STATE OF CALIFORNIA - DEPARTMENT OF GENERAL SERVICES

PC#39102

STANDARD AGREEMENT

STD 213 (Rev. 03/2019)

AGREEMENT NUMBER	PURCHASING AUTHORITY NUMBER (If Applicable)
C1970800	

1. This Agreement is entered into between the Contracting Agency and the Contractor named below:

CONTRACTING AGENCY NAME
Department of Parks and Recreation

CONTRACTOR NAME
Fresno County Department of Agriculture

2. The term of this Agreement is:

START DATE
NTP

THROUGH END DATE
January 1, 2023

3. The maximum amount of this Agreement is:
$144,165.88 One hundred forty-four thousand one hundred sixty-five dollars and eighty-eight cents.

4. The parties agree to comply with the terms and conditions of the following exhibits, which are by this reference made a part of the Agreement.

EXHIBITS	TITLE	PAGES
Exhibit A	Scope of Work	1
Exhibit A	Budget Detail and Payment Provisions	2
Exhibit B	General Terms and Conditions	1
Exhibit B	Attachment 1- Cost Sheet	1
Exhibit C*	General Terms and Conditions *GTC 04/2017	
Exhibit D	Special Terms and Conditions	2
Exhibit D	Attachment A- 2013 Water Hyacinth Control Program Report	76
Exhibit D	Attachment B- Water Quality Order No. 2013-0002-DWQ, General Permit No. CAG990005 Report	86
Exhibit D	Attachment C- Endangered Species Act Section 7 (a) (2) Programmatic Biological Opinion	86
Exhibit D	Attachment D- Fish Passage Protocol Report	14

Items shown with an asterisk (*), are hereby incorporated by reference and made part of this agreement as if attached hereto.
These documents can be viewed at https://www.dgs.ca.gov/OLS/Resources

IN WITNESS WHEREOF, THIS AGREEMENT HAS BEEN EXECUTED BY THE PARTIES HERETO.

CONTRACTOR

CONTRACTOR NAME (if other than an individual, state whether a corporation, partnership, etc.)
Fresno County Department of Agriculture

CONTRACTOR BUSINESS ADDRESS	CITY	STATE	ZIP
1730 South Maple Avenue	Fresno	CA	93702

PRINTED NAME OF PERSON SIGNING	TITLE
Nathan Magsig	Chairman, Board of Supervisors

CONTRACTOR AUTHORIZED SIGNATURE	DATE SIGNED
	8-20-19

ATTEST:
BERNICE E. SEIDEL
Clerk of the Board of Supervisors
County of Fresno, State of California

By Susan Bishop
Deputy

STATE OF CALIFORNIA - DEPARTMENT OF GENERAL SERVICES

STANDARD AGREEMENT

STD 213 (Rev. 03/2019)

AGREEMENT NUMBER	PURCHASING AUTHORITY NUMBER (If Applicable)
C1970800	

STATE OF CALIFORNIA

CONTRACTING AGENCY NAME			
Department of Parks and Recreation			
CONTRACTING AGENCY ADDRESS	CITY	STATE	ZIP
One Capital Mall, Suite 500	Sacramento	CA	95814
PRINTED NAME OF PERSON SIGNING	TITLE		
Ramona Fernandez	Deputy Director (A)		
CONTRACTING AGENCY AUTHORIZED SIGNATURE	DATE SIGNED		
	8/19/19		
CALIFORNIA DEPARTMENT OF GENERAL SERVICES APPROVAL	EXEMPTION (If Applicable)		
D.G.S. APPROVAL NOT REQUIRED	PC 10351		

EXHIBIT A
(Standard Agreement)

SCOPE OF WORK

1. Contractor agrees to provide to the Department of Parks and Recreation, Division of Boating and Waterways (DBW), Water Hyacinth treatment services as described herein:

   The Contractor shall initiate and carry out an effective Water Hyacinth control program on the San Joaquin River and adjacent waterways (tributaries) within the boundaries of the County of Fresno. The program shall consist of approximately 360 hours of labor for Water Hyacinth treatment, and approximately 5 hours of administration and supervision.

   The treatment shall consist of topical herbicide application and other methods as necessary to effectively reduce Water Hyacinth plant growth.

2. The services shall be performed at:
   Tributaries of the San Joaquin River in the County of Fresno.

3. The services shall be provided during:
   The peak season of the Water Hyacinth plant growth, May through October. Services shall be provided Monday through Friday.

