UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700

Refer to NMFS No: WCR-2017-8268

MAY 15 2018

John Madsen, PhD
Research Biologist
United States Department of Agriculture-Agriculture Research Service
Exotic and Invasive Weeds Research Unit
University of California, Davis
Davis, California 95616

Re: Endangered Species Act Section 7(a)(2) Programmatic Biological Opinion, Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response and Fish and Wildlife Coordination Act Recommendations for the Aquatic Invasive Plant Control Program located in the Sacramento-San Joaquin Delta, its surrounding tributaries and Suisun Marsh, California.

Dear Dr. Madsen:

Thank you for your letter and enclosed biological assessment on October 16, 2017, requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.) for the *Aquatic Invasive Plant Control Program (AIPCP)*.

Thank you, also, for your request for consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1855(b)) for this action. However, after reviewing the proposed action, we concluded that it would not adversely affect EFH, therefore, no EFH consultation is required.

In the enclosed programmatic biological opinion, NMFS concludes that the AIPCP is not likely to jeopardize the continued existence of federally listed species or their designated critical habitats. Additionally, NMFS has included an incidental take statement, reasonable and prudent measures, and non-discretionary terms and conditions that are necessary and appropriate to avoid and minimize "take", and monitor incidental take of federally listed fish.

Please contact Dr. Melanie Okoro at the California Central Valley Office at 916-930-3728 or via email at Melanie.Okoro@noaa.gov if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

Maria Rea
for Barry A. Thom
Regional Administrator

Enclosure

cc: Copy to File: ARN151422-WCR2017-SA00382

Edward Hard, California States Parks, Department of Boating and Waterways, 1 Capitol Mall, Suite 410, Sacramento, California 95814.

Wendy Pratt, Crowe Horwarth, LLP, Wells Fargo Center, 400 Capitol Mall, Suite 1400, Sacramento, California 95814

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Endangered Species Act Section 7(a)(2) Programmatic Biological Opinion Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response and Fish and Wildlife Coordination Act Recommendations

Aquatic Invasive Plant Control Program

National Marine Fisheries Service Consultation Number: WCR-2017-8268

Action Agency: U.S. Department of Agriculture-Agriculture Service

Affected Species and NMFS' Determinations:

Endangered Species Act Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Sacramento River winter-run Chinook salmon *(Oncorhynchus tshawytscha)*	Endangered	Yes	No	No	N/A
Central Valley Spring-run Chinook salmon (*O. tshawytscha)*	Threatened	Yes	No	No	N/A
California Central Valley steelhead (*O. mykiss*)	Threatened	Yes	No	No	N/A
Southern distinct population segment of North American green sturgeon (*Acipenser medirostris*)	Threatened	Yes	No	No	N/A

Fishery Management Plan That Identifies Essential Fish Habitat (EFH) in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Groundfish	No	No
Pacific Coast Salmon	No	No

Consultation Conducted By: National Marine Fisheries Service, West Coast Region

Issued By:

Maria Rea for Barry A. Thom
Regional Administrator

Date: MAY 15 2018

List of Acronyms

ACID	Anderson-Cottonwood Irrigation District Diversion Dam
AIPCP	Aquatic Invasive Plant Control Program
AIS	Aquatic Invasive Species
BA	Biological Assessment
BMP	Best Management Practice
CDBW	California Department of Boating and Waterways
CDFG	California Department of Fish and Game
CDFW	California Department of Fish and Wildlife
CDPR	California Department of Pesticide Regulation
CNFH	Coleman National Fish Hatchery
Corps	United States Army Corps of Engineers
CCV	California Central Valley
CV	Central Valley
DIZ	Demonstration Investigation Zone
DNA	Deoxyribonucleic Acid
DO	Dissolved Oxygen
DPS	Distinct Population Segment
DQA	Data Quality Act
EAV	Emergent Aquatic Vegetation
EC	Effect Concentration
EDCP	*Egeria densa* Control Program
EFH	Essential Fish Habitat

ESU	Evolutionarily Significant Unit
FAV	Floating Aquatic Vegetation
FR	Federal Register
FRFH	Feather River Fish Hatchery
FWCA	Fish and Wildlife Coordination Act
GPS	Global Positioning System
HAPC	Habitat Areas of Particular Concern
ITS	Incidental Take Statement
JPE	Juvenile Population Estimate
LWD	Large Woody Debris
LOEC	Lowest Observable Effect Concentration
MSDS	Material Safety Data Sheet
MSA	Magnuson-Stevens Fishery Conservation and Management Act
NASA	National Aeronautics and Space Administration
NRC	National Research Council
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NOEC	No Observable Effect Concentration
PFMC	Pacific Fishery Management Council
PBF	Physical and Biological Features
PCE	Primary Constituent Elements
RNA	Ribonucleic Acid
RPA	Reasonable and Prudent Alternative

RBDD	Red Bluff Diversion Dam
SAV	Submerged Aquatic Vegetation
SCP	Spongeplant Control Program
sDPS	Southern Distinct Population Segment
SWRCB	State Water Resources Control Board
TCP	Temperature Compliance Points
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
WHCP	Water Hyacinth Control Program

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1. INTRODUCTION

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into Sections 2 and 3 below.

1.1 Background

The National Marine Fisheries Service (NMFS) prepared the programmatic biological opinion (opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 USC 1531 et seq.), and implementing regulations at 50 CFR 402.

Because the proposed action would modify a stream or other body of water, NMFS also provides recommendations and comments for the purpose of conserving fish and wildlife resources, and enabling the Federal agency to give equal consideration with other project purposes, as required under the Fish and Wildlife Coordination Act (FWCA, 16 U.S.C. 661 et seq.).

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available through NMFS' Public Consultation Tracking System [https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts]. A complete record of this consultation is on file at California Central Valley Office, located in Sacramento, California.

1.2 Consultation History

The United States Department of Agriculture – Agricultural Research Service (USDA) serves as the Federal nexus for a cooperative project with the applicant, the California State Parks Division of Boating and Waterways (CDBW), with regards to managing invasive plant control in the Delta, its tributaries, and the Suisun Marsh and providing research and scientific expertise. The Aquatic Invasive Plant Control Program (AIPCP) incorporates and replaces the previous Delta invasive species control programs implemented by USDA and CDBW and previously consulted on by NMFS, which include Water Hyacinth (*Eichhornia crassipes)* Control Program (WHCP), Spongeplant (*Limnobium laevigatum*) Control Program (SCP), *Egeria densa* Control Program (EDCP), and new invasive plant species (*e.g.*, water primrose [*Ludwigia spp.*], curly-leaf pondweed [*Potamogeton crispus*], coontail [*Ceratophyllum demersum*], Eurasian watermilfoil [*Myriophyllum spicatum*], and Carolina fanwort [*Cabomba caroliniana*]) incorporated through the process as defined by California Assembly Bill 763.

This opinion is based on information developed through the preceding formal and informal consultations; information exchange; a series of coordination meetings with USDA, CDBW, United States Fish and Wildlife Service (USFWS), and Army Corps of Engineers (Corps); and key correspondence with USDA and CDBW.

- On February 2, 2017, a meeting was held at the CDBW Sacramento office between staff from USDA, CDBW, USFWS, Corps, and NMFS to discuss the AIPCP program alternatives and obtain feedback from each agency on the proposed treatment methods and overall program approach. During this meeting, NMFS noted that the treatment locations identified were a concern due to the potential to create low dissolved oxygen (DO) levels as a result of herbicide and mechanical treatment. NMFS suggested USDA use historical DO data collected throughout the Delta to identify low DO areas of concern for listed fish and their habitat.

- On May 11, 2017, a second meeting was held at the CDBW Sacramento office between staff from USDA, CDBW, USFWS, Corps, and NMFS to present the "Description of the Proposed Action" and obtain feedback on key topics (*i.e.,* herbicide selection, treatment timing, and location of physical treatment methods). During this meeting, NMFS requested that CDBW provide information on the DO analyses mentioned above, mapping of fish presence during mechanical treatment, and toxicology information (University of California (UC) – Davis and CDBW toxicology studies) on herbicide effects to listed salmonids and their habitat (*i.e.,* prey items) as a result of the proposed treatment activities. NMFS also requested additional information on the effects of the proposed biocontrol methods (*i.e.,* water hyacinth weevils [*Neochetina bruchi* and *Neochentina eichhorniae*] and water hyacinth planthopper [*Megamelus scutellaris*]) on listed fish species and their habitats.

- On July 11, 2017, a third meeting was held at CDBW Sacramento office between staff from USDA, CDBW, USFWS, Corps, and NMFS to present the first working draft of the AIPCP BA. USDA and CDBW presented the effects analyses that were in progress (*i.e.,* herbicide drift and overspray study, DO analysis, UC-Davis toxicology studies and biocontrol feeding studies), the timeline for completion, and summary of control methods. During this meeting, USDA and CDBW requested NMFS review and comment on the working draft of the BA.

- Prior to review of the draft BA, NMFS request a meeting with USDA, CDBW and UC-Davis to review the results of the toxicity and biocontrol feeding studies. On September 8, 2017, a meeting was held with USDA, CDBW, UC-Davis, and NMFS to discuss the results of each study mentioned above. During the meeting, NMFS recommended that USDA and CDBW remove herbicides that contain the active ingredient (carfentrazone-ethyl, endothall, and flumioxazin) that were found to affect fish and their prey items at acute (96 hours) and chronic (seven days) concentrations based on the proposed herbicide application concentrations, timing, and duration of exposure. In addition, NMFS requested that all herbicide active ingredients (carfentrazone-ethyl, florpyrauxifen-benzyl) "under consideration for use in California" be removed from the AIPCP until approved by the CDPR.

- On June 20, 2017, USDA sent to NMFS a courtesy copy of the first working draft of the AIPCP BA, and requested NMFS's review. The working draft AIPCP BA did not include an "Effects of the Proposed Action" section, which was critical in determining the sufficiency of the draft BA. NMFS provided comments on September 21, 2017, based on the ESA section 7 and EFH programmatic consultation process designed to evaluate the decision-making process a Federal action agency employs to authorize, fund, or carry out specific actions under a proposed plan (*e.g*. AIPCP) or regulation.

- On September 29, 2017, NMFS received a second draft of the AIPCP BA, and provided comments on October 13, 2017.

- On October 16, 2017, USDA, requested formal consultation to implement the AIPCP for floating aquatic vegetation (FAV), emergent aquatic vegetation (EAV), and submerged aquatic vegetation (SAV) in the Sacramento-San Joaquin Delta (Delta), its tributaries, and Suisun Marsh covering 5 years (2018-2022). NMFS also received the AIPCP BA and supplemental materials. NMFS determined that the initiation package was complete to initiate formal section 7 consultation.

Based on guidance from NMFS, USDA has determined that the proposed action is likely to adversely affect (LAA) four ESA-listed species (Table 1), but not likely to adversely affect (NLAA) their critical habitats. USDA also determined that the proposed action would not adversely affect areas designated by the Pacific Fishery Management Council (PFMC) as essential fish habitat for Pacific Coast salmon (PFMC and NMFS 2014), and Pacific Coast groundfish (PFMC 2005), including estuarine areas designated as Habitat Areas of Particular Concern (HAPCs).

Table 1. Listed species, status, and relevant Federal Register (FR) notices for ESA-listed species considered in this opinion.

Listed Species	Scientific Name	Listing Status	Listing Determination
Central Valley (CV) spring-run Chinook salmon evolutionarily significant unit (ESU)	*Oncorhynchus tshawytscha*	Threatened	†70 FR 37160, June 28, 2005
Sacramento River winter-run Chinook salmon ESU	*O. tshawytscha*	Endangered	†70 FR 37160, June 28, 2005
California CV steelhead distinct population segment (DPS)	*O. mykiss*	Threatened	†71 FR 834, January 5, 2006
Southern DPS of North American green sturgeon	*Acipenser medirostris*	Threatened	†71 FR 17757, April 7, 2006

†species listing

1.3 Proposed Federal Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02). For EFH consultation, "Federal action" means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910). Under the FWCA, consultation is required whenever the waters of any stream or other body of water are proposed or authorized to be impounded, diverted, the channel deepened, or the stream or other body of water otherwise controlled or modified for any purpose whatever, including navigation and drainage, by any department or agency of the United States, or by any public or private agency under Federal permit or license” (16 USC 662(a)).

The AIPCP proposed action is a “mixed programmatic action” that includes an adaptive management framework to control the spread of aquatic invasive plants in the Delta, its tributaries, and the Suisun Marsh. The AIPCP is comprised of a comprehensive set of treatment tools and approaches (herbicides, physical and mechanical removal, and biological controls) to optimize program efficacy. Portions of the proposed action that are authorized as part of the adoption of the program under consultation will not be subject to further consultation under ESA section 7(a)(2), including certain herbicides, physical and mechanical removal, and biological controls specifically described and analyzed in this opinion. We have provided an incidental take statement for those portions of the proposed action that will result in take of listed species.

In addition, the proposed action includes the adoption of a framework for the development of future actions that are proposed to be authorized, funded, or carried out at a later time as part of the mixed programmatic action under consultation, and any take of listed species would not occur unless and until those future actions are authorized, funded, and carried out and subject to further ESA section 7(a)(2) consultation, when those actions are ready for consideration (*e.g.,* application of herbicides pending approval for use by U.S. Environmental Protection Agency [USEPA] and the California Department of Pesticide Regulation [CDPR]; and new or different physical, mechanical, and biological control activities that are not specifically described and analyzed in this opinion). We have not provided an incidental take statement that addresses the adoption of a framework for the development of such future actions, because adoption of a framework will not itself result in the take of listed species.

The AIPCP replaces the prior WHCP, SCP, and EDCP actions (which included actions routinely or previously implemented by CDBW), with one comprehensive program for the Delta, its tributaries, and the Suisun Marsh (which includes the newly proposed treatment methods not previously used in the WHCP, EDCP, and SCP) (Table 2). USDA serves as the Federal nexus for a cooperative project with the applicant CDBW, with regard to managing invasive plants in the Delta, its tributaries, and the Suisun Marsh and providing research and scientific technical expertise. The California Harbors and Navigation Code, Section 64, authorizes CDBW aquatic invasive species control programs.

Table 2. Summary of AIPCP Control Methods for SAV and FAV in the Delta, its tributaries, and the Suisun Marsh.

	SAV	FAV[1]	STATUS
Herbicide active ingredients			
2, 4-D		X	routine
Glyphosate		X	routine
Penoxsulam	X	X	routine
Imazamox	X	X	routine
Diquat	X	X	routine
Fluridone	X		routine
Imazapyr		X	routine
Carfentrazone-ethyl	X	X	Newly proposed
Endothall (Aquathol K®)	X		Newly proposed
Flumioxazin	X	X	Newly proposed
Florpyrauxifen-benzyl	X	X	Newly proposed[2]
Tank Mixes	X	X	Newly proposed
Physical and Mechanical Method			
Benthic mats	X		Newly proposed
Hand/nets		X	routine
Diver hand removal, hand pulling	X		routine
Diver assisted suction removal	X		Newly proposed
Booms and floating barriers	X	X	Newly proposed
Curtains, screens		X	Newly proposed
Surface excavators		X	Newly proposed
Harvesters	X	X	routine
Cutters and shredders		X	routine
Herding		X	routine
Adjuvants			
Agri-Dex		X	routine
Competitor		X	routine
Cygnet Plus		X	Newly proposed
Break-Thru SP 133		X	Newly proposed[2]
Dyes			
Rhodamine	X		Newly proposed
Bright Dyes	X		Newly proposed
Biological Controls (Water hyacinth only)[3]			
Neochetina *sp.*weevil		X	Newly proposed
Plant hopper (*Megamelus scutellaris*)		X	Newly proposed

X indicates the type of plants proposed for each method

[1] Treatment methods used to control FAV also apply to EAV treatment.
[2] Current use label pending approval by the California Department of Pesticide Regulations

[3] Biological controls will ONLY be used in designated investigation zones to control the growth of water hyacinth.

1.3.1 Operations Management Plan

The proposed limit of the AIPCP is 15,000 treatment acres per year for all SAV, EAV, and FAV during a 5-year (2018-2022) implementation period. Mechanical harvest activities are limited to 200 treatment acres per year. Because aquatic invasive plants growth patterns are unpredictable and these plants may move throughout the Delta, its tributaries, and the Suisun Marsh with winds, tides, and water flow, specific information about the number, location, timing, frequency and intensity of the actions that are carried out are not specified at the AIPCP programmatic level. Each year, USDA and CDBW will develop a SAV, EAV, and FAV Operations Management Plan (hereafter, OMP) for review and approval by NMFS and other regulatory agencies prior to implementation. The OMP will include a prioritization and site selection process to implement treatment methods based on the type and density of AIS in the area, and the hydrological and geographical characteristics (*e.g.*, water characteristics, channel type, marina status, flow, and potable water or plant nursery intakes).

The OMP will follow the AIPCP that specifies:

- Pre-treatment application protocol
- Treatment application and monitoring coordination protocol
- Best management practices (BMPs) for handling herbicides
- BMPs for physical and mechanical treatment methods
- Spray equipment maintenance and calibration protocol
- Herbicide Spill Contingency Plan

The OMP will include requirements for the avoidance of threatened and endangered species, habitat evaluations, annual monitoring protocols, and various AIPCP state (Center Valley Regional Water Quality Control Board Statewide General National Pollutant Discharge Elimination System (NPDES) permit for residual discharge) and federal monitoring requirements (*i.e.,* incidental take authorized under the AIPCP). USDA and CDBW will continuously monitor conditions (*e.g.*, water quality, water quantity and habitat) in the Delta, its tributaries, and the Suisun Marsh and use the data collected to modify the AIPCP as needed.

1.3.2 Biological Controls

The USDA and CDBW propose to use two new biological controls methods (water hyacinth weevil [*Neochetina bruchi* and *Neochetina eichhorniae*] and water hyacinth planthopper [*Megamelus scutellaris*]) to control the spread of water hyacinth in the Delta, its tributaries, and the Suisun Marsh. These methods are important to supplement the herbicide, physical removal and mechanical control methods, particularly in locations where herbicide use is not possible due to permit restrictions or logistics.

Water Hyacinth Weevil (*N. bruchi* and *N. eichhorniae*)

Water hyacinth weevil adults are easily visible on water hyacinth plants. The weevils have proved to be safe for release on water hyacinth without damage to non-target plants. The length of an adult is approximately 5 mm (about 1/8th of an inch) (Warner 1970). Water hyacinth weevils are light to dark brown or black on the dorsal side, often with a chevron-like mark across the top. In the daytime, adults are typically found in a non-feeding state, hiding in the furled leaves in the center of the rosette. Adults feed on unfurled leaves at night and show preference for young leaves (Center *et al.* 1999a). Adult females lay eggs in mature leaves (Center and Dray 1992), as these are most suitable for the development of the larvae. The larvae tunnel through the expanded, spongy petioles of the water hyacinth leaves, reaching the central growth point or 'crown' of the plant by the third and final larval stage.

When both species of *Neochetina* are present, the effects on water hyacinth include increased rate of leaf death and turnover; reduced formation of asexual buds or 'daughter' plants; decreased plant size and live biomass; and reduced competitiveness (Center *et al.* 1999a, Center *et al.* 199b; Center and Dray 2010). These effects increase the rate at which water hyacinth sink and therefore, are not able to reproduce. In Florida, the combined presence of the two weevil species as the primary biocontrol agents of water hyacinth has reduced water hyacinth biomass by over 50 percent (Tipping *et al.* 2014). However, Moran (2005) did not observe similar effects in the Delta. Several attributable factors include the presence of only one weevil species (*N. bruchi*); possible marginal climate suitability in the Delta; the lack of other non-weevil biocontrol species; and the lack of opportunistic plant pathogens that invade weevil feeding scars (Moran 2005).

Water hyacinth planthopper (*M. scutellaris*)

Water hyacinth planthopper adults are white with light brown markings, and are approximately 3 mm long [1/10th inch]. Two adult forms of water hyacinth planthoppers exist: the short-winged or brachypterous form (Fitzgerald and Tipping 2013; Moran *et al.* 2016), which can hop great distances but not fly; and the full-winged 'macropterous' form, which develops under crowded conditions, and can fly and hop. The planthopper occurs in its native range from 5 to 35 °S latitude, and completes five nymphal immature instars in approximately 25 days under summer outdoor conditions (26°C average daily temperature) (Sosa *et al.* 2005). Adults cannot survive on other plants, but nymphs emerge in quarantine on North American natives in the family Pontederiaceae (5% or less of emerged populations on E. *crassipes*), specifically *Heteranthera* spp. and *Pontederia cordata Linneaus.*

Biological control agents are self-perpetuating and disperse on their own. Both the weevil and the planthopper can disperse at least 50 to 100 meters per year by hopping or flying. Passive dispersal on floating mats of plants is likely to occur; however, the extent of dispersal is unknown. The Army Corps of Engineers released *Neochetina* spp. in the early 1980s. Follow-up surveys found *N. bruchi* to be widely distributed (Akers *et al*. in review), and *N. bruchi* is ubiquitous in the Delta (Hopper *et al.* 2017). A new biocontrol release at one site should be considered to actively disperse up to 100 meters per year.

Release Methods

USDA will release the weevil *N. eichhorniae* as a 'new' agent for re-establishment. The *N. bruchi*, may be released at specific sites early in the field season to increase effectiveness. USDA will release the water hyacinth planthopper as a 'new' agent for release in the Delta, its tributaries, and the Suisun Marsh. Biological control agents will be released as adults, either free of plant material (to determine exact counts of adults) or while feeding on colony-reared water hyacinth plants (typically the more convenient method; this approach maximizes adult survival in transit).

