Arthur-Jean Williams
Associate Director
Environmental Fate and Effects Division
Office of Pesticide Programs
U.S. Environmental Protection Agency
Washington, DC

Subject: Request for Endangered Species Act Section 7 Informal Consultation on the Environmental Protection Agency's Registration and Use of Racemic Metolachlor and Risks to 26 Evolutionarily Significant Units of Endangered and Threatened Pacific Salmon and Steelhead.

Technical Appendix

The National Marine Fisheries Service's (NMFS) Technical Review of the Environmental Protection Agency's Pesticides Effect determinations for Racemic Metolachlor on Federally Listed Salmonid Species in the Pacific Northwest and California.

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1 Introduction

This appendix describes the technical findings of the National Marine Fisheries Service (NMFS) review of EPA's effect determinations (referred to herein as Biological Evaluation [BE]) for the effects of racemic-metolachlor on 26 threatened and endangered salmon and steelhead under NMFS' jurisdiction and concludes with recommendations for meeting the substantive requirements of section 7(a)(2) of the Endangered Species Act (16 U.S.C. 1536). Before NMFS can concur with the conclusions presented in any BE (effect determinations) developed by Environmental Protection Agency (EPA) or any other federal agency, NMFS must also agree the rationale and evidence for that determination are valid (NMFS 2007).

The ESA and its implementing regulations form the foundation for evaluating whether agency actions are not likely to jeopardize the continued existence of endangered or threatened species or destroy or adversely modify designated critical habitat. Additional guidance and interagency policy for meeting the procedural and substantive requirements of section 7 are established within a variety of sources including the Consultation Handbook (FWS and NMFS 1998), Interagency Policy on Information Standards of the ESA (59 FR 166, 34271-34274; July 1, 1994), Information Quality Act (Section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001 [Public Law 106-554; H.R. 5658]), numerous judicial decisions resulting from litigation, and the Administrative Procedure Act (5 U.S.C. 706; hereafter APA).

1.1 The Evaluation Framework

1.1.1 The Principles, Practices and Protocols of Section 7 Determinations

Section 7 of the ESA requires federal agencies, in consultation with and with the assistance of the Secretaries of Commerce and Interior, to insure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of endangered or threatened species or destroy or adversely modify designated critical habitat (unless such agency has been granted an exemption for such action by the Committee pursuant to section 7(h) of the ESA). Interagency consultations conducted pursuant to section 7 of the ESA were established to help fulfill the purposes of the ESA, which are: "…to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species…" and the policy that "…all Federal departments and agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of the purposes of this Act (16 U.S.C. 1531 (b, c))." The procedural duty is to "consult" with the Secretary using procedures that have been codified in regulations found at 50 CFR Part 402. In so doing, federal agencies are required to "*use the best scientific and commercial data available* (16 U.S.C. 1536(a))."

To help agencies fulfill the statutory requirements of section 7 of the ESA, the NMFS first determines if actions are likely to adversely affect listed resources. When an action is likely to adversely affect listed resources, the Services conduct more detailed analyses that are designed to determine (a) if the action can be expected to reduce a listed species' reproduction, number, distribution; (b) if any reduction in reproduction, number, or distribution would appreciably reduce the species likelihood of both surviving and recovering in the wild (given the importance of the action area, the species' base condition in the action area, and the species' overall extinction risk); (c) if the action can be expected to destroy or adversely modify constituent elements of critical habitat that has been designated for threatened or endangered species, and (d) if impacts to constituent elements effect the ability of critical habitat to fulfill its conservation role for the listed species.

Pending the outcome of NMFS' evaluation of the effects of the proposed action, the action may be modified to minimize or eliminate consequences to listed species and their designated critical habitat. The challenge in conducting these assessments is to characterize future environmental conditions resulting from the execution of specific federal activities, and making predictions of species responses to those future conditions in the face of uncertainty. The intent of section 7 consultations, when conducted using the best available scientific and commercial data, is to make the best possible predictions of the likely outcome from exposing listed species and their habitat to proposed federal activities. Federal agencies then would consider this information in making their decision to take, or not take, or modify the action as it was originally proposed to minimize the risk of adverse consequences on listed species and their designated critical habitats. Through consultation NMFS and the federal agency determine what, if any, changes to the federal action are necessary to insure listed species are not likely to be jeopardized or critical habitat adversely modified or destroyed.

1.1.2 The Standards of Review

Interagency consultations and the documents they produce (e.g., concurrence letters and biological opinions) generally must comply with the requirements of the ESA and the Administrative Procedure Act (5 U.S.C. 706). To comply with the role Congress established for us in section 7 consultations, the Services believe they have an obligation to provide federal agencies and applicants, if any, consultations and consultation documents that are legally-defensible. To insure the legal defensibility of our documents, the Services evaluate their consultations and consultation documents using the standards of review courts would use: the arbitrary and capricious standards of section 706 of the APA. Based on numerous opinions from federal courts, a section 7 consultation or consultation document would be arbitrary and capricious if we:

- Relied on factors that Congress did not intend us to consider;
- Failed to consider an important aspect of a problem;
- Offered an explanation for our conclusion that runs counter to the evidence before us;
- Or failed to articulate a rational connection between the facts that were found and the conclusions we reached[1].

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[1] See *Bennett v Spear*, 520 U.S. 154 (117 S.Ct. 1154). See also, *Idaho Department of Fish and Game* v. *National Marine Fisheries Service et al*., 850 F. Supp. 886 (D.Or 1994)] in which the court concluded that “judicial review is limited to an assessment of whether the agency ‘conducted a reasoned evaluation of the relevant information and reached a decision that, although perhaps disputable, was not arbitrary or capricious.’” In determining “whether an agency decision was ‘arbitrary or capricious,’ the reviewing court ‘must consider whether the decision was based on a

Under the authority of the APA courts can hold unlawful and set aside any findings or conclusions that are found to be arbitrary and capricious. Therefore, our shared challenge in this consultation is to make certain that the conclusions we reach are not arbitrary and capricious. National Marine Fisheries Service endeavors to meet this standard by using strong arguments to demonstrate a reasoned reflection of the relevant evidence available, that the premises of our reasoning are acceptable and warranted, that the premises provide sufficient grounds for our conclusions, and that we consider and rebut obvious challenges to the reasoning we present. To comply with the requirements of section 7, our reasons and evidence must include the best scientific and commercial data available, the status of listed resources, the environmental baseline of an action area, the effects of the proposed action, and the cumulative effects of future state or private activities that are reasonably certain to occur within the action area.

We use the same four general criteria that we apply to our own arguments to determine if we can agree with the reasons, evidence, and conclusion presented to us by a federal action agency during consultation. When the argument presented to us by a federal agency during section 7 consultation does not meet these four general criteria we will come to the conclusion that has the strongest support from the evidence available. Pending the outcome of our review of any consultation documents, we will provide our own support for the conclusion of the federal action agency's argument (e.g., supplement the action agency's argument further demonstrating the reasons for our concurrence) or present our rebuttal to their argument (e.g., provide reasoning why the federal agency should request formal consultation or modify their action to eliminate potential adverse effects).

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consideration of the relevant factors and whether there has been a clear error of judgment.'" *Marsh v Oregon Natural Resources Council*, 490 U.S. 360, 378 (1989). An agency action is also arbitrary and capricious when the agency fails "to articulate a satisfactory explanation for its action." *Northern Spotted Owl v Hodel*, 716 F.Supp. 479, 482 (W.D. Wash. 1988). "A biological opinion is arbitrary and capricious and will be set aside when it has failed to articulate a satisfactory explanation for its conclusions or when it has entirely failed to consider an important aspect of the problem. While courts must defer to an agency's reasonable interpretation of equivocal evidence, such deference is not unlimited. The presumption of agency expertise may be rebutted if its decisions, even though based on scientific expertise, are not reasoned." *Greenpeace et al. v NMFS*, 55 F.Supp. 2d 1248, 1259 (W.D. Wash. 1999), citing *Defenders of Wildlife v Babbitt*, 958 F.Supp. 670, 679 (D.D.C. 1997).

1.2 Interagency Identified Uncertainties in Pesticide Risk Assessments

In December 2002 EPA, NMFS and the Fish and Wildlife Service began an interagency dialogue aimed at assisting EPA to streamline section 7 consultation processes. In January 2003, the agencies jointly published an Advanced Notice of Proposed Rulemaking to address the consultation process for pesticides and to discuss potential joint counterpart regulations. On August 5, 2004, NMFS and the USFWS published joint interagency counterpart regulations for EPA's pesticide registration program allowing EPA to conduct independent analysis of the potential impacts of pesticide registration on listed species and their habitats. The basis of the decision was in part based on the Services' review of the procedures and methods EPA employs in conducting ecological risk assessments on pesticide registration applications as described in EPA's January 23, 2004, Overview Document (OD), as reviewed by the Services in a January 26, 2004 letter. As a result of our ongoing dialogue and review of the OD several critical areas of scientific and procedural uncertainties were identified with the current processes EPA employs. The uncertainties and limitations identified in the OD and by the Services form the basis for our recent development of a joint interagency interagency research agenda to address these issues and minimize their potential impact on the adequacy of effect determinations made pursuant to the counterpart regulations. The jointly developed document identified eight areas of risk assessment and research uncertainties. Two of the identified areas of uncertainty are of particular relevance to EPA's current assessment of racemic metolachlor's potential risk to listed Pacific salmon and steelhead. NMFS disagrees with the manner in which EPA addressed these uncertainties and believes that EPA's approach likely underestimates the actual risk of adverse effects of racemic metolachlor to ESA-listed Pacific salmonids. The two uncertainties include:

- "*Methods for estimating aqueous concentrations of pesticides in unique water bodies (e.g., vernal pools, low volume/flow scenarios, irrigation drains) to predict nontarget exposure*". Pacific salmonids rely extensively on low flow, shallow off-channel aquatic habitats. The BE predicts exposure concentrations to these habitats using a farm pond model. This model likely underestimates exposure to juvenile rearing habitats based on habitat size comparisons and therefore generated exposure concentrations do not support the BE's effect determinations.