4. The project representatives during the term of this Agreement will be:

State Agency:	Department of Parks and Recreation	Contractor:	Fresno County Department of Agriculture
Section/Unit:	Division of Boating and Waterways	Section/Unit:	Weed and Vertebrate Control Unit
Attention:	Eddie Hard	Attention:	Mike Konda
Address:	1 Capitol Mall, Suite 410	Address:	1730 S. Maple Avenue
City/State/Zip Code:	Sacramento, CA 95814	City/State/Zip Code:	Fresno, CA 93702
Phone:	(916) 327-1865	Phone:	(559) 600-7510
Fax:	(916) 327-1775	Fax:	
E-mail Address:	edward.hard@parks.ca.gov	E-mail Address:	Mkonda@co.fresno.ca.us

Additional Scope of Work

1. Definitions

A. Loaned Equipment" means boats, trailers, pumps, GPS devices, or any other equipment loaned by the Department of Parks and Recreation, Division of Boating & Waterways (DBW) to the County of Fresno for the **Floating Aquatic Vegetation (FAV) Control Program**.

B. "Purchased Equipment" means equipment purchased with DBW funds for use in the **FAV Control Program,** which shall remain the property of the Department of Parks and Recreation, Division of Boating and Waterways.

2. Scope of Work

DBW enters into an agreement with the County of Fresno (Contractor) to treat the following, authorized for control plants, if found: **Water Hyacinth, Water Primrose, Sponge plant, and Alligator weed** in the San Joaquin River within Fresno and Madera Counties, and its tributaries within Fresno County, . The proposed work shall be as follows.

A. No **FAV** treatment shall take place until confirmed by DBW. The Biological Opinions written by the United States Fish and Wildlife Service (USFWS dated 3/13/13) and National Oceanic and Atmospheric Administration with National Marine Fisheries Service (NOAA, NMFS, dated 5/15/18) are attached to this agreement as Exhibit D, Attachment A and Exhibit D, Attachment C. The Contractor will abide by all regulatory provisions governing at the time of treatment as detailed in the Biological Opinions pursuant to Section 7 of the Endangered Species Act of 1973 (ESA 12/28/73 as amended 16 U.S.C. 1531 et seq),. The Contractor will be held responsible for any fines associated with violations of the provisions set forth in ESA Section 7 permits that may occur within their **FAV** Control Program jurisdiction as described within the Scope of Work, part C, of this Agreement.

B. The Contractor shall follow all regulations set forth in the provisions of the National Pollutant Discharge Elimination System (NPDES) permit which has been issued, and governing at the time of treatment, to DBW by the State Water Resources Control Board. The NPDES permit is incorporated into this contract by reference and may be referred to herein. The Contractor shall be held responsible for any fines associated with violations of the provisions of the NPDES permit.

C. The Contractor shall initiate and carry out an effective **FAV** Control Program on the San Joaquin River within Fresno and Madera Counties, and adjacent waterways (tributaries) within the boundaries of Fresno County.

D. The program shall consist of approximately 2,000 hours of **FAV** treatment labor and approximately 80 hours of administration and supervision.

E. The treatment shall consist of topical herbicide application and other methods as necessary to effectively reduce **FAV** plant growth.

F. DBW shall provide the Contractor, to the best of the DBW's ability, herbicides and loaned equipment. The Contractor shall maintain the loaned equipment in good working condition and repair.

G. The Contractor agrees to repair or replace any equipment loaned or purchased under this contract if lost, stolen, or damaged.

H. The Contractor shall take a physical inventory of any equipment purchased under this agreement and reconcile the inventory with the property records at least annually to verify the existence, current utilization, and continued need for equipment. Contractor shall keep complete and accurate records of all expenditure pertaining to the purchase of additional equipment and the operation and maintenance of DBW funded vessels; such records shall be available and open to DBW for inspection and audit by any authorized DBW representative during business hours.

I. Property records shall be maintained by the Contractor and provided to DBW on an annual basis. Such records shall include a description of the property, manufacturer, serial number or other identification number, property location, and condition.

3. Duration

The terms of this Agreement shall begin upon notice to proceed and shall continue until January 01, 2023, unless terminated earlier in accordance with the terms and conditions of this Agreement.

EXHIBIT B
(Standard Agreement)

BUDGET DETAIL AND PAYMENT PROVISIONS

1. Invoicing and Payment

A. For services satisfactorily rendered, and upon receipt and approval of the invoices, the State agrees to compensate the Contractor for actual expenditures incurred in accordance with the rates specified in Cost Sheet, marked Exhibit B, Attachment 1, which is attached hereto and made a part of this Agreement.

B. Itemized invoices shall include the Agreement Number, service period covered by the invoice, and shall be submitted in triplicate not more frequently than monthly in arrears to:

California State Parks
Division of Boating and Waterways
Attn: Contract Analyst
1 Capitol Mall, Suite 410
Sacramento, CA 95814

2. Budget Contingency Clause

A. It is mutually agreed that if the Budget Act of the current year and/or any subsequent years covered under this Agreement does not appropriate sufficient funds for the program, this Agreement shall be of no further force and effect. In this event, the State shall have no liability to pay any funds whatsoever to Contractor or to furnish any other considerations under this Agreement and Contractor shall not be obligated to perform any provisions of this Agreement.

B. If funding for any fiscal year is reduced or deleted by the Budget Act for purposes of this program, the State shall have the option to either cancel this Agreement with no liability occurring to the State, or offer an agreement amendment to Contractor to reflect the reduced amount.