USDA will release biocontrols to complement herbicide and physical removal control methods. For example, USDA proposes to release weevils and planthoppers in areas with a high density of valley elderberry shrubs, or within the 0.5 km buffer from an agricultural water intake where herbicides cannot be applied. To monitor establishment and effectiveness, initial releases will focus on a limited number of backwater coves/flooded islands in the North Delta where herbicide and mechanical control are impossible due to logistical factors.

Releases will be made throughout the treatment control season (March 1 to November 30). Most releases will occur between April and October, when warm temperatures and long day lengths provide conditions most favorable for rapid mating, egg-laying and feeding and development of the immature life stages. Once establishment is confirmed at the initial 'nursery' sites, plants will be re-distributed throughout the Delta, its tributaries, and the Suisun Marsh, focusing on the specific locations where herbicide and mechanical control are excluded.

USDA will collaborate with CDBW to select specific biocontrol release locations based on presence of water hyacinth at the time of release.(*e.g.,* release sites identified in Section 3 of the AIPCP BA) These areas are suitable for biocontrol releases due to backwaters with little or no water movement during the release season (April-October). These sites are less likely to be treated by CDBW, and are likely to maintain their water hyacinth biomass due to limited water movement. For purposes of determining acres, the initial release sites will encompass a maximum of 1 acre each, 5 acres in total.

To release the water hyacinth weevil, *N. eichhorniae*, adults will be collected from mass rearing facilities (USDA's Exotic and Invasive Weeds Research Unit). The sex ratio of adults will be noted. Approximately 100 and 500 adults will be inoculated at each release site during summer months, depending on availability.

To release the water hyacinth planthopper, infested plants from tank-based colonies will be collected and the roots removed. A subset of the plants will be dissected in the lab to count planthopper adults and nymphs and estimate total planthopper density per plant. This information will be used to determine the number of plants needed to release approximately 1,000 adults and 5,000 nymphs per site.

At each release site, four plots, each one square meter, will be delineated with removable PVC square quadrats. Each plot will be placed 10 meters apart. Each plot will receive approximately 250 adults and 1,250 planthopper nymphs. Releases will be made by placing infested plants upside-down inside the plot to kill the infested plant and encourage the planthoppers or weevils to disperse to the plants in the plot. Global Position System (GPS) coordinates will be used to locate plots in successive visits. Releases will be conducted over several weeks, with successive trips as planthoppers and weevils begin to colonize.

Monitoring and Evaluations of Biocontrols

After releases are complete, plots will be monitored monthly for the remainder of the growing season (through November) and live adult and immature life stage counts obtained. In the year following release, a transect that bisects the four release plots and extends 50 meters beyond the first and last plot will be delineated with GPS; planthoppers can disperse at least 50 meters per year (Moran *et al.* 2016). Transects will be sampled at 15 meter intervals every 1-2 months depending on personnel, and live insect densities assessed. One plant will be collected from each sampling point, taken to the lab and dissected to assess plant size, live leaf counts, and live and dead above-water biomass. Transect sampling will occur throughout the field season, or until the biological control agents become abundant (more than 10 per plant).

Sampling of the initial release sites will continue in subsequent years. Four plots, each one square meter, will be sampled as described above to verify continued biological control agent presence and to monitor the impact on water hyacinth. To document insect population expansion, additional sampling will be conducted in water hyacinth patches up to 1 km from each of the 10 release sites. That additional sampling will favor water hyacinth infestations that are not able to be treated with herbicides.

Studies in the Delta and surrounding areas (Moran *et al.* 2016 and Hopper *et al.* 2017) indicate that sampling of plants in the field followed by dissection in the lab is the most effective way to quantify biocontrol agent populations. Dissection also allows determination of plant size and biomass, to determine impact. Baseline data for water hyacinth biomass throughout the year in the Delta are already available and will be used to measure impact. In the first 3 years, plants will be selected from quadrats (1 to 6 m^2) placed at the point of release and in transects extending up to several hundred meters from that point, with sampling every 10 to 50 meters. These studies will continue at sites not subject to other control methods for at least 3 years. Models such as water flow and nutrient content models developed through the USDA by National Aeronautics and Space Administration (NASA) and UC-Davis cooperators will be used to gain knowledge of insect dispersal capabilities. These models will also be used to predict the most likely locations for long-distance dispersal, based on water movement and local variation in water quality, which may influence plant quality and thus biocontrol agent abundance. Sampling will be conducted in these areas beginning in the third year and will continue for the remainder of the WHCP. Spot and automated measurement of DO will be conducted at release sites not subject to herbicide and physical removal control methods.

1.3.3 Demonstration Investigation Zones

USDA and CDBW will use demonstration investigation zones (DIZs) to evaluate and monitor the effectiveness of newly proposed treatment methods (*i.e.,* methods not previously used in the WHCP, EDCP, or SCP). Each research activity and location will be defined during the annual review process prior to the beginning of the treatment season.

USDA and CDBW will identify DIZ sites that do not co-occur (spatially and temporally) with listed species to avoid contact with and minimize impacts of the proposed treatment methods. Sites will be chosen that represent conditions that support aquatic invasive plants; typically occur in 10- to 20-acre plots; and minimize off-site movement of herbicides and biological control methods (releases will occur in 1-acre plots). DIZs research activities may include:

- testing new herbicides and tank mixes by concentrations and plant species,
- testing new application methods (*e.g.*, drones or helicopters for herbicide treatments),
- DO monitoring post treatment after large infestations,
- DO monitoring for various aquatic invasive plant species,
- testing new physical treatment methods, and
- evaluating the effectiveness of biocontrol releases on water hyacinth.

The AIPCP will only use herbicides that are approved by the USEPA, CDPR, and are included in the NPDES general permit. USDA and CDBW will conduct pre-treatment and post-treatment water quality monitoring to ensure compliance with NPDES receiving water limitations, DO, baseline expectations for expected environmental concentrations, and other water quality parameters (for details on the environmental monitoring requirements see Exhibit 3-94 of the AIPCP BA).

1.3.4 AIPCP Performance Metrics

In addition to the methods described above, CDBW may also employ aerial surveys or remote sensing methods to assist in site prioritization and follow-up evaluation. Remote sensing and cover assessment could include aerial monitoring (*e.g.*, fixed wing, drone, satellite [AVRIS, SPECTIR]). Landsat monitoring data provided by the NASA to CDBW through the Delta Region Area-wide Aquatic Weed Project will support field monitoring and inform program performance and planning for future treatment seasons. It is important to note that there are numerous technical challenges inherent in measuring FAV and SAV coverage, including the ability to identify species from aerial photogrammetry, movement of FAV species, growth of FAV species, and the size of the action area. USDA and CDBW will adaptively manage program monitoring to improve measurement capabilities over time. Data to support program performance metrics will include the following:

- acres of infestation (by FAV and SAV species when possible),
- biomass and biocover (from hydroacoustic monitoring),
- acres of infestation in particular locations (nursery sites, problem sites),
- herbicide application (pounds of active ingredient),
- acres treated in ecosystem restoration sites,
- number of reported FAV and SAV sightings and complaints, and
- acres/cubic yards of aquatic vegetation removal by physical/mechanical methods.

For a complete description of the proposed Federal action, refer to Section 3.1 of the AIPCP BA.

"Interrelated actions" are those that are part of a larger action and depend on the larger action for their justification. "Interdependent actions" are those that have no independent utility apart from the action under consideration (50 CFR 402.02).

We have not identified any interrelated or interdependent actions associated with the proposed action for this consultation.

2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, each Federal agency must ensure that its actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provides an opinion stating how the agency's actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

USDA determined the proposed action is not likely to adversely affect critical habitat designated for Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, California CV (CCV) steelhead, and Southern DPS (sDPS) green sturgeon. Our concurrence is documented in the "Not Likely to Adversely Affect" Determinations section 2.12.

2.1 Analytical Approach

This biological opinion includes a jeopardy analysis. An adverse modification analysis is not applicable, because NMFS concurs with USDA's determination that the proposed action is not likely to adversely affect designated critical habitat. The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of" a listed species, which is "to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This biological opinion relies on the definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features" (81 FR 7214; February 11, 2016).

The designations of critical habitat for Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon use the term primary constituent element (PCE) or essential features. The new critical habitat regulations (81 FR 7414; February 11, 2016) replace this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a ‘‘destruction or adverse modification’’ analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Identify the rangewide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Describe the environmental baseline in the action area.
- Analyze the effects of the proposed action on both species and their habitat using an "exposure-response-risk" approach.
- Describe any cumulative effects in the action area.
- Integrate and synthesize the above factors by: (1) Reviewing the status of the species and critical habitat; and (2) adding the effects of the action, the environmental baseline, and cumulative effects to assess the risk that the proposed action poses to species and critical habitat.
- Reach a conclusion about whether species are jeopardized or critical habitat is adversely modified.
- If necessary, suggest a RPA to the proposed action.

2.1.1 Ecological Risk Assessment Framework

The ecological risk assessment framework follows an interim approach recommended by the National Research Council (NRC) in the form of a report entitled, "*Assessing Risk to Endangered and Threatened Species from Pesticides*" (National Research Council 2013), and the most up to date scientific information on pesticides risk assessment framework (NMFS 2011c, 2013). NMFS conducted risk assessment analysis based on each herbicide stressor using the data and information provided by USDA and CDBW, as well as other data from the USEPA's ECOTOX database (USEPA 2014), journal articles, toxicology studies, Material Safety Data Sheets (MSDS) and technical reports (Hamelink et al. 1986, Habig 2004, Laetz et al. 2009, MacNeale et al. 2010, Michel et al. 2004, Nielson and Dahllof 2007, Reylea 2009, Schlenk et al. 2012, Scholz et al. 2012, NMFS 2013).

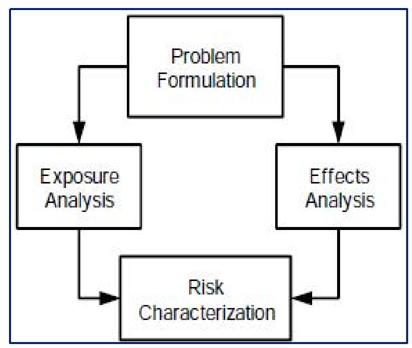

Figure 1. Ecological risk assessment process for chemical stressor. From USEPA (2004).

The risk assessment framework organizes the available information into four parts: problem formation, analysis of exposure and response, effects analysis, and risk characterization (USEPA 2004, Figure 1).

The USEPA, USFWS, NMFS, and USDA have worked together to develop and implement a shared approach of an interim risk assessment framework, which focuses on a species centric weight-of-evidence approach rather than a chemical-centric approach (National Research Council 2013). Studies with listed species are preferable; however, when there is not a complete suite of information relating to effects on listed species, data from other surrogate species are used, recognizing and noting where there may be substantial interspecies extrapolation. For example, rainbow trout are used as surrogates for salmonids and white sturgeon for green sturgeon. Even though there may be interspecies extrapolation, data from surrogates are considered the best available and were used in previous national pesticide consultations.

NMFS evaluated the individual fitness of exposed salmonids and green sturgeon and developed risk hypothesis for each species. Specifically, NMFS evaluated whether the AIPCP use of each treatment method is likely to:

a) kill salmonids/green sturgeon from direct exposure,
b) reduce reproduction of salmonids and green sturgeon,
c) reduce growth of salmonids and green sturgeon through impacts on the availability and quantity of prey, or
d) accumulate in salmonids and green sturgeon, which would impair fitness.

NMFS also evaluated the effects from the stressors of the action and contributing environmental factors and developed risk hypothesis for critical habitat. Specifically, NMFS evaluated the likelihood of each stressor to cause adverse effects to critical habitat from:

a) exposure to each of the five herbicides,
b) exposure to the degradates of the five herbicides,
c) exposure to other herbicides present in the action area that act in combination with the proposed herbicides to increase effects, and
d) exposure to elevated temperatures, which may enhance the toxicity of the stressors of the action.

2.2 Rangewide Status of the Species

This opinion examines the status of each species that would be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02.

The following federally listed species evolutionarily significant units (ESU) or distinct population segments (DPS) may be affected by the proposed AIPCP:

Sacramento River winter-run Chinook salmon ESU (*O. tshawytscha*)
Listed as endangered (70 FR 37160, June 28, 2005)

Central Valley spring-run Chinook salmon ESU (*O. tshawytscha*)
Listed as threatened (70 FR 37160, June 28, 2005)

California Central Valley steelhead DPS (*O. mykiss*)
Listed as threatened (71 FR 834, January 5, 2006)

Southern DPS of North American green sturgeon (*Acipenser medirostris*)
Listed as threatened (71 FR 17757, April 7, 2006)

2.2.1 Sacramento River Winter-run Chinook Salmon ESU

Historically, Sacramento River winter-run Chinook salmon (hereafter, winter-run Chinook salmon) population estimates were as high as 120,000 fish in the 1960s, but declined to less than 200 fish by the 1990s (NMFS 2011a). In recent years, since carcass surveys began in 2001, the highest adult escapement occurred in 2005 and 2006 with 15,839 and 17,296, respectively [California Department of Fish and Game (CDFG) 2012]. However, from 2007 to 2013, the population has shown a precipitous decline, averaging 2,486 during this period, with a low of 827 adults in 2011 (CDFG 2012). This recent declining trend is likely due to a combination of factors such as poor ocean productivity (Lindley et al. 2009), drought conditions from 2007 to 2009, and low in-river survival rates (NMFS 2011a). In 2014 and 2015, the population was approximately 3,000 adults, slightly above the 2007 to 2012 average, but below the high (17,296) for the last 10 years [California Department of Fish and Wildlife (CDFW) 2016].

The year 2014 was the third year of a drought that increased water temperatures in the upper Sacramento River, and egg-to-fry survival to the Red Bluff Diversion Dam (RBDD) was approximately 5 percent (NMFS 2016a). Due to the anticipated lower than average survival in 2014, hatchery production from Livingston Stone National Fish Hatchery (LSNFH) was tripled (*i.e.,* 612,056 released) to offset the impact of the drought (CVP and SWP Drought Contingency Plan 2014). In 2014, hatchery production represented approximately 83 percent of the total in-river juvenile production. In 2015, egg-to-fry survival was the lowest on record (approximately 4 percent) due to the inability to release cold water from Shasta Dam in the fourth year of a drought. As expected, winter-run Chinook salmon returns in 2016 and 2017 were both very low, estimated at 1,546 and 1,155 (CDFW 2017), respectively, due to drought impacts on juveniles from brood years 2013 and 2014 (NMFS 2016a).

Although impacts from hatchery fish (*i.e.,* reduced fitness, weaker genetics, smaller size, less ability to avoid predators) are often cited as having deleterious impacts on natural in-river populations (Matala et al. 2012), the winter-run Chinook salmon conservation program at LSNFH is strictly controlled by the FWS to reduce such impacts. The average annual hatchery production at LSNFH is approximately 176,348 per year (2001 to 2010 average) compared to the estimated natural production that passes RBDD, which is 4.7 million per year based on the 2002 to 2010 average (Poytress and Carrillo 2011). Therefore, hatchery production typically represents approximately 3 to 4 percent of the total in-river juvenile winter-run production in any given year. However, because drought conditions were expected to result in low juvenile winter-run Chinook salmon survival in the Sacramento River, LSNFH tripled its production of juvenile winter-run in brood year 2014 and released ~600,000 juvenile winter-run Chinook salmon into the upper Sacramento River. For brood year 2015, LSNFH doubled its production, and released ~400,000 juvenile winter-run Chinook salmon into the upper Sacramento River. As a result of the increased contribution of hatchery production to total in-river production in recent years, the 2017 returns (brood year 2014) was represented by more than 70 percent hatchery influence, indicating the population is at a moderate risk of extinction.

The distribution of winter-run spawning and initial rearing historically was limited to the upper Sacramento River (upstream of Shasta Dam), McCloud River, Pitt River, and Battle Creek, where springs provided cold water throughout the summer, allowing for spawning, egg incubation, and rearing during the mid-summer period (Yoshiyama et al. 1998). The construction of Shasta Dam in 1943 blocked access to all of these waters except Battle Creek, which currently has its own impediments to upstream migration [*i.e.,* a number of small hydroelectric dams situated upstream of the Coleman National Fish Hatchery (CNFH) weir]. The Battle Creek Salmon and Steelhead Restoration Project is currently removing these impediments, restoring spawning and rearing habitat suitable for winter-run Chinook salmon in Battle Creek, which will be reintroduced to establish an additional population. Approximately 299 miles of former tributary spawning habitat above Shasta Dam are inaccessible to winter-run Chinook salmon. Yoshiyama et al. (2001) estimated that in 1938, the upper Sacramento River had a "potential spawning capacity" of approximately 14,000 redds equal to 28,000 spawners. Since 2001, the majority of winter-run chinook salmon redds have occurred in the first 10 miles downstream of Keswick Dam. Most components of the winter-run Chinook salmon life history (*e.g.* spawning, incubation, freshwater rearing) have been compromised by the construction of Shasta Dam.

The greatest risk factor for winter-run Chinook salmon lies within its spatial structure (NMFS 2011a). The winter-run Chinook salmon ESU is comprised of only one population that spawns below Keswick Dam. The remnant and remaining population cannot access 95 percent of their historical spawning habitat and must therefore be artificially maintained in the upper Sacramento River by spawning gravel augmentation, hatchery supplementation, and regulation of the finite cold water pool behind Shasta Dam to reduce water temperatures.

Winter-run Chinook salmon require cold water temperatures in the summer that simulate their upper basin habitat, and they are more likely to be exposed to the impacts of drought in a lower basin environment. Battle Creek is currently the most feasible opportunity for the ESU to expand its spatial structure, but restoration is not scheduled to be completed until 2020. The Central Valley Salmon and Steelhead Recovery Plan (Recovery Plan) includes criteria for recovering the winter-run Chinook salmon ESU, including re-establishing a population into historical habitats in Battle Creek as well as upstream of Shasta Dam (NMFS 2014). LSNFH is scheduled to release approximately 200,000 juvenile winter-run Chinook salmon into Battle Creek from its captive broodstock program during the spring of 2018 in order to jumpstart the reintroduction.

Winter-run Chinook salmon embryonic and larval life stages that are most vulnerable to warmer water temperatures occur during the summer, which makes the species particularly at risk from climate warming. The only remaining population of winter-run Chinook salmon relies on the cold water pool in Shasta Reservoir, which buffers the effects of warm temperatures in most years. The exception occurs during drought years, which are predicted to occur more often with climate change (Yates et al. 2008). U.S. Bureau of Reclamation (2008) considered the effects of climate change in three possible forms: less total precipitation; a shift to more precipitation in the form of rain rather than snow; or, earlier spring snow melt. Additionally, air temperature appears to be increasing at a greater rate than what was previously analyzed (Lindley 2008, Beechie et al. 2012, Dimacali 2013). These factors will compromise the quantity and/or quality of winter-run Chinook salmon habitat available downstream of Keswick Dam. Underscoring the importance of habitat diversity to the resiliency of the ESU, Phillis et al. (2018) documented the reliance of an average of 58% of returning winter-run Chinook salmon adults (brood years 2007-2009) on non-natal rearing habitats. It is imperative for additional populations of winter-run Chinook salmon to be re-established into historical habitat in Battle Creek and above Shasta Dam for long-term viability of the ESU (NMFS 2014).

There are several criteria that would qualify the winter-run Chinook salmon population to be placed at a moderate risk of extinction (continued low abundance, a negative growth rate over two complete generations, significant rate of decline since 2006, increased hatchery influence on the population, and increased risk of catastrophe), and because there is still only one population that spawns below Keswick Dam, the winter-run Chinook salmon ESU is at a high risk of extinction in the long term. The extinction risk for the winter-run Chinook salmon ESU has increased from moderate risk to high risk of extinction since 2005, and several listing factors have contributed to the recent decline, including drought, poor ocean conditions, and hatchery influence (NMFS 2016a). Thus, large-scale fish passage and habitat restoration actions are necessary for improving the winter-run Chinook salmon ESU viability (NMFS 2016a).

2.2.2 Central Valley Spring-run Chinook Salmon ESU

Historically, Central Valley (CV) spring-run Chinook salmon were the second most abundant salmon run in the Central Valley and one of the largest on the west coast (CDFG 1990) These fish occupied the upper and middle elevation reaches (1,000 to 6,000 feet) of the San Joaquin, American, Yuba, Feather, Sacramento, McCloud and Pit rivers, with smaller populations in most tributaries with sufficient habitat for over-summering adults (Stone 1872, Rutter 1904, Clark 1929). The Central Valley drainage as a whole is estimated to have supported CV spring-run Chinook salmon runs as large as 600,000 fish between the late 1880s and 1940s (CDFG 1998). The San Joaquin River historically supported a large run of CV spring-run Chinook salmon, suggested to be one of the largest runs of any Chinook salmon on the West Coast, with estimates averaging 200,000 to 500,000 adults returning annually (CDFG 1990).