- *"Toxicity of mixtures/formulated products, including environmental mixtures, tank mixtures and approaches for evaluating risks of chemical mixtures."* Information demonstrates that racemic metolachlor in combination with other pesticides results in greater toxicity to primary producers and to aquatic invertebrates than from metolachlor alone. However, this information was not used to support the effect determinations. Rather, EPA risk quotients that formed the basis for the effect determinations relied on toxicity and exposure data for the active ingredient alone.

1.3 Background Information on Metolachlor Use and Prevalence in Surface Waters of the Pacific Northwest and California

Use and monitoring data indicated that metolachlor is present across the geographic distribution of salmonid habitats from head waters to estuaries and nearshore ocean environments. Racemic metolachlor was first registered for use in 1976. In 1997, S-metolachlor, an enantomerically enriched version of s-metolachlor was registered pursuant EPA's reduced risk pesticide program. The use of S-metolachlor has surpassed racemic metolachlor in the state of California. Racemic and S- metolachlor belong to the class of herbicides known as chloroacetanilides. Other members of the chloroacetanilide herbicides include alachlor, acetochlor, butachlor, heptachlor, delachlor, metazachlor, propachlor, xylachlor, diethatyl, and terbuchlor as well as four others. Racemic metolachlor is currently registered for use on corn, peanuts, cotton, beans, peas, safflower, sorghum, soybeans, and potatoes and technical formulated labels include other non-crop uses. The majority of these crops are grown throughout the Pacific Northwest and California overlapping with salmonid habitats. Since racemic metolachlor has been applied to crops and other land types for more than 30 years it is a frequently sampled pesticide in local, state, academic, and federal monitoring programs. Generally surface water detections of metolachlor do not distinguish between the two forms of metolachlor i.e., racemic metolachlor (50 % R: 50%S) and S-metolachlor (12% R: 88% S), because analytical chemistry techniques are usually not steriospecific.

Figure 1. ESA-Listed salmonid ESUs and distribution of NAWQA study basins

Metolachlor is commonly detected in U.S. surface waters and the Pacific Northwest and California with concentrations ranging from below detectable to as high as 143 ug/L (Battaglin et al. 2000). Two of metolachlor's degradation products, ethane sulfonic acid and oxanilic acid, are also commonly detected in surface waters alongside metolachlor; concentrations reach levels as high as 12 ug/L (ESA) and 7 ug/L (OXA). The United States Geologic Survey (USGS) routinely samples surface and ground water for pesticides within designated study basins across the United States as part of their National Water-Quality Assessment (NAWQA) Program. Several of these study basins contain ESA-listed salmon and steelhead and racemic metolachlor use in Washington, Oregon, Idaho, and California (Figure 1).

1.3.1 Commonly Detected Pesticides Co-occurring with Metolachlor

Racemic metolachlor is frequently applied within formulations and tank mixes that contain other pesticides such as atrazine (Table 1) and is commonly detected in surface water samples with multiple pesticides.

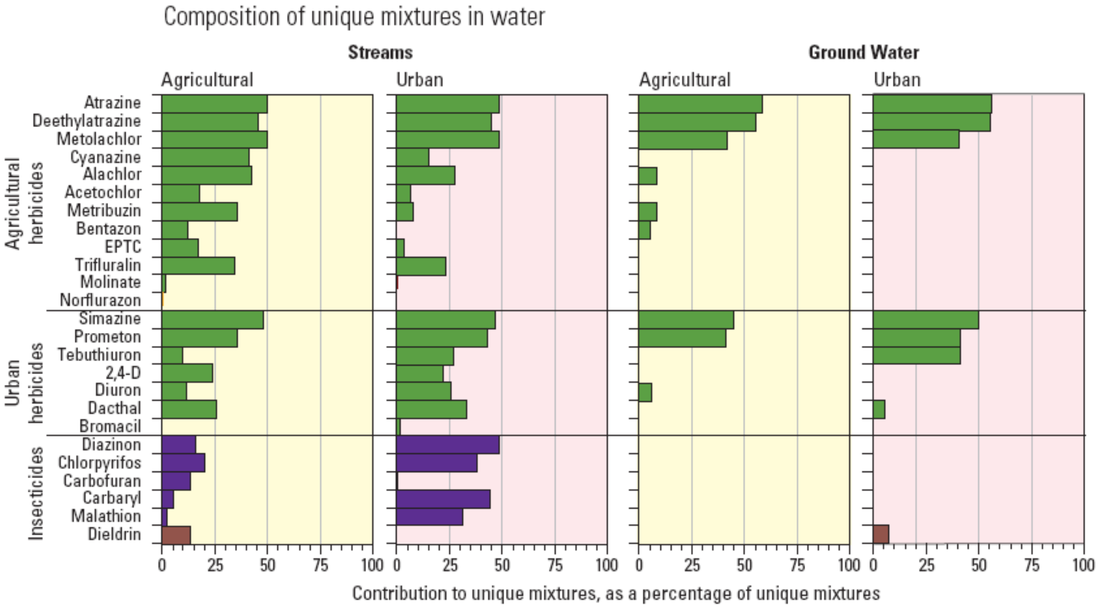
Table 1. Representative examples of registered racemic metolachlor containing formulations and tank mixes.

Formulated product (% metolachlor)	**Crop**	**Other formulation ingredients**	**Label recommended tank mixes (active ingredients)**
Stalwart Xtra Herbicide[1] (26.1%)	Corn	Atrazine 33%, other 40.2%	Atrazine, isoxaflutole, metolachlor, simazine, paraquat, 2,4-D, glyphosate
Stalwart Herbicide[1] (86.4%)	Pod crops, cotton, peanuts, potatoes, safflower, sorghum, soybeans, sudangrass	13.6%	Atrazine, 2,4-D, benfluralin, dicamba, chlorimuron, prometryn, clomazone, fluometuron, EPTC, glufosinate-ammonium, linuron, MSMA, pendimethalin, imazethapyr, imazaquin, metribuzin, ethalfluralin, trifluralin
Stalwart C[1] (84.1%)	Corn	15.9%	Atrazine, 2,4-D, dicamba, linuron, simazine, pendimethalin, paraquat, glyphosate
Me-too-lachlor[2] (86.4%)	Cotton, safflowers, peanuts, pod crops, potatoes, soybeans, sorghum	13.6%	Atrazine, 2,4-D, benfluralin, dicamba, chlorimuron, prometryn, clomazone, fluometuron, EPTC, linuron, MSMA, simazine, pendimethalin, imazethapyr, imazaquin, metribuzin, ethalfluralin, trifluralin, paraquat, glyphosate
Me-too-lachlor II[2] (84.4%)	Corn	15.6%	2,4-D, atrazine, dicamba, linuron, pendimethalin, simazine, paraquat, glyphosate
Parallel[3] (84.4%)	Cotton, peanuts, pod crops, potatoes, sorghum, soybeans	15.6%	Atrazine, 2,4-D, benfluralin, dicamba, chlorimuron, prometryn, clomazone, fluometuron, EPTC, linuron, simazine, pendimethalin, imazethapyr, imazaquin, metribuzin, ethalfluralin, trifluralin
Parallel PCS[3] (86.4%)	Cotton, safflowers, peanuts, pod crops, soybeans,	13.6%	Atrazine, 2,4-D, benfluralin, dicamba, bentazon, MSMA, glyphosate, paraquat dichloride, clomazone, fluometuron, EPTC, linuron, simazine, pendimethalin, imazethapyr, imazaquin, metribuzin, ethalfluralin, trifluralin,prometryn chlorimuron,

[1] (www.sipcamagrousa.com/mainframe.htm) ; [2] (www.cdms.net/LDat/ld7SO000.pdf); [3] (Greenbook 2006)

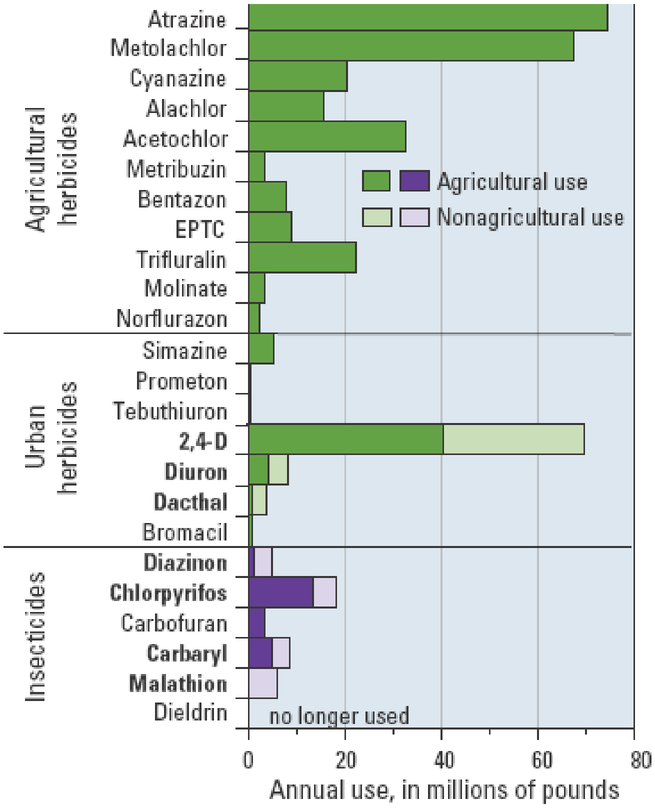
This is particularly true of samples from watersheds that have a high degree of agricultural land uses such as several NAWQA study basins that threatened and endangered salmonids inhabit including Yakima, Willamette, Puget Sound, Sacramento-San Joaquin Delta, and California Central Valley (Figure 1). The top six herbicides detected in agriculturally dominated areas in the nation were atrazine, metolachlor, an atrazine degradate (de-ethylatrazine), acetochlor, cyanazine, and alachlor (Figure 2). These herbicides were also the most frequently used (Figure 3). Atrazine is typically co-applied with racemic and s-metolachlor, and acetochlor and alachlor are both chloroacetanilides expected to result in similar toxicological responses in aquatic ecosystems. Pacific salmon and steelhead habitats are expected to contain these commonly used pesticides especially in agricultural areas.