3. Prompt Payment Clause

Payment will be made in accordance with, and within the time specified in, Government Code Chapter 4.5, commencing with Section 927.

4. Timely Submission of Final Invoice

A. A final undisputed invoice shall be submitted for payment no more than ninety (90) calendar days following expiration or termination date of this Agreement, unless a later or alternate deadline is agreed to in writing by the project representative. Said invoice should be clearly marked "Final Invoice," thus indicating that all payment obligations of the State under this Agreement have ceased and that no further payments are due or outstanding.

B. The State may, at its discretion, choose not to honor any delinquent final invoice if the Contractor fails to obtain prior written State approval of an alternate final invoice submission deadline. Written State approval shall be sought from the project representative prior to the expiration or termination date of this Agreement.

5. Travel and Per Diem

A. Any reimbursement for necessary traveling and per diem shall be at rates not to exceed those amounts paid to the state's represented employees under collective bargaining Agreements currently in effect. No travel outside the State of California shall be reimbursed unless prior written authorization is obtained from DBW.

COST SHEET

FRESNO COUNTY DEPARTMENT OF AGRICULTURE
Water Hyacinth Survey/Treatment Program

COST BREAKDOWN	19-20 Year 1	20-21 Year 2	21-22 Year 3	22-23 Year 4
PERSONNEL SERVICES				
LABOR				
Classification				
Hours	16	16	16	16
Hourly Rate	$79.62	$79.62	$79.62	$79.62
Labor Costs	$1,273.92	$1,273.92	$1,273.92	$1,273.92
Classification				
Hours	400.00	400.00	400.00	400.00
Hourly Rate	$63.50	$63.50	$63.50	$63.50
Labor Costs	$25,400.00	$25,400.00	$25,400.00	$25,400.00
Classification				
Hours	80.00	80.00	80.00	80.00
Hourly Rate	$33.57	$33.57	$33.57	$33.57
Labor Costs	$2,685.60	$2,685.60	$2,685.60	$2,685.60
TOTAL LABOR	**$29,359.52**	**$29,359.52**	**$29,359.52**	**$29,359.52**
10% Indirect Costs	**$2,935.95**	**$2,935.95**	**$2,935.95**	**$2,935.95**
TOTAL LABOR PLUS INDIRECT COST	**$32,295.47**	**$32,295.47**	**$32,295.47**	**$32,295.47**
VEHICLES				
Vehicle Mileage	4,000	4,000	4,000	4,000
Cost per Mile	0.545	0.545	0.545	0.545
TOTAL MILEAGE COSTS	**$2,180.00**	**$2,180.00**	**$2,180.00**	**$2,180.00**
PARTS & MISC. SUPPLIES				
Equipment maintenance/purchase	$1,000.00	$1,000.00	$1,000.00	$1,000.00
Supplies	$566.00	$566.00	$566.00	$566.00
Chemicals**	$0.00	$0.00	$0.00	$0.00
TOTAL PARTS & MISC. COSTS	**$1,566.00**	**$1,566.00**	**$1,566.00**	**$1,566.00**
FISCAL YEAR TOTAL	**$36,041.47**	**$36,041.47**	**$36,041.47**	**$36,041.47**
GRAND TOTAL	**$ 144,165.88**			

****Chemicals to be purchased by DBW as part of DBW's chemical order**

EXHIBIT D — PUBLIC ENTITY
(Standard Agreement)

SPECIAL TERMS AND CONDITIONS

1. Disputes

Unless otherwise provided in this agreement, any dispute concerning a question of fact arising under this agreement which cannot be resolved informally shall be decided by the following two-step procedures.

Contractor must provide written notice of the particulars of such disputes to the Project Manager or his/her duly appointed representative. The Project Manager must respond in writing within ten (10) working days of receipt of the written notice of dispute. Should Contractor disagree with the Project Manager's decision, Contractor may appeal to the second level. Pending the decision on appeal, Contractor shall proceed diligently with the performance of this agreement in accordance with the Project Manager's decision. The second level appeal must indicate why the Project Manager's decision is unacceptable, attaching to it Contractor's original statement of the dispute with supporting documents, along with a copy of the Project Manager's response. The second level appeal shall be sent to the Deputy Director of Administrative Services or his/her duly appointed representative. The second level appeal must be filed within fifteen (15) working days of receipt of the Project Manager's decision. Failure to submit an appeal within the period specified shall constitute a waiver of all such right to an adjustment of this agreement. The Deputy Director or designee shall meet with Contractor to review the issues raised. A written decision signed by the Deputy Director or designee shall be returned to Contractor within fifteen (15) working days of the receipt of the appeal.

2. Termination for Convenience

State reserves the right to terminate this agreement subject to 30 days written notice to Contractor. Contractor may submit a written request to terminate this agreement only if State should substantially fail to perform its responsibilities as provided herein.