Monitoring of the Sacramento River mainstem during CV spring-run Chinook salmon spawning timing indicates some spawning occurs in the river (CDFW 2014). Genetic introgression has likely occurred here due to lack of physical separation between spring-run and fall-run Chinook salmon populations (CDFG 1998). Battle Creek and the upper Sacramento River represent persisting populations of CV spring-run Chinook salmon in the basalt and porous lava diversity group, though numbers remain low. Other Sacramento River tributary populations in Mill, Deer, and Butte creeks are likely the best trend indicators for CV spring-run Chinook salmon. Generally, these streams showed a positive escapement trend between 1991 and 2006, displaying broad fluctuations in adult abundance. The Feather River Fish Hatchery (FRFH) CV spring-run Chinook salmon population represents an evolutionary legacy of populations that once spawned above Oroville Dam. The FRFH population is included in the ESU based on its genetic linkage to the natural spawning population and the potential for development of a conservation strategy (70 FR 37160; June 28, 2005).

The Central Valley Technical Review Team estimated that historically there were 18 or 19 independent populations of CV spring-run Chinook salmon, along with a number of dependent populations, all within four distinct geographic regions (*i.e.,* diversity groups) (Lindley et al. 2004). Of these populations, only three independent populations currently exist (Mill, Deer, and

Butte creeks tributary to the upper Sacramento River), and they represent only the northern Sierra Nevada diversity group. Additionally, smaller populations are currently persisting in Antelope and Big Chico creeks and the Feather and Yuba rivers in the northern Sierra Nevada diversity group (CDFG 1998). The northwestern California diversity group has two low abundance persisting populations of spring-run in Clear and Beegum creeks. In the San Joaquin River basin, the southern Sierra Nevada diversity group, observations in the last decade suggest that spring-running populations may currently occur in the Stanislaus and Tuolumne rivers (Franks 2015).

The CV spring-run Chinook salmon ESU is comprised of two known genetic complexes. Analysis of natural and hatchery spring-run Chinook salmon stocks in the Central Valley indicates that the northern Sierra Nevada diversity group spring-run Chinook salmon populations in Mill, Deer, and Butte creeks retain genetic integrity as opposed to the genetic integrity of the Feather River population, which has been somewhat compromised by introgression with the fall-run ESU (Good *e*t al. 2005, Garza and Pearse 2008, Cavallo et al. 2011).

Because the populations in Butte, Deer and Mill creeks are the best trend indicators for ESU viability, NMFS can evaluate risk of extinction based on Viable Salmonid Population framework in these watersheds. Over the long term, these three remaining populations are considered to be vulnerable to anthropomorphic and naturally occurring catastrophic events. The viability assessment of CV spring-run Chinook salmon, conducted during NMFS' 2011 status review (NMFS 2011b), found that the biological status of the ESU had worsened since the previous status review in 2005), and the status review recommends that the species status be reassessed in 2 to 3 years as opposed to waiting another 5 years if the decreasing trend continued. In 2012 and 2013, most tributary populations increased in returning adults, averaging more than 13,000. However, 2014 returns were lower again—approximately 5,000 fish—indicating the ESU remains highly fluctuating. The most recent status review was conducted in 2015 (NMFS 2016c), and it looked at promising increasing populations in 2012 to 2014; however, the 2015 returning fish were extremely low (1,195), with additional pre-spawn mortality reaching record lows. Returns in 2016 were slightly better but still low (6,453), signifying a continuation of the instability of the population and reason for concern (CDFW 2017). Since the effects of the 2012 to 2015 drought have not been fully realized, NMFS anticipates at least several more years of very low returns, which may result in severe rates of decline (NMFS 2016c).

Spring-run Chinook salmon adults are vulnerable to climate change because they over-summer in freshwater streams before spawning in autumn (Thompson et al. 2011) CV spring-run Chinook salmon spawn primarily in the tributaries to the Sacramento River, and those tributaries without cold water refugia (usually input from springs) will be more susceptible to impacts of climate change. Even in tributaries with cool water springs, in years of extended drought and warming water temperatures, unsuitable conditions may occur. Additionally, juveniles often rear in the natal stream for one to two summers prior to emigrating, and they would be susceptible to warming water temperatures. In Butte Creek, fish are limited to low elevation habitat that is currently thermally marginal, as demonstrated by high summer mortality of adults in 2002, 2003, and 2015, and will become intolerable within decades if the climate warms as expected. Ceasing water diversion for power production from the summer holding reach in Butte Creek resulted in cooler water temperatures, more adults surviving to spawn, and extended population survival time (Mosser et al. 2013).

In summary, the extinction risk for the CV spring-run Chinook salmon ESU was evaluated for years 2012 – 2014, which remained at moderate risk of extinction (NMFS 2016c). However, based on the severity of the drought and the low escapements, as well as increased pre-spawn mortality in Butte, Mill, and Deer creeks in 2015, there is concern that these CV spring-run Chinook salmon strongholds will deteriorate into high extinction risk in the coming years based on the population size or rate of decline criteria (NMFS 2016c).

2.2.3 California Central Valley Steelhead DPS

Historic California Central Valley (CCV) steelhead run sizes are difficult to estimate given the paucity of data, but may have approached one to two million adults annually (McEwan 2001). By the early 1960s, the CCV steelhead run size had declined to about 40,000 adults (McEwan 2001). Current abundance data for CCV steelhead are limited to returns to hatcheries and redd surveys conducted on a few rivers. The hatchery data are the most reliable because redd surveys for steelhead are often made difficult by high flows and turbid water usually present during the winter-spring spawning period.

CCV steelhead returns to CNFH increased from 2011 to 2014. After reaching a low of only 790 fish in 2010, 2013 and 2014 have averaged 2,895 fish. Wild adults counted at the hatchery each year represent a small fraction of overall returns, but their numbers have remained relatively steady, typically 200 to 300 fish each year. Numbers of wild adults returning each year ranged from 252 to 610 from 2010 to 2014, respectively.

Redd counts are conducted in the American River and in Clear Creek (Shasta County). An average of 143 redds have been counted on the American River from 2002 to 2015 (Hannon *et al.* 2003, Hannon and Deason 2008, Chase 2010). An average of 178 redds have been counted in Clear Creek from 2001 to 2015 following the removal of Saeltzer Dam, which allowed steelhead access to additional spawning habitat. The Clear Creek redd counts range from 100 to 1,023 and indicates an upward trend in abundance since 2006 (U.S. Fish and Wildlife Service 2015).

The returns of CCV steelhead to the FRFH experienced a sharp decrease from 2003 to 2010, with only 679, 312, and 86 fish returning in 2008, 2009 and 2010, respectively. In recent years, however, returns have experienced an increase, with 830, 1,797, and 1,505 fish returning in 2012, 2013, and 2014, respectively. Overall, steelhead returns to hatcheries have fluctuated so much from 2001 to 2015 that no clear trend is present.

An estimated 100,000 to 300,000 naturally-produced juvenile steelhead are estimated to leave the Central Valley annually, based on rough calculations from sporadic catches in trawl gear (Good et al. 2005). Nobriga and Cadrett (2001) used the ratio of adipose fin-clipped (hatchery) to unclipped (wild) steelhead smolt catch ratios in the FWS Chipps Island trawl from 1998 through 2000 to estimate that about 400,000 to 700,000 steelhead smolts are produced naturally each year in the Central Valley. Trawl data indicate that the level of natural production of steelhead has remained very low since the 2011 status review, suggesting a decline in natural production based on consistent hatchery releases. Catches of steelhead at the fish collection facilities in the southern Delta are another source of information on the production of wild steelhead relative to hatchery steelhead (CDFW 2017). The overall catch of steelhead has declined dramatically since the early 2000s, with an overall average of 2,705 in the last 10 years as measured by expanded salvage (CDFW 2014 and NMFS 2016b). The percentage of wild (unclipped) fish in salvage has fluctuated, but has leveled off to an average of 36 percent since a high of 93 percent in 1999.

About 80 percent of the historical spawning and rearing habitat once used by CCV steelhead in the Central Valley is now upstream of impassible dams (Lindley *et al.* 2006). Many historical populations of CCV steelhead are entirely above impassable barriers and may persist as resident or adfluvial rainbow trout, although they are presently not considered part of the DPS. Steelhead are well-distributed throughout the Central Valley below the major rim dams (Good et al. 2005, NMFS 2016b). Most of the steelhead populations in the Central Valley have a high hatchery component, including Battle Creek (adults intercepted at the CNFH weir), the American River, Feather River, and Mokelumne River.

The CCV steelhead abundance and growth rates continue to decline, largely the result of a significant reduction in the amount and diversity of habitats available to these populations (Lindley et al. 2006). Recent reductions in population size are supported by genetic analysis (Nielsen et al. 2003). Garza and Pearse (2008) analyzed the genetic relationships among CCV steelhead populations and found that unlike the situation in coastal California watersheds, fish below barriers in the Central Valley were often more closely related to below barrier fish from other watersheds than to *O. mykiss* above barriers in the same watershed. This pattern suggests the ancestral genetic structure is still relatively intact above barriers, but may have been altered below barriers by stock transfers. The genetic diversity of CCV steelhead is also compromised by hatchery origin fish, placing the natural population at a high risk of extinction (Lindley et al. 2007). Steelhead in the Central Valley historically consisted of both summer-run and winter-run Chinook salmon migratory forms. Only winter-run (ocean maturing) steelhead currently are found in California Central Valley rivers and streams as summer-run have been extirpated (McEwan and Jackson 1996, Moyle 2002).

Although CCV steelhead will experience similar effects of climate change to Chinook salmon in the Central Valley, as they are also blocked from the vast majority of their historic spawning and rearing habitat, the effects may be even greater in some cases, as juvenile steelhead need to rear in the stream for one to two summers prior to emigrating as smolts. In the Central Valley, summer and fall temperatures below the dams in many streams already exceed the recommended temperatures for optimal growth of juvenile steelhead, which range from 57 degrees Fahrenheit (°F) to 66°F [14 degrees Celsius (°C) to 19°C]. Several studies have found that steelhead require colder water temperatures for spawning and embryo incubation than salmon (McCullough *et al.* 2001). McCullough et al. (2001) recommended an optimal incubation temperature at or below 52°F to 55°F (11°C to 13°C). Successful smoltification in steelhead may be impaired by temperatures above 54°F (12°C), as reported in (Richter and Kolmes 2005). As stream temperatures warm due to climate change, the growth rates of juvenile steelhead could increase in some systems that are currently relatively cold, but potentially at the expense of decreased survival due to higher metabolic demands and greater presence and activity of predators. Stream temperatures that are currently marginal for spawning and rearing may become too warm to support wild steelhead populations.

All indications are that natural CCV steelhead have continued to decrease in abundance and in the proportion of natural fish over the past 25 years (NMFS 2016b); the long-term trend remains negative. Hatchery production and returns are dominant. Most wild CCV populations are very small and may lack the resiliency to persist for protracted periods if subjected to additional stressors, particularly widespread stressors such as climate change. The genetic diversity of CCV steelhead has likely been impacted by low population sizes and high numbers of hatchery fish relative to wild fish. In summary, the status of CCV steelhead appears to have remained unchanged since the 2011 status review, and the DPS is likely to become endangered within the foreseeable future throughout all or a significant portion of its range (NMFS 2016b).

2.2.4 Southern DPS of North American Green Sturgeon

Green sturgeon are known to range from Baja California to the Bering Sea along the North American continental shelf. During late summer and early fall, subadults and non-spawning adult green sturgeon can frequently be found aggregating in estuaries along the Pacific coast (Emmett *et al.* 1991, Moser and Lindley 2006). Using polyploid microsatellite data, Israel et al. (2009) found that green sturgeon within the Central Valley of California belong to the Southern DPS (sDPS). Additionally, acoustic tagging studies have found that green sturgeon found spawning within the Sacramento River are exclusively sDPS of North American green sturgeon (hereafter referred to as sDPS green sturgeon, Lindley *et al.* 2011). In waters inland from the Golden Gate Bridge in California, sDPS green sturgeon are known to range through the estuary and the Delta and up the Sacramento, Feather, and Yuba rivers (Israel *et al.* 2009, Sciences 2011, Seesholtz *et al.* 2014). It is unlikely that green sturgeon utilize areas of the San Joaquin River upriver of the Delta with regularity, and spawning events are thought to be limited to the upper Sacramento River and its tributaries. There is no known modern usage of the upper San Joaquin River by green sturgeon, and adult spawning has not been documented there (Jackson and Van Eenennaarn 2013).

Recent research indicates that sDPS green sturgeon is composed of a single, independent population, which principally spawns in the mainstem Sacramento River and also breeds opportunistically in the Feather River and possibly the Yuba River (Cramer Fish Sciences 2011, Seesholtz et al. 2014). Concentration of adults into a very few select spawning locations makes the species highly vulnerable to poaching and catastrophic events. Whether sDPS green sturgeon display diverse phenotypic traits, such as ocean behavior, age at maturity, and fecundity, or if there is sufficient diversity to buffer against long-term extinction risk is not well understood. It is likely that the diversity of sDPS green sturgeon is low, given recent abundance estimates (NMFS 2015).

Trends in abundance of sDPS green sturgeon have been estimated from two long-term data sources: (1) salvage numbers at the state and Federal pumping facilities (CDFW 2017), and (2) by incidental catch of green sturgeon by the California Department of Fish and Wildlife's (CDFW) white sturgeon sampling/tagging program (DuBois et al. 2011). Historical estimates from these sources are likely unreliable because the sDPS was likely not taken into account in incidental catch data, and salvage does not capture range-wide abundance in all water year types. A decrease in sDPS green sturgeon abundance has been inferred from the amount of take observed at the south Delta pumping facilities -- the Skinner Delta Fish Protection Facility, and the Tracy Fish Collection Facility. These data should be interpreted with some caution. Operations and practices at the facilities have changed over the project lifetime, which may affect salvage data. These data likely indicate a high production year versus a low production year qualitatively, but cannot be used to rigorously quantify abundance.

Since 2010, more robust estimates of sDPS green sturgeon have been generated. As part of a doctoral thesis at the University of California at Davis (UC Davis), Ethan Mora has been using acoustic telemetry to locate green sturgeon in the Sacramento River and to derive an adult spawner abundance estimate (Mora et al. 2015). Preliminary results of these surveys estimate an average annual spawning run of 223 (using DIDSON cameras) and 236 (using telemetered fish). These estimates do not include the number of spawning adults in the lower Feather or Yuba Rivers, where green sturgeon spawning was recently confirmed (Seesholtz et al. 2014).

The parameters of green sturgeon population growth rate and carrying capacity in the Sacramento Basin are poorly understood. Larval count data show enormous variance among sampling years. In general, sDPS green sturgeon year class strength appears to be highly variable with overall abundance dependent upon a few successful spawning events NMFS 2010a, 2010b, 2015a, 2015b). Other indicators of productivity such as data for cohort replacement ratios and spawner abundance trends are not currently available for sDPS green sturgeon.

The sDPS green sturgeon spawn primarily in the Sacramento River in the spring and summer. The Anderson-Cottonwood Irrigation District Diversion Dam (ACID) is considered the upriver extent of green sturgeon passage in the Sacramento River (71 FR 17757, April 7, 2006). The upriver extent of green sturgeon spawning, however, is approximately 30 kilometers downriver of ACID where water temperature is higher than ACID during late spring and summer (Heublein et al. in review). Thus, if water temperatures increase with climate change, temperatures adjacent to ACID may remain within tolerable levels for the embryonic and larval life stages of green sturgeon, but temperatures at spawning locations lower in the river may be more affected. It is uncertain, however, if green sturgeon spawning habitat exists closer to ACID, which could allow spawning to shift upstream in response to climate change effects. Successful spawning of green sturgeon in other accessible habitats in the Central Valley (*i.e.,* the Feather River) is limited, in part, by late spring and summer water temperatures (NMFS 2015). Similar to salmonids in the Central Valley, green sturgeon spawning in tributaries to the Sacramento River is likely to be further limited if water temperatures increase and higher elevation habitats remain inaccessible.

The viability of sDPS green sturgeon is constrained by factors such as a small population size, lack of multiple populations, and concentration of spawning sites into just a few locations. The risk of extinction is believed to be moderate (NMFS 2010a). Although threats due to habitat alteration are thought to be high and indirect evidence suggests a decline in abundance, there is much uncertainty regarding the scope of threats and the viability of population abundance indices (NMFS 2010a). Lindley et al. (2008), in discussing winter-run Chinook salmon, states that an ESU (or DPS) represented by a single population at moderate risk of extinction is at high risk of extinction over a large timescale; this would apply to sDPS for green sturgeon. The most recent 5-year status review for sDPS green sturgeon found that some threats to the species have recently been eliminated such as take from commercial fisheries and removal of some passage barriers (NMFS 2015). Since many of the threats cited in the original listing still exist, the threatened status of the DPS is still applicable (NMFS 2015).

2.2.5 Climate Change

Warmer temperatures associated with climate change reduce snowpack and alter the seasonality and volume of seasonal hydrograph patterns (Cohen et al. 2000). Central California has shown trends toward warmer winters since the 1940s (Dettinger and Cayan 1995). An altered seasonality results in runoff events occurring earlier in the year due to a shift in precipitation falling as rain rather than snow (Roos 1991, Dettinger et al. 2004). Specifically, the Sacramento River basin annual runoff amount for April-July has been decreasing since about 1950 (Roos 1987, 1991). Increased temperatures influence the timing and magnitude patterns of the hydrograph.

The magnitude of snowpack reductions is subject to annual variability in precipitation and air temperature. The large spring snow water equivalent (SWE) percentage changes, late in the snow season, are due to a variety of factors including reduction in winter precipitation and temperature increases that rapidly melt spring snowpack (VanRheenen et al. 2004). Factors modeled by VanRheenen et al. (2004) show that the melt season shifts to earlier in the year, leading to a large percent reduction of spring SWE (up to 100% in shallow snowpack areas). Additionally, an air temperature increase of 2.1°C (3.8°F) is expected to result in a loss of about half of the average April snowpack storage (VanRheenen et al. 2004). The decrease in spring SWE (as a percentage) would be greatest in the region of the Sacramento River watershed, at the north end of the Central Valley, where snowpack is shallower than in the San Joaquin River watersheds to the south.

Projected warming is expected to affect CV Chinook salmon. Because the runs are restricted to low elevations as a result of impassable rim dams, if climate warms by 5°C (9°F), it is questionable whether any CV Chinook salmon populations can persist (Williams 2006). Based on an analysis of an ensemble of climate models and emission scenarios and a reference temperature from 1951- 1980, the most plausible projection for warming over Northern California is 2.5°C (4.5°F) by 2050 and 5°C by 2100, with a modest decrease in precipitation (Dettinger 2005). Chinook salmon in the Central Valley are at the southern limit of their range, and warming will shorten the period in which the low elevation habitats used by naturally-producing fall-run Chinook salmon are thermally acceptable. This would particularly affect fish that emigrate as fingerlings, mainly in May and June, and especially those in the San Joaquin River and its tributaries.

For winter-run Chinook salmon, the embryonic and larval life stages that are most vulnerable to warmer water temperatures occur during the summer, so this run is particularly at risk from climate warming. The only remaining population of winter-run Chinook salmon relies on the cold water pool in Shasta Reservoir, which buffers the effects of warm temperatures in most years. The exception occurs during drought years, which are predicted to occur more often with climate change (Yates *et al.* 2008). The long-term projection of operations of the CVP/SWP expects to include the effects of climate change in one of three possible forms: less total precipitation; a shift to more precipitation in the form of rain rather than snow; or, earlier spring snow melt (USBR 2008). Additionally, air temperature appears to be increasing at a greater rate than what was previously analyzed (Lindley 2008, Beechie et al. 2012, Dimacali 2013). These factors will compromise the quantity and/or quality of winter-run Chinook salmon habitat available downstream of Keswick Dam. It is imperative for additional populations of winter-run Chinook salmon to be re-established into historical habitat in Battle Creek and above Shasta Dam for long-term viability of the ESU (NMFS 2014).

Spring-run Chinook salmon adults are vulnerable to climate change because they over-summer in freshwater streams before spawning in autumn (Thompson *et al.* 2011). Spring-run Chinook salmon spawn primarily in the tributaries to the Sacramento River, and those tributaries without cold water refugia (usually input from springs) will be more susceptible to impacts of climate change. Even in tributaries with cool water springs, in years of extended drought and warming water temperatures, unsuitable conditions may occur. Additionally, juveniles often rear in the natal stream for one to two summers prior to emigrating, and would be susceptible to warming water temperatures. In Butte Creek, fish are limited to low elevation habitat that is currently thermally marginal, as demonstrated by high summer mortality of adults in 2002 and 2003, and will become intolerable within decades if the climate warms as expected. Ceasing water diversion for power production from the summer holding reach in Butte Creek resulted in cooler water temperatures, more adults surviving to spawn, and extended population survival time (Mosser *et al*. 2013).

Although steelhead will experience similar effects of climate change to Chinook salmon, as they are also blocked from the vast majority of their historic spawning and rearing habitat, the effects may be even greater in some cases, as juvenile steelhead need to rear in the stream for one to two summers prior to emigrating as smolts. In the Central Valley, summer and fall temperatures below the dams in many streams already exceed the recommended temperatures for optimal growth of juvenile steelhead, which range from 14°C to 19°C (57°F to 66°F). Several studies have found that steelhead require colder water temperatures for spawning and embryo incubation than salmon (McCullough et al. 2001). McCullough *et al.* (2001) recommended an optimal incubation temperature at or below 11°C to 13°C (52°F to 55°F). Successful smoltification in steelhead may be impaired by temperatures above 12°C (54°F), as reported in Richter and Kolmes (2005). As stream temperatures warm due to climate change, the growth rates of juvenile steelhead could increase in some systems that are currently relatively cold, but potentially at the expense of decreased survival due to higher metabolic demands and greater presence and activity of predators. Stream temperatures that are currently marginal for spawning and rearing may become too warm to support wild steelhead populations.