Figure 2. USGS nation wide monitoring results of pesticides mixtures. The most common components of mixtures, not surprisingly, were the pesticides and degradates that were detected most often. The most frequent contributors to unique mixtures were the herbicides atrazine (and deethylatrazine), metolachlor, simazine, and prometon—all of which were detected in more than 30 percent of all unique mixtures found in agricultural and urban areas and in streams and ground water. This analysis is based on detections at any concentration, but includes only those unique mixtures that were composed of the 25 most prevalent pesticides and were detected in at least 2 percent of samples. (Figure 8-5; Gilliom et al. 2006).



Another study monitored eight urban streams across the United States which resulted in detections of two or more herbicides and insecticides in 85 and 54% of the samples, respectively (Hoffman et al. 2000). For herbicides, the co-occurrence of multiple compounds was common. Four or more herbicides were detected in 61% of the water samples. Interestingly, metolachlor, although only registered for uses on agricultural commodities, was detected in ~ 20% of the samples. Atrazine (a co-formulated active ingredient) was detected in 54% of the samples while simazine (another triazine) was detected in >70% of samples. One finding from a USGS study that evaluated 10 years of pesticide monitoring data in surface waters (1989-1998) concluded that multiple samples containing herbicides had probable toxicity to duckweed and green algae based on a toxicity index (Battaglin and Fairchild 2002).

Figure 2. Use of frequently detected pesticides, 1992-2001 (Figure 4-3; Gilliom et. al. 2006)



Racemic metolachlor frequently co-occurs with other chloroacetanilides and other co-formulated active ingredients such as atrazine. Detections are not limited to agriculture areas as metolachlor is detected in urban areas as well. Surface water habitats for Pacific salmon and steelhead typically contain many different pesticides of which metolachlor is one of the most frequently detected.

2 Comments on the Racemic Metolachlor Effect Determinations

In this section NMFS provides technical comments on EPA's racemic metolachlor effect determinations. Comments are organized by key components of the BE including problem formulation and action area, exposure, effects, and risk characterization.

2.1 Problem Formulation and Description of Action

The BE addresses 26 ESUs of Pacific salmon and steelhead and associated designated critical habitat. Puget Sound steelhead ESU was proposed for listing by NMFS under the ESA on March 29, 2006 (71 FR 60 15666-15680), and was recently listed by NMFS as threatened on May 11, 2007 (72 FR 91 26722-26735). NMFS recommends that the Puget Sound steelhead ESU be included during formal consultation on racemic metolachlor pesticide products.

NMFS agrees with the BE's description of the action as, "…the specific registered uses of metolachlor are 'the actions' permitted by EPA, and the subject of this assessment" (p.10, EPA 2006) and is further described as, "The actual and potential use of these products [currently registered formulations of racemic metolachlor] in the area of the threatened or endangered salmonids form the basis of this assessment" (p. 10, EPA 2006). One complicating component of this action description is that the effect determinations for racemic metolachlor products are based on the assessed risk of the active ingredient only rather than end use products that are permitted by EPA's approval of pesticide labels. Although some racemic metolachlor formulations contain several ingredients and more than one active ingredient, the BE does not include an evaluation of mixtures. Mixtures authorized by the label include pesticide formulations and tank mixtures. By not addressing exposure, effects, and risk characterization of these mixtures, the action was not addressed in its entirety.

EPA classified the racemic metolachlor and S-metolachlor as separate active ingredients. These two types of metolachlor share the same chemical formula and almost identical structure (a slight difference in orientation around a chiral center), and have similar toxicity profiles as well as fate and transport characteristics. The BE acknowledged the similarity and used toxicity and fate and transport data on the two types interchangeably when assessing risk to Pacific salmon and steelhead. The two forms differ only in the ratio of R to S enantiomers; racemic metolachlor has a ratio of 50S:50R and S-metolachlor has a ratio of 88S:12R. The BE did not assess the effects of S-metolachlor use which has largely replaced the use of racemic metolachlor (EPA 2006, p. 15, Fig 2.4.4). NMFS is uncertain when EPA will assess whether S-metolachlor end use products affect ESA-listed salmonids. The classification of racemic metolachlor and S-metolachlor as separate actions limits the reliability of the effects assessment because the two forms of metolachlor are expected to have additive effects to Pacific salmon, steelhead, and their habitats.

2.1.1 Action Area Analysis

The BE delineated the action area for 20 of the 26 threatened and endangered ESUs utilizing an iterative approach that relied on a combination of data sources including 1997 and 2002 United States Department of Agriculture Census of Agriculture for crop types and locations, salmonid species habitat maps produced by NMFS, PRZM-EXAMS predicted racemic metolachlor concentrations, toxicity information on plants, and LOC exceedances for aquatic plants. NMFS reviewed EPA's process for determining the action area and does not agree with the action area delineated for ESA-listed Pacific salmonids. The method, as employed, does not account for potential use of racemic metolachlor end use products i.e. formulations and tank mixes. The method relied on an outdated crop database to represent current and potential uses of racemic metolachlor. Given racemic metolachlor's registration for a variety of crops, its potential use is difficult to predict for small acreages and likely underestimated actual acreages of small scale producers.

Action area is defined by regulation as “all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action” (50 CFR 402.02). EPA has defined the federal action as “the actual and potential use of these products [currently registered formulations of racemic metolachlor] in the area of the threatened or endangered salmonids (p.10, EPA 2006).” EPA permits the use of racemic metolachlor on specified crops throughout the range of 26 ESUs of Pacific salmon and Steelhead found in Idaho, Washington, Oregon, and California (Figure 1). Therefore, by definition the action area includes all locations within the species’ ranges where metolachlor could potentially be used and extends to all areas directly or indirectly affected.

The method used in the BE to define the action area relied on crop distribution data from 1997 (potatoes) and 2002 which does not accurately characterize existing and potential use areas for metolachlor. Using selective data on historic crop locations is problematic because cropping patterns are influenced by market forces and are subject to change. Additionally, the database was apparently not reliable in terms of actual cropping patterns. For example, EPA’s analysis of crop coverage indicates no potatoes are grown in Oregon or California. However, both states have major potato production areas that overlap the ranges of listed salmon and steelhead ESUs. In California potatoes were produced on more than 35,000 acres each year from 1996-2005 (CDFA 2006); the North Coast, Central Coast, and San Joaquin Basin are historically areas of potato production (CDFA 2006, VRIC 1975). In Oregon, potatoes are typically grown on about 60,000 acres with several major production areas that overlap listed salmonid habitats including the Willamette Valley, Central Oregon, and the Columbia Basin (OSU 2007). Similar observations were noted for other crops. The BE stated that “based on data from the 2002 AgCensus there are no peas currently grown in the western United States (EPA 2006).” However, the Washington State University Cooperative Extension reports that 110,000 acres of dry peas were harvested by Washington Growers in 1999 with major production areas in several counties that contain listed salmonid ESUs (WSU 2000). The BE also stated that “soybeans are not grown in western United States” (EPA 2006). However, in 2004 approximately 4000 acres of soybeans were grown in the Sacramento

Valley alone (Cline 2004). The action area was inaccurately delineated because geographic areas within salmonid ESUs where racemic metolachlor could be used were not taken into account e.g. peas and potatoes, and possibly for other crops as well. The oversight likely resulted in an under estimation of exposure and risk to individual threatened and endangered salmonids.

Racemic metolachlor is a general use pesticide and therefore its purchase and use is not limited to certified pesticide applicators. It may be used on a variety of crops that are grown on small acreage or for non-commercial purposes (e.g. corn and pod crops) throughout the ranges of many of the listed ESUs. These uses are not represented in the AgCensus data used in the BE evaluation. Additionally, as discussed in the exposure, effects, and risk characterization sections below, the risk quotient analysis employed in the BE may underestimate risk.

2.2 Exposure Assessment

2.2.1 PRZM/EXAMS Scenarios

NMFS does not agree that the estimated environmental concentrations (EECs) generated in the BE represent the potential maximum exposure. Data were not provided to suggest the input values assumed are “high end” estimates given the range of conditions at potential application sites. The BE used PRZM-3 and EXAMS II (PRZM/EXAMS) models to estimate aquatic concentrations of racemic metolachlor because GENEEC2, the initial screening level model, produced racemic metolachlor concentration estimates that exceeded Levels of Concern (LOC) (EPA 2002). According to EPA’s assessment process, PRZM/EXAMS was then used to refine racemic metolachlor exposure concentrations by incorporating site-specific conditions that likely influence runoff (EPA 2004). Six scenarios were developed by EPA to estimate racemic metolachlor concentration for all water bodies within Washington, Oregon, California, and Idaho containing listed salmonids. The six scenarios included one site for potatoes (SE Idaho) and cotton (Central California), and two sites for corn (Central California, NW Oregon) and pod crops (NW Oregon, Coastal CA).

Additionally, it is difficult to determine from the information in the BE if the site-specific inputs used in the model are applicable and representative of vulnerable runoff sites across the four states. For example, the BE did not indicate when simulated applications occurred relative to peak rainfall. This information is important because rainfall drives runoff events following applications. The selected application date may or may not represent a peak runoff event. Other influential environmental, site-specific variables that affect runoff e.g. soil type and slope of land, were not described relative to the range of these values that are present throughout the action area (Idaho, Washington, California, and Oregon). Therefore, NMFS questions the surrogacy of the chosen scenarios to reliably predict high end EECs.