3. Force Majeure

Except for defaults of subcontractors, neither party shall be responsible for delays or failures in performance resulting from acts beyond the control of the offending party. Such acts shall include but shall not be limited to acts of God, fire, flood, earthquake, other natural disaster, nuclear accident, strike, lockout, riot, freight embargo, public regulated utility, or governmental statutes or regulations superimposed after the fact. If a delay or failure in performance by Contractor arises out of a default of its subcontractor, and if such default of its subcontractor, arises out of causes beyond the control of both Contractor and subcontractor, and without the fault or negligence of either of them, Contractor shall not be liable for damages of such delay or failure, unless the supplies or services to be furnished by subcontractor were obtainable from other sources in sufficient time to permit Contractor to meet the required performance schedule.

4. Forced, Convict, and Indentured Labor

No foreign-made equipment, materials, or supplies furnished to State pursuant to this agreement may be produced in whole or in part by forced labor, convict labor, or indentured labor. By submitting a bid to State or accepting a purchase order, Contractor agrees to comply with this provision of this agreement.

5. Potential Subcontractors

Nothing contained in this agreement or otherwise, shall create any contractual relation between State and any subcontractors, and no subcontract shall relieve Contractor of its responsibilities and obligations hereunder. Contractor agrees to be as fully responsible to State for the acts and omissions of its subcontractors and of persons either directly or indirectly employed by any of them as it is for the acts and omissions of persons directly employed by Contractor. Contractor's obligation to pay its subcontractors is an independent obligation from State's obligation to make payments to Contractor. As a result, State shall have no obligation to pay or to enforce the payment of any moneys to any subcontractor.

6. Priority Hiring Considerations for Contracts with a Value of $200,000

If the resulting agreement will have a total value of $200,000 or more, Contractor is hereby advised that it will be obligated to give priority consideration in filling vacancies in positions funded by the resulting agreement to qualified recipients of aid under Welfare and Institutions Code Section 11200. This requirement shall not interfere with or require a violation of a collective bargaining agreement, a federal affirmative action obligation for hiring disabled veterans of the Vietnam era, or nondiscrimination compliance laws of California and does not require the employment of unqualified recipients of aid.

7. Intellectual Property

Any works developed during and/or pursuant to this agreement by Contractor, including all related copyrights and other proprietary rights therein, as may now exist and/or which hereafter come into existence, shall belong to State upon creation, and shall continue in State's exclusive ownership upon termination of this agreement. Contractor further intends and agrees to assign to State all right, title and interest in and to such materials as well as all related copyrights and other proprietary rights therein.

Contractor agrees to cooperate with State and to execute any document or documents that may be found to be necessary to give the foregoing provisions full force and effect, including but not limited to, an assignment of copyright.

Contractor agrees not to incorporate into or make the works developed, dependent upon any original works of authorship or Intellectual Property Rights of third parties without first (a) obtaining State's prior written permission, and (b) granting to or obtaining for State a nonexclusive, royalty-free, paid-up, irrevocable, perpetual, world-wide license, to use, reproduce, sell, modify, publicly and privately display and distribute, for any purpose whatsoever, any such prior works.

8. Contractor's Duties, Obligations and Rights

Contractor is hereby apprised that California Public Contract Code Section 10335 through 10381 are applicable relative to Contractor's duties, obligations, and rights in performing the agreement.

9. Amendment

No amendment of variation of the terms of this Agreement shall be valid unless made in writing, signed by the parties, and approved as required. No oral understanding or agreement not incorporated in the Agreement is binding on any of the parties.

United States Department of the Interior

FISH AND WILDLIFE SERVICE

San Francisco Bay-Delta Fish and Wildlife Office
650 Capitol Mall, Suite 8-300
Sacramento, California 95814

IN REPLY REFER TO:
81410-2013-F-0005

Dr. Raymond Carruthers
Research Leader/Ecologist
United States Department of Agriculture
Agriculture Research Service
Exotic and Invasive Weed Research Unit
800 Buchanan Street
Albany, California 94710

MAR 13 2013

Subject: 2013 Water Hyacinth Control Program in the Sacramento-San Joaquin Delta within Eleven Counties, California

Dear Dr. Carruthers:

This letter is in response to the U.S. Department of Agriculture's Agriculture Research Service's (USDA-ARS) October 25, 2012, letter requesting consultation with the U.S. Fish and Wildlife Service (Service) on the proposed State of California Department of Boating and Waterways (CDBW) 2013-2017 Water Hyacinth Control Program (WHCP) in the Sacramento-San Joaquin Delta (Delta) and its tributaries. Your consultation initiation letter was received in our San Francisco Bay-Delta Office (BDFWO) on October 25, 2012, and your subsequent February 14, 2013, electronic mail (e-mail) was received in our office with updates to your project description. USDA-ARS requested consultation for the federally-threatened valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) (VELB) and its critical habitat, giant garter snake (*Thamnophis gigas*) (GGS), and the delta smelt (*Hypomesus transpacificus*) and its critical habitat. This response is in accordance with Section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act).