Southern DPS green sturgeon spawn primarily in the Sacramento River in the spring and summer. Anderson-Cottonwood Irrigation District Diversion Dam (ACID) is considered the upriver extent of green sturgeon passage in the Sacramento River. The upriver extent of green sturgeon spawning, however, is approximately 30 kilometers downriver of ACID where water temperature is higher than ACID during late spring and summer. Thus, if water temperatures increase with climate change, temperatures adjacent to ACID may remain within tolerable levels for the embryonic and larval life stages of green sturgeon, but temperatures at spawning locations lower in the river may be more affected. It is uncertain, however, if green sturgeon spawning habitat exists closer to ACID, which could allow spawning to shift upstream in response to climate change effects. Successful spawning of green sturgeon in other accessible habitats in the Central Valley (*i.e.,* the Feather River) is limited, in part, by late spring and summer water temperatures. Similar to salmonids in the Central Valley, green sturgeon spawning in the major lower river tributaries to the Sacramento River are likely to be further limited if water temperatures increase and suitable spawning habitat remains inaccessible.

In summary, observed and predicted climate change effects are generally detrimental to the species (McClure 2011), so unless offset by improvements in other factors, the status of the species and critical habitat is likely to decline over time. The climate change projections referenced above cover the time period between the present and approximately 2100. While there is uncertainty associated with projections, which increases over time, the direction of change is relatively certain (McClure et al. 2013).

2.3 Action Area

"Action area" means 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).

In this Opinion, the action area includes USDA and CDBW's defined AIPCP boundary (see Exhibit 3-27, 3-28a, and 3-28b of the AIPCP). The action area for the proposed AIPCP generally includes the "Delta, its tributaries, and the Suisun Marsh" (Harbors and Navigation Code Section 64), and extends a distance of 100 feet in all directions, both up and down river and laterally across the entire width of the channel; where water levels are influenced by tributary inflows and tidal action. This distance is based on USDA and CDBW's monitoring data on the fate and transport of herbicides, and the expected extent of herbicide effects emanating from herbicide treatment activity. The State of California legal definition of the Delta includes six counties (San Joaquin, Yolo, Sacramento, Solano, Contra Costa, and Alameda). The AIPCP includes 11 counties: (1) San Joaquin, (2) Yolo, (3) Sacramento, (4) Solano, (5) Contra Costa, (6) Alameda, (7) Fresno, (8) Madera, (9) Merced, (10) Stanislaus, and (11) Tuolumne.

The general boundaries for the action area are as follows:

- West along the Sacramento River to and including Sherman Island at the confluence of the Sacramento and San Joaquin rivers
- West along the Sacramento River to the Sacramento Northern Railroad to include water bodies north of the southern confluence of the Sacramento River and Sacramento River Deep Water Ship Channel
- North along the Sacramento River to the northern confluence of the Sacramento River and Sacramento River Deep Water Ship Channel, plus waters within Lake Natoma
- South along the San Joaquin River to Mendota, just east of Fresno
- East along the San Joaquin River from Mendota to Friant Dam on Millerton Lake
- East along the Tuolumne River to LaGrange Reservoir below Don Pedro Reservoir
- East along the Merced River to Merced Falls, below Lake McClure.

2.4 Environmental Baseline

The "environmental baseline" includes the past and present impacts of all Federal, state, 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 *Rangewide Status of Species* section shows that past and present impacts to the Sacramento and San Joaquin river basins and the Delta have caused significant salmonid and green sturgeon habitat loss, fragmentation and degradation throughout the historical and occupied areas for these species.

2.4.1 Status of the Species in the Action Area

The action area functions primarily as a migratory corridor for winter-run, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon, but it also provides some use as holding and rearing habitat for each of these species as well.

2.4.1.1 Sacramento River Winter-Run Chinook Salmon

The temporal occurrence of winter-run smolts and juveniles within the action area are best described by a combination of fish monitoring programs conducted in the Northern and Central Delta and the salvage records of the CVP and SWP fish collection facilities. Using the fish monitoring data from the northern and Central Delta, 3 percent of the annual winter-run juvenile population emigrates into the Delta in November, 24 percent in December, 17 percent in January, 19 percent in February, 37 percent in March and only 1 percent in April. The first entry of winter-run juveniles into the Delta (as measured by both the Knights Landing RST and the Sacramento Trawls monitoring data) can occur as early as the beginning of October.

These early arrivals to the Delta typically coincide with precipitation events that produce a sharp spike in the Sacramento River hydrograph. Over a 12-year period (water years 2001 to 2012) approximately 4 percent of the annual cumulative catch at the Knights Landing RST occurred by the end of October and 10.7 percent by the end of November. Presence of juvenile winter-run at either the Knights Landing RST site or at the Sacramento River trawl site would be considered as evidence that these fish would be present in the action area, provided that the DCC gates remained open immediately prior to and during the tide-related rise in river levels. The timing of juvenile winter-run presence in the Delta is corroborated by the salvage records covering water years 2000 to 2009 at the CVP and SWP fish collection facilities which pertain to operations prior to the modifications of operations resulting from the biological opinions from the USFWS and NMFS for the long-term operations of the State and Federal water projects. Juvenile winter-run are typically present in the action area starting no later than December, if not earlier, based on salvage in the South Delta. During the study period 5-year AIPCP, a significant rain event may occur in the upper Sacramento River basin causing a sharp increase in the river flows in a 24-hour period or flows greater than approximately 400 cubic meters per second ($m^3 s^{-1}$) (approximately 14,000 cfs, (del Rosario et al. 2013)) as measured at Wilkins Slough near the Knights Landing RST site. If such an event occurs, considerable winter-run Chinook salmon juvenile emigration is expected to occur, and they would be considered to be in the Delta and in the action area.

Presence of adult Chinook salmon in the Delta is interpolated from historical data derived from the upstream passage of adult fish past RBDD. Assuming a migratory movement rate of 15.5 miles per day, fish would be in the Delta approximately 2 weeks earlier than the dates at RBDD. Adult winter-run Chinook salmon are expected to enter the action area starting in January (~ 3 percent), with the majority of winter-run adults passing through the action area from February to the end of April (~ 66 percent).

2.4.1.2. CV Spring-Run Chinook Salmon

A similar application of the CVP and SWP salvage records and the northern and Central Delta fish monitoring data to the presence of CV spring-run Chinook salmon indicate that juvenile yearling spring-run Chinook salmon first begin to appear in the action area in December and January, but that a significant presence does not occur until March and peaks in April (17.2 and 65.9 percent of average annual salvage, respectively). By May, the salvage of juvenile CV spring-run Chinook salmon declines sharply and essentially ends by the end of June (15.5 and 1.2 percent of average annual salvage, respectively). The data from the North and Central Delta fish monitoring programs indicate that a small proportion of the annual juvenile spring-run emigration occurs in January (3 percent) and is considered to be mainly comprised of older yearling spring-run juveniles based on their length at date. Based on the Delta length-at-date criteria, the majority of CV spring-run Chinook salmon juveniles (young-of-the-year size) emigrate in March (53 percent) and April (43 percent) and tails off sharply by May (1 percent) and thus will be present in the action area during these periods. This pattern is further supported and consistent with salmonid passage estimates derived from rotary screw trap data collected by USFWS in the upper Sacramento River, which indicate two significant peaks in the annual passage of juvenile CV spring-run Chinook salmon at RBDD occurring in the months of December and April. Using information from the Knights Landing RST operated by the CDFW, the first appearance of CV spring-run juveniles in the lower Sacramento River area can occur as early as October; however, these fish typically show up weeks later in the Sacramento River trawl. Based on the data from the Knights Landing RST, the cumulative annual catch by the end of September is 0 percent, 0.07 percent by the end of October, and 0.54 percent by the end of November. Adult CV spring-run Chinook salmon are expected to start entering the action area in approximately January. Low levels of adult migration are expected through early March. The peak of adult CV spring-run Chinook salmon movement through the action area in the Delta is expected to occur from April to June, with adults continuing to entering the Delta through the summer and early fall. However, there is the potential for a small proportion of adult spring-run moving upriver to spawn to be present in the action area during September and October.

2.4.1.3. CCV Steelhead

CCV steelhead smolts first start to appear in the action area no later than November based on the records from the CVP and SWP fish salvage facilities (water years 2000 – 2009), as well as the fish monitoring program in the North and Central Delta. Their presence increases through December and January (21.6 percent of average annual salvage) and peaks in February (37.0

percent) and March (31.1 percent) before rapidly declining in April (7.7 percent). By June, the emigration has essentially ended, with only a small number of fish being salvaged through the summer at the CVP and SWP. Data from the North and Central Delta fish monitoring programs indicate that steelhead smolts begin to enter the Northern Delta as early as September through December, but do not substantially increase in numbers until February and March. During the study periods (September 1 through November 13, 2015, and September 1 through November 12, 2016), less than 3 percent of the annual juvenile emigration through the Delta likely occur. Adult steelhead are expected to move through the action area during the AIPCP, as the peak of upriver immigration occurs from August through November on the Sacramento River (McEwan 2001).

2.4.1.4. Southern DPS of North American Green Sturgeon

Juvenile sDPS green sturgeon are routinely collected at the SWP and CVP salvage facilities throughout the year. However, numbers are considerably lower than for other species of fish monitored at the facilities. Based on the salvage records from 1981 through 2017, green sturgeon may be present during any month of the year, and have been particularly prevalent during July and August. The sizes of these fish are less than 1 m (3.3 ft) and average 330 mm (13.0 inches) with a range of 136 mm to 774 mm (5.35 to 30.5 inches). The size range indicates that these are juvenile fish rather than sub-adult/adult or larval fish. The range of sizes of recovered fish indicate that these juvenile fish utilize the Delta for rearing for up to a period of approximately 3 years before migrating to the ocean and becoming sub-adult fish. The action area is located in close proximity to the main migratory route that juvenile green sturgeon would utilize to enter the Delta from their natal areas upstream on the upper Sacramento River. If the DCC gates are open, there is a direct connection to the Mokelumne River system, and green sturgeon are likely to be present in the action area. The fact that juvenile green sturgeon are captured at the CVP and SWP facilities would indicate that green sturgeon are more likely to be present in the action area during the proposed AIPCP, and in higher densities, than are observed at the fish collection facilities. Likewise, since the action area is on the main migratory route utilized by adult green sturgeon to access the spawning grounds in the upper Sacramento River, it is likely that adult green sturgeon will be present in the action area during AIPCP implementation. Adult green sturgeon begin to enter the Sacramento – San Joaquin Delta in late February and early March during the initiation of their upstream spawning run. The peak of adult entrance into the Delta appears to occur in late February through early April, with fish arriving upstream of the Glen-Colusa Irrigation District’s water diversion on the upper Sacramento River in April and May to access known spawning areas. During this period, the DCC gates are closed and the majority of adult green sturgeon are expected to remain in the mainstem Sacramento River during their upstream movements. Adults continue to enter the Delta until early summer (June-July) as they move upriver to spawn, at which time the DCC gates are typically open, allowing an alternative migratory route to the upper Sacramento River basin. It is also possible that some adult green sturgeon will be moving back downstream as early as April and May through the action area, either as early post spawners or as unsuccessful spawners. The majority of post spawn adult green sturgeon will move down river to the delta either in the summer or during the fall when the DCC gates are open. Fish that over summer in the upper Sacramento River will move downstream when the river water cools and rain events increase the river’s flow. When the gates are open, fish may enter the DCC and move into the

Mokelumne River system. Acoustically-tagged adult green sturgeon have been detected by receivers placed in the DCC channel, indicating that they have moved through it from the Sacramento River.

2.4.2 Factors Affecting the Species in the Action Area

The action area encompasses a large portion of the area utilized by winter-run and CV spring-run Chinook salmon, and CCV steelhead as well as sDPS green sturgeon. Many of the range-wide factors affecting these species are discussed in section 2.2 of this opinion, and are considered the same in the action area. This section will focus on the specific factors in the action area that are most relevant to the proposed AIPCP, specifically alteration of river flows and timing; high water temperatures; levee armoring and channelization; reduction of large woody debris (LWD) in the waterways, and the introduction of point and non-point source contaminants.

The magnitude and duration of peak flows during the winter and spring, which affects listed salmonids in the action area, are reduced by water impoundment in upstream reservoirs. Instream flows during the summer and early fall months have increased over historic levels for deliveries of municipal and agricultural water supplies (NMFS 2014, NMFS 2018). Overall, water management now reduces natural variability by creating more uniform flows year-round. Current flood control practices require peak flood discharges to be held back and released over a period of weeks to avoid overwhelming the flood control structures downstream of the reservoirs (*i.e.,* levees) and low lying terraces under cultivation (*i.e.,* orchards and row crops) in the natural floodplain along the basin tributaries. Consequently, managed flows in the main stem of the river often truncate the peak of the flood hydrograph and extend the reservoir releases over a protracted period. These actions reduce or eliminate the scouring flows necessary to mobilize sediments and create natural riverine morphological features within the action area. Furthermore, the unimpeded river flow in the San Joaquin River basin is severely reduced by the combined storage capacity of the different reservoirs located throughout the basin's watershed. Very little of the natural hydrologic input to the basin is allowed to flow through the reservoirs to the valley floor sections of the tributaries leading to the Delta. Most is either stored or diverted for anthropogenic uses. Elevated flows on the valley floor are typically only seen in wet years or flood conditions, when the storage capacities of the numerous reservoirs are unable to contain all of the inflow from the watersheds above the reservoirs.

High water temperatures also limit habitat availability for listed salmonids in the San Joaquin River and the lower portions of the tributaries feeding into the main stem of the river. High summer water temperatures in the lower San Joaquin River frequently exceed 72ºF, and create a thermal barrier to the migration of adult and juvenile salmonids.

Levee construction and bank protection have affected salmonid habitat availability and the processes that develop and maintain preferred habitat by reducing floodplain connectivity, changing riverbank substrate size, and decreasing riparian habitat and shaded riverine aquatic cover (NMFS 2014, NMFS 2018). Such bank protection generally results in two levels of impacts to the environment: (1) site-level impacts which affect the basic physical habitat structure at individual bank protection sites; and (2) reach-level impacts which are the cumulative impacts to ecosystem functions and processes that accrue from multiple bank protection sites within a given river reach (FWS 2000).

Armored embankments result in loss of sinuosity and braiding and reduce the amount of aquatic habitat. Impacts at the reach level result primarily from halting erosion and controlling riparian vegetation. Reach-level impacts which cause significant impacts to fish are reductions in new habitats of various kinds, changes to sediment and organic material storage and transport, reductions of lower food-chain production, and reduction in LWD.

The use of rock armoring limits recruitment of LWD from non-riprapped areas, and greatly reduces, if not eliminates, the retention of LWD once it enters the river channel. Riprapping creates a relatively clean, smooth surface which diminishes the ability of LWD to become securely snagged and anchored by sediment. LWD tends to become only temporarily snagged along riprap, and generally moves downstream with subsequent high flows. Habitat value and ecological functioning aspects are thus greatly reduced, because wood needs to remain in place for extended periods to generate maximum values to fish and wildlife (FWS 2000). Recruitment of LWD is limited to any eventual, long-term tree mortality and whatever abrasion and breakage may occur during high flows (FWS 2000). Juvenile salmonids are likely being impacted by reductions, fragmentation, and general lack of connectedness of remaining near shore refuge areas.

Point and non-point sources of pollution resulting from agricultural discharge and urban and industrial development occur upstream of, and within the action area. Environmental stresses as a result of low water quality can lower reproductive success and may account for low productivity rates in fish. Organic contaminants from agricultural drain water, urban and agricultural runoff from storm events, and high trace element (*i.e.,* heavy metals) concentrations may deleteriously affect early life-stage survival of fish in the Central Valley watersheds (FWS 1995). Water flow through the south Delta is highly manipulated to serve human purposes. Rainfall and snowmelt is captured by reservoirs in the upper watersheds, from which its release is dictated primarily by downstream human needs. The SWP and CVP pumps draw water towards the southwest corner of the Delta which creates a net upstream flow of water towards their intake points (NMFS 2017). Fish, and the forage base they depend upon for food, represented by free floating phytoplankton and zooplankton, as well as larval, juvenile, and adult forms, are drawn along with the current towards these diversion points. In addition to the altered flow patterns in the south Delta, numerous discharges of treated wastewater from sanitation wastewater treatment plants (*e.g.,* Cities of Tracy, Stockton, Manteca, Lathrop, Modesto, Turlock, Riverbank, Oakdale, Ripon, Mountain House, and the Town of Discovery Bay) and the untreated discharge of numerous agricultural wasteways are emptied into the waters of the San Joaquin River and the channels of the south Delta (NMFS 2014). This leads to cumulative additions to the system of thermal effluent loads as well as cumulative loads of potential contaminants (*i.e.,* selenium, boron, endocrine disruptors, pesticides, biostimulatory compounds, etc.).

2.5 Effects of the Action

Under the ESA, "effects of the action" means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.

USDA and CDBW will evaluate each project prior to treatment to ensure that: (a) the anticipated range of effects is within the range considered in this opinion; and (b) project and program level monitoring and reporting requirements are met. Moreover, implementation of each project may only begin after NMFS approval.

As noted in the Proposed Action Section 1.3, USDA and CDBW propose to carry out the AIPCP for the control of SAV, EAV, and FAV in the Delta, its tributaries, and the Suisun Marsh. All proposed treatment activities will occur within the Delta, its tributaries, and the Suisun Marsh and are connected to floodplain, riparian, or aquatic habitats and will require entry into, or any disturbance of, those habitats. Because the treatment of aquatic plants will not be isolated, the effects of these projects will be direct and indirect effects caused by the application of herbicides associated with the use of active ingredients carfentrazone-ethyl, endothall, flumioxazin, and florpyrauxifen-benzyl into receiving waters; physical removal activities such as hand/net, diver hand removal, diver assisted suction removal, benthic mats, barriers, booms, curtains and screens, and herding; and mechanical harvest activities from tools and specialized equipment that are used to cut, remove, or control the growth and spread of aquatic invasive plants. Herbicide treatment methods may result in negative sublethal impacts which may result in negative physiological and behavioral effects, to salmonids and green sturgeon. Moreover, physical removal and mechanical harvest methods may result in negative effects to salmonids and green sturgeon in the form of injury, mortality, avoidance activity, gill fouling, and reduced forging capability.

2.5.1 Assumptions

In the absence of definitive data or conclusive evidence, NMFS must make a logical series of assumptions to overcome the limits of the available information. These assumptions will be made using sound, scientific reasoning that can be logically derived from the available information. The progression of the reasoning will be stated for each assumption, and supporting evidence cited.

Additional information from fish and invertebrate acute and chronic toxicity studies conducted by the USDA, CDBW and UC Davis regarding fish species and invertebrate response in the Delta, its tributaries, and the Suisun Marsh was incorporated into the calculations for risk assessment. Turbidity effects utilized information pertaining to salmonids and green sturgeon in general, rather than to the specific listed species present in the action area, due to a lack of direct information concerning this response.

The degree to which herbicides affect listed salmonids and sturgeon are not clear. The USDA and CDBW routinely test for herbicides across all areas where herbicide treatment is proposed to occur prior to the commencement of activities in accordance with the regulatory requirements for obtaining a NPDES permit, as administered by the CVRWQCB. Specific regulatory criteria have not yet been designated for all herbicides or life history stages relevant to the listed species under consideration in this opinion.

In assessing the impacts of herbicides on the listed anadromous fish species, NMFS used the available data for several different species of fish for which acute and chronic toxicity data are available. The likelihood of each herbicide (stressor) to cause adverse effects on listed species was based on exposure, defined as: (1) the herbicide level or amount (*i.e.,* concentration) and (2) duration of exposure (*i.e.,* the time that it takes for the herbicide to completely dissipate in the water column). Protective herbicide levels were then determined that were appropriate for fish in general, due to a lack of data specific to salmonids.

2.5.2 Herbicide Treatment

The following brief summaries and figures from toxicological profiles for carfentrazone-ethyl, endothall, flumioxazin, and florpyrauxifen-benzyl (AIPCP BA Section 6) provide the observed residence time of each herbicide in the Delta, its tributaries, and the Suisun Marsh; the subsequent exposure of listed species and critical habitats to the herbicide, and the anticipated effects and/or response (*i.e.,* No Observable Effect Concentrations [NOEC], Lowest Observable Effect Concentration [LOEC], and Effect Concentration [EC]) due to exposure.

Carfentrazone-ethyl

USEPA-approved carfentrazone-ethyl is a reduced risk herbicide. Carfentrazone-ethyl is classified as moderately toxic to fish and to macroinvertebrates. There is currently no NPDES maximum monitoring trigger for carfentrazone-ethyl and the herbicide has not been used in previous control programs. NPDES permit triggers are not violations, but when triggered (by monitoring results) require the permit holder, in this case CDBW, to stop treatment application. If carfentrazone-ethyl is approved for use by the California Department of Pesticide Regulation and the State Water Resources Control Board, CDBW will use it in a tank mixture and monitor and collect data in DIZs to determine the most effective environmental concentration to apply to control the spread of aquatic invasive plants in the Delta, its tributaries, and the Suisun Marsh Delta. For carfentrazone-ethyl, acute 96-hr LC50 endpoints for fish range from 0.08 ppm to 25.4 ppm. The lowest chronic fish NOEC reported is 0.0187 mg/L (21 days) (SePRO 2015). In a study commissioned by CDBW from 2014 to 2017, Stillway and Teh (2017a) reported 96-hour and 7-day impaired weight and survival endpoints ranging from 0.8 to 3.1 ppm for rainbow trout and fathead minnow species (refer to Exhibit 6-25 of the AIPCP BA). In that study, LC50 values < 0.195 ppm were observed for rainbow trout sac-fry. Of the nine herbicides tested, acute and chronic exposure to carfentrazone-ethyl resulted in impaired weight and survival endpoints across all fish species.