2.2.2 PRZM/EXAMS EEC Predictions Likely Underestimate Exposure

The EECs underestimated exposure because low flow, shallow off-channel habitats are not considered, EECs were not generated for other co-occurring chloroacetanilides including s-metolachlor, and other pathways of exposure were not factored into exposure estimates. The use of PRZM/EXAMS, a pond model, likely underestimated exposure to off-channel habitats used by threatened and endangered salmonids. The BE recognized the uncertainty of applying predicted EECs from a standard pond simulation model to salmonid habitats in the following statements:

- “Extrapolating the risk conclusions from this pond scenario may either over estimate or underestimate the potential risks” (p. 133. paragraph 3);
- “The use of higher watershed: pond ratios may lead to higher modeled pesticide concentrations when compared to standard watershed: pond ratio [sic 10:1] (p. 134, paragraph 1);
- “Extrapolating the risk conclusions from the standard pond scenario to other aquatic habitats e.g., marshes, streams, creeks, and shallow rivers, intermittent aquatic areas may either underestimate or over estimate the potential risks in those habitats (p.134, paragraph 2).

Model-derived EECs are used as the exposure values in risk quotient calculations (EPA 2004). Since minute changes in EECs can be the difference between a “no effect” and a “may affect”, NMFS evaluated the underlying assumptions of the exposure models in the context of susceptible salmonid aquatic habitats. Pacific salmon and steelhead utilize a variety of aquatic habitats from headwater streams to estuaries and nearshore saltwater environments where they might encounter racemic metolachlor. The six crop scenarios utilized PRZM/EXAMs to generate EECs for racemic metolachlor and two of its degradates, ESA and OXA, and were expected to be representative of aquatic habitats in Washington, Idaho, California, and Oregon. NMFS reviewed the available literature on the type and size of habitats utilized by threatened and endangered Pacific salmonids. NMFS developed a simple, yet coarse, method that adjusted the BE’s predicted EECs to provide examples of the degree to which the current pond scenario might have underestimated racemic metolachlor concentrations in salmonid habitats.

2.2.2.1 Off-channel habitats

Small streams and edge of field, off-channel habitats are particularly susceptible to runoff and drift. Juvenile salmonids rely upon a variety of non-main channel habitats that are critical to rearing. Examples include alcoves, channel edge sloughs, overflow channels, backwaters, terrace tributaries, off-channel dredge ponds, off channel ponds, and braids (Anderson 1999, Swift 1979). 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. As such, rearing and migrating juvenile salmonids extensively utilize these habitats (Beechie et al. 2005, Caffrey 1996, Henning et al. 2006, Montgomery et al. 1999, Morley et al. 2005, Opperman and Merenlender 2004, Roni 2002). Diverse, abundant communities of invertebrates (many of which are salmonid prey items) also inhabit these habitats and, in part, are responsible for juvenile salmonids reliance on off-channel habitats. Their reliance on these rearing habitats for food and shelter overlap with racemic metolachlor uses in Idaho, Washington, California, and Oregon. All listed salmonids utilize habitats at some point in their lifecycle that are shallow, low flow systems. In particular, juvenile coho, stream-type Chinook, and steelhead use them for extended durations (several months).

NMFS adjusted PRZM-EXAMS predicted EECs to provide examples of how racemic metolachlor concentrations used in the BE might change with increasing surface area of the "watershed:pond ratio" to account for off-channel aquatic habitats. The calculations were based on scaling down the modeled pond volume to represent the morphological characteristics of freshwater habitats utilized by Pacific salmonids (Swift 1979, Caffrey 1996, Anderson 1999, Beechie et al. 1999, Montgomery et al. 1999, Roni 2002, Opperman and Merenlender 2004, Morley et al. 2005, Henning et al. 2006). Two sizes of off-channel habitats were evaluated which resulted in watershed:pond ratios of 133:1 and 2222:1 (Table 2). The land area contributing to runoff was kept the same as the PRZM-EXAMS default assumption of 10 hectares, the only adjustment was the size of the receiving water body which was reduced. The examples are course approximations of how the BE's EECs would be affected by decreasing the volume of water indicative of off-channel salmonid habitat sizes. Although the adjusted concentrations are imprecise, they act as a general comparison to EPA's pond scenario-derived concentrations. The dimensions of habitats were selected by NMFS using data acquired from ecologically representative Pacific salmonid off-channel habitats. Habitats with smaller sizes are also possible, but were not modeled. Additionally, NMFS' calculated surface water concentrations that would be expected following a direct overspray event to provide a comparison to EECs (Table 2).

Results of off-channel habitat examples:

Risk quotients based on off-channel habitat EECs for the six crop scenarios exceeded the majority of aquatic acute and chronic (data not shown) LOCs for fish, invertebrates, and plants (Table 2). This is in contrast with EPA's current metolachlor assessment in which aquatic plant LOCs were the only ones that were exceeded. The magnitude of aquatic LOC exceedances is also much greater in the off channel habitat examples compared to EPA's exceedances in the pond scenario. NMFS did not assess the two metolachlor degradates, but risk quotients for ESA and OXA will also increase well above current PRZM-EXAM estimates in off-channel habitats. Direct overspray examples indicated that concentrations in surface water following a single application could reach more than a mg/L. Table two highlights that the BE's exposure estimates for racemic metolachlor are likely underestimates of short term and long term concentrations (data not shown) in low flow, shallow habitats utilized by juvenile salmonids. The LOC exceedances also reveal the potential hazard to salmonids by setting the action area based on the current BE's risk quotients and LOCs.

Table 2. Estimated Environmental Concentrations (EECs) for off-channel habitat crop scenarios and direct overspray. PRZM/EXAMS EECs were adjusted to account for low volume habitats utilized by juvenile salmonids. Underlined risk quotient values exceed EPA established LOCs

Crop Scenario and Habitat modeled	**Dimensions of Aquatic Habitat**				**Land: water**	**Runoff 24hr EEC (µg/L)**	**RQ acute fish (3200 ug/L)**	**RQ acute aquatic inverts (3800 ug/L)**	**RQ acute aquatic plant (10 ug/L)**
	Depth (m)	**Width (m)**	**Length (m)**	**Volume (l)**					
California Veg - Farm pond	2	100	100	$2X10^7$	10:1	16.7	<0.01	0.00	1.67
California Veg - Offchannel habitat 1	1	15	100	$1.5X10^6$	133:1	222	0.07	0.06	22.21
California Veg - Offchannel habitat 2	0.3	3	100	$9x10^4$	2222:1	3700	1.16	0.97	370
California Veg – Direct over spray (2.0 lbs/acre)	0.15	na	na	na	na	1470	0.46	0.39	147
ID potato – no irrigation – Direct over spray (2.67 lbs/acre)	0.15	na	na	na	na	1960	0.61	0.52	196
Other Crop scenarios									
Oregon Corn - Offchannel habitat 2	0.3	3	100	$9x10^4$	2222:1	3240	1.01	0.85	323
California Corn - Offchannel habitat 2	0.3	3	100	$9x10^4$	2222:1	1940	0.61	0.51	194
California Cotton - Offchannel habitat 2	0.3	3	100	$9x10^4$	2222:1	524	0.16	0.14	52
Idaho Potato - Offchannel habitat 2	0.3	3	100	$9x10^4$	2222:1	1364	0.43	0.36	136
Oregon Pea - Offchannel habitat 2	0.3	3	100	$9x10^4$	2222:1	1964	0.61	0.52	196

2.2.2.2 Racemic metolachlor application rates

The BE did not report maximum racemic metolachlor application rates, maximum number of applications, or minimum application intervals permitted by EPA. These pesticide label specifications define the action (what EPA is permitting) and also represent a primary tool for avoiding and minimizing risk to listed species, their habitat, and other nontarget organisms. NMFS compared application rates that were used in the BE as inputs for the PRZM/EXAMS crop scenarios with application rates found on two currently registered racemic metolachlor labels, Me-Too-Lachlor 19713-548 and 19713-549 (Table 3).

In all six scenarios the BE used application rates that were less than the label-specified maximum rates permitted for single and/or seasonal applications (Table 3). This is not in accordance with the Overview Document (EPA 2004). For example, a single application rate of 2 lbs/acre was used to assess vegetables in the coastal California scenario. Yet, soybeans (2.75 lbs/acre) and other vegetables (potatoes 2.75 lbs/acre, corn 2.6 lbs/acre) allow a single application of racemic metolachlor at higher rates. In cotton, only a single application of 1.33 lbs/acre was evaluated yet the label allows repeated applications, with no minimum application interval and a seasonal application rate of up to 4 lbs/acre. Racemic metolachlor is classified as persistent in soil and likely accumulates with successive applications. In several cases the highest single and seasonal use rates permitted by the label were not used in the BE's scenarios. By not using maximum rates authorized by the label, exposure is underestimated.

Additionally, the two labels that NMFS reviewed did not report a minimum application interval for any of its crop uses which introduces substantial uncertainty as to the frequency of application. The BE contained one crop scenario, corn, that included more than one application with a frequency of 60 days, however no justification is given why this duration was selected. In aggregate, these uncertainties revealed that potential exposure of listed Pacific salmon and steelhead to racemic metolachlor is substantially underestimated in the BE.

Table 3 Application information for BE modeled crop scenarios versus application information for two currently registered racemic metolachlor labels.