The USDA-ARS determined that the action may affect, but is not likely to adversely affect the federally-threatened GGS and VELB and its critical habitat. The applicant proposes to implement Conservation Measures (page 21), as described in the Project Description, to avoid adverse effects to GGS and VELB and its critical habitat. The Service concurs with your determination that the project may affect, but will not likely adversely affect the federally-listed GGS or VELB as a result of the proposed action based on the applicant's strict implementation of the proposed Conservation Measures and the proposed WHCP treatment restrictions. No critical habitat has been designated for GGS, and as such none will be adversely modified or destroyed. Critical habitat has been designated for VELB on the American River in Sacramento County; however, the WHCP does not conduct operations within the area and therefore no destruction or adverse modification of VELB critical habitat is anticipated.

On June 1, 2001, the Service issued a biological opinion (BO) for the WHCP (Service file No. 1-1-01-F-0050). This biological opinion was subsequently amended five times (Service file No.'s 1-1-02-F-0157, 1-1-03-F-0114, 1-1-04-F-0113, and 81410-2011-F-0035). This current consultation for the 2013-2017 WHCP was submitted to the Service due to changes in the project description and updates to the delta smelt status of the species that have occurred since issuance of the previous BOs and amendments.

This document hereby represents the Service's BO on the effects of CDBW's WHCP the Sacramento-San Joaquin Delta and its tributaries on the federally-threatened delta smelt and its critical habitat. This BO supersedes the Service's June 1, 2001, biological opinion and its amendments.

This biological opinion is based on the following information:

1) The USDA-ARS and CDBW October 25, 2012, *Water Hyacinth Control Program Biological Assessment* (BA) and *Supplemental Materials Binder* (BA Binder);

2) The CDBW's November 20, 2009, Programmatic Environmental Impact Report Volume I, II, and III;

3) The CDBW's WHCP 2009, 2010, 2011, and 2012 Annual Reports;

4) The CDBW's February 14, 2013, e-mail titled *WHCP-Responses to Questions Raised by the Service*;

5) Numerous electronic mails, phone conversations, and meetings between the CDBW, USDA-ARS, National Marine Fisheries Service (NMFS), and the Service between October 2012 and March 2013; and

6) other information available to the service.

CONSULTATION HISTORY

June 1, 2001	The Service issued a BO (Service file No. 1-1-01-F-0050) to the USDA-ARS. Associated amendments were written by the Service the following three years (Service file No.'s 1-1-02-F-0157, 1-1-03-F-0114, and 1-1-04-F-0113).
April 27, 2011	USDA-ARS issued a letter requesting reinitiation of formal consultation for the WHCP.

June 30, 2011	The Service issued a letter to USDA-ARS for the WHCP requesting additional information regarding potential effects. The Service determined the WHCP may continue to operate under the Service's May 21, 2004, biological opinion (Service file number 1-1-04-F-0149) for the 2011 treatment season.
October 19, 2011	USDA-ARS issued a letter requesting to extend the WHCP to November 30, 2011.
October 31, 2011	The Service issued a letter stating that no extension was required as long as the WHCP was operating as the project was described within the latest May 21, 2004, amended biological opinion (Service File No. 1-1-04-F-0113).
January 18, 2012	The Service met with CDBW, USDA-ARS, and NMFS to discuss the proposed 2012 WHCP and the project's federal nexus.
March 5, 2012	The USDA-ARS issued a letter requesting reinitiation of formal consultation.
March 23, 2012	The USDA-ARS provided additional information to the Service responding to the Service's June 30, 2011, request for more information.
March 30, 2012	The Service met with CDBW, USDA-ARS, and NMFS to further discuss the 2012 WHCP.
December 2011 through June 2012	The Service, the USDA-ARS and the CDBW exchanged e-mail communications regarding the 2012 project description.
October 25, 2012	The Service received a letter from USDA requesting formal ESA section 7 consultation on the 2013-2017 WHCP. The Service also received a BA and a BA Binder prepared by USDA and CDBW for the consultation.
December 12, 2012	The Service requested a meeting to discuss numerous updates to the 2013–2017 WHCP project description.
January 3, 2013	The Service received a copy of information regarding changes to the project description that had been provided to the National Marine Fisheries Service (NMFS) by the USDA-ARS on January 3, 2013.

January 16, 2013	The Service held a meeting with USDA-ARS, CDBW and the Newpoint Group at the BDFWO to discuss 2013-2017 WHCP project description changes.
January 2013 to March 1, 2013	The Service, the USDA-ARS, and the CDBW communications regarding the 2013-2017 WHCP project description.