For FAV, the proposed maximum concentration of carfentrazone-ethyl in 1 meter of water, with an assumed 20 percent overspray, is 4.5 ppb. This represents a conservative instantaneous maximum concentration. Figure 2 illustrates no overlap between FAV carfentrazone-ethyl treatment application and the Environmental Exposure Concentrations (EECs). All of the reptile surrogates and fish toxicity endpoint concentrations are orders of magnitude higher than the proposed carfentrazone-ethyl treatment concentrations. However for SAV, the two endpoints for rainbow trout (LOEC, EC25) are within the range of proposed AIPCP herbicide treatment concentrations (a maximum of 200 ppb of carfentrazone-ethyl is permitted for discharge into receiving waters).

Due to the limited amount of data on the environmental fate of carfentrazone-ethyl, and based on the proposed maximum application concentration applied to Delta, its tributaries, and the Suisun Marsh waterways FAV (4.5 ppb) and SAV (200 ppb; *i.e.,* level of exposure) and duration of exposure (time to dissipate), we assume that at any treatment site, the duration of exposure to carfentrazone-ethyl for listed fish will be approximately 36 hours. Given the low levels at which rainbow trout are affected by carfentrazone-ethyl, the sublethal acute and chronic effects to growth and survival endpoints at various life stages (*i.e.,* rainbow trout sac-fry and juvenile), the lack of data on effects to surrogates for sDPS green sturgeon, and the co-occurrence of listed species in the action area; juvenile and adult winter-run, yearling CV spring-run, juvenile and adult CCV steelhead, and all life stages of sDPS green sturgeon are likely to experience adverse physiological effects (*i.e.,* reduced growth and survival), and are likely vulnerable to predation as a result of carfentrazone-ethyl exposure.

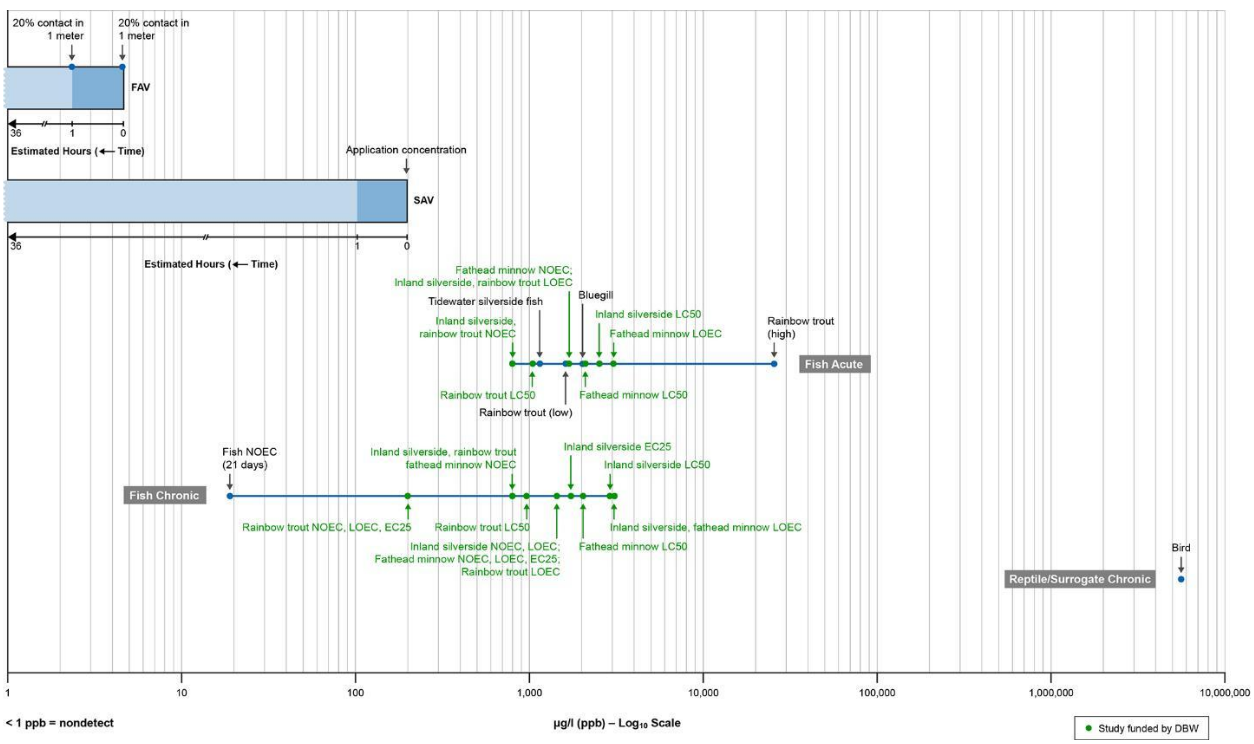

Figure 2. Exposure concentrations for amphibian surrogate and fish species endpoint effects for carfentrazone-ethyl (µg/L or ppb, CDBW 2017).

Endothall

USEPA approved endothall as a reduced risk herbicide. Endothall will only be used for SAV treatment. The AIPCP will only use the dipotassium salt formulation of endothall (as Aquathol®) and will not use the amine salt (Hydrothol) formulations, which are highly toxic to fish and invertebrates (SERA 2009). Aquathol® concentrations up to 500 ppm are safe for fish (EXTOXNET 1995).

Fish acute and chronic toxicity endpoints for endothall dipotassium salt are provided in Exhibit 6-27 of the AIPCP BA. To summarize fish endpoints in Exhibit 6-25 relevant to ESA listed species, LC50s for Chinook salmon range from 23 ppm to >150 ppm and >100 ppm for coho salmon. In a study commissioned by CDBW from 2014 to 2017, Stillway and Teh (2017) reported a wide range of acute effects to fish species ranging from NOEC for growth and survival effects at the highest concentration tested (NOEC > 500 ppm) for rainbow trout.

Figure 3 provides an illustration of endothall estimated EECs and LC50, NOEC, and LOEC levels for reptile surrogate and fish species. The upper left hand corner of the figure illustrates the maximum application concentrations of 5 ppm (5,000 ppb) as well as the likely application concentration of 2 ppm (2,000 ppb). The NPDES permit limit for endothall in receiving waters is 100 ppb. Figure 3 illustrates some overlap between the lowest (most conservative) fish toxicity endpoints and the highest (most conservative) application concentration allowed. The lowest chronic fish endpoint observed is impaired weight for the fathead minnow at 3.1 ppm and NOEC for Chinook salmon at ~ 3.5 ppm are within the range of maximum EEC values and maximum application concentration.

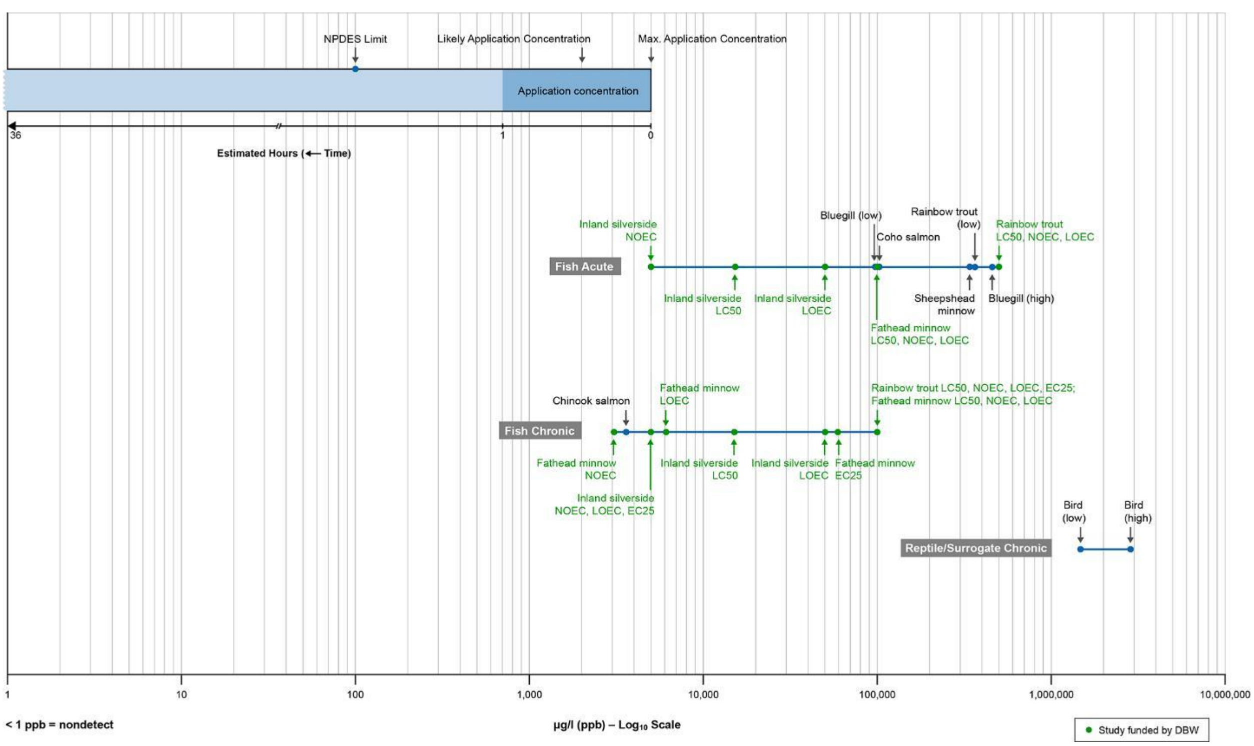

Figure 3. Exposure concentrations for amphibian surrogate and fish species endpoint effects for endothall (µg/L or ppb, CDBW 2017).

Until CDBW obtains monitoring data, we assume that based on the proposed maximum application concentration applied to Delta, its tributaries, and the Suisun Marsh waterways for SAV (4,000 ppb) (*i.e.,* level of exposure to fish) and duration of exposure (time to dissipate) at any treatment site, the duration of exposure to endothall for listed fish will be approximately 36 hours. USDA and CDBW will use limited quantities of endothall to target curly-leaf pondweed in the AIPCP; initial use will occur in DIZs to monitor and evaluate effects.

Given the low concentrations at which Chinook salmon are affected by endothall, the acute and chronic effects to endpoints at various life stages (juvenile growth and survival are within the range of maximum application concentration), the lack of data on effects to surrogates for sDPS green sturgeon, and the co-occurrence of listed species in the action area; juvenile and adult winter-run, yearling CV spring-run, and all life stages of sDPS green sturgeon are likely to experience adverse physiological effects (*i.e.,* reduced growth and survival), and are likely vulnerable to predation as a result of endothall exposure.

<u>Flumioxazin</u>

Flumioxazin is considered moderately toxic to slightly toxic to fish, and slightly toxic to macroinvertebrates. The NPDES monitoring trigger for flumioxazin is 0.23 ppm. Flumioxazin has not been used in previous CDBW control programs. CDBW will collect monitoring data throughout the AIPCP to determine the most effective environmental concentration to apply to control the spread of AIS in the Delta, its tributaries, and the Suisun Marsh. Similar to the work by Stillway and Teh (2017a), as described below, CDBW/UC Davis will expand their lab studies to field studies in the DIZs for each new herbicide to determine the effective environmental concentrations.

There are few published toxicological studies on the effect of flumioxazin to aquatic organisms. To supplement the lack of data, CDBW commissioned a study of flumioxazin toxicity to rainbow trout and fathead minnows. For acute toxicity test, rainbow trout sac-fry were the most sensitive (96-hour LC50 = 27.230 ppm; NOEC = 3.125 ppm) (Stillway and Teh 2017a). Fathead minnow were less sensitive, with 96-hour LC50 at 58.670 ppm (Stillway and Teh 2017a). Rainbow trout were the most sensitive in chronic tests. The 7-day LC50 for rainbow trout was 17.810 ppm and the 7-day EC25 for impaired growth was 0.643 ppm (Stillway and Teh 2017a). Fathead minnow 7-day LC50s were 56.610 ppm, while the 7-day EC25s for growth effects were 8.780 ppm and 27.970 ppm, respectively (Stillway and Teh 2017a). A detailed summary of the acute and chronic toxicity endpoints of flumioxazin to fish species are provided in Exhibit 6-29 of the AIPCP BA.

Figure 4 provides an illustration of flumioxazin estimated SAV and FAV EECs, LC50, NOEC, and LOEC for reptile surrogate and fish species. One advantage of flumioxazin is the low concentration required for treatment, as evidenced by the maximum FAV concentration of 8.6 ppb in 1 meter of water (conservative estimate of 20 percent overspray). This represents a conservative instantaneous maximum concentration. For SAV treatments, flumioxazin will be applied at a maximum concentration of 400 ppb.

Figure 4 illustrates no overlap between AIPCP EECs and acute toxicity levels, as all of the acute reptile surrogate and fish toxicity endpoints are orders of magnitude higher than the proposed flumioxazin concentration for FAV treatment. The values reported far exceed the maximum EEC of 8.6 ppb for flumioxazin for FAV and the maximum application of 400 ppb for SAV. There is, however, the potential for negative chronic effects on early life stage rainbow trout, as evidenced by the NOEC value between 7.7 ppb and 16 ppb (*i.e.,* the maximum applications for FAV and SAV could be higher than the NOEC value). We note, however, that those values are provided on the product Material Safety Data Sheet (MSDS) without indication of the exposure time period.

There are few published toxicity data points for flumioxazin, which creates some uncertainty regarding the magnitude of effect to fish. However, given the more recent CDBW commissioned study by Stillway and Teh (2017a) of acute and chronic effects on three fish species, the information may provide the most relevant and up-to-date information on effects to growth and survival rather than the registrant data on the product MSDS. The AIPCP will use flumioxazin in tank mixes in DIZs to monitor the effects of herbicide application.

Until CDBW obtains monitoring data, we assume that based on the proposed maximum application concentration applied to Delta, its tributaries, and the Suisun Marsh waterways for FAV (8.6 ppb) and SAV (400 ppb) (*i.e.,* level of exposure to fish) and duration of exposure (*i.e.,* time to dissipate) at any treatment site, the duration of exposure to flumioxazin for listed fish will be approximately 36 hours. The AIPCP will use flumioxazin in DIZs to monitor and evaluate effects as result of herbicide applications.

Given the low concentrations at which rainbow trout are affected by flumioxazin, chronic effects to growth and survival at various life stages (are within the range of SAV application concentration and NPDES monitoring trigger), the lack of data on effects to surrogates for Chinook salmon and sDPS green sturgeon, and the co-occurrence of listed species in the action area; winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead and sDPS green sturgeon, are likely to be negatively affected by flumioxazin application.

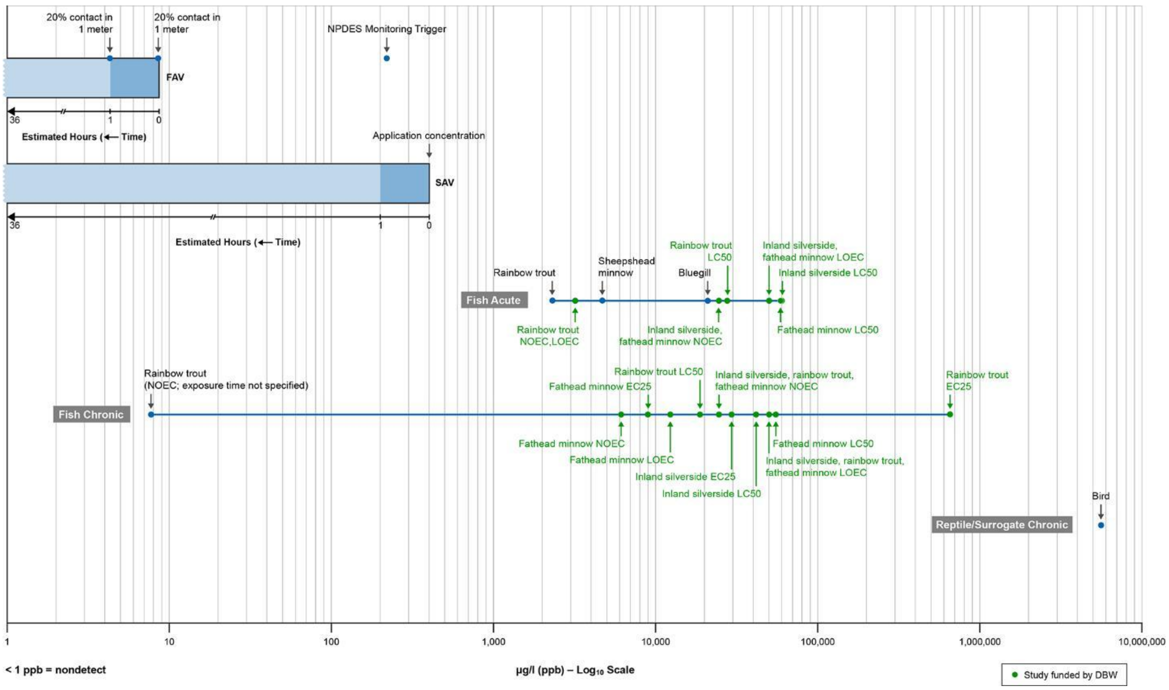

Figure 4. Exposure concentrations for amphibian surrogate and fish species endpoint effects for flumioxazin (µg/L or ppb, CDBW 2017).

Florpyrauxifen-benzyl

The relatively new herbicide ingredient florpyrauxifen-benzyl was approved by USEPA in 2016 as a reduced risk herbicide, and is under consideration for aquatic use in California by the California Department of Pesticide Regulation and the State Water Resources Control Board. Grue and Crosson (2017) found no observable effects to Chinook fry and smolts exposed to 50 ppb and 100 ppb Procellacor® (active ingredient florpyrauxifen-benzyl), respectively, for 96 hours. To supplement the lack of data on florpyrauxifen-benzyl effects to aquatic organisms, CDBW commissioned a study from 2014-2017 to evaluate the acute and chronic endpoints of florpyrauxifen-benzyl for rainbow trout. In that study, all 96-hour acute and 7-day (*i.e.,* chronic test) endpoints for rainbow trout and fathead minnows exceeded the highest concentration of 100 ppm, with the exception of a NOEC of 50 ppm for rainbow trout and a NOEC of 50 ppm for fathead minnows (Stillway and Teh 2017). A detailed summary of the results are provided in Exhibit 6-31 of the AIPCP BA.

Figure 5 shows no overlap between the FAV EECs and toxicity data points for florpyrauxifen-benzyl, but some overlap between SAV EECs (20-50 ppb) and fish acute endpoints for sheepshead minnow, fathead minnow and rainbow trout. The lowest fish acute endpoint (survival) concentration of 13 ppb was observed for rainbow trout using the technical grade florpyrauxifen-benzyl (*i.e.,* active ingredient) as opposed to product formulations (active and inert ingredients). Additional tests on rainbow trout and fathead minnow used the product formulation and found no chronic effects at the highest concentration (100,000 ppb) tested. Similarly, no chronic effects were identified at the two highest concentrations tested (50,000 and 100,000 ppb) for the two fish species.

There are few published toxicity data points for florpyrauxifen-benzyl and to our knowledge, no peer-reviewed studies, which creates some uncertainty regarding the magnitude of effect to fish.

CDBW will continue to actively research the literature to understand potential direct and indirect on fish species. If approved for use in California and if used in the AIPCP, CDBW will collect data and monitor florpyrauxifen-benzyl in DIZs to evaluate the effects to aquatic organisms as a result of herbicide applications.

Given the low levels at which rainbow trout are affected by florpyrauxifen-benzyl, acute effects to endpoints at various life stages (juvenile growth and survival are within the range of SAV application concentration), the lack of data on effects to surrogates for Chinook salmon and sDPS green sturgeon, and the co-occurrence of listed species in the action area; juvenile and adult winter-run Chinook salmon, yearling CV spring-run, juvenile and adult CCV steelhead, and all life stages of sDPS green sturgeon are likely to experience adverse physiological effects (*i.e.,* reduced growth and survival), as a result of florpyrauxifen-benzyl exposure.