	Modeled Crop Scenario in BE	**Label (EPA Reg. No.)**
	Potatoes	**Me-Too-Lachlor (19713-548) Potatoes**
Maximum single rate (lbs active ingredient/acre)	2.67	2.75
Maximum seasonal rate (lbs active ingredient/acre)	Not evaluated	3.7
Maximum number applications	1	No limit
Application Interval	Not evaluated	No limit
	Cotton	**Me-Too-Lachlor (19713-548) Cotton**
Maximum single rate (lbs active ingredient/acre)	1.33	1.33
Maximum seasonal rate (lbs active ingredient/acre)	Not evaluated	4
Maximum number applications	1	No limit
Application Interval	Not evaluated	No limit
	Pea	**Me-Too-Lachlor (19713-548) Pod Crops**
Maximum single rate (lbs active ingredient/acre)	2	2
Maximum seasonal rate (lbs active ingredient/acre)	Not evaluated	3
Maximum number applications	1	No limit
Application Interval	Not evaluated	No limit
	Vegetable	**Me-Too-Lachlor (19713-548) Soybeans**
Maximum single rate (lbs active ingredient/acre)	2	2.75
Maximum seasonal rate (lbs active ingredient/acre)	Not evaluated	2.75
Maximum number applications	1	No limit
Application Interval	Not evaluated	No limit
	Corn	**Me-Too-Lachlor II (19713-549) Corn**
Maximum single rate (lbs active ingredient/acre)	2	2.6
Maximum seasonal rate (lbs active ingredient/acre)	4	4
Maximum number applications	2	No limit
Application Interval	60	No limit

2.2.3 Concurrent Exposure to Multiple Pesticides

The actual risk of racemic metolachlor-containing pesticides to threatened and endangered Pacific salmon and steelhead is likely underestimated in the BE if other co-occurring pesticides that interact with racemic-metolachlor are not addressed. EECs were generated exclusively for racemic metolachlor and two degradates (oxanillic and ethane sulfonic acids) in the BE although use and surface water data indicate co-occurrence with multiple pesticides including other chloroacetanilides and atrazine.

Pesticide monitoring data collected since metolachlor's registration indicated that individual water samples across the United States including Pacific Northwest and California watersheds typically contain metolachlor, atrazine, alachlor, acetochlor and other frequently used insecticides, herbicides, and fungicides (Figure 2; Gilliom et al. 2006). Particularly note worthy is the frequency of detection of two chloroacetanilides, acetochlor and alachlor, combined with the frequency of detection of atrazine and its degradates. These pesticides generally result in additive toxicity to primary producers (see mixture effects section below; 2.2.4). The BE did not produce exposure estimates for other active ingredients present in racemic metolachlor formulations e.g. atrazine, or commonly detected in environmental mixtures known to result in additive responses. Consequently, risk to listed species is likely underestimated because exposure to these co-applied and co-occurring compounds, although likely, was not used in the risk quotient calculations.

2.2.4 NMFS' Exposure Conclusion

The BE used a pesticide runoff model to estimate racemic metolachlor concentrations stemming from selected crop scenarios that listed salmonids are potentially exposed to in Idaho, Oregon, Washington, and California. The estimates likely and consistently underestimated peak and chronic concentrations, particularly to habitats utilized by early lifestages of salmonids for shelter, growth, and rearing. Concentration estimates of racemic metolachlor in these low-flow, shallow off-channel habitats are underestimated by the current model because the dimensions of these habitats result in much higher land to surface water volumes (Table 2). Off-channel habitat examples resulted in LOCs that were exceeded by as much as two orders of magnitude. Additionally, BE modeled exposure did not evaluate maximum single and seasonal application rates which increases the likelihood that potential exposure to listed species is underestimated. Moreover, racemic metolachlor is expected to co-occur in aquatic habitats with other chloroacetanalides, including s-metolachlor, which may result in increased risk to threatened and endangered Pacific salmon and steelhead and their habitats. The available information supports that salmon and steelhead individuals and their habitat will likely be exposed to racemic metolachlor throughout their freshwater residency and in some circumstances exposed in estuarine and near shore saltwater habitats.

2.3 Effects Assessment

NMFS reviewed the toxicity information presented in the BE and compiled and reviewed other available toxicity information to ascertain if the data support the BE conclusions regarding racemic metolachlor's potential for direct and indirect effects to ESA-listed Pacific salmon and steelhead.

2.3.1 Toxicity Endpoints Used in BE

The BE evaluated the potential direct toxic effects of racemic metolachlor on the survival, reproduction, and growth of Pacific salmon and steelhead by evaluating the toxicity data for racemic and s-metolachlor. The BE addressed potential effects to listed species habitat by evaluating racemic metolachlor and s-metolachlor toxicity information from other aquatic species such as plants and invertebrates. All toxicity information used in the BE to quantify risk to listed species was from standard laboratory toxicity tests submitted by registrants and from studies acquired from ECOTOX. The toxicity data used in risk quotients to estimate effects to listed species and habitat included:

1) Median lethal concentration data from two fish species (representing a freshwater and saltwater species) to estimate direct acute toxicity to survival of listed Pacific salmon and steelhead;
2) No observable effect concentration (NOEC) data from early-life stage study with fish surrogate to estimate direct, chronic effects to growth and reproduction of Pacific salmon steelhead;

3) Median effect concentrations in aquatic invertebrates and plant studies to estimate effects to salmonid prey and cover;
4) Effect concentration data in terrestrial plants to estimate direct effects to riparian vegetation.

In addition to standard FIFRA guideline toxicity studies submitted to EPA by pesticide registrants, other effect data presented in this BE were obtained from ECOTOX and to a lesser extent from the open literature. However, ECOTOX poses constraints that limit inclusion of ecologically relevant toxicity data. In order to be included in ECOTOX papers must meet the following criteria:

1) the toxic effects are related to single chemical exposure;
2) the toxic effects are on an aquatic or terrestrial plant or animal species (no microorganisms);
3) there is a biological effect on live, whole organisms;
4) a concurrent environmental chemical concentration/dose or application rate is reported; and
5) there is an explicit duration of exposure.

2.3.2 Toxicity to Pacific Salmon and Steelhead Individuals

EPA's assessment process as described in the Overview Document indicates that the lowest acceptable LC_{50} is selected to assess acute risk to listed species' individuals (EPA 2004). The BE selected one of the lowest fish LC_{50}s from the available data (registrant submitted, open literature, ECOTOX) to evaluate acute risk to salmon and steelhead. However, NMFS search of ECOTOX (EPA 2007) indicated an LC_{50} for guppy of 20 ug/L which suggests much greater potential for direct lethality than the 3200 ug/L LC_{50} for bluegill used in the acute risk quotient calculation (Ref. No. 312, Vykusova and Svobodova 1987). This LC_{50} is counter to other LC_{50}s generated from standard toxicity tests which cumulatively indicate racemic metolachlor LC_{50} is greater than 1 mg/L. NMFS was not able to obtain this paper to assess the quality of this report. Additionally, the BE did not comment on the quality of this study and therefore the applicability of the data remain uncertain.

Although the BE noted incidental sublethal effects observed during acute lethality tests with fish (Table 4.1.1a, page 73-75), no studies investigating sublethal responses resulting from acute exposure to racemic metolachlor or s-metolachlor were found. This is a notable data gap. Additionally, no information was available on the chronic toxicity of racemic metolachlor to fish. EPA reported a fathead minnow early life stage NOEC of 30 ug/L for s-metolachlor (EPA 2006, MRID 44995903) which was the value used in chronic risk quotient calculations to assess the risk of chronic exposure to racemic metolachlor. The NOEC of 30 ug/L is also supported by data for alachlor, another chloroacetanilide with environmental fate and acute toxicity values that are similar to metolachlor. Two studies with freshwater fish following 64 days of exposure to alachlor produced toxicity responses at a similar range with NOEC values of 60 and 140 ug/L (EPA 2007, reference number 10635; Call et al. 1984).

Data with other aquatic species indicated sublethal responses to racemic metolachlor may occur at lower exposure concentrations. Wolf and Moore (2002) found racemic metolachlor significantly decreased crayfish ability to locate food odor at all metolachlor concentrations of 25, 50, and 75 ug/L atrazine ($p \leq 0.05$). Olfaction is a critical chemosensory function for Pacific salmon and steelhead which underlies important behaviors including detecting and avoiding predators, participating in reproduction, locating food, imprinting, and navigating migratory routes. No studies were located that evaluated whether or not metolachlor affected olfactory processes in fish. If olfaction in salmonids is as sensitive as observed effects to crayfish chemosensory systems, racemic metolachlor may adversely affect listed Pacific salmon and steelhead individuals at concentrations less than or equal to 25 ug/L.

NMFS' evaluation of procedures used in the BE to assess direct toxicity to listed species suggests that toxicity values were selected in accordance with the Overview Document for risk quotient analysis based on the available data (EPA 2004). However, substantial uncertainty remains in the use of selected toxicity estimates to represent biologically relevant salmonid responses due to the absence of studies evaluating sublethal responses such as chemosensory systems, behaviors, reproduction, endocrine disruption, growth, and smoltification.

2.3.3 Effects to Habitat

Racemic metolachlor may cause adverse effects to listed species by impacting aquatic communities due to its herbicidal action on aquatic primary producers and toxicity to aquatic invertebrates. EPA analyzed the potential for adverse effects to Pacific salmonids via associated habitat degradation by predicting the response of aquatic invertebrates and plants to EECs according to EPA screening methods (EPA 2004). Briefly, as stated in the Overview Document (EPA 2004), the lowest tested toxicity values from "acceptable" acute and chronic test durations should be utilized to estimate risk. For example, acute risk to aquatic invertebrates is determined by selecting the lowest EC_{50} or LC_{50} from the available information that meets EPA's selection criteria for an acceptable study. Chronic risk to invertebrates is determined by selecting the lowest NOEC using the same selection criteria. However potential risk to threatened and endangered salmonids via racemic metolachlor-induced habitat degradation was substantially underestimated in the BE because the lowest toxicity values from studies with salmonid prey items (daphnids and midges) and vascular plants were not used.