BIOLOGICAL OPINION

Description of the proposed action

The WHCP is an aquatic weed program designed to control the growth and spread of the non-native invasive plant, water hyacinth (*Eichhornia crasipes)*, in the Delta and its tributaries. Water hyacinth forms dense mats that interfere with navigation, recreation, irrigation, power generation, and native aquatic flora and fauna. These mats competitively exclude native submersed and floating-leaved plants which are part of the habitat used by listed species and their forage base. Low oxygen conditions develop beneath water hyacinth mats and the dense floating mats impede water flow and create good breeding conditions for mosquitoes (CALFED, ERP Vol. 1, 2000).

The USDA-ARS serves as the Federal nexus for the WHCP which is managed by the CDBW. The proposed program consists of an integrated and adaptive approach, emphasizing chemical treatment, supported by hand-picking, herding, mechanical removal, and continued assessment of biological controls, adjusting over time, as treatment methods, technology, and environmental factors change.

Selected primary program herbicides will be 2,4-Dichlorophenoxyacetic acid, dimethylamine (DMA) salt, or 2,4-D) and glyphosate, with 2,4-D being used for the majority of treatments. Beginning in 2013, WHCP proposes to add two new herbicides that have recently been approved by the California Department of Pesticide Regulation (CDPR) for water hyacinth treatment in aquatic environments: penoxsulam and imazamox. In addition, WHCP had proposed to utilize a third new herbicide, imazapyr, but it was rescinded because it has not been approved by CDPR for use on water hyacinth. CDBW applies herbicides with an adjuvant to increase adhesion to water hyacinth leaves. WHCP proposes to utilize the adjuvant Agridex and the vegetable oil-based adjuvant, Competitor.

In addition to herbicide treatments, the WHCP proposes to utilize hand-picking, herding, and mechanical removal. These approaches can help reduce the need for herbicides. Hand-picking would primarily be utilized to reduce plant biomass in nursery areas. Herding would be used in order to push water hyacinth mats (1) into main channels where it would flow naturally out of the Delta and die in the more saline water of San Francisco Bay; or (2) toward mechanical removal sites. The WHCP proposes to utilize two mechanical removal methods: (1) use of specialized mechanical equipment with conveyors to physically remove plants, and (2) use of small excavators sited on concrete boat ramps to scoop plants into trucks/trailers for disposal. In addition, the USDA-ARS, CDBW, and their partners initially proposed biological control methods, but withdrew them from the proposed action.

Action Area

USDA-ARS and CDBW propose to apply herbicide products and physical removal methods to control water hyacinth in the Delta (See Figure 1; Treatment Areas 1, 2, 3, and a portion of 4) and the San Joaquin River (SJR; See Figure 2; Treatment Area a portion of 3 and 4) waterways for 5 years (2013-2017). Figures 1 and 2 below illustrate the WHCP treatment Areas 1, 2, 3, and 4 and are referred to as such throughout this document. There are approximately 350 treatment sites with water hyacinth mats that average between one and two miles in length. Only waterways within any given treatment site are actually part of the action area, and in any given treatment season water hyacinth is growing, and treated in, only a portion of the 350 total treatment sites. The general boundaries for the treatment area are as follows:

- West up to and including Sherman Island at the confluence of the Sacramento and San Joaquin Rivers;
- West up 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 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 to Friant Dam on Millerton Lake;
- East along the Tuolumne River to LaGrange Reservoir below Don Pedro Reservoir; and
- East along the Merced River to Merced Falls, below Lake McClure.