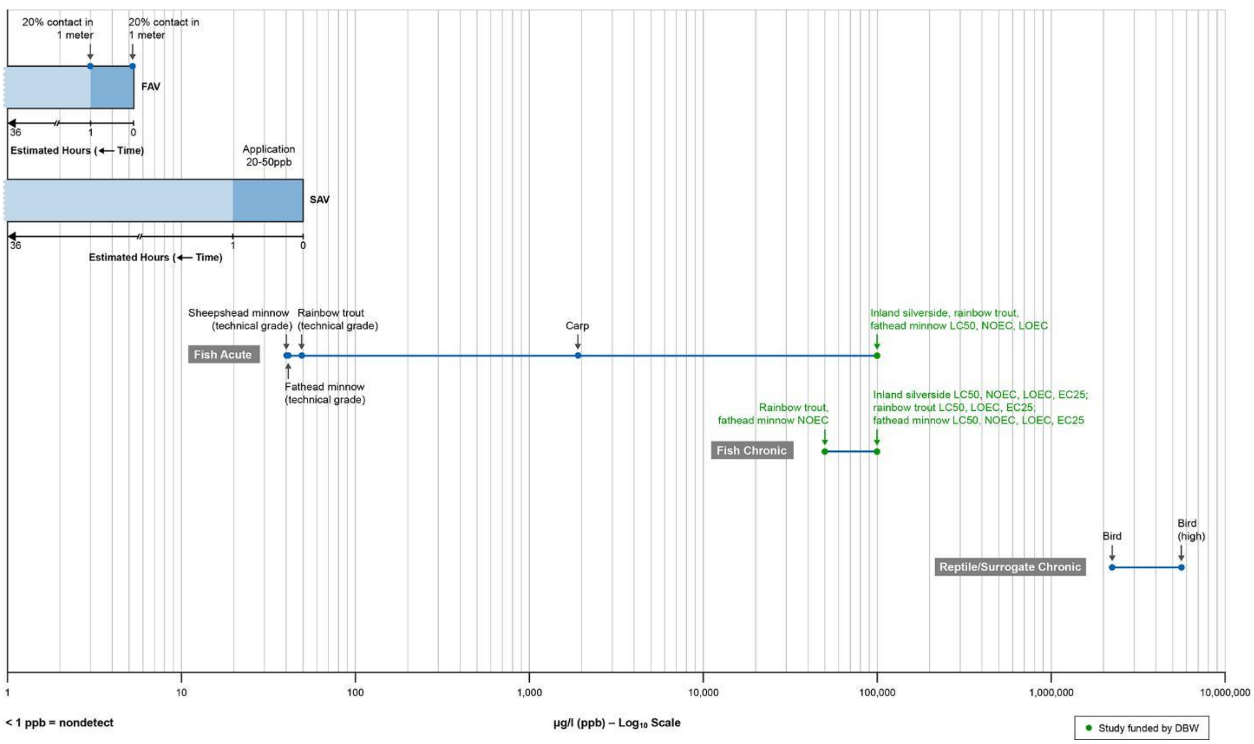

Figure 5. Exposure concentrations for amphibian surrogate and fish species endpoint effects for florpyrauxifen-benzyl (μg/L or ppb, CDBW 2017).

Adjuvants and Tank Mixtures

USDA and CDBW will use the adjuvants Competitor and Agridex, which have been used previously in the EDCP, WHCP and SCP. There has been relatively little research on the toxic effects of adjuvants. For rainbow trout, the non-ionic adjuvant Agridex has a 96-hour LC50 >1,000 ppm. The vegetable oil-based adjuvant Competitor has a 96-hour LC50 of 95 ppm for rainbow trout. In addition, USDA and CDBW will incorporate the deposition aid Cygnet Plus. For fish species, Cygnet Plus has a wide range of 96-hour LC50s (9 ppm and 30.2 ppm, Haller and Stocker 2003). If approved for aquatic use by CDPR, USDA and CDBW will incorporate Break-Thru SP 133. This new product has very little toxicity data available; however, the manufacturer reports an LC50 exceeding 1,000 ppm for rainbow trout (Evonik 2016). Exhibit 6-33 in the AIPCP BA summarizes toxicity data for the four proposed adjuvants.

CDBW commissioned studies of Agridex and Competitor to supplement the available literature and better understand toxicity effects on listed species. For rainbow, Stillway and Teh (2017b) determined that Agridex alone had no significant impact on acute (96 hour) or chronic (7-day) survival and weight endpoints, respectively. For Cygnet Plus, acute LC50s for rainbow trout were 8.8 ppm; the acute NOECs was 6.250 ppm and the acute LOECs was 12.500 ppm (Stillway and Teh 2017b). Similarly, in chronic 7-day tests, rainbow trout elicited similar lethal (LC50 9.396 ppm) and sublethal responses (impaired weight, chronic EC25s > 3.125 ppm (Stillway and Teh 2017b). From 2007 to 2016, DBW collected 309 water samples for Agridex residue analysis, and all samples had non-detectable concentrations (<100 ppm) of Agridex. In 2015, CDBW analyzed eight water samples for Competitor residue, all samples had non-detectable concentrations (<100 ppm). CDBW will monitor the concentrations of each adjuvant used in the AIPCP.

As described in Section 6 of the AIPCP BA, USDA and CDBW may use tank mixes of the herbicides and adjuvants included in the AIPCP, in compliance with label requirements. The components of tank mixes can have additive, synergistic, or antagonistic effects on listed species. For example, Matthiessen (1988) studied the toxicity of various fungicide and herbicide tank mixes on rainbow trout – when compared to the expected additive toxicity that might be expected from the individual components – tank mixture toxicity values ranged from half of the expected additive toxicity values to 1.4 times than what would be expected (Matthiessen 1988).

To better understand the effects of tank mixes that might be used in the AIPCP on listed fish species, CDBW commissioned a study from 2014-2017 to evaluate the toxicity of various mixtures on rainbow trout and fathead minnows. Stillway and Teh (2017b) evaluated the following tank mixes for rainbow trout:

- Imazamox + carfentrazone-ethyl + Agridex
- Fluridone + endothall
- Glyphosate + flumioxazin + Agridex
- Penoxsulam + Agridex[4]

None of the above tank mixes elicited effects on rainbow trout or fathead minnows for the 96-hour acute toxicity test or the 7-day chronic tests rainbow trout (Stillway and Teh 2017b). Fathead minnows did not exhibit significant effects on 7-day survival in these mixtures, but did exhibit statistically significant effects to growth in the chronic tests (Stillway and Teh 2017b). The authors conclude that survival of the two tested fish species was not negatively affected by the tank mixtures, and reported no evidence of additive effects to fish from the tank mix components (Stillway and Teh 2017b).

<u>Bioaccumulation of Herbicides and Adjuvants</u>

The AIPCP is not likely to result in effects due to bioaccumulation of herbicides. Bioaccumulation is an increase in the concentration of a chemical in a biological organism over time, compared to the chemical's concentration in the environment. Compounds accumulate in organisms whenever

[4] Acute test (96-hour) were only analyzed for Delta smelt larvae due to the effects of Penoxulam on listed Delta smelt.

they are taken up and stored faster than they are broken down (metabolized) or excreted. Bioaccumulation of chemicals in herbicides can occur in plant or animal tissues due to direct uptake or exposure, or in animal tissues by consumption and ingestion of other plant or animal species that have bioaccumulated these chemicals.

There is limited information on bioaccumulation of adjuvants. The MSDS for Agridex, Competitor, and Cygnet Plus state that no information on bioaccumulation is available (Bayer Crop Science 2004, Wilbur-Ellis 2010). The primary ingredient in Competitor, ethyloleate, is approved by the Food and Drug Administration as a regulated food additive (Bakke 2007). Break-Thru SP133 is comprised of fatty acid esters and polyglycerol esters, and is readily biodegradable (Evonik 2016a).

Based on the available data on the bioaccumulation of herbicides and adjuvants used in the AIPCP (see Section 6 in the AIPCP BA), and the available information on the exposure and effects to those chemicals, the AIPCP is not likely to result in direct or indirect effects due to bioaccumulation of herbicides and adjuvants.

In summary, herbicide application associated with the use of active ingredients carfentrazone-ethyl, endothall, flumioxazin, and florpyrauxifen-benzyl are likely to result in acute and chronic sublethal impacts which may result in adverse physiological (impaired chemical signaling) and behavioral effects (reductions in both swimming behavior and rate at which salmon consume prey, and avoid predators) to salmonids and green sturgeon. Although the acute and chronic toxicity data for rainbow trout and Chinook salmon indicated a wide range of effects, the application of the four herbicides may have potential negative effects at moderate to higher application concentration. The potential acute and chronic effects are deemed significant considering the dissipation half-life and observed concentrations of the herbicides, the size and location of the AIPCP treatment area, the timing of juvenile Chinook salmon or steelhead migration speed in the Delta, its tributaries, and the Suisun Marsh, and the uncertainty regarding the effects to listed fish species in the action area. As a result, juvenile and adult winter-run, CV spring-run, juvenile and adult CCV steelhead, and all life stages of sDPS green sturgeon are likely to experience adverse physiological effects (*i.e.,* reduced growth and survival), and are likely vulnerable to predation as a result of carfentrazone-ethyl, endothall, flumioxazin, and florpyrauxifen-benzyl exposure.

2.5.3 Physical and Mechanical Removal

The potential for direct and indirect effects to listed species as a result of physical and mechanical removal methods depends on the magnitude (duration and frequency of exposure) of disturbance, the type of method used, and the presence and proximity of listed species in the treatment site. The temporary installation of benthic mats or barriers are not anticipated to disturb (*i.e.,* alter) listed species feeding and foraging behavior due to their location and placement of the barriers and benthic mats (sloughs and backwater areas), with the exception of the presence of divers for the one-time installation and periodic monitoring of the barriers. Hand/net removal, diver hand removal, and diver-assisted suction removal are highly selective and low-impact activities that are not expected to have direct or indirect effects on listed species. Diver suctioning may temporarily increase sediments and turbidity (Madsen 2000), but the effects to salmonids and green sturgeon are anticipated to be temporary and insignificant.

Depending on their exact placement, booms, floating barriers, and curtains and screens are likely to negatively affect juvenile and adult salmonids and green sturgeon in the form of injury, mortality, avoidance activity, gill fouling, and reduced forging capability, and restrict listed species movement within the Delta, its tributaries, and the Suisun Marsh and delay fish access to spawning habitat or migratory passages. Additionally, the installation of equipment (such as train axels or Danforth type anchors) to anchor curtains and screens may cause a temporary increase in turbidity and may affect fish swimming behavior and ability to forage on prey items such as macroinvertebrates and other fish. Curtains and screens are not anticipated to extend deeper than one meter in the water column and are anticipated to have open passage along the channel bottom. To minimize effects as a result of these methods, CDBW will refer to historical fish presence/absence maps and CDFW trawl data, and carefully choose the timing and location of the physical control placement to minimize the potential for impeding sensitive species movement or access to rearing habitat in the Delta, its tributaries, and the Suisun Marsh.

Surface excavators have the potential to indirectly and directly affect (*i.e.,* injure or kill) listed species if the species are collected along with the biomass in the excavator. Additionally, surface excavators may cause a temporary increase in turbidity, although the excavators generally do not reach deep enough into the water to contact the sediment itself. Turbidity does not typically have an acute effect on organisms unless suspended solids exceed 25 mg/L (NMFS 2017).

Harvesters, cutters, and shredders have the potential to indirectly (*i.e.,* alter feeding behavior and foraging of prey items) and directly affect (*i.e.,* injure or kill) listed species due to the mechanics of the cutting equipment and, for harvesters, the conveyor belt systems that will be used to remove biomass (and any potential bycatch) from the water. Engel (1995) found that harvesting also has the potential for direct and indirect effects by removing macroinvertebrates, aquatic vertebrates, forage fishes, young-of-the-year fishes and game fishes (Madsen 2000). Herding may have direct impacts on sensitive species by temporarily disturbing sensitive species as the boats and machines push FAV mats between locations, which may temporary harass or alter feeding behavior and foraging of prey items. Although CDBW conducted visual surveys of bycatch in mechanical harvesting and found no ESA listed species, CDBW reported bycatch of fish, reptile, amphibian species, and invertebrates in six mechanical harvesting sites (*i.e.,* Stockton Deep Water Channel/Port and Waterfront, Seven Mile Slough, Old River/West Side Irrigation District, Sycamore Slough, Whiskey Slough, and Sycamore Slough; refer to Exhibit 6-37 of the AIPCP BA).

Additionally, fragmentation caused by cutting may spread invasive plant infestations, and both harvesting and cutting may suspend sediments, temporarily increasing turbidity (Madsen 2000). Madsen (2000) showed that these methods may release nutrients. This finding is supported by a USACE study that determined that shredding had mixed effects on nutrients and dissolved oxygen – plant decomposition tended to increase biochemical oxygen demand and nutrient cycling, but this was offset by increases in algal productivity and the increase in oxygen caused by the shredding machine's mixing of the water (James *et al.* 2000). CDBW monitors turbidity in its water quality samples for NPDES compliance, and will monitor results to ensure turbidity does not exceed the 25 mg/L threshold at which acute effects would be expected.

In addition, CDBW employees and contractors will be trained and qualified to survey the site prior to using all equipment associated with physical and mechanical removal. Surface excavators, harvesters, cutters and shredders will not be used if listed or sensitive species are present. CDBW will review ongoing fish survey data, and evaluate the historical fish presence/absence maps provided in Section 12 of the AIPCP BA when selecting sites for mechanical harvesting (including excavators, harvesters, cutters, and shredders). However, because of the location of the activity (sloughs and along river banks that are nurseries for invertebrate forage base), timing of the proposed activity, and potential for all listed fish to be present in the action area; these activities are likely to result in injury or mortality of the listed species.

2.5.4 Biological Controls

Effects analyses for listed fish species assume that the biocontrol agents will be present throughout the year. Actual exposure of the fish to the water hyacinth planthopper and the water hyacinth weevil is likely to vary greatly based on 10-fold or greater spatial and temporal variation in abundance of the weevil *N. bruchi* in the Delta (Hopper *et al.* 2017). Exposure is also likely to depend on similar seasonal variation documented for the water hyacinth planthopper near Folsom, California (Moran *et al.* 2016), in addition to the substantial and well-documented seasonal and spatial variation in fish presence in the Delta, its tributaries, and Suisun Marsh.

USDA and CDBW commissioned feeding studies at the UC-Davis using rainbow trout as a surrogate for Chinook salmon. NMFS used these 96-hour feeding studies conducted by UC-Davis on juvenile rainbow trout to evaluate the potential effects on listed species. Fish were fed 1.5 percent of their respective body weights: 1) formulated diet (control), 2) planthopper, 3) weevil, and 4) a fasting treatment was included as a comparison. Fish were evaluated for survival, success of feeding, and growth determinations by ribonucleic acid/deoxyribonucleic acid (RNA/DNA) analysis. Gut content analysis showed juvenile rainbow trout consumed both weevils and planthoppers. In preliminary tests, larval rainbow trout (used as a surrogate species for Chinook salmon and steelhead) rejected water hyacinth planthoppers for feeding. Juvenile rainbow trout are more likely to accept the planthopper as food. Subsequent tests found no significant effects in RNA/DNA growth indicators in the fish as compared to control fish (Stillway and Teh 2017). It should be noted that the short-term 96-hr study is insufficient to evaluate the nutritional status of planthopper and weevil for rainbow trout. (Stillway and Teh 2017).

Winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead, threatened, juveniles and adults may feed on terrestrial insects; however, given the timing and location of treatment these fish are not expected to feed on weevil and planthoppers. Southern distinct population segment of green sturgeon preferentially feed on benthic aquatic crustaceans and gastropods, and not terrestrial insects. Feeding on the water hyacinth weevil or water hyacinth planthopper is therefore not expected to occur.

<u>Integration with other control methods in the AIPCP</u>

Glyphosate and 2,4-D show no toxicity to water hyacinth weevils (Haag 1986, Jadhav *et al.* 2008, Moran 2012). Direct exposure of *M. scutellaris* and *N. eichhorniae* to herbicides will be avoided at long-term monitoring sites. The existing biocontrol agent *(N. bruchi*) will be augmented at sites that cannot be treated with herbicide or mechanical methods, or other sites in marinas that are not typically prioritized for herbicide and mechanical control early in the season.

Analysis of *N. eichhorniae* and *M. scutellaris* dispersal will take into account history of herbicide application within the sampling year at all sampling sites. At sites where herbicide has been applied, elevated densities of both biocontrol agents are expected on plants that could not be sprayed due to the water intake buffer. Although herbicide doses applied by CDBW in the AIPCP are not likely to be sublethal, studies on *Neochetina* spp, weevils have shown that sublethal application of 2,4-D and glyphosate alters plant growth and/or quality in ways that increase weevil populations (Wright and Bourne 1990, Jadhav *et al.* 2008). Over time the release of new and re-established biological control agents is expected to reduce the number of treatment sites and re-treatment acres for herbicide control, and the volume of water hyacinth that must be mechanically removed.

The negative effects of herbicide bioaccumulation in biological control agents and the direct impact on listed fish species are extremely unlikely to occur due to the nature and limited scope of the activities. The potential negative effects would be discountable to federally listed winter-run Chinook salmon, CV spring-run Chinook salmon, juvenile and adult CCV steelhead, and all life stages of sDPS green sturgeon based on the following information:

- treatment will focus on specific locations where herbicide and mechanical control are excluded to minimize the combined negative effects of herbicide and mechanical treatment methods on listed species; and
- biological release sites and numbers of adults (1000) and nymphs (5,000) released per site will be relatively small, will only occur in DIZs, and are not expected to co-occur with listed species presence, thus adverse effects are unlikely to occur.

NMFS expects that any negative effects of the biological control treatments will be outweighed by the long-term benefits to species. Although it is possible that rainbow trout may eat the insects in the Delta, its tributaries, and the Suisun March if food availability is limited, the limited number of biocontrol releases in the action area make it likely that any impacts on the food web would be insignificant, thus adverse effects to listed fish are unlikely to occur. However, biological control methods may positively affect listed species when they co-occur in the treatment area. Weevils and planthoppers may serve as prey items for juvenile and adult salmonids.

2.5.5 Boat Operations

Operations of the boats used to deploy and retrieve the equipment in the action area may cause sediment to be resuspended from the channel bottom and banks due to propeller wash, wakes, and anchoring. Resuspended sediment increases turbidity, may resuspend contaminants in the channel sediments, smother organisms and plants in the waterways, and reduce primary and secondary production by blocking sunlight needed for photosynthesis. In addition, boats can be a source of chemical contaminants and sound pollution (PFMC 2014) that may affect aquatic systems and organisms. However, boats will be maintained in good condition so that the engines are operating at optimal performance with no fluid leaks or discharges to the water. This will reduce or eliminate potential contaminants from entering the water due to their operations via exhausts or leaks.

Boats will be operated in such a way as to reduce wakes and prop wash where sediments can be resuspended from the banks or from the channel bottoms. Boats will not be operated so that large wakes are generated in confined areas of the channel or in shallow waters where the prop wash can interact with the channel bottom and resuspend sediment.

NMFS expects that any negative effects of the AIPCP will be outweighed by the long-term benefits to species. These benefits would be derived through enhancements to estuarine habitat quality, potential increase in prey availability, reduced predation hotspots, and improved passage and migration opportunities throughout the Delta, its tributaries and Suisun Marsh. PFMC (2005) suggests that nonnative plant invasions may increase food resources for Chinook salmon that feed on invertebrates in the water column or on the surface. However, macrophyte mats that cover significant spatial area can also be responsible for negative impacts on fish (Shultz and Dibble 2011). Given that most of the Delta salmonids historic habitat is either gone, not accessible or no longer functional, it is unknown whether the AIPCP would have much direct benefit to their food resources. However, experimental evidence from Donley Marineau *et al.* (2017) on glyphosate treatment of FAV in the central Delta demonstrated that herbicide treatment did not significantly reduce the densities of zooplankton found in and around water hyacinth mats. Therefore, it is unclear how removal of FAV/SAV through the AIPCP might impact the availability of some food sources, like phytoplankton. For glyphosate and water hyacinth, copepods and other zooplankton were not significantly reduced by AIPCP activities (Donley Marineau *et al*. 2017); thus further studies are needed to evaluate the possible increase in prey availability as a result of the AIPCP.

Because dense invasive vegetation tends to provide habitat for predatory fishes, such as largemouth bass, the removal of those plant infestations will reduce predation on sensitive species. Previous research indicates that *Egeria densa* is an ecosystem engineer (Champion and Tanner 2000, Brown 2003), which is defined as "a species that directly or indirectly modulates the availability of resources (other than themselves) by causing physical state changes in biotic or abiotic materials" (Jones et al. 1994, Drexler 2006). *Egeria densa* is a major agent of ecosystem change, altering basic abiotic properties of ecosystems, which results in increased predation on and competition for native fishes. *Egeria densa* reduces water velocity, increases sedimentation, and increases water clarity (Conrad et al. 2011). The increase in water clarity likely favors visual, lie-in-wait predators such as largemouth bass (Conrad et al. 2011).

Rapid growth and invasion of aquatic invasive plants reduces open water habitat and impairs wetlands and sensitive riparian habitats, altering the natural food web. The AIPCP may benefit Delta salmonids (winter-run, CV spring-run and CCV steelhead) and sDPS green sturgeon as well by improving passage to migration corridors. The availability of unobstructed migratory corridors is of great importance to both Delta salmonids and sDPS green sturgeon. AIPCP activities will likely benefit both of these groups' movement during migration by eliminating macrophyte barriers to flow (riverine and tidal) as well as physical obstructions in the migratory paths of the fish themselves. As a benthic fish, green sturgeon may particularly benefit from the AIPCP activities that address SAV.

2.6 Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02). 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.

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the Rangewide Status of the Species (Section 2.2.3).

Non-Federal actions in the action area include ongoing agricultural activities and increased urbanization. Agricultural practices in the action area may negatively affect riparian and wetland habitats through upland modifications of the watershed that lead to increased siltation or reductions in water flow in stream channels flowing into the rivers and streams that flow into the Delta and Suisun Marsh. Unscreened agricultural diversions along the Sacramento and San Joaquin rivers and throughout the Delta entrain fish, including juvenile salmonids. Stormwater and irrigation discharges related to both agricultural and urban activities contain numerous pesticides and herbicides that may negatively affect salmonid and sturgeon reproductive success and survival rates

Increased urbanization and housing developments can impact habitat by altering watershed characteristics and changing both water use and stormwater runoff patterns. Increased urbanization is also expected to result in increased wave action and propeller wash in Delta waterways due to increased recreational boating activity. This will potentially degrade riparian and wetland habitat by eroding channel banks and mid-channel islands, thereby causing an increase in siltation and turbidity. Wakes and propeller wash also churn up benthic sediments, thereby potentially resuspending contaminated sediments and degrading areas of submerged vegetation. This will result in reduced habitat quality for the invertebrate forage base required for the survival of juvenile salmonids and sturgeon. Increased recreational boat operation in the Delta is also anticipated to result in elevated contamination from the operation of engines on powered watercraft entering the water bodies of the Delta.

