hog Creek (43.4767,-123.2516);
Jeffers Creek (43.4522,-123.1047);
Long Valley Creek (43.4474,-123.1460);
Middle Fork South Fork Calapooya Creek (43.4772,-122.9952);
Markam Creek (43.3751,-123.1479);
Marsh Creek (43.5223,-123.3348);
Mill Creek (43.4927,-123.1315);
Norton Creek (43.5046,-123.3736);
Pine Tree Creek (43.4179,-123.0688);
Pollock Creek (43.5326,-123.2685);
Salt Creek (43.5161,-123.2504);
Salt Lick Creek (43.4510,-123.1168);
Slide Creek (43.3926,-123.0919);
Timothy Creek (43.4862,-123.0896);
Unnamed (43.4469,-123.4268);
Unnamed (43.4481,-123.4283);
Unnamed (43.4483,-123.4134);

Unnamed (43.4658,-122.9899);
Unnamed (43.4707,-122.9896);
Unnamed (43.4908,-123.0703);
Unnamed (43.5173,-123.0564);
Wheeler Canyon (43.4840,-123.3631);
White Creek (43.4637,-123.0451);
Williams Creek (43.4703,-123.4096).

(iii) Elk Creek Watershed 1710030303.
Outlet(s) = Elk Creek (Lat 43.6329, Long -123.5662)
Upstream to endpoint(s) in:

Adams Creek (43.5860,-123.2202);
Allen Creek (43.6375,-123.3731);
Andrews Creek (43.5837,-123.3920);
Asker Creek (43.6290,-123.2668);
Bear Creek (43.6195,-123.3703);
Bear Creek (43.7119,-123.1757);
Bennet Creek (43.6158,-123.1558);
Big Tom Folley Creek (43.7293,-123.4053);
Big Tom Folley Creek, North Fork (43.7393,-123.4917);
Big Tom Folley Creek, Trib A (43.7231,-123.4465);
Billy Creek, East Fork (43.5880,-123.3263);
Billy Creek, South Fork (43.5725,-123.3603);
Blue Hole Creek (43.5677,-123.4405);
Brush Creek (43.5662,-123.4140);
Buck Creek (43.6981,-123.1818);
Cowan Creek (43.5915,-123.2615);
Cox Creek (43.6356,-123.1794);
Curtis Creek (43.6839,-123.1734);
Dodge Canyon (43.6225,-123.2509);
Elk Creek (43.5097,-123.1620);
Ellenburg Creek (43.7378,-123.3296);
Fitch Creek (43.6986,-123.3152);
Five Point Canyon (43.5707,-123.3526);
Flagler Creek (43.5729,-123.3382);
Green Creek (43.6851,-123.4688);
Green Ridge Creek (43.5920,-123.3958);
Halo Creek (43.5990,-123.2658);
Hancock Creek (43.6314,-123.5188);
Hanlon Creek (43.6190,-123.2785);
Hardscrabble Creek (43.7111,-123.3517);
Huntington Creek (43.5882,-123.2808);
Jack Creek (43.7071,-123.3819);
Johnny Creek (43.7083,-123.3972);
Johnson Creek (43.6830,-123.2715);
Lancaster Creek (43.6442,-123.4361);
Lane Creek (43.5483,-123.1221);

Lees Creek (43.6610,-123.1888);
Little Sand Creek (43.7655,-123.2778);
Little Tom Folley Creek (43.6959,-123.5393);
McClintock Creek (43.6664,-123.2703);
Parker Creek (43.6823,-123.4178);
Pass Creek (43.7527,-123.1528);
Pheasant Creek (43.7758,-123.2099);
Rock Creek (43.7759,-123.2730);
Saddle Butte Creek (43.7214,-123.5219);
Salt Creek (43.6796,-123.2213);
Sand Creek (43.7709,-123.2912);
Shingle Mill Creek (43.5314,-123.1308);
Simpson Creek (43.6629,-123.2553);
Smith Creek (43.6851,-123.3179);
Squaw Creek (43.6010,-123.4284);
Taylor Creek (43.7642,-123.2712);
Thief Creek (43.6527,-123.1459);
Thistleburn Creek (43.6313,-123.4332);
Unnamed (43.5851,-123.3101);
Walker Creek (43.5922,-123.1707);
Ward Creek (43.7486,-123.2023);
Wehmeyer Creek (43.6823,-123.2404);
Wilson Creek (43.5699,-123.2681);
Wise Creek (43.6679,-123.2772);
Yoncalla Creek (43.5563,-123.2833).