Figure 1: WHCP Project – Treatment Areas # 1, 2, 3, and a portion of 4

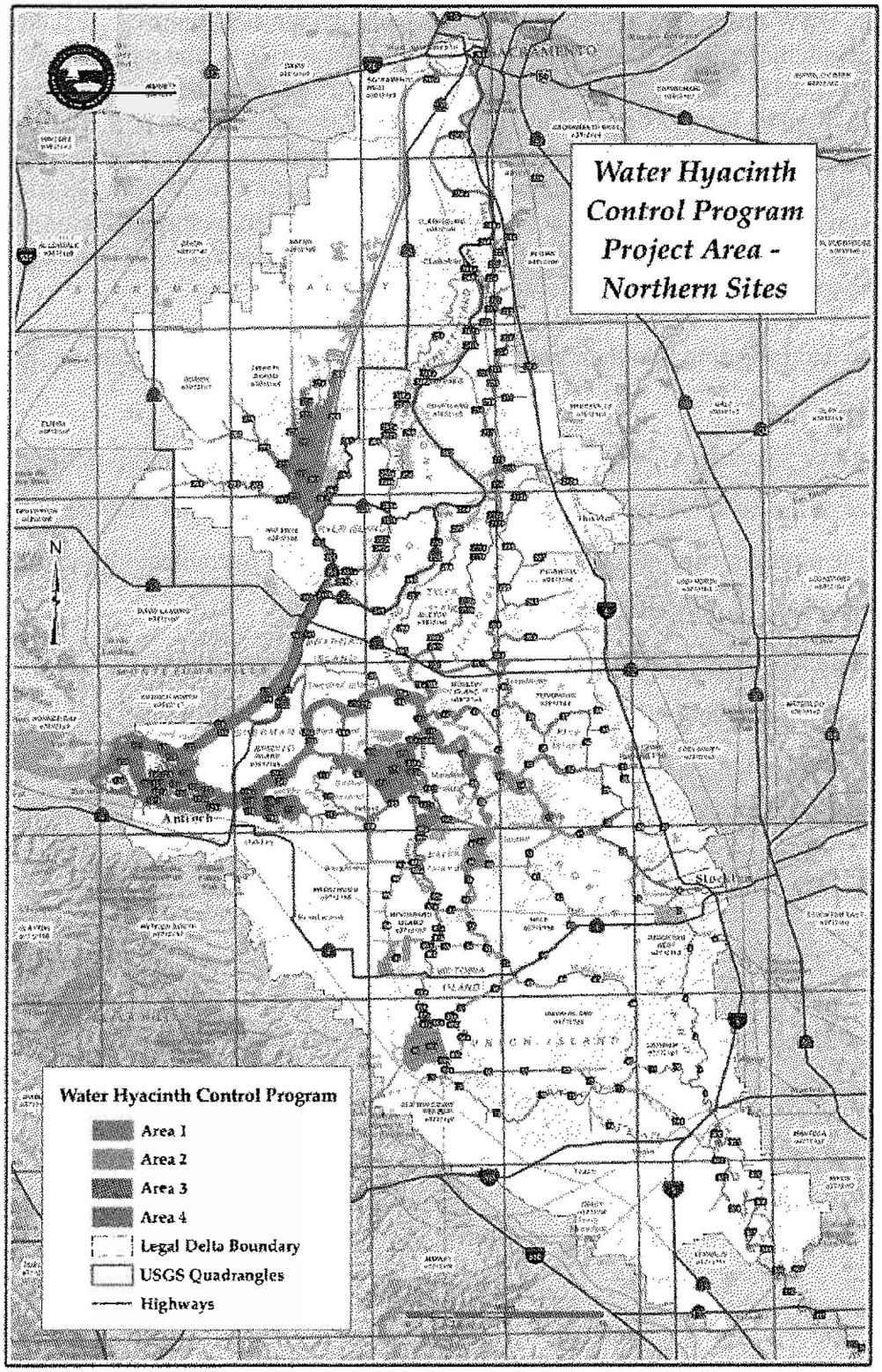
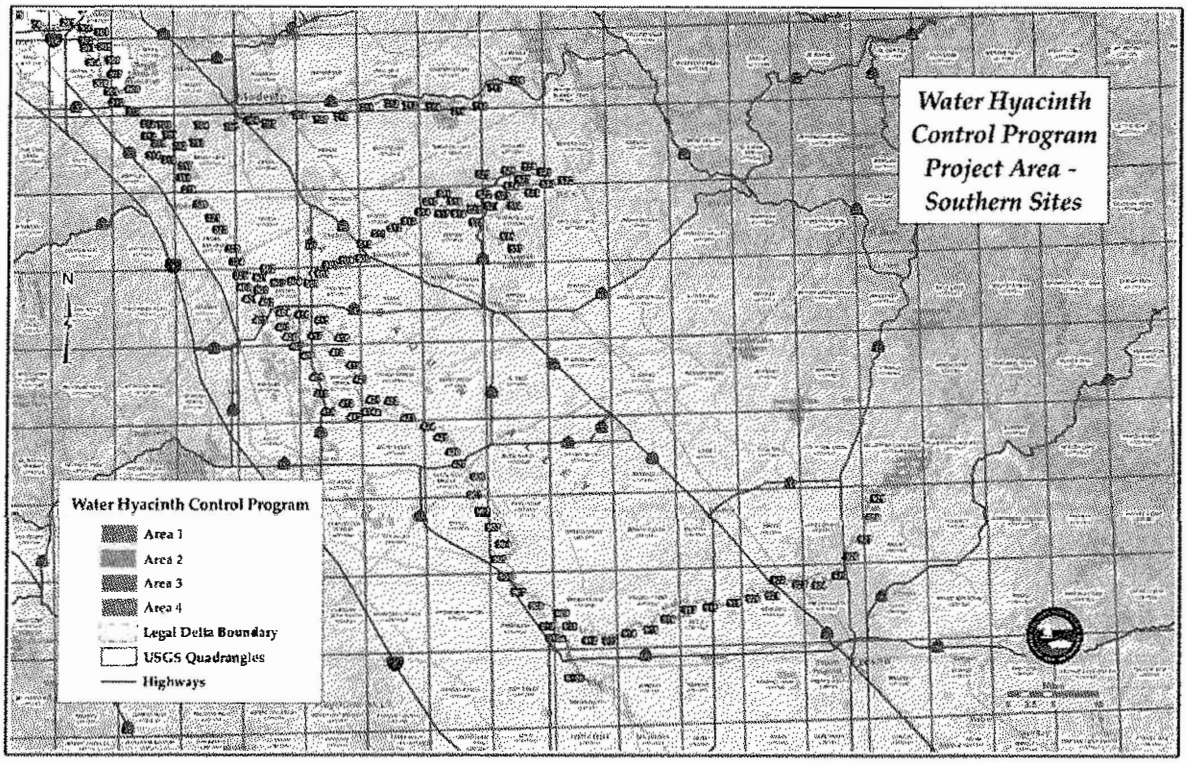