The available acute and chronic toxicity data for invertebrates and plants indicated that the lowest effect concentrations were not selected in the BE. Notably, one study not used in the risk quotient analysis addressed the acute and chronic effects of racemic metolachlor and s-metolachlor to individual daphnid biological endpoints and to daphnid populations (Ecotox Ref. No. 83887, Liu et al. 2006). The results indicated that both forms of metolachlor are toxic to an individual daphnid's size and longevity which may affect the availability of this prey item and other sensitive invertebrates to juvenile salmonids. More striking are the effects from racemic metolachlor on female daphnid reproduction endpoints including number of progeny per female and number of broods per female. At 10 ug/L racemic metolachlor, number of young per female was statistically significantly affected (reduced by 10%). This study then used survival and fecundity empirical data to predict the effect of racemic and s- metolachlor on invertebrate populations. The model results predicted that racemic metolachlor at and above 10 ug/L would significantly reduce a daphnid population's intrinsic growth rate (Liu et al. 2006). This population endpoint has been recommended as a replacement for LC_{50} data because it combines both sublethal and lethal effects into one parameter (Stark et al. 1997). By affecting an invertebrate population's intrinsic growth rate, racemic metolachlor could lead to reduced prey availability for foraging salmonids particularly in areas where multiple applications are applied year after year.

Aquatic primary producers are adversely affected by both forms of metolachlor at concentrations in the low ug/L range. Aquatic primary producers include phytoplankton (diatoms, algae), macrophytes (vascular plants, macro algae), and periphyton (including *Aufwuchs*). The lowest EC_{50} for aquatic plants, 8 ug/L, was not used in the BE's risk quotient although it is 1.25 times more toxic (Table 4). Additionally, vascular plant toxicity data indicated toxicity at lower concentrations than were used in the BE (Table 4). As mentioned earlier, risk quotients are a simple function of an exposure concentration divided by an effect concentration, therefore a small change (including a change of 2 ug/l) in either value can mean the difference between a no effect and a may affect determination.

Table 4. Salmonid habitat assessment endpoints and toxicity values from racemic metolachlor and s-metolachlor studies.

Salmonid Habitat Assessment Endpoint in BE	**Acute and Chronic Toxicity Values Used in Risk Quotients**		**Information on Toxicity Values Not Used in Risk Quotients (Racemic or S-metolachlor)**
Freshwater invertebrate (prey item)	3800 ug/L (LC$_{50}$) midge	1100 ug/L (LC$_{50}$) daphnid (#6777)	
Freshwater invertebrate (prey item)	3200 ug/L (NOEC) daphnid	1 ug/L (NOEC) racemic-metolachlor daphnid (#83887)	NOEC 1 ug/L # young/female (Rac) NOEC 500 ug/L length (Rac) NOEC 500 ug/L longevity (Rac) NOEC 500 ug/L brood#/female (Rac)
		100 ug/L (NOEC) s-metolachlor daphnid (#83887)	NOEC 100 ug/L # young/female (S) NOEC 500 ug/L length (S)
		10 ug/L (LOEC) (#83887)	LOEC 10 ug/L reduction in intrinsic population growth rate
Marine invertebrate	130 ug/L (NOEC) mysid shrimp	-	-
Freshwater alga (primary production)	10 ug/L (EC$_{50}$) green alga	8 ug/L (EC$_{50}$) green alga (#344)	EC$_{50}$ reduction in primary production
Freshwater vascular plants (primary production and shelter)	48 ug/L (EC$_{50}$) duckweed	21 ug/L (EC$_{50}$) duckweed (#344)	EC$_{50}$ reduction in photosynthesis
Marine plants (primary production and shelter)	61 ug/L (EC$_{50}$) marine diatom	10 ug/L (NOEC) American bulrush (#61985)	NOEC reduction in photosynthesis

2.3.4 Potential Effects of Racemic-Metolachlor Containing Mixtures

ECOTOX screened out toxicity studies that evaluated responses to contaminant mixtures. The exclusion of mixture toxicity data and subsequent lack of evaluation to response of Pacific salmonids to mixtures expected in the environment underestimated the potential risk of racemic metolachlor to aquatic organisms, particularly primary producers. EPA-approved pesticide labels commonly recommend the use of racemic metolachlor containing pesticides in “tank mixes” with other pesticide formulations during application (Table 1, Greenbook 2006). EPA permits racemic metolachlor to be formulated with other active ingredients, such as atrazine. Metolachlor is the second most frequently detected herbicide following atrazine in surface water samples with a variety of other pesticides including other chloroacetanilides known to result in additive responses to primary producers (Figure 2; EPA 1989, Battaglin et al. 2001, EPA 2002, Gilliom et al. 2006, Gilliom et al. 2007).

In one study racemic metolachlor was co-applied with alachlor (a chloroacetanilide), atrazine, and metribuzin in stream mesocosms to determine effects to *Aufwuchs*’ (similar to periphyton) biomass and nutrient uptake (Krieger et al. 1988). Atrazine and metribuzin are common pesticides in metolachlor tank mixes and atrazine is co-formulated with racemic metolachlor (Table 1); both are also commonly detected in surface waters utilized by Pacific salmonids (Figure 2; Gilliom et al. 2006; Gilliom 2007). Biomass of *Aufwuchs* was significantly reduced following pulsed exposures of the pesticide mixture at 10 ºC and 25 ºC and nutrient uptake was also reduced at 10 ºC, but not statistically significantly at 25ºC. Racemic metolachlor concentrations within the two experiments were 85 and 95 ug/L. The *Aufwuchs* provides a primary energy and nutrient source for aquatic invertebrates, many of which are prey items for salmonids, and therefore effects of herbicide mixtures to *Aufwuchs* may adversely affect the structure and function of the aquatic community.

No information was located as to the effects of racemic metolachlor containing mixtures on any fish species. However, a mixture study with frogs indicated that concentrations of 0.1 ug/L of nine pesticides, including s-metolachlor, resulted in statistically significant reductions of growth and development (Hayes et al. 2006). Although some of the pesticides individually inhibited larval growth, the pesticide mixtures had much greater effects. Bicep II Magnum a formulation of atrazine and s-metolachlor increased the frequency of animals with thymic plaques relative to rates observed when animals were exposed to either atrazine or s-metolachlor alone; however disease rates were not increased unless animals were also exposed to the nine-pesticide mixture. Whether these effects are relevant to listed salmonids is difficult to determine. However, EPA uses fish toxicity data as a surrogate to evaluate risk to amphibians (EPA 2004).

Carder and Hoagland (1998) found statistically significant reductions in algal community biovolume following a single application of environmentally realistic concentrations of atrazine, alachlor (a chloroacetanilide with similar transport and fate as well as toxicity characteristics as metolachlor), and from mixture combinations of the two pesticides. Artificial streams were sampled at 1, 7, 14, and 21 days for algal community biomass. Statistically significant effects in biovolume, a measure of algal community production, manifested at 14 days and persisted for the duration of the experiment, 21 days. Combinations of atrazine and alachlor resulted in additive toxicity. The authors concluded that "addition [additive toxicity] may be a reasonable assumption for the hazard assessment of chemical mixtures". This study demonstrated that additive toxicity (reduction in biovolume), resulted from two pesticides with different modes of action, which underscores the potential for mixture effects that are greater than from single pesticide exposures. Although racemic metolachlor was not tested in this experiment, the similarity between the two chloroacetanilides, supports that racemic metolachlor mixed with atrazine may also result in additive toxicity.

2.3.4.1 Additive toxicity of chloroacetanilides

The available scientific literature and EPA assessments recognize that racemic and s-metolachlor share a toxic mode of action with other chloroacetanilides. Chloroacetanilide herbicides adversely affect primary producers (and by extension aquatic communities) by interfering with amino acid synthesis. Due to the racemic metolachlor's herbicidal action, primary producers are expected to be the most susceptible part of the aquatic community. Indeed, phytoplankton and periphyton, both ecologically important groups of primary producers, have been shown to be highly sensitive to chloroacetanilides. In the case of toxicity to primary producers, one study clearly showed that eight chloroacentanilides (acetochlor, alachlor, butachlor, dimethochlor, metazachlor, metolachlor, pretiliachlor, and propachlor) resulted in additive toxicity in the green alga, *Scenedesmus vacuolatus* (Junghans et al. 2003). Furthermore the effects of the chloroacetanilide mixtures were "considerably higher than those of the individual components: a complete inhibition of algal reproduction was observed when each of the mixture components was present in a concentration that would cause a 5% effect if applied singly" (Junhghans et al. 2003). The EC_{05} for racemic metolachlor used in the experiment was 69.2 ug/L and is within the concentration range detected in surface waters. Other alga appeared to be more sensitive to metolachlor.

Environmental mixtures of herbicides are common and chloroacetanilides including metolachlor, alachlor, and acetochlor are among the most frequently detected herbicides in agricultural watersheds utilized by listed salmon and steelhead (Figure 2). The BE addressed potential effects of two metolachlor degradates, OXA and ESA which presumably share a common mode of action to primary producers. However, additive toxicity resulting from concurrent exposure to racemic metolachlor, OXA, ESA and other chloroacetanilides was not addressed in the BE. When aquatic habitats are exposed to several chloroacetanilides simultaneously, resultant toxicity is likely from the combination of chloroacetanilides, not a single constituent. Additive toxicity to primary producers is the expected outcome from such mixtures, yet is not characterized in the current BE. Existing monitoring data, modeling data, and approaches for assessing the additive toxicity of mixtures likely occurring in these species' habitats were not utilized in the BE. The potential risk of racemic metolachlor to listed species was likely underestimated.

2.3.5 NMFS' Effect Data Conclusions

Utilization of data to assess the potential toxicity of racemic metolachlor to acute and chronic fish endpoints generally followed procedures outlined in the Overview Document (EPA 2004). One notable exception was the failure to incorporate the lowest fish LC_{50} to assess lethality from acute exposure to racemic metolachlor. The study was not available, so uncertainty in its quality exists. Considerable uncertainty also remains in the risk quotients due to the absence of studies evaluating ecologically relevant sublethal responses. Of particular interest are the potential effects on olfaction-mediated behaviors given the observation that racemic metolachlor has been shown to impair crayfish ability to locate food odor at environmentally relevant metolachlor concentrations. The influence of racemic metolachlor on fish olfaction has not been tested but olfaction has been shown to be a sensitive endpoint for several other pesticides including atrazine (reduced olfaction at 1 ug/L) and the widely used herbicide glyphosate reduced olfaction at 100 ug/L (Tierney et al. 2007).