(iv) Middle Umpqua River Watershed 1710030304.
Outlet(s) = Umpqua River (Lat 43.6556, Long -123.8752)
Upstream to endpoint(s) in:

Burchard Creek (43.6680,-123.7520);
Butler Creek (43.6325,-123.6867);
Cedar Creek (43.7027,-123.6451);
House Creek (43.7107,-123.6378);
Little Mill Creek (43.6729,-123.8252);
Little Paradise Creek (43.6981,-123.5630);
Paradise Creek (43.7301,-123.5738);
Patterson Creek (43.7076,-123.6977);
Purdy Creek (43.6895,-123.7712);
Sawyer Creek (43.6027,-123.6717);
Scott Creek (43.6885,-123.6966);
Umpqua River (43.6329,-123.5662);
Unnamed (43.6011,-123.7084);
Unnamed (43.5998,-123.6803);
Unnamed (43.6143,-123.6674);
Unnamed (43.6453,-123.7619);
Unnamed (43.6461,-123.8064);
Unnamed (43.6923,-123.7534);

Unnamed (43.7068,-123.6109);
Unnamed (43.7084,-123.7156);
Unnamed (43.7098,-123.6300);
Unnamed (43.7274,-123.6026);
Weatherly Creek (43.7205,-123.6680);
Wells Creek (43.6859,-123.7946).

(v) Upper Smith River Watershed 1710030306.
Outlet(s) = Smith River (Lat 43.7968, Long -123.7565)
Upstream to endpoint(s) in:

Amberson Creek (43.7787,-123.4944);
Argue Creek (43.7656,-123.6959);
Beaver Creek (43.7865,-123.6949);
Beaver Creek (43.8081,-123.4041);
Big Creek (43.7372,-123.7112);
Blackwell Creek (43.8145,-123.7460);
Blind Creek (43.7518,-123.6551);
Bum Creek (43.8044,-123.5802);
Carpenter Creek (43.7947,-123.7258);
Clabber Creek (43.7919,-123.5878);
Clearwater Creek (43.8138,-123.7375);
Cleghorn Creek (43.7508,-123.4997);
Clevenger Creek (43.7826,-123.4087);
Coldwater Creek (43.8316,-123.7232);
Deer Creek (43.8109,-123.5362);
Devils Club Creek (43.7916,-123.6148);
Elk Creek (43.8004,-123.4347);
Halfway Creek (43.7412,-123.5112);
Hall Creek (43.7732,-123.3836);
Haney Creek (43.8355,-123.5006);
Hardenbrook Creek (43.7943,-123.5660);
Hefty Creek (43.7881,-123.3954);
Herb Creek (43.8661,-123.6782);
Jeff Creek (43.8079,-123.6033);
Marsh Creek (43.7831,-123.6185);
Mosetown Creek (43.7326,-123.6613);
Mosetown Creek, East Fork (43.7185,-123.6433);
North Sister Creek (43.8492,-123.5771);
Panther Creek (43.8295,-123.4464);
Pearl Creek (43.8263,-123.5350);
Peterson Creek (43.7575,-123.3947);
Plank Creek (43.7635,-123.3980);
Redford Creek (43.7878,-123.3520);
Rock Creek (43.7733,-123.6222);
Russell Creek (43.8538,-123.6971);
South Sister Creek (43.8366,-123.5611);
Salmonberry Creek (43.8085,-123.4482);

Scare Creek (43.7631,-123.7260);
Sleezer Creek (43.7535,-123.3711);
Slideout Creek (43.7831,-123.5685);
Smith River, Little South Fork (43.7392,-123.4583);
Smith River, South Fork (43.7345,-123.3843);
Smith River (43.7529,-123.3310);
Spring Creek (43.7570,-123.3276);
Summit Creek (43.7985,-123.3487);
Sweden Creek (43.8618,-123.6468);
Tip Davis Creek (43.7739,-123.3301);
Twin Sister Creek (43.8348,-123.7168);
Unnamed (43.7234,-123.6308);
Unnamed (43.7397,-123.6984);
Unnamed (43.7433,-123.4673);
Unnamed (43.7492,-123.6911);
Unnamed (43.7495,-123.5832);
Unnamed (43.7527,-123.5210);
Unnamed (43.7533,-123.7046);
Unnamed (43.7541,-123.4805);
Unnamed (43.7708,-123.4819);
Unnamed (43.7726,-123.5039);
Unnamed (43.7748,-123.6044);
Unnamed (43.7775,-123.6927);
Unnamed (43.7830,-123.5900);
Unnamed (43.7921,-123.6335);
Unnamed (43.7955,-123.7013);
Unnamed (43.7993,-123.6171);
Unnamed (43.8020,-123.6739);
Unnamed (43.8034,-123.6959);
Unnamed (43.8133,-123.5893);
Unnamed (43.8197,-123.4827);
Unnamed (43.8263,-123.5810);
Unnamed (43.8360,-123.6951);
Unnamed (43.8519,-123.5910);
Unnamed (43.8535,-123.6357);
Unnamed (43.8541,-123.6155);
Unnamed (43.8585,-123.6867);
Upper Johnson Creek (43.7509,-123.5426);
West Fork Halfway Creek (43.7421,-123.6119);
Yellow Creek (43.8193,-123.5545).