2.7 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species (Section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution.

2.7.1 Summary of the Status of the Species, Environmental Baseline and Effect of the Action to Listed Species

The action area currently has returning populations of winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon. As described earlier (in *Status of the Species* Section 2.2), populations of winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon have experienced significant declines in abundance and available habitat in California's Central Valley relative to historical conditions. The current status of listed salmonids and green sturgeon within the action area, based upon their risk of extinction, has not significantly improved since the species were listed (Good et al. 2005, NMFS 2016a-c). These severe declines in populations over many years, and in consideration of the degraded environmental baseline, demonstrate the need for actions which will assist in the recovery of all of the ESA-listed species in the action area, and that if measures are not taken to reverse these trends, the continued existence of winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and the sDPS green sturgeon will continue to be at risk. The current extinction risk for each species was described in section 2.2 above.

As described in the effects section (Section 2.5), the proposed action is likely to negatively affect various life stages of winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon, including rearing and emigrating juveniles, and migrating adults, as summarized below.

Herbicide Treatment Effects

During herbicide treatment, given the short length of exposure (*i.e.* 36 hours) to sublethal herbicide concentrations and the timing during which juveniles forage and rear and adults migrate within the action area, a small proportion of juvenile and adult winter-run Chinook salmon, yearling CV spring-run Chinook salmon, juvenile and adult CCV steelhead, and all life stages of sDPS green sturgeon are expected to experience adverse physiological effects (*i.e.,* reduced growth and survival) as a result of the direct application of and exposure to herbicides containing the active ingredients carfentrazone-ethyl, endothall, flumioxazin, and florpyrauxifen-benzyl.

As previously mentioned in Section 2.5, herbicide application associated with the use of active ingredients carfentrazone-ethyl, endothall, flumioxazin, and florpyrauxifen-benzyl are likely to result in acute and chronic sublethal impacts which may result in adverse physiological (impaired chemical signaling) and behavioral effects (reductions in both swimming behavior and rate at which salmon consume prey, and avoid predators), to salmonids and green sturgeon.

Short-term and long-term sublethal exposure of listed species to carfentrazone-ethyl, endothall, flumioxazin, and florpyrauxifen-benzyl, when applied as proposed, may result in reduced salmon growth, which may in turn reduce individual salmon survival. However, based on the proposed timing, location, and duration of application, the herbicide applications pose a low risk to juvenile population survival. Exposure of listed species to adjuvants, as proposed, poses a low risk of fish mortality and reduction in fish growth and survival for winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and juvenile sDPS green sturgeon.

For juvenile and outmigrating salmonids and green sturgeon, the herbicide treatment activities will result in some short- and long-term adverse effects to individuals. There is the potential for indirect effects to migrating populations that are exposed to the toxicants such as delayed migration or behavioral effects which result in increased predation. However, these negative effects to adult salmonids are not expected because they prefer open channel and deeper water, and are unlikely to use the habitat that will be affected by the herbicide treatment activities.

Physical Removal and Mechanical Harvest Removal Effects

During physical removal (hand/net, diver hand removal, diver assisted suction removal, benthic mats, barriers, booms, curtains and screens, and herding) and mechanical harvest removal activities, which consist of using specialized cutting and conveyor equipment mounted on boats to remove dense FAV and SAV mats, juvenile winter-run Chinook salmon, juvenile and adult CV spring-run Chinook salmon, juvenile and adult CCV steelhead, and juvenile and spawning adult sDPS green sturgeon are the life stages most likely to be impacted. This approach has the potential for direct effects on listed species due to the mechanics of the cutting equipment and conveyor belt systems. Injury or death to individual fishes is likely to result from tools and specialized equipment that are used to cut (cutters, shredders, harvesters), remove (hand/net, surface excavators, diver hand removal, diver assisted suction removal), or control the growth and spread (benthic mats, barriers, booms, curtains and screens, and herding) of aquatic invasive plants.

Mechanical harvest removal activities associated with the use of cutters, shedders, harvesters, benthic mats, barriers, booms, curtains, and screens are likely to result in various stressors (*e.g.*, conveyor mechanism and bycatch, increased turbidity, and low DO) which may result in direct and indirect negative effects to salmonids and green sturgeon in the form of injury, mortality, avoidance activity, gill fouling, and reduced forging capability. For juvenile rearing salmonids and green sturgeon, open channel habitat conditions and shoreline habitat conditions are temporarily worsened by the removal of invasive and non-native vegetation compared to the environmental baseline due to increases in turbidity and the loss of shade and cover resulting in negative effects such as reduced survival from increased predation. However, negative effects to migrating adult salmonids are unlikely because they prefer deeper water rather than the nearshore habitat that will be affected by the AIPCP. The AIPCP is not anticipated to cause an increase in predation due to the temporary installation of any structural features (curtains, booms, and barriers) that might impede adult migration.

Physical and mechanical harvest removal activities are likely to result in injury or mortality to a small proportion of juvenile and adult winter-run Chinook salmon, yearling, juvenile and adult CV spring-run Chinook salmon, juvenile and adult CCV steelhead, and all life stages of sDPS green sturgeon. These physical and mechanical removal actions will occur in no more than 200 acres per year (maximum of 1,000 acres for the 5-year AIPCP), primarily in sloughs and tributaries located in the Delta and Suisun Marsh and locations in the Sacramento River and San

Joaquin River when the abundance of individual salmon, steelhead and green sturgeon is high and is expected to result in low-to-medium levels of injury or death (Table 3).

Table 3. Integration and synthesis of herbicide, physical and mechanical control treatment effects including the environmental baseline and cumulative effects.

Stressor	Location	Species and Life Stage (timing)	Individual response and rationale	Magnitude of the effect	Weight of evidence	Probable change in fitness	Magnitude of overall effect[§]	Diversity Groups and Populations affected
Herbicide treatment	Delta, its tributaries, and Suisun Marsh	Juvenile: Mid Nov.-June; Adults Jan.-May (winter-run Chinook salmon, CV Chinook, and CCV steelhead ; year-round all life-history stages green sturgeon	Injury caused by sublethal acute and chronic exposure to herbicide active ingredients which may be delayed.	Low – Expected acute and chronic effect to a small proportion of juveniles and adults	High – Multiple technical publications and quantitative laboratory studies	Reduced growth and survival	Low – Expected acute and chronic sublethal exposure to a small proportion of juveniles.	Winter-run (Basalt and Porous Lava); spring-run (Basalt and Porous Lava, Northwestern California, Northern Sierra Nevada); CCV steelhead (Basalt Porous Lava Northwestern California, Northern Sierra Nevada, Southern Sierra Nevada); and sDPS green sturgeon
Mechanical harvest	Mormon slough, San Joaquin River, Stockton Deep Water Ship Channel	Jan- June, Juvenile/ adult CCV steelhead, and year-round all life history stages green sturgeon	Injury or mortality caused by cutters, shredders, and conveyor built system which may be instantaneous or delayed.	Low – Expected acute effect to small proportion of juvenile and adults.	High – Multiple technical publications, including quantitative fish and invertebrate surveys	Reduced survival	Low – Considering the condition of the baseline, location of the action, direct and indirect effects are expected for juvenile and adults.	CCV steelhead (Northern Sierra Nevada and Southern Sierra Nevada); and sDPS green sturgeon
	Seven Mile Slough	Sept-Dec. All life stages of salmon and steelhead; year-round all life history stages green sturgeon	Injury or mortality caused by cutters, shredders, and conveyor built system which may be instantaneous or delayed.	Low – Expected acute effect to small proportion of juvenile and adults.	High – Nursery for invertebrate forage base, multiple technical publications, including quantitative fish and invertebrate surveys.	Reduced survival	Low – Considering the condition of the baseline, location of the action, direct and indirect effects are expected for juvenile and adults.	Winter-run (Basalt and Porous Lava); spring-run (Basalt and Porous Lava, Northwestern California, Northern Sierra Nevada); CCV steelhead (Basalt Porous Lava Northwestern California, Northern Sierra Nevada, Southern Sierra Nevada); and sDPS green sturgeon
	Sycamore/ Hog Slough	July-Nov. juvenile winter-run, yearling spring-run, CCV steelhead, and year-round all life-history stages green sturgeon	Injury or mortality caused by cutters, shredders, and conveyor built system which may be instantaneous or delayed.	Low– Expected acute effect to small proportion of juvenile and adults.	High – Nursery for invertebrate forage base, multiple technical publications, including quantitative fish and invertebrate surveys.	Reduced survival	Low – Considering the condition of the baseline, location of the action, direct and indirect effects are expected for juvenile and adults.	Winter-run (Basalt Porous Lava); all extant populations of spring-run in the Sacramento River basin, and CCV steelhead (Northern Sierra Nevada); and sDPS green sturgeon
	Snodgrass Slough*	Aug-Dec. Adult CCV steelhead, adult winter-run,	Injury or mortality caused by cutters, shredders, and	Low – Expected acute effect to small proportion	High – Nursery for invertebrate forage base, multiple	Reduced survival	Low – Considering the condition of the baseline, location of the	Winter-run (Basalt and Lava Porous); all extant populations of

Stressor	Location	Species and Life Stage (timing)	Individual response and rationale	Magnitude of the effect	Weight of evidence	Probable change in fitness	Magnitude of overall effect[§]	Diversity Groups and Populations affected
		yearling spring-run, year-round all life-history stages green sturgeon.	conveyor built system which may be instantaneous or delayed.	of juvenile and adults.	technical publications, including quantitative fish and invertebrate surveys.		action, direct and indirect effects are expected for juvenile and adults.	spring-run in the Sacramento River basin spring-run and CCV steelhead (Northern Sierra Nevada); and sDPS green sturgeon
	Hass Slough	Jan-Mar. adult winter-run, Feb.-May all life history stages of spring –run, year-round all life-stages history green sturgeon.	Injury or mortality caused by cutters, shredders, and conveyor built system which may be instantaneous or delayed.	Low – Expected acute effect to a marginal proportion of juveniles and adults.	Low – Limited technical publications and quantitative fish and invertebrate surveys.	Reduced survival	None - Low Considering location action, marginal effects are expected for juvenile and adults.	Winter-run (Basalt Porous Lava); spring-run (Northern Sierra Nevada, Southern Sierra Nevada); and sDPS green sturgeon
	Walthall Slough	Sept.-Mar. adult CCV steelhead, Jan-June CCV steelhead, year-round .all life stages green sturgeon.	Injury or mortality caused by cutters, shredders, and conveyor built system which may be instantaneous or delayed.	Low – Expected acute effect to a marginal proportion of juveniles and adults.	Low – Limited technical publications and quantitative fish and invertebrate surveys.	Reduced survival	None - Low Considering location action, marginal effects are expected for juvenile and adults.	CCV steelhead (Southern Sierra Nevada) and sDPS green sturgeon
	Old River	All species and life-history stages present salmon, steelhead, and green sturgeon.	Injury or mortality caused by cutters, shredders, and conveyor built system which may be instantaneous or delayed.	Low – Expected acute effect to small proportion of juvenile and adults.	High – Multiple technical publications, including quantitative fish and invertebrate surveys.	Reduced survival	Low – Considering the condition of the baseline, location of the action, direct and indirect effects are expected for juvenile and adults.	Winter-run (Basalt and Porous Lava); spring-run (Basalt and Porous Lava, Northwestern California, Northern Sierra Nevada); CCV steelhead (Basalt Porous Lava Northwestern California, Northern Sierra Nevada, Southern Sierra Nevada); and sDPS green sturgeon

[§]The magnitude of the overall effect includes proposed action, baseline, and cumulative effects.
*The DCC Gates are closed from December through May.

Biological Controls Effects

As previously mentioned in 2.5.4, actual exposure of the fish to the water hyacinth planthopper and the water hyacinth weevil is likely to vary and depend on similar seasonal, in addition to the substantial and well-documented seasonal and spatial variation in fish presence in the Delta, its tributaries, and Suisun Marsh.

A small proportion of juvenile and adult winter-run Chinook salmon, yearling CV spring-run Chinook salmon, juvenile and adult CCV steelhead, and all life stages of sDPS green sturgeon may feed on terrestrial insects; however, given the timing and location of treatment these fish are not expected to feed on weevil and planthoppers. Southern distinct population segment of green sturgeon preferentially feed on benthic aquatic crustaceans and gastropods, and not terrestrial insects. NMFS expects that any negative effects of the biological control treatments will be outweighed by the long-term benefits to species. The limited number of biocontrol releases in the action area make it likely that any impacts on the food web would be insignificant, thus adverse effects to listed fish are unlikely to occur.

ESU/DPS

As identified in Section 2.2, the ESUs/DPSs that may be affected by the AIPCP reside in the Basalt and Porous Lava, Northwestern California, Northern Sierra Nevada, and Southern Sierra Nevada diversity groups of the Central Valley. NMFS considered the direct and indirect effects of the AIPCP in the context of the overall risk of extinction. Given the size of the action area, AIPCP projects will expose populations of the four species considered in this opinion to sublethal herbicide concentrations, and physical and mechanical removal activities in the Delta, its tributaries, and the Suisun Marsh. Individual fish will respond to that exposure in different ways depending on their life history stage at the time of exposure. That, in turn, will determine (1) the duration of exposure (*i.e.,* rearing fish are exposed longer than migrating fish), (2) the pathways of exposure (*e.g*., water quality or prey), and (3) the nature of the effect (*e.g.,* juveniles more likely to experience latent sublethal effects, returning adults more likely to have olfactory detriments that can impair homing ability*).*

Given these factors, we expect that the populations of winter-run Chinook salmon, CV spring-run, and CCV steelhead are likely to have the greatest level of exposure and response in the Delta, it tributaries and the Suisun Marsh due the location and timing of the control activities, the pathway of exposure for juvenile and adult salmonid species, and the nature of the effects (*e.g.* observed sublethal herbicide effects). All life history stages of sDPS green sturgeon are likely to have the longest period of exposure, based on their migratory and rearing behaviors in the Sacramento River and the Delta. The responses are likely to include impairments to growth for some individuals, reduced reproduction and survival, and injury or death for some individuals among each of the species considered

It is important to note that delays of benefits to listed species increase risk to survival and recovery. For listed fish, open channel habitat conditions and shoreline habitat conditions are temporarily worsened by the removal of invasive and non-native vegetation compared to the environmental baseline due to increases in turbidity and the loss of shade and cover resulting in negative effects such as reduced survival from increased predation. As identified in Section 2.5, NMFS expects that any negative effects of the AIPCP will be outweighed by the long-term benefits to species. These benefits would be derived through enhancements to estuarine habitat quality, potential increase in prey availability, reduced predation hotspots, and improved passage and migration opportunities throughout the Delta, its tributaries and Suisun Marsh.

Overall, considering the status of the species, the environmental baseline, and cumulative effects, NMFS expects that any negative effects of the AIPCP are not the type or magnitude that are expected to appreciably reduce the likelihood of both the survival and recovery of the affected listed species at the ESU/DPS level.

2.8 Conclusion

After reviewing and analyzing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, California Central Valley steelhead, and the Southern Distinct Population Segment of North American green sturgeon.

2.9 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "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. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

NMFS provides an ITS for those portions of the AIPCP that are authorized at the program level, reasonably certain to result in incidental take, and otherwise compliant with ESA section 7(a)(2). As previously mentioned in Section 1.3, some actions that are part of the AIPCP are proposed to be authorized, funded, or carried out at a later time (*e.g.,* actions such as the application of herbicides pending approval for use by USEPA and CDPR; and new or different physical, mechanical, and biological control activities that are not specifically described and analyzed in this opinion) and will be subject to a subsequent tiered section 7(a)(2) consultation when those actions become ready for consideration; the ITS does not apply to these actions. The ITS applies to all applications of permitted and approved herbicides, and physical and mechanical removal, specifically described and analyzed in this opinion, for the 5-year period of the AIPCP (2018-2022), providing the terms and conditions of this biological opinion are implemented. As described in Section 2.5.4, biological controls (*i.e.,* water hyacinth planthopper and the water hyacinth weevil) are not anticipated to result in incidental take of listed species; thus, this ITS does not apply to those biological controls.

The ITS provided in this biological opinion will terminate following the close of the 2022 operational season. After this time, incidental take of listed species by the AIPCP will not be exempt from the take prohibitions of the ESA through compliance with the terms and conditions of this ITS.

2.9.1 Extent of Take

NMFS cannot, using the best available information, quantify the anticipated incidental take as a result of the proposed action of individual winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon because the population size, timing of migration, and individual habitat use varies for each species in the action area.. In addition, detection of killed or injured individuals is unlikely to occur or be effective without extensive impracticable site monitoring efforts. Therefore, this ITS will use ecological surrogates to describe the expected extent of take due to the proposed action. Surrogates are used for this ITS since it is not practical to quantify the number of individuals of listed species exposed to the proposed action, but it is reasonably certain that those individuals that are exposed will incur some level of adverse response to the exposure resulting in take as defined under the ESA. In the ITS, NMFS will explain the causal link between the surrogate and the expected response from the exposed listed species; the reason why quantifying the amount of individuals exposed to the action (*i.e.*, take) is impractical to measure; and finally, establish a clear standard as to when take is exceeded (the surrogate parameter).

We have identified treatment acreage limits and DO criteria as ecological surrogates for take associated with sublethal herbicide levels that reduce fish growth and survival and increase vulnerability to predation; and physical removal and mechanical harvest activities that injure or kill fish.

- NMFS expects mixing zones (initial zone of dilution) in sloughs and backwater areas to have higher herbicide concentrations for up to 36 hours in order for the target plant species to be exposed to the proposed maximum herbicide concentrations. The zone of dilution is directly related to the extent of habitat affected and harm to juvenile rearing and migrating subadults and adult species in the area of altered habitat. The sublethal herbicide concentrations are identified in Figures 2-5. The habitat surrogate for the extent of incidental take is the zone of dilution, which is the area 25% greater than the total herbicide treatment site acreage, and limited to 36 hours. Any exceedances of the 15,000 treatment acres per year for all SAV, EAV, and FAV described in the AIPCP BA will be considered exceeding the extent of incidental take described in this ITS.
- Enumeration of death, injury, and harm as a result of physical removal and mechanical harvest is difficult because it involves fish that are beneath the aquatic invasive species mats, those that are injured or removed, and caught as bycatch. NMFS has identified the maximum physical removal and mechanical harvest acreage to be treated as a surrogate for this type of take. The physical removal and mechanical harvest treatment acreage is directly related to the extent of habitat affected, and harm to juvenile rearing and migrating subadults and adult species in the area of altered habitat. In any given year (2018-2022), the habitat surrogate for the extent of incidental take from physical removal and mechanical harvest treatment acreage is not to exceed 200 acres. Any exceedances of this parameter will be considered exceeding the extent of incidental take described in this ITS.

- We assumed that post treatment DO will temporarily decrease in the treatment site below background DO concentrations, and at concentrations below 2 mg/L listed fish species will not be present. The habitat surrogate for the extent of incidental take from DO is a DO concentration at 5 mg/L. Fish exposed to DO levels below 5 mg/L for extended periods are usually compromised in their growth and survival (Piper et al. 1982). NMFS expects that fish will generally avoid areas with extensive infestations of invasive plants due to the decreased ambient levels of DO in the water column. DO below 5 mg/L will be considered exceeding the extent of incidental take described in this ITS.

In some years, due to hydrological conditions, it will not be possible to meet the acreage limits or DO criteria. When such specific conditions are expected to occur, these will be identified as conference years. In conference years, an OMP will be developed to address that year's specific conditions and to minimize the effects of the AIPCP on listed anadromous fish species. There will be a tiered consultation for conference year OMPs, which will include an ITS for that year's specific conditions. In conference years, implementation of the OMP for that year, as approved by NMFS, will be considered the surrogate for that conference year. As long as there is no deviation from the conference year OMP.

If any specific parameter of these ecological surrogates are exceeded, the anticipated incidental take levels are also exceeded, which would trigger the need to reinitiate consultation on the proposed AIPCP.

In the biological opinion, NMFS determined that incidental take is reasonably certain to occur as follows:

<u>Herbicide Control Methods</u>

NMFS considers that it is likely juvenile, adult and sub adult salmonids and green sturgeon will be present in the areas where herbicides are applied to waters of the Delta. Therefore, NMFS anticipates incidental take of winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon due to sublethal effects caused by the application of herbicides to waters of the Delta. Any incidental take resulting from the AIPCP will most likely be limited to emigrating juveniles, and migrating adults of Chinook salmon and steelhead and all life stages of green sturgeon present in the action area during the operational herbicide treatment season of the AIPCP. The incidental take is expected to be in the form of injury, harassment, and harm as a result herbicide levels that reduce fish growth and survival and increase vulnerability to predation.