The toxicity data reviewed by NMFS from plant and invertebrate studies do not support EPA's selection of toxicity values to evaluate risk via habitat degradation. Racemic metolachlor is highly toxic to primary producers and to aquatic invertebrates in the low ug/L range. For example, the BE selected an acute LC_{50} for invertebrates that is 3.5 fold less toxic than an LC_{50} from a study with a daphnid (Table 4). The chronic toxicity value, a NOEC, was 3200 fold less toxic than a NOEC from an experiment with *Daphnia magna*. Together these two disparities result in substantial underestimation of potential risk to threatened and endangered salmonid habitats from racemic metolachlor. Racemic metolachlor impacts to primary producers are expected to result in a cascade of adverse ecological impacts including effects to abundance of salmonid prey items that feed on primary producers. Additionally, the BE effects section did not address mixture toxicity, although convincing evidence suggests that chloroacetanalides share a common mode of action which results in predictable, additive toxicity to primary producers (Junghans et al. 2003). The degree to which threatened and endangered salmonids will be impacted from effects to aquatic plants and prey items is dependent on aquatic exposure, and site- and species-specific relationships which will be further discussed in the risk characterization section below.

2.4 Risk Characterization

NMFS does not concur with the effect determinations, and believes that the available exposure and effect data indicate that threatened and endangered Pacific salmon and steelhead will likely be adversely affected by exposure to racemic metolachlor. This conclusion is supported by the available information on salmonid ecology, current and potential use and exposure of racemic metolachlor, and studies that addressed the effects of metolachlor to aquatic flora and fauna.

NMFS anticipates that individuals from 25 of the 26 ESA-listed ESUs will likely be exposed at some point in their lifecycle to racemic metolachlor end use products. It is unlikely that Ozette Lake sockeye individuals or their habitat will be exposed based on current and future land uses within the ESU's geographic local i.e., the majority of the ESU is in the Olympic National Park and Forest and the remaining portions of the ESU's watershed is largely private, coastal, temperate rainforest where racemic metolachlor is not expected to be used. Given the statewide registration of multiple racemic metolachlor end use products combined with the current and potential use of those products on a wide array of crops throughout Washington, Idaho, Oregon, and California, it is not possible to definitively rule out aquatic exposure to individuals or to habitat. In addition, national and regional surface water and ground water monitoring efforts consistently detect metolachlor in watersheds utilized by Pacific salmon and steelhead. Concentrations as high as 143 ug/L have been reported from national monitoring data and concentrations in the low ug/L were common. No studies were available that directly targeted racemic or s-metolachlor applications with runoff events so peak concentrations are not available.

The BE evaluated the potential direct toxicity of racemic metolachlor to listed species using a risk quotient analysis to make the effect determinations (EPA 2004). Risk quotients were calculated by dividing estimates of racemic metolachlor exposure (EECs) by toxicity values and comparing the result to EPA established Levels of Concern (LOC) (EPA 2004). However, the BE-generated EECs are not expected to represent potential high end exposure to salmonids and their habitat (reviewed in section 2.2). Since the BE's resulting risk quotients did not exceed EPA derived LOCs for direct effects, EPA concluded that current and potential racemic metolachlor use in the states of Idaho, Washington, Oregon, and California would have "no effect" on threatened and endangered Pacific salmon and steelhead via direct toxicity (EPA 2006). However, NMFS questions several of EPA's selections of exposure and effect values used in the risk quotient analysis (reviewed in sections 2.3).

The following points highlight uncertainties with the information used in the RQ analysis applied to direct effects to fish. In regard to the selection of the lowest 96 hr LC_{50}, EPA selected 3200 ug/L although a much lower LC_{50} was available from ECOTOX. The sublethal effects of metolachlor on biologically relevant salmonid endpoints such as chemosensory systems, behaviors, reproduction, endocrine disruption, growth, and smoltification were absent. This is a notable data gap as other pesticides including herbicides e.g. atrazine and glyphosate, have affected multiple sublethal endpoints such as olfaction, endocrine systems, and behaviors. An experiment with crayfish did demonstrate chemosensory effects from racemic metolachlor exposures. While this indicates that metolachlor has the potential to disrupt ecologically relevant sensory systems of aquatic species, it is uncertain how comparable salmonid sensory systems are with crayfish.

The information reviewed by NMFS on exposure and direct toxicity to listed salmonids indicates that ESA-listed Pacific salmon and steelhead are likely to be exposed in off-channel habitats resulting in effects that are neither insignificant, nor discountable or wholly beneficial.

2.4.1 Exposure and Effects to Pacific Salmon and Steelhead Habitat

EPA addressed the potential effects of racemic metolachlor to primary producers because the risk quotient analyses exceeded acute levels of concern for freshwater plants indicating to EPA that freshwater plants may be impacted by several crop scenarios. The subsequent analyses were driven by a well articulated conceptual model (figure 3.4; EPA 2006). However, NMFS does not agree with EPA's interpretation of the data for several reasons. As discussed earlier, low flow, off channel habitats are particularly susceptible to racemic metolachlor contamination that could achieve much higher concentrations than those used in the BE. In some circumstances, concentrations may attain levels at or above a mg/L and would be expected to persist for many weeks based on the physical-chemical properties of racemic metolachlor combined with the environmental characteristics of the habitat (temperatures of 15º C or less, flow, depth, shade, etc.). Direct overspray calculations of some of these small habitats, although not permitted according to the labels, is possible and would potentially achieve low mg/L concentrations (Table 2). NMFS' EEC examples, while coarse and imprecise, indicate that acute and chronic habitat-based LOCs were consistently exceeded for invertebrates (prey items) and aquatic plants (algae, periphyton, vascular) (Table 2).

2.4.1.1 Aquatic primary production

Adverse impacts to primary producers can occur at concentrations as low as 8 ug/L. It is likely that algae (macro and microphytic), periphyton, and vascular plants will be affected by racemic metolachlor throughout the range of threatened and endangered salmonids. The BE concluded that racemic metolachlor's effect on aquatic plants is insignificant and discountable based on the following reasons:

1) effects from metolachlor to aquatic plants appeared to be limited to algae;
2) exposures exceeding algal levels of concern (50% growth inhibition levels) were not expected to occur more than 10 times over a period of 30 years;
3) the highest exposure levels would be expected to last only a few hours;
4) algae would be expected to recover rapidly.

The above statements are not supported by exposure, effects, and ecological data presented in the BE, open literature, metolachlor RED, and previous EPA effect determinations for metolachlor to ESA-listed salmonids (EPA 2002). Below, NMFS addresses each of the reasons as they form the basis for EPA's NLAA conclusions for listed Pacific salmonid ESUs and designated critical habitat.

1). Effects from metolachlor to aquatic plants appeared to be limited to algae;

Primary producers are the base of the foodweb for lotic and lentic environments. EPA's assessment of literature that met their acceptable criteria indicated that algae, periphyton, and aquatic vascular plants are all very sensitive to racemic metolachlor and s-metolachlor (low ppb concentrations). The effect concentrations to aquatic plants indicate that metolachlor is "very highly toxic" according to EPA's classification system. Two “core” studies with duck weed (*Lemna gibba*) also showed that metolachlor is “very highly toxic” to aquatic vascular plants. *Lemna gibba* EC_{50}s were 48 ug/L (racemic metolachlor) and 21 ug/L (s-metolachlor). These data do not support the claim that metolachlor toxicity is limited to algae, but rather indicate that metolachlor is “very highly toxic” to aquatic plants. Metolachlor’s herbicidal properties are well documented as evidenced by its efficacy and toxicity to multiple primary producers including target plants, i.e. weeds, non-target terrestrial plants including crops, and non-target aquatic plants.

2). Exposures exceeding algal levels of concern (50% growth inhibition levels) were not expected to occur more than 10 times over a period of 30 years; This statement is not supported in the BE and it is not clear how this conclusion was derived. If the calculation includes the underestimates of potential exposure and toxicity the probability of exceeding toxicity thresholds may be underestimated. However, the statement cannot be evaluated or verified with the information presented, as the BE exposure scenarios do not quantitatively address the variability in site specific conditions across the range of salmonid habitats.

3). *The highest exposure levels would be expected to last only a few hours;* No evidence is presented in the BE to suggest that racemic metolachlor will dissipate substantially after a few hours. The biodegradation rate for metolachlor in surface waters is 141 days (aerobic half-life). Additionally the high frequency of surface water monitoring detections suggests that salmon habitats would have metolachlor residence times much longer than a few hours. This is particularly the case for small streams and off-channel habitats utilized by salmonids. Given metolachlor’s soil and aquatic half lives, it would be expected to persist for weeks to months in semi-static and low flow habitats.

4). *Algae would be expected to recover rapidly*. There is no scientific evidence presented that supports this statement and other evidence suggests that effects to algae can lead to long term community impacts. Racemic metolachlor and atrazine have relatively similar environmental fate profiles and EC_{50}s for inhibition of photosynthesis within aquatic primary producers. Atrazine is slightly less toxic (lowest EC_{50} atrazine, 22 ug/L) than racemic metolachlor (lowest EC_{50}, 8 ug/L). While NMFS did not locate any studies with racemic or s-metolachlor that evaluated recovery, studies with atrazine (a co-formulated active ingredient with racemic metolachlor) indicated that effects to primary producers resulted in cascading ecological effects. A variety of aquatic community level endpoints were adversely affected for weeks, months, and in some cases, more than a year. For example, significant reductions in biomass of tadpoles, abundance of a single fish species, and cover by emerged, floating and submerged aquatic plants lasting more than a year have been documented following a single exposure to 20 ug/L atrazine (Carney 1983, Kettle et al. 1987, deNoyelles et al. 1989, deNoyelles et al. 1994, deNoyelles and Kettle 1983, deNoyelles and Kettle 1980, Dewey 1986). Fairchild et al. (1994) found changes in plant species composition that lasted over 15 weeks following a single application of 50 ug/L of atrazine to an experimental pond. Several other studies' results showed clear adverse effects in aquatic species composition and in abundance of primary producers which never recovered during study periods of ≤56 days (Stay et al. 1989, Hamala and Kollig 1985, Johnson 1986, Berard et al. 1999, Carder and Hoagland 1998, Detenback et al 1996, Kosinski 1984, Krieger et al. 1988, Kosinski and Merkle 1984). The degree to which effects may result is presumably dependent on concentration and duration of exposure and these studies were conducted with a variety of exposure conditions. However, the results demonstrate that herbicide effects to primary producers can persist for extended durations and result in cascading effects to higher level organisms.