(vi) Lower Smith River Watershed 1710030307.
Outlet(s) = Smith River (Lat 43.7115, Long -124.0807)
Upstream to endpoint(s) in:
Bear Creek (43.8087,-123.8202);
Beaver Creek (43.8983,-123.7559);
Black Creek (43.7544,-123.9967);

Brainard Creek (43.7448,-124.0105);
Buck Creek (43.7719,-123.7823);
Cassady Creek (43.7578,-123.9744);
Cedar Creek (43.8541,-123.8562);
Chapman Creek (43.8181,-123.9380);
Coon Creek (43.8495,-123.7857);
Crane Creek (43.8592,-123.7739);
Edmonds Creek (43.8257,-123.9000);
Eslick Creek (43.8153,-123.9894);
Eslick Creek, East Fork (43.8082,-123.9583);
Franz Creek (43.7542,-124.1006);
Frarey Creek (43.7683,-124.0615);
Georgia Creek (43.8373,-123.8911);
Gold Creek (43.9002,-123.7470);
Harlan Creek (43.8635,-123.9319);
Holden Creek (43.7901,-124.0178);
Hudson Slough (43.7725,-124.0736);
Johnson Creek (43.8291,-123.9582);
Johnson Creek (43.8480,-123.8209);
Joyce Creek (43.7892,-124.0356);
Joyce Creek, West Fork (43.7708,-124.0457);
Kentucky Creek (43.9313,-123.8153);
Middle Fork of North Fork Smith River (43.8780,-123.7687);
Moore Creek (43.8523,-123.8931);
Moore Creek (43.8661,-123.7558);
Murphy Creek (43.7449,-123.9527);
Noel Creek (43.7989,-124.0109);
Otter Creek (43.7216,-123.9626);
Otter Creek, North Fork (43.7348,-123.9597);
Paxton Creek (43.8847,-123.9004);
Peach Creek (43.8963,-123.8599);
Perkins Creek (43.7362,-123.9151);
Railroad Creek (43.8086,-123.8998);
Smith River, West Fork (43.9102,-123.7073);
Smith River (43.7968,-123.7565);
Spencer Creek (43.8429,-123.8321);
Spencer Creek, West Fork (43.8321,-123.8685);
Sulphur Creek (43.8512,-123.9422);
Unnamed (43.7031,-123.7463);
Unnamed (43.7106,-123.7666);
Unnamed (43.7203,-123.7601);
Unnamed (43.7267,-123.7396);
Unnamed (43.7286,-123.7798);
Unnamed (43.7322,-124.0585);
Unnamed (43.7325,-123.7337);
Unnamed (43.7470,-123.7416);

Unnamed (43.7470,-123.7711);
Unnamed (43.7569,-124.0844);
Unnamed (43.7606,-124.0853);
Unnamed (43.7623,-124.0753);
Unnamed (43.7669,-124.0766);
Unnamed (43.7734,-124.0674);
Unnamed (43.7855,-124.0076);
Unnamed (43.7877,-123.9936);
Unnamed (43.8129,-123.9743);
Unnamed (43.8212,-123.8777);
Unnamed (43.8258,-123.8192);
Unnamed (43.8375,-123.9631);
Unnamed (43.8424,-123.7925);
Unnamed (43.8437,-123.7989);
Unnamed (43.8601,-123.7630);
Unnamed (43.8603,-123.8155);
Unnamed (43.8655,-123.8489);
Unnamed (43.8661,-123.9136);
Unnamed (43.8688,-123.7994);
Unnamed (43.8831,-123.8534);
Unnamed (43.8883,-123.7157);
Unnamed (43.8906,-123.7759);
Unnamed (43.8916,-123.8765);
Unnamed (43.8922,-123.8144);
Unnamed (43.8953,-123.8772);
Unnamed (43.8980,-123.7865);
Unnamed (43.8997,-123.7993);
Unnamed (43.8998,-123.7197);
Unnamed (43.9015,-123.8386);
Unnamed (43.9015,-123.8949);
Unnamed (43.9023,-123.8241);
Unnamed (43.9048,-123.8316);
Unnamed (43.9075,-123.7208);
Unnamed (43.9079,-123.8263);
Vincent Creek (43.7035,-123.7882);
Wassen Creek (43.7419,-123.8905);
West Branch North Fork Smith River (43.9113,-123.8958).