The number of winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon directly and indirectly taken will be difficult to quantify because dead and injured individuals will be difficult to detect and recover. Since acute exposure of sDPS green sturgeon to the herbicides is likely to be greater in duration than that of the listed salmonids, adverse effects are expected to be more than that experienced by listed salmonids exposed to the herbicide. Long-term exposure to low levels of herbicides may be greater for green sturgeon due to their prolonged residency in the Delta compared to salmonids, but herbicide levels are expected to be lower due the extensive mixing of water in the open channels preferred by green sturgeon.

The highest level of take for listed salmonids resulting from the implementation of the AIPCP is expected to occur during the months of March-November when various life stages of winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon, including rearing and emigrating juveniles and migrating adults, will be present in the Delta waters. Take is expected to occur year-round for green sturgeon based on their migratory and rearing behaviors.

Physical and Mechanical Methods

NMFS anticipates incidental take of winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon from impacts directly related to the physical removal and mechanical control activities. The incidental take is expected to be in the form of harassment, injury, and death of winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon resulting from tools and specialized equipment that are used to cut (cutters, shredders, harvesters), remove (hand/net, surface excavators, diver hand removal, diver assisted suction removal), or control the growth and spread (benthic mats, barriers, booms, curtains and screens, and herding) of aquatic invasive plants.

The number of winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon directly or indirectly taken will be difficult to quantify because dead and injured individuals will be difficult to detect and recover. Short-term exposure to mechanical harvest activities may be greater for juvenile winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead than sDPS green sturgeon due to their prolonged rearing and foraging in shallow open water habitat in the Delta compared to sturgeon.

The highest level of take for listed salmonids as a result from the implementation of the AIPCP is expected to occur during the months of March-December when various life stages of winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, including rearing and emigrating juveniles and migrating adults, will be present in the Delta waters. Take is expected to occur year-round for sDPS green sturgeon based on their migratory and rearing behaviors.

Future Actions

The AIPCP provides a framework for the development of future actions that are proposed to be authorized, funded, or carried out at a later time as part of the mixed programmatic action under consultation, and will be subject to a subsequent ESA section 7(a)(2) consultation, when those actions are ready for consideration (*e.g.,* actions such as the application of herbicides pending approval for use by USEPA and CDPR; and new or different physical, mechanical, and biological control activities that are not specifically described or analyzed in this opinion). At this time, the specific details of such potential actions that would be selected and implemented under the AIPCP are not available in enough specificity to make estimates of the amount of take that may result. Once studies are completed and necessary treatment methods are proposed, a tiered consultation will be required depending on the details of those activities and potential effects on ESA-listed anadromous fish species. We have not provided an incidental take statement that addresses the adoption of a framework for the development of such future actions, because adoption of a framework will not itself result in the take of listed species

2.9.2 Effect of the Take

In the biological opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely jeopardize the continued existence of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and the Southern distinct population segment of North American green sturgeon.

2.9.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" are nondiscretionary measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02).

1. USDA and CDBW shall implement measures to minimize incidental take due to chemical, physical and mechanical removal treatment methods to increase the likelihood of survival for listed species.

2. USDA and CDBW shall submit an AIPCP Annual Report and participate in an annual coordination meeting with NMFS by January 31st and March 31st, respectively, of each year to discuss the annual report of incidental take for the preceding calendar year and any actions that can improve minimization of the impact of the amount or extent of incidental take under this opinion, or make the program more efficient and accountable. In addition, USDA and CDBW shall submit an AIPCP Project Completion Report to NMFS within 45 days of completing treatment for an AIPCP project.

3. USDA and CDBW shall monitor and report incidental take to NMFS.

2.9.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and the USDA or CDBW must comply with them in order to implement the RPMs (50 CFR 402.14). USDA or CDBW has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

1. The following terms and conditions implement reasonable and prudent measure 1:
    a. Environmental Review
        i. USDA and CDBW shall ensure that the environmental review process for every AIPCP project covered by this opinion includes a written record of the ESA effects determination ("no effect," "may affect, not likely to adversely affect," "likely to adversely affect").
        ii. USDA and CDBW projects with a "not likely to adversely affect" or "likely to adversely affect" ESA listed species determination shall also

include an OMP, as described in NMFS' Criteria for AIPCP Project (Appendix A). USDA or CDBW shall prepare and provide NMFS with an OMP describing how listed species in the action area would be protected and/or monitored and to document the observed effects of the action on listed species in the action area.

(1) USDA or CDBW must submit any OMP to NMFS for review to ensure that the effects of carrying out the OMP are within the range of effects considered in this opinion.
(2) NMFS will notify USDA or CDBW within 30 calendar days as to whether or not the OMP is approved.

2. The following terms and conditions implement reasonable and prudent measure 2:

a. AIPCP Annual Report: After each implementation year, USDA or CDBW shall provide NMFS with an AIPCP Annual Report by January 31st, submitted online at AIPCPBiOp.wcr@noaa.gov, for NMFS to review and to determine whether the terms and conditions set forth by NMFS were met during the prior calendar year. Implementation of the monitoring and evaluation activities authorized under this opinion is contingent upon receipt of this annual report. Once an annual report is submitted to NMFS, USDA and CDBW may continue authorized activities unless otherwise notified by NMFS. NMFS will notify USDA and CDBW if the annual report is inadequate and more information is required. If information is requested but not provided within 30 days, reinitiation of consultation may be warranted.
b. Annual Coordination Meeting: USDA and CDBW shall facilitate an annual meeting with NMFS by March 31st of each year to discuss compliance with this opinion during the prior calendar year. The meeting topics shall include, at a minimum, an assessment of overall program project, suggestions or modifications to improve minimization of the impact of the amount or extent of incidental take under this opinion or program efficiency and accountability, and any other data or analyses USDA, CDBW, or NMFS deem necessary or helpful to assess habitat trends resulting from actions authorized under this opinion.
c. AIPCP Project Completion Report: USDA and CDBW shall submit an AIPCP Project Completion Report (Appendix B) to NMFS within 45 days of completing treatment for an AIPCP project. All reports shall be submitted to AIPCPBiOp.wcr@noaa.gov

3. The following terms and conditions implement reasonable and prudent measure 3:

a. Any Chinook salmon, steelhead or green sturgeon found dead or injured within 0.25 miles of the treatment site shall be reported immediately to NMFS via fax or phone within 24 hours of discovery to:

Assistant Regional Administrator
NMFS California Central Valley Office
Fax: (916) 930-3629, or
Phone: (916) 930-3600

b. Any dead specimen(s) shall be placed in a cooler with ice, frozen prior to shipment and sent to: NMFS, Southwest Fisheries Science Center, Fisheries Ecology Division, 110 Shaffer Road, Santa Cruz, California 95060.

c. USDA and CDBW shall make records/log books related to implementing the AIPCP available to any personnel from NMFS's Office of Law Enforcement, or CDFW Wardens, upon request for review of compliance with the terms and conditions.

d. USDA and CDBW biologists shall carry a copy of the ITS at all times while in the field and implementing the AIPCP.

2.10 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 the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

1. USDA and CDBW should continue to work collaboratively with NMFS, USFWS, CDFW, and the Corps to identify and implement measures to reduce fisheries bycatch during physical removal and mechanical harvest control activities.

2. USDA and CDBW should continue to support, through research, studies which evaluate juvenile salmonid rearing and migratory behavior in the Sacramento-San Joaquin Delta, including the effects of various chemicals and biocontrol methods on juvenile salmonid survival and behavior.

3. USDA and CDBW should fund studies which evaluate how non-native species compete with Chinook salmon, steelhead, and green sturgeon for habitat and the impacts of non-native species on the prey base for all life stages of green sturgeon.

The conservation measures listed above support critical watershed and site-specific recovery actions identified in the "Recovery Plan for the Evolutionarily Significant Units of winter-run, Central Valley Spring-run Chinook Salmon, and the Distinct Population Segment of California Central Valley Steelhead for the Central Valley" (NMFS 2014), to address threats that occur within a migration corridor (*i.e.,* Delta), Sacramento and San Joaquin River. Specific recovery actions include:

- Implement and evaluate actions to minimize the adverse effects of exotic (non-native invasive) species (plants and animals) on the aquatic ecosystem used by anadromous salmonids.
- Implement management actions to address aquatic species, including those described in the California Aquatic Invasive Species Management Plan.

- Increase monitoring and enforcement to ensure that the water quality criteria established in the Basin Plan are met for pollutants entering the main stem Sacramento River, San Joaquin River, and the Delta (SWRCB 2007).

In addition, the conservation measures listed above support recovery actions and research priorities identified in the "Draft Recovery Plan for the Southern Distinct Population Segment of North American Green Sturgeon (*Acipenser medirostris*)" (NMFS 2018), to address threats that occur within the Sacramento River Basin for eggs, juveniles, subadults, adults, and the San Francisco Bay Delta Estuary for juveniles, adults, and subadults. Specific recovery actions and research priorities include:

- Improve compliance and implementation BMPs to reduce input of point and non-point source contaminants within the Sacramento River Basin and San Francisco Bay-Delta Estuary.
- Conduct research to determine the toxicity of identified contaminants on green sturgeon (*e.g.,* physiologically) and their prey base.
- Conduct research to gain a better understanding of the prey base of all life stages of green sturgeon and potential effect of non-native species and climate change.
- Conduct research to determine how native and non-native species compete with green sturgeon for habitat.

NMFS requests that the USDA and CDBW inform us if any of the conservation recommendations will be implemented.

2.11 Reinitiation of Consultation

This concludes formal consultation for USDA and CDBW programs identified in this opinion.

As 50 CFR 402.16 states, 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 amount or extent of incidental taking specified in the ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect on 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 action.

If USDA or CDBW fails to provide specified information annually (by January 31 of each year, pursuant to term and condition in Section 2.9.4.2.a), reinitiation of consultation may be warranted. In addition, if a requirement within the ITS is not met, reinitiation of consultation may be warranted. To reinitiate consultation, contact the California Central Valley Office of NMFS.

2.12 "Not Likely to Adversely Affect" Determinations

USDA determined the proposed action is not likely to adversely affect critical habitat designated for Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon. This determination was based on the broad positive benefits of the AIPCP to the Delta, its tributaries, and Suisun Marsh ecosystem that are likely to be significant and long lasting. By minimizing the spread of invasive aquatic plants, AIPCP activities will lead to five primary interrelated subsidies for critical habitat: (1) food web benefits; (2) reduced physiochemical impacts; (3) biological benefits; (4) reduced potential for significant detrimental impacts, and (5) increased ecosystem restoration opportunities.

The AIPCP has the potential to positively benefit Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon and CCV steelhead and sDPS green sturgeon critical habitat by improving passage to migration corridors. AIPCP activities will likely benefit critical habitat and listed species movement during migration by eliminating invasive species barriers to flow (riverine and tidal) as well as physical obstructions in the migratory paths of the fish themselves. Treatment and elimination of invasive EAV, SAV, and FAV have important consequences for water quality parameters like amount of light that reaches the water column, temperature, salinity, turbidity and food availability that influence the critical habitat used by winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon.

Within the action area, the relevant PBFs of the designated critical habitat for Sacramento River winter-run Chinook salmon (58 FR 33212; June 16, 1993), CV spring-run Chinook salmon (70 FR 52488; September 2, 2005), CCV steelhead (70 FR 52488; September 2, 2005), and sDPS green sturgeon (74 FR 52300; October 9, 2009) are related to migratory corridors and rearing habitat.

Under the ESA, "effects of the action" means the direct and indirect effects of an action on the listed species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action (50 CFR 402.02). The applicable standard to find that a proposed action is not likely to adversely affect listed species or critical habitat is that all of the effects of the action are expected to be discountable, insignificant, or completely beneficial. Beneficial effects are contemporaneous positive effects without any adverse effects to the species or critical habitat. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur.

The AIPCP will have minimal transitory effects on the functioning of the critical habitat as a migratory corridor during physical and mechanical removal. There will be temporary localized effects to the treatment areas of benthic substrate, but it will have negligible effects on the functioning of the designated critical habitat and will be transitory due to the temporary nature of the physical barriers, curtains, booms, and screens. The AIPCP would improve the habitat condition and water quality in the action area by increasing the establishment of native vegetation, improving shallow-water habitat for native species, increasing DO levels, minimizing the potential for invasive weed species colonization, and increasing water velocity in the action area. Therefore, effects to critical habitat from AIPCP activities are expected to be insignificant.

Based on this analysis, NMFS concurs with USDA that the proposed action is not likely to adversely affect designated critical habitat for Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon.

3. FISH AND WILDLIFE COORDINATION ACT

The purpose of the FWCA is to ensure that wildlife conservation receives equal consideration, and is coordinated with other aspects of water resources development (16 USC 661). The FWCA establishes a consultation requirement for Federal agencies that undertake any action to modify any stream or other body of water for any purpose, including navigation and drainage (16 USC 662(a)), regarding the impacts of their actions on fish and wildlife, and measures to mitigate those impacts. Consistent with this consultation requirement, NMFS provides recommendations and comments to Federal action agencies for the purpose of conserving fish and wildlife resources, and providing equal consideration for these resources. NMFS' recommendations are provided to conserve wildlife resources by preventing loss of and damage to such resources. The FWCA allows the opportunity to provide recommendations for the conservation of all species and habitats within NMFS' authority, not just those currently managed under the ESA and MSA.

The following recommendations apply to the AIPCP:

- NMFS incorporates the conservation recommendations provided in section 2.10 (*Conservation Recommendations*) of the preceding biological opinion as applicable and consistent with the purposes of the FWCA.

The action agency must give these recommendations equal consideration with the other aspects of the AIPCP so as to meet the purpose of the FWCA.

This concludes the FWCA portion of this consultation.

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are USDA. Other interested users include CDBW. Individual copies of this opinion were provided to the USDA and CDBW staff. This opinion will be posted on the Public Consultation Tracking

System website (https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts). The format and naming adheres to conventional standards for style.

4.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3 Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA implementation, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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6. APPENDICES

APPENDIX A: NMFS Criteria for AIPCP Projects

May 14, 2018

The following administrative elements and treatment criteria comprise actions that United States Department of Agriculture—Agricultural Research Service (USDA) and/or California Department of Boating and Waterways (CDBW) shall follow for AIPCP Projects to ensure consistency with this Opinion. Some of these elements and criteria provide additional detail referenced in and necessary to comply with the Terms and Conditions in Section 2.9.4 of the Opinion.

1. <u>USDA Environmental Review</u>: USDA and CDBW shall ensure that the environmental review process for every AIPCP project covered by this opinion includes a written record of the ESA effects determination ("no effect," "may affect, not likely to adversely affect," "likely to adversely affect"):
    a. For actions that will have "no effect" on ESA-listed species or their critical habitat, no consultation with NMFS is required.
    b. Actions that are "not likely to adversely affect" (NLAA) ESA-listed species and/or critical habitat must also include an operational management plan (OMP) as described below. The OMP must be reviewed and approved by NMFS.
    c. Actions that are "likely to adversely affect" (LAA) ESA-listed species must also include an operational management plan (OMP) as described below. The OMP must be reviewed and approved by NMFS.
    d. For actions that are "likely to adversely affect" (LAA) critical habitat, reinitiation of consultation is warranted.

2. <u>NMFS Review and Approval Process:</u> To request NMFS review and approval of an OMP, USDA or the CDBW must submit the proposed OMP and the AIPCP Project Notification Form (as described in Appendix B, Part 1 and Part 2) at least 45 days before the anticipated completion of the environmental review for the subject action.

3. <u>Treatment Operational Management Plan:</u> An OMP must include the following information:
    a. All plans, maps, and AIPCP Information Form (Appendix B) must be signed by a licensed, professional biologist.
    b. A site map(s) for the action(s) that identifies all:
        i. Treatment zone(s);
        ii. Treatment site(s);
        iii. Acres to be treated at each site;
        iv. Treatment Methods:
            1. Chemical treatment methods by type, application concentration, and load;
            2. Physical/mechanical removal methods by type and capacity;
            3. Biocontrol by type, capacity and release sites

v. All drinking water intake buffers and buffer sites to the nearest receiving water;
vi. Presence or absence of ESA-listed species; and
vii. Conservation measures or Integrated Pest Management practices (IPMPs) by type.

c. A description of how each conservation measure and other IPMPs will minimize impacts to ESA-listed species and their habitat (*e.g.,* label-use restrictions or requirements) while providing adequate treatment at each site.
d. A description of the proposed treatment activities and schedule for the treatment, and the party responsible for implementation and contact information for the responsible party, including the name, email address, telephone number of the person responsible for the treatment so that NMFS may contact that person if additional information is needed.

4. <u>Conservation Measures and Integrated Pest Management Practices for AIPCP Projects</u>: AIPCP projects shall include conservation measures and IPMPs that minimize or reduce the potential impacts to ESA-listed species and their critical habitats. Examples of conservation measures include:
   a. Avoid mechanical treatment when ESA-listed species, sensitive riparian and wetland habitat, and other biologically important resources such as PBFs for migratory corridors and rearing sites in critical habitat for listed species, occur within the treatment area;
   b. Follow all material safety labels for herbicide and chemical application;
   c. Monitor dissolved oxygen levels pre/post treatment for all AIPCP treatment sites over time (1 week prior to and 6 week post);
   d. Collect plant fragments during and immediately following treatments;
   e. Identify and utilize spoil areas for harvesting plants that are at least 50 feet away from biologically important resources such as sensitive riparian and wetland habitat; and
   f. Follow conservation measures and integrated pest management practices for species avoidance, equipment operation, and spoiling when conducting mechanical harvesting operations, or when installing physical controls.

5. <u>Demonstration Investigation Zone:</u> When a demonstration investigation zone (DIZ) project is necessary to investigate the feasibility and effectiveness of a treatment method, USDA, CDBW and/or responsible parties must submit a Project Notice Form, and the following requirements apply:
   a. Provide specific locations, acres, and detailed study protocol for each DIZ;
   b. Use herbicides approved by the Environmental Protection Agency (USEPA) and the California Department of Pesticide Regulations (CDPR), and included in the National Pollutant Discharge Elimination System (NPDES) general permit;
   c. Implement USDA and CDBW pre/post treatment water quality monitoring protocol;
   d. Document the presence of any ESA listed species or critical habitat in the DIZ; and
   e. Apply conservation measures and IPMPs to be implemented to minimize effects.

6. Project Completion Report: USDA or CDBW must submit the AIPCP Project Completion Report (Appendix B, Part 3) within 45 days of the end of the project. The Project Completion Report should include all information necessary to document that the project was completed in compliance with the provisions of this Opinion.

7. Failure to Report May Trigger Reinitiation: NMFS may recommend reinitiation of this consultation if USDA or CDBW fails to provide all applicable notifications, plans and reports; fails to schedule or attend quarterly and annual meetings; or fails to implement any of the above, including the conservation measures, as specified.

APPENDIX B: Email Guidelines and Forms

For Use with the AIPCP Programmatic Opinion

May 14, 2018

Use the AIPCP programmatic e-mail box at AIPCPBiOp.wcr@noaa.gov to request that NMFS review and approve the operational management plan (OMP) for an AIPCP Project, to withdraw a request for review, and to submit the project completion report forms.

The e-mail box will send you an automatic reply after receipt of any message, but you will not receive any other communication from the programmatic e-mail box. Please direct all other communications or questions to the appropriate NMFS biologist or branch chief.

Please only submit one request for review, withdrawal, or submission of a completion report per e-mail. Please remember to attach all supporting information, including:

E-mail Subject Line

In the subject line of the email (see below for examples), include the type of action you are requesting (*i.e.,* Project Notification, Withdrawal, *etc*.), Project Name, Applicant Name, County, and Waterway (to which the action will effect).

Use caution when entering the necessary information in the subject line. Not using the subject line conventions may result in unnecessary delays to the request.

Examples:

> *Project Notification:* *AIPCP Project Name, Floating Aquatic Vegetation, Sacramento County, Snodgrass Slough*
>
> *Withdrawal:* *AIPCP Project Name, Biological Control Release, Contra Costa County, Bethel Island*
>
> *Project Completion:* *AIPCP Project Name, Submerged Aquatic Vegetation, San Joaquin County, Headreach Island, San Joaquin River*

Project Notification and AIPCP Information Forms

USDA or the CDBW must submit a Project Notification Form, a complete AIPCP Information Form, and a complete OMP to the AIPCP programmatic e-mail box to request that NMFS review and approve the OMP for an AIPCP project. Submit this form to NMFS 45 days prior to the anticipated completion of the project's environmental review. Within 7 calendar days, NMFS will reply to the requestor, identifying which staff person is assigned to complete the review, and within 45 calendar days, NMFS will determine whether the proposed treatment plan is approved or not.

If asked, the consultation biologist will provide an estimate of the time necessary to complete the review based on the complexity of the proposed action and work load considerations at the time of the request.

Approval or denial may delayed if the Project Notification Form, the AIPCP Information Form, or the OMP is incomplete or unsatisfactory. Please contact NMFS through the AIPCP programmatic e-mail box early during the development phase of a project if you have any questions about how these guidelines may affect your project.

Withdraw a Request for Review
If it is necessary to withdraw a request for review, reply to your previous e-mail, using the word "WITHDRAWN" at the beginning of the subject line, but otherwise follow the e-mail subject line conventions as described above. State the reason for the withdrawal in the e-mail. If USDA or CDBW re-submits a request for NMFS review that has been previously withdrawn, NMFS will process the resubmittal as if it is a new action notification.

Project Completion Report USDA or CDBW must submit the Project Completion Form to NMFS within 45 days of completing treatment for an AIPCP project. Failure to submit the Project Completion Form may result in NMFS recommending reinitiation of the programmatic consultation.