NMFS expects that exposures to racemic metolachlor that are sufficient to reduce primary production i.e. at or above 8 ug/L, could lead to adverse cascading ecological effects within listed salmonid habitats, potentially affecting listed salmonids themselves. Additionally, NMFS expects concentrations to persist especially in shallow, off-channel habitats inhibiting the recovery of primary producers. This is supported by metolachlor's aerobic aquatic half-life of 141 days and the frequency of detection in monitoring programs. Therefore NMFS believes that effects to primary producers are expected in each of the exposed salmonid ESUs.

2.4.1.2 Salmonid prey

Since the aquatic invertebrate LOCs were not triggered, EPA concluded a “no effect” to salmonid prey. NMFS’ review of the available information indicated that salmonid prey are likely to be exposed at higher concentrations than estimated by EPA and that adverse effects are likely for sensitive taxa. For example, the chronic toxicity value used in the BE, a NOEC, was 3200 fold less toxic than a NOEC from an experiment with the invertebrate *Daphnia magna* (Liu et al. 2006). Aquatic invertebrates are important prey items for rearing anadromous salmonids and often are frequently absent from degraded systems. The BE used *Daphnia magna* toxicity data as a surrogate for all freshwater invertebrates, although many of the stream dwelling organisms that salmonid’s rely on for growth and development are more sensitive to water quality changes especially contaminants. Mayflies (Ephemeroptera), stoneflies (Plecoptera), caddis flies (Trichoptera), and amphipods (Amphipoda) are primary prey items for juvenile salmonids and are frequently the first organisms to be eradicated from stream systems due to organic contaminants such as pesticides. Typically, taxa within these orders are much more sensitive or less tolerant than *Daphnia magna* (Wogram and Liess 2001). Therefore the use of *Daphnia magna* toxicity data is likely an underestimate to other salmonid prey items. Reduced populations of prey may affect growth and development at critical life stage transitions of salmonids e.g., alevin-fry.

One such vulnerable life-stage transition is the time period following the complete utilization of the yolk-sac when active feeding begins. This critical period is referred to as time to first feeding and is a foundation of early life stage fish ecology and development. Fry must begin active feeding during the first week of this critical period to avoid the onset of starvation. Starvation effects of juveniles can manifest in as little as a few days following absorption of the yolk sac and sustained periods of low or poor quality prey can reduce salmonid growth prior to entering the ocean. Hatching of some juvenile salmonids occurs throughout spring corresponding with the periods of high racemic metolachlor use and subsequent runoff.

The available information on the ecology of Pacific salmon and steelhead and their use of aquatic habitats throughout their range does not support EPA's effect determinations that racemic metolachlor is not likely to adversely affect salmonids via habitat effects. Racemic metolachlor use within salmonid watersheds likely degrades freshwater habitats utilized by salmonid lifestages, particularly juveniles, and likely results in cascading ecological effects. Risk to ESA-listed species' habitat from mixtures containing racemic metolachlor will likely be underestimated if evaluated in isolation of other co-occurring pesticides.

2.4.2 Designated Critical Habitat

Within an ESU's designated critical habitat, primary constituent elements (PCEs) essential for the conservation of an ESU are those sites and habitat components that support one or more lifestages (70 FR 170, 52629-52858; September 2, 2005). The relevant habitat components and PCEs for this action include: 1) Freshwater spawning sites with water quality conditions supporting incubation and larval development; 2) Freshwater rearing sites with water quality and forage supporting juvenile development, natural cover such as aquatic vegetation; 3) Freshwater migration corridor's water quality and natural cover supporting juvenile and adult mobility and survival; 4) Estuarine areas with water quality supporting juvenile and adult physiological transitions between freshwater and seawater, natural cover such as aquatic vegetation, juvenile and adult forage including aquatic invertebrates supporting growth and maturation; 5) Near shore marine areas with natural cover such as aquatic vegetation, water quality and forage including aquatic invertebrates supporting growth and maturation (70 FR 170, 52629-52858; September 2, 2005). Based on the expected exposure and effects to primary producers and salmonid prey items, NMFS believes that designated critical habitat will be adversely affected via the degradation of water quality and forage PCEs.

2.4.3 Ecological Relevance of Mixture Toxicity

The BE did not address the likelihood of mixture exposures and the consequent biological response of habitat or listed individual salmonids which contributed to the likelihood that risk to listed species was underestimated.

The best scientific and commercial data available predict likely exposure of threatened and endangered Pacific salmonids to racemic metolachlor containing pesticide mixtures. Watersheds containing salmonid aquatic habitats including streams, rivers, estuaries, and near shore marine environments which contain crops where racemic metolachlor can be used are expected to contain other chloroacetanilides, atrazine, and metribuzin, all which have been shown to interact with metolachlor resulting in additive toxicity. Monitoring and use data indicated that metolachlor is a common constituent of pesticide mixtures in agricultural (occurring in 50% of samples containing mixtures) and urban watersheds (Gilliom et al. 2006). Given the frequent co-occurrence of atrazine, metolachlor, and alachlor containing mixtures, it is expected that aquatic primary producers will respond to the mixture and not to racemic metolachlor alone. Environmentally realistic concentrations of atrazine, metolachlor, and alachlor are sufficient to adversely affect primary production and when combined, would lead to greater toxicity than expected from any one of the pesticides alone. This is supported by several studies that showed additive effects of metolachlor in combination with other chloroacetanilides, atrazine, and metribuzin, to *Awufuchs*, periphyton, and algae (Junghans et al. 2003, Carter and Hoagland 1998; Krieger et al. 1988). Consumer species such as invertebrate salmonid prey items feeding on fewer, smaller, primary producers likely result in reduced feeding efficiency and subsequent reduced growth and potentially affects juvenile salmonids.

The available information on environmentally realistic mixtures does not support EPA's effect determinations and suggest that racemic metolachlor is likely to impact aquatic communities, thereby adversely affecting listed species that utilize those habitats. By not incorporating an evaluation of mixtures, the BE likely underestimated the risk posed to ESA-listed salmonids and their habitats. The degree to which each salmonid ESU is affected by racemic metolachlor containing mixtures will be dependent on life stage and life history habitat requirements of individuals, coupled with the frequency and magnitude of encounters with racemic metolachlor induced degraded habitat.

2.4.4 Field level information on incidents of metolachlor toxicity

Ecological incidents with racemic metolachlor are presented, but are not used in characterizing risk. Eighteen reported incidents resulted in fish kills of which EPA characterized the likelihood that metolachlor was a causative agent as "probable" for four of the incidents and "highly probable" for one of the incidents. The incident classified as highly probable involved a reportedly accidental misuse of the product which killed more than 5000 fish. In four other incidents metolachlor applications were reported to be "in accordance with label dictated application rates and timing" (EPA 2006). In the 2002 metolachlor assessment, three of the incidents were described that resulted from runoff and drift as follows.

- "A fish kill occurred in a pond in South Carolina on March 31, 1984 that was attributed to runoff of metolachlor and atrazine from an adjacent corn field. The event occurred after a rainfall event of 4.2 inches. Metolachlor was detected at 28.3 ppb and atrazine at 19.8 ppb in the pond water."
- "A fish kill in a Louisiana pond in 1997 occurred after heavy rains two days after application of metolachlor and atrazine to a nearby field. Metolachlor was detected and 57 ppb and atrazine at 32 and 116 ppb."
- "A kill of 300 bass and 300 bluegills occurred in a pond in Delaware in 1997 following application of metolachlor and atrazine and nitrogen fertilizer to a corn field."

These three incidents serve as weight of evidence that racemic metolachlor, particularly in combination with atrazine (a commonly co-formulated active ingredient), can kill or contribute to mortalities of fish following applications in accordance with the label. In general, measured concentrations associated with these fish kills were greater than environmental concentrations predicted by BE exposure modeling despite being applied at rates in accordance with label specifications. Additionally, mortality occurred at measured concentrations below the acute threshold used to determine "No Effect" to listed fish in the BE. NMFS agrees with EPA's previous explanation that some degradation of metolachlor may have occurred prior to environmental sampling and that “fish mortality also might have been enhanced from exposure to multiple stressors” (EPA 2002). “Atrazine was detected along with metolachlor in three incidents and cyanazine in another and the combination of pesticides may have had additive or possibly even synergistic effects” (EPA 2002). This line of evidence further supports NMFS’ position that the BE may underestimate potential exposure and effects to listed species.

3 Summary

NMFS reviewed EPA’s effect determinations using the substantive requirements of section 7. NMFS concurs with the NLAA determination for Ozette Lake Sockeye ESU which is not likely to be exposed to racemic metolachlor products. NMFS does not concur with the remaining 25 Pacific salmon and steelhead ESUs. NMFS expects racemic metolachlor may affect, and is likely to adversely affect, 25 salmonid ESUs. NMFS also expects that racemic metolachlor contamination of designated critical habitats will adversely affect water quality and forage (primary constituent elements for salmonid designated critical habitats). Measured and predicted environmental concentrations of racemic metolachlor in surface waters of Idaho, California, Washington, and Oregon are likely to be directly toxic to salmonids and their habitats based on the best scientific and commercial data available.

NMFS recommends that EPA initiate formal section 7 consultations on the effects of racemic metolachlor end use products on threatened and endangered Pacific salmon and steelhead ESUs including the recently listed threatened Puget Sound steelhead ESU.

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