(vii) Lower Umpqua River Watershed 1710030308.
Outlet(s) = Umpqua River (Lat 43.6696, Long -124.2025)
Upstream to endpoint(s) in:

Alder Creek (43.6310,-124.0483);
Bear Creek (43.7053,-123.9529);
Butler Creek (43.7157,-124.0059);
Charlotte Creek (43.6320,-123.9307);
Dean Creek (43.6214,-123.9740);
Dry Creek (43.6369,-124.0595);

Franklin Creek (43.6850,-123.8659);
Hakki Creek (43.6711,-124.0161);
Indian Charlie Creek (43.6611,-123.9404);
Johnson Creek (43.6711,-123.9760);
Koepke Slough (43.6909,-124.0294);
Little Franklin Creek (43.6853,-123.8863);
Luder Creek (43.6423,-123.9046);
Miller Creek (43.6528,-124.0140);
Oar Creek (43.6620,-124.0289);
Providence Creek (43.7083,-124.1289);
Scholfield Creek (43.6253,-124.0112);
Umpqua River (43.6556,-123.8752);
Unnamed (43.6359,-123.9572);
Unnamed (43.6805,-124.1146);
Unnamed (43.6904,-124.0506);
Unnamed (43.6940,-124.0340);
Unnamed (43.7069,-123.9824);
Unnamed (43.7242,-123.9369);
Winchester Creek (43.6657,-124.1247);
Wind Creek, South Fork (43.6346,-124.0897).
(11) Coos Subbasin 17100304-
(i) South Fork Coos Watershed 1710030401.
Outlet(s) = South Fork Coos (Lat 43.3905, Long -123.9634)
Upstream to endpoint(s) in:
Beaver Slide Creek (43.2728,-123.8472);
Bottom Creek (43.3751,-123.7065);
Bottom Creek, North Fork (43.3896,-123.7264);
Buck Creek (43.2476,-123.8023);
Burnt Creek (43.2567,-123.7834);
Cedar Creek (43.3388,-123.6303);
Cedar Creek, Trib E (43.3423,-123.6749);
Cedar Creek, Trib F (43.3330,-123.6523);
Coal Creek (43.3426,-123.8685);
Eight River Creek (43.2638,-123.8568);
Fall Creek (43.2535,-123.7106);
Fall Creek (43.4106,-123.7512);
Fivemile Creek (43.2341,-123.6307);
Gods Thumb Creek (43.3440,-123.7013);
Gooseberry Creek (43.2452,-123.7081);
Hatcher Creek (43.3021,-123.8370);
Hog Ranch Creek (43.2754,-123.8125);
Lake Creek (43.2971,-123.6354);
Little Cow Creek (43.1886,-123.6133);
Lost Creek (43.2325,-123.5769);
Lost Creek, Trib A (43.2224,-123.5961);
Mink Creek (43.3068,-123.8515);

Panther Creek (43.2593,-123.6401);
Shotgun Creek (43.2920,-123.7623);
Susan Creek (43.2720,-123.7654);
Tioga Creek (43.2110,-123.7786);
Unnamed (43.2209,-123.7789);
Unnamed (43.2305,-123.8360);
Unnamed (43.2364,-123.7818);
Unnamed (43.2548,-123.8569);
Unnamed (43.2713,-123.8320);
Unnamed (43.2902,-123.6662);
Unnamed (43.3168,-123.6491);
Unnamed (43.3692,-123.8320);
Unnamed (43.3698,-123.8321);
Unnamed (43.3806,-123.8327);
Unnamed (43.3846,-123.8058);
Unnamed (43.3887,-123.7927);
Unnamed (43.3651,-123.7073);
Wilson Creek (43.2083,-123.6691).

(ii) Millicoma River Watershed 1710030402.
Outlet(s) = West Fork Millicoma River (Lat 43.4242, Long -124.0288)
Upstream to endpoint(s) in:

Bealah Creek (43.4271,-123.8445);
Buck Creek (43.5659,-123.9765);
Cougar Creek (43.5983,-123.8788);
Crane Creek (43.5545,-123.9287);
Dagget Creek (43.4862,-124.0557);
Darius Creek (43.4741,-123.9407);
Deer Creek (43.6207,-123.9616);
Deer Creek, Trib A (43.6100,-123.9761);
Deer Creek, Trib B (43.6191,-123.9482);
Devils Elbow Creek (43.4439,-124.0608);
East Fork Millicoma River (43.4204,-123.8330);
Elk Creek (43.5441,-123.9175);
Fish Creek (43.6015,-123.8968);
Fox Creek (43.4189,-123.9459);
Glenn Creek (43.4799,-123.9325);
Hidden Creek (43.5646,-123.9235);
Hodges Creek (43.4348,-123.9889);
Joes Creek (43.5838,-123.9787);
Kelly Creek (43.5948,-123.9036);
Knife Creek (43.6163,-123.9310);
Little Matson Creek (43.4375,-123.8890);
Marlow Creek (43.4779,-123.9815);
Matson Creek (43.4489,-123.9191);
Otter Creek (43.5935,-123.9729);
Panther Creek (43.5619,-123.9038);