Figure 2: WHCP Project – Treatment Area: a portion of #3 and #4



In any given year, WHCP will treat only a portion of the total treatment sites. Table 1 below provides the acres treated over 29 years of the WHCP. The highest treatment area was 2,770 acres in 2004 and the lowest was 166 acres in 1985, accounting for 4.1% and 0.2%, respectively, of the total waterway area (~67,800 acres) including the Delta and the San Joaquin River basin. In 2013, CDBW may treat up to 5,000 acres of water hyacinth mats within the 350 treatment sites. From years 2014 to 2017 CDBW may treat up to 3,500 acres of water hyacinth mats within the 350 treatment sites. However, the action area is expected to encompass a greater area than the actual treatment area due to water movement resulting from flow and tidal influences.

Multiple treatments within a treatment site may be necessary because many sites in the Delta cannot be treated during the ideal early growth phase due to the potential presence of listed fish species. In addition, some larger sites may have more water hyacinth than can be treated at one time in order to reduce DO (DO) impacts. These sites will be treated in more than one application.

Table 1: Treatment area from 1983 to 2011

Year	Treatment area (acre)	Year	Treatment area (acre)
1983	507	1998	2,434
1984	244	1999	521
1985	166	2000	-
1986	227	2001	1,013
1987	384	2002	1,854
1988	633	2003	2,222
1989	849	2004	2,770
1990	699	2005	2,208
1991	350	2006	2,446
1992	798	2007	1,137
1993	1,506	2008	421
1994	2,743	2009	705
1995	1,826	2010	1,024
1996	2,051	2011	787
1997	1,907		

Project Activities

Prior to the start of each treatment season, CDBW will conduct environmental awareness training for all field crew members. The training includes: species identification and impact avoidance guidelines; protocol for identification and protection of valley elderberry shrubs; protocol for identification and protection of delta smelt, Chinook salmon, steelhead, green sturgeon, and associated protected habitats; and protocol for take of protected species, if any. In addition, field crew members also will be trained on use and calibration of spray equipment and the WHCP Operations Management Plan.

The WHCP will implement pre- and post-season surveys to identify locations and coverage of water hyacinth, and supplement these formal surveys with mid-season evaluations of water hyacinth coverage. Starting in February, and again in October and November, field crews will conduct visual surveys of all treatment sites. For each site, crews will record the extent of water hyacinth coverage (acres and percent coverage), and status of water hyacinth at the site.

In the February survey, field crews will identify problem areas such as those with the greatest impact on navigation, public safety, nursery areas, and sites close to pumps or other structures in the southern-most portion of the northern sites as well as the southern sites. Treatment crews will also identify crops adjacent to treatment sites in order to help select the appropriate herbicide for treatment. Crews will validate field survey information with data from the prioritization process and note any changes. This survey information will be used to help prioritize treatment locations at the start of the treatment season, and to measure efficacy of water hyacinth treatments at the end of the season. Following the prioritization and site selection, USDA-ARS and CDBW will identify likely treatment sites and acres prior to each treatment season and will provide a list of these sites to the Service. Based on the extent of water hyacinth infestation, only a portion of any given site may be treated to comply with herbicide label requirements.

During the treatment season, as crews are working throughout the Delta, they will continue to monitor and record water hyacinth coverage by site. This ongoing survey will assist the management team in identifying mid-season adjustments to prioritizing treatment sites and determining treatment effectiveness.

Each year USDA and CDBW will prepare an annual report for the WHCP and submit it to the Service. This annual report will summarize infestation levels, treatment acreage and types, amount of herbicide use, materials and methods, water quality monitoring results (including herbicide concentration and dissolved oxygen (DO), and daily treatment logs.

Chemical Treatment

The WHCP proposes to use four herbicides 2,4-D, glyphosate, penoxulam, and imazamox to control water hyacinth. All herbicides will be applied with an adjuvant, either Agridex or Competitor. Two of these herbicides, 2,4-D and glyphosate, have been used since the inception of the WHCP. Penoxulum and imazamox are new to the WHCP and have received approval from the

United States Environmental Protection Agency (USEPA). Treatment timelines and Areas proposed for each of the herbicides and adjuvants can be found in the *Conservation Measures* The utilization of additional herbicides on the treatment of water hyacinth reduces the potential for target species to develop resistance. While there are no indications of water hyacinth resistance to date, some terrestrial species of weeds have developed resistance to glyphosate (Powles 2