Rainy Creek (43.4293,-124.0400);
Rodine Creek (43.4434,-123.9789);
Schumacher Creek (43.4842,-124.0380);
Totten Creek (43.4869,-124.0457);
Trout Creek (43.5398,-123.9814);
Unnamed (43.4686,-124.0143);
Unnamed (43.5156,-123.9366);
Unnamed (43.5396,-123.9373);
Unnamed (43.5450,-123.9305);
West Fork Millicoma River (43.5617,-123.8788).
(iii) Lakeside Frontal Watershed 1710030403.
Outlet(s) = Tenmile Creek (43.5618,-124.2308)
Upstream to endpoint(s) in:
Adams Creek (43.5382,-124.1081);
Alder Creek (43.6012,-124.0272);
Alder Gulch (43.5892,-124.0665);
Benson Creek (43.5813,-124.0086);
Big Creek (43.6085,-124.0128);
Blacks Creek (43.6365,-124.1188);
Clear Creek (43.6040,-124.1871);
Hatchery Creek (43.5275,-124.0761);
Johnson Creek (43.5410,-124.0018);
Murphy Creek (43.6243,-124.0534);
Noble Creek (43.5897,-124.0347);
Parker Creek (43.6471,-124.1246);
Roberts Creek (43.5557,-124.0264);
Saunders Creek (43.5417,-124.2136);
Shutter Creek (43.5252,-124.1398);
Swamp Creek (43.5550,-124.1948);
Unnamed (43.5203,-124.0294);
Unnamed (43.6302,-124.1460);
Unnamed (43.6353,-124.1411);
Unnamed (43.6369,-124.1515);
Unnamed (43.6466,-124.1511);
Unnamed (43.5081,-124.0382);
Unnamed (43.6353,-124.16770;
Wilkins Creek (43.6304,-124.0819);
Winter Creek (43.6533,-124.1333).
(iv) Coos Bay Watershed 1710030404.
Outlet(s) =
Big Creek (Lat 43.3326, Long -124.3739);
Coos Bay (43.3544,-124.3384)
Upstream to endpoint(s) in:
Bear Creek (43.5048,-124.1059);
Bessey Creek (43.3844,-124.0253);
Big Creek (43.2834,-124.3374);

Big Creek (43.3980,-123.9396);
Big Creek, Trib A (43.2999,-124.3711);
Big Creek, Trib B (43.2854,-124.3570);
Blossom Gulch (43.3598,-124.2410);
Boatman Gulch (43.3445,-124.2483);
Boone Creek (43.2864,-124.1762);
Cardwell Creek (43.2793,-124.1277);
Catching Creek (43.2513,-124.1586);
Coalbank Creek (43.3154,-124.2503);
Coos Bay (43.3566,-124.1592);
Daniels Creek (43.3038,-124.0725);
Davis Creek (43.2610,-124.2633);
Day Creek (43.3129,-124.2888);
Deton Creek (43.4249,-124.0771);
Echo Creek (43.3797,-124.1529);
Elliot Creek (43.3037,-124.2670);
Farley Creek (43.3146,-124.3415);
Ferry Creek (43.2628,-124.1728);
Goat Creek (43.2700,-124.2109);
Haywood Creek (43.3067,-124.3419);
Hendrickson Creek (43.3907,-124.0594);
Isthmus Slough (43.2622,-124.2049);
Joe Ney Slough (43.3382,-124.2958);
John B Creek (43.2607,-124.2814);
Johnson Creek (43.4043,-124.1389);
Kentuck Creek (43.4556,-124.0894);
Larson Creek (43.4930,-124.0764);
Laxstrom Gulch (43.3372,-124.1350);
Lillian Creek (43.3550,-124.1330);
Mart Davis Creek (43.3911,-124.0927);
Matson Creek (43.3011,-124.1161);
McKnight Creek (43.3841,-123.9991);
Mettman Creek (43.4574,-124.1293);
Millicoma River (43.4242,-124.0288);
Monkey Ranch Gulch (43.3392,-124.1458);
Morgan Creek (43.3460,-124.0318);
North Slough (43.5032,-124.1408);
Noble Creek (43.2387,-124.1665);
Packard Creek (43.4058,-124.0211);
Palouse Creek (43.5123,-124.0667);
Panther Creek (43.2733,-124.1222);
Pony Slough (43.4078,-124.2307);
Rogers Creek (43.3831,-124.0370);
Ross Slough (43.3027,-124.1781);
Salmon Creek (43.3618,-123.9816);
Seaman Creek (43.3634,-124.0111);

Seelander Creek (43.2872,-124.1176);
Shinglehouse Slough (43.3154,-124.2225);
Smith Creek (43.3579,-124.1051);
Snedden Creek (43.3372,-124.2177);
Southport Slough (43.2981,-124.2194);
Stock Slough (43.3277,-124.1195);
Storey Creek (43.3238,-124.2969);
Sullivan Creek (43.4718,-124.0872);
Talbott Creek (43.2839,-124.2954);
Theodore Johnson Creek (43.2756,-124.3457);
Unnamed (43.5200,-124.1812);
Unnamed (43.2274,-124.3236);
Unnamed (43.2607,-124.2984);
Unnamed (43.2772,-124.3246);
Unnamed (43.2776,-124.3148);
Unnamed (43.2832,-124.1532);
Unnamed (43.2888,-124.1962);
Unnamed (43.2893,-124.3406);
Unnamed (43.2894,-124.2034);
Unnamed (43.2914,-124.2917);
Unnamed (43.2942,-124.1027);
Unnamed (43.2984,-124.2847);
Unnamed (43.3001,-124.3022);
Unnamed (43.3034,-124.2001);
Unnamed (43.3051,-124.2031);
Unnamed (43.3062,-124.2030);
Unnamed (43.3066,-124.3674);
Unnamed (43.3094,-124.1947);
Unnamed (43.3129,-124.1208);
Unnamed (43.3149,-124.1347);
Unnamed (43.3149,-124.1358);
Unnamed (43.3149,-124.1358);
Unnamed (43.3169,-124.0638);
Unnamed (43.3224,-124.2390);
Unnamed (43.3356,-124.1542);
Unnamed (43.3356,-124.1526);
Unnamed (43.3357,-124.1510);
Unnamed (43.3357,-124.1534);
Unnamed (43.3368,-124.1509);
Unnamed (43.3430,-124.2352);
Unnamed (43.3571,-124.2372);
Unnamed (43.3643,-124.0474);
Unnamed (43.3741,-124.0577);
Unnamed (43.4126,-124.0599);
Unnamed (43.4203,-123.9824);
Unnamed (43.4314,-124.0998);

Unnamed (43.4516,-124.1023);
Unnamed (43.4521,-124.1110);
Unnamed (43.5345,-124.1946);
Vogel Creek (43.3511,-124.1206);
Wasson Creek (43.2688,-124.3368);
Willanch Creek (43.4233,-124.1061);
Willanch Creek, Trib A (43.4032,-124.1169);
Wilson Creek (43.2652,-124.1281);
Winchester Creek (43.2145,-124.3116);
Winchester Creek, Trib E (43.2463,-124.3067);
Woodruff Creek (43.4206,-123.9746);
Wren Smith Creek (43.3131,-124.0649).

(12) Coquille Subbasin 17100305-

(i) Middle Fork Coquille Watershed 1710030502.
Outlet(s) = Middle Fork Coquille River (Lat 43.0340, Long -124.1161)
Upstream to endpoint(s) in:

Anderson Creek (43.0087,-123.9445);
Axe Creek (43.0516,-123.9468);
Bear Creek (43.0657,-123.9284);
Belieu Creek (43.0293,-123.9470);
Big Creek (43.0991,-123.8983);
Brownson Creek (43.0879,-123.9583);
Endicott Creek (43.0401,-124.0710);
Fall Creek (43.0514,-123.9910);
Indian Creek (43.0203,-124.0842);
Little Rock Creek (42.9913,-123.8335);
McMullen Creek (43.0220,-124.0366);
Middle Fork Coquille River (42.9701,-123.7621);
Myrtle Creek (42.9642,-124.0170);
Rasler Creek (42.9518,-123.9643);
Rock Creek (42.9200,-123.9073);
Rock Creek (43.0029,-123.8440);
Salmon Creek (43.0075,-124.0273);
Sandy Creek (43.0796,-123.8517);
Sandy Creek, Trib F (43.0526,-123.8736);
Sheilds Creek (42.9184,-123.9219);
Slater Creek (42.9358,-123.7958);
Slide Creek (42.9957,-123.9040);
Smith Creek (43.0566,-124.0337);
Swamp Creek (43.0934,-123.9000);
Unnamed (43.0016,-123.9550);
Unnamed (43.0681,-123.9812);
Unnamed (43.0810,-123.9892).

(ii) Middle Main Coquille Watershed 1710030503.
Outlet(s) = South Fork Coquille River (Lat 43.0805, Long -124.1405)
Upstream to endpoint(s) in:

Baker Creek (42.8913,-124.1297);
Beaver Creek (42.9429,-124.0783);
Catching Creek, Middle Fork (42.9913,-124.2331);
Catching Creek, South Fork (42.9587,-124.2348);
Coquille River, South Fork (42.8778,-124.0743);
Cove Creek (43.0437,-124.2088);
Dement Creek (42.9422,-124.2086);
Gettys Creek (43.0028,-124.1988);
Grants Creek (42.9730,-124.1041);
Horse Hollow (43.0382,-124.1984);
Knight Creek (43.0022,-124.2663);
Koontz Creek (43.0111,-124.2505);
Long Tom Creek (42.9342,-124.0992);
Matheny Creek (43.0495,-124.1892);
Mill Creek (42.9777,-124.1663);
Rhoda Creek (43.0007,-124.1032);
Roberts Creek (42.9748,-124.2385);
Rowland Creek (42.9045,-124.1845);
Russell Creek (42.9495,-124.1611);
Unnamed (42.9684,-124.1033);
Ward Creek (43.0429,-124.2358);
Warner Creek (43.0196,-124.1187);
Wildcat Creek (43.0277,-124.2225);
Wolf Creek (43.0136,-124.2318);
Woodward Creek (42.9023,-124.0658).
(iii) East Fork Coquille Watershed 1710030504.
Outlet(s) = East Fork Coquille River (Lat 43.1065, Long -124.0761)
Upstream to endpoint(s) in:
Bills Creek (43.1709,-123.9244);
China Creek (43.1736,-123.9086);
East Fork Coquille River (43.1476,-123.8936);
Elk Creek (43.1312,-123.9621);
Hantz Creek (43.1832,-123.9713);
South Fork Elk Creek (43.1212,-123.9200);
Steel Creek (43.1810,-123.9354);
Unnamed (43.0908,-124.0361);
Unnamed (43.0925,-124.0495);
Unnamed (43.0976,-123.9705);
Unnamed (43.1006,-124.0052);
Unnamed (43.1071,-123.9163);
Unnamed (43.1655,-123.9078);
Unnamed (43.1725,-123.9881);
Weekly Creek (43.0944,-124.0271);
Yankee Run (43.1517,-124.0483);
Yankee Run, Trib C (43.1626,-124.0162).
(iv) North Fork Coquille Watershed 1710030505.

Outlet(s) = North Fork Coquille River (Lat 43.0805, Long -124.1405)
Upstream to endpoint(s) in:
Alder Creek (43.2771,-123.9207);
Blair Creek (43.1944,-124.1121);
Cherry Creek, North Fork (43.2192,-123.9124);
Cherry Creek, South Fork (43.2154,-123.9353);
Coak Creek (43.2270,-124.0324);
Coquille River, Little North Fork (43.2988,-123.9410);
Coquille River, North Fork (43.2974,-123.8791);
Coquille River, North Fork, Trib E (43.1881,-124.0764);
Coquille River, North Fork, Trib I (43.2932,-123.8920);
Coquille River, North Fork, Trib Y (43.3428,-123.9678);
Evans Creek (43.2868,-124.0561);
Fruin Creek (43.3016,-123.9198);
Garage Creek (43.1508,-124.1020);
Giles Creek (43.3129,-124.0337);
Honcho Creek (43.2628,-123.8954);
Hudson Creek (43.2755,-123.9604);
Jerusalem Creek (43.1844,-124.0539);
Johns Creek (43.0760,-124.0498);
Little Cherry Creek (43.2007,-123.9594);
Llewellyn Creek (43.1034,124.1063);
Llewellyn Creek, Trib A (43.0969,-124.0995);
Lost Creek (43.1768,-124.1047);
Lost Creek (43.2451,-123.9745);
Mast Creek (43.2264,-124.0207);
Middle Creek (43.2332,-123.8726);
Moon Creek (43.2902,-123.9493);
Moon Creek, Trib A (43.2976,-123.9837);
Moon Creek, Trib A-1 (43.2944,-123.9753);
Neely Creek (43.2960,-124.0380);
Park Creek (43.2508,-123.8661);
Park Creek, Trib B (43.2702,-123.8782);
Schoolhouse Creek (43.1637,-124.0949);
Steele Creek (43.2203,-124.1018);
Steinnon Creek (43.2534,-124.1076);
Unnamed (43.1305,-124.0759);
Unnamed (43.2047,-124.0314);
Unnamed (43.2127,-124.1101);
Unnamed (43.2165,-123.9144);
Unnamed (43.2439,-123.9275);
Unnamed (43.2444,-124.0868);
Unnamed (43.2530,-124.0848);
Unnamed (43.2582,-124.0794);
Unnamed (43.2584,-123.8846);
Unnamed (43.2625,-124.0474);

Unnamed (43.2655,-123.9269);
Unnamed (43.2676,-124.0367);
Vaughns Creek (43.2378,-123.9106);
Whitley Creek (43.2899,-124.0115);
Wimer Creek (43.1303,-124.0640);
Wood Creek (43.1392,-124.1274);
Wood Creek, North Fork (43.1454,-124.1211).
(v) Lower Coquille Watershed 1710030506.
Outlet(s) = Coquille River (Lat 43.1237, Long -124.4261)
Upstream to endpoint(s) in:
Alder Creek (43.1385,-124.2697);
Bear Creek (43.0411,-124.2893);
Beaver Creek (43.2249,-124.1923);
Beaver Creek (43.2525,-124.2456);
Beaver Slough, Trib A (43.2154,-124.2731);
Bill Creek (43.0256,-124.3126);
Budd Creek (43.2011,-124.1921);
Calloway Creek (43.2060,-124.1684);
Cawfield Creek (43.1839,-124.1372);
China Creek (43.2170,-124.2076);
Cold Creek (43.2038,-124.1419);
Coquille River (43.0805,-124.1405);
Coquille River, Trib A (43.2032,-124.2930);
Cunningham Creek (43.2349,-124.1378);
Dutch John Ravine (43.1744,-124.1781);
Dye Creek (43.2274,-124.1569);
Fahys Creek (43.1676,-124.3861);
Fat Elk Creek (43.1373,-124.2560);
Ferry Creek (43.1150,-124.3831);
Fishtrap Creek (43.0841,-124.2544);
Glen Aiken Creek (43.1482,-124.1497);
Grady Creek (43.1032,-124.1381);
Gray Creek (43.1222,-124.1286);
Hall Creek (43.0583,-124.2516);
Hall Creek, Trib A (43.0842,-124.1745);
Harlin Creek (43.1326,-124.1633);
Hatchet Slough, Trib A (43.1638,-124.3065);
Hatchet Slough (43.1879,-124.3003);
Lampa Creek (43.0531,-124.2665);
Little Bear Creek (43.0407,-124.2783);
Little Fishtrap Creek (43.1201,-124.2290);
Lowe Creek (43.1401,-124.3232);
Mack Creek (43.0604,-124.3306);
Monroe Creek (43.0705,-124.2905);
Offield Creek (43.1587,-124.3273);
Pulaski Creek (43.1398,-124.2184);

Randleman Creek (43.0818,-124.3039);
Rich Creek (43.0576,-124.2067);
Rink Creek (43.1764,-124.1369);
Rock Robinson Creek (43.0860,-124.2306);
Rollan Creek (43.1266,-124.2563);
Sevenmile Creek (43.2157,-124.3350);
Sevenmile Creek, Trib A (43.1853,-124.3187);
Sevenmile Creek, Trib C (43.2081,-124.3340);
Unnamed (43.1084,-124.2727);
Unnamed 43.1731,-124.1852);
Unnamed (43.1924,-124.1378);
Unnamed (43.1997,-124.3346);
Unnamed (43.2281,-124.2190);
Unnamed (43.2424,-124.2737);
Waddington Creek (43.1105,-124.2915).
(13) Sixes Subbasin 17100306'
(i) Sixes River Watershed 1710030603.
Outlet(s) = Sixes River (Lat 42.8543, Long -124.5427)
Upstream to endpoint(s) in:
Beaver Creek (42.7867,-124.4373);
Carlton Creek (42.8594,-124.2382);
Cold Creek (42.7824,-124.2070);
Crystal Creek (42.8404,-124.4501);
Dry Creek (42.7673,-124.3726);
Edson Creek (42.8253,-124.3782);
Hays Creek (42.8455,-124.1796);
Little Dry Creek (42.8002,-124.3838);
Murphy Canyon (42.8516,-124.1541);
Sixes River (42.8232,-124.1704);
Sixes River, Middle Fork (42.7651,-124.1782);
Sixes River, North Fork (42.8878,-124.2320);
South Fork Sixes River (42.8028,-124.3022);
Sugar Creek (42.8217,-124.2035);
Unnamed (42.8189,-124.3567);
Unnamed (42.7952,-124.3918);
Unnamed (42.8276,-124.4629).
(ii) New River Frontal Watershed 1710030604.
Outlet(s) =
New River (Lat 43.0007, Long-124.4557);
Twomile Creek (43.0440,-124.4415)
Upstream to endpoint(s) in:
Bethel Creek (42.9519,-124.3954);
Boulder Creek (42.8574,-124.5050);
Butte Creek (42.9458,-124.4096);
Conner Creek (42.9814,-124.4215);
Davis Creek (42.9657,-124.3968);

Floras Creek (42.9127,-124.3963);
Fourmile Creek (42.9887,-124.3077);
Fourmile Creek, South Fork (42.9642,-124.3734);
Langlois Creek (42.9238,-124.4570);
Little Creek (43.0030,-124.3562);
Long Creek (42.9828,-124.3770);
Lower Twomile Creek (43.0223,-124.4080);
Morton Creek (42.9437,-124.4234);
New River (42.8563,-124.4602);
North Fourmile Creek (42.9900,-124.3176);
Redibough Creek (43.0251,-124.3659);
South Twomile Creek (43.0047,-124.3672);
Spring Creek (43.0183,-124.4299);
Twomile Creek (43.0100,-124.3291);
Unnamed (43.0209,-124.3386);
Unnamed (43.0350,-124.3506);
Unnamed (43.0378,-124.3481);
Unnamed (43.0409,-124.3544);
Unnamed (42.8714,-124.4586);
Unnamed (42.9029,-124.4222);
Unnamed (42.9031,-124.4581);
Unnamed (42.9294,-124.4421);
Unnamed (42.9347,-124.4559);
Unnamed (42.9737,-124.3363);
Unnamed (42.9800,-124.3432);
Unnamed (43.0058,-124.4066);
Willow Creek (42.8880,-124.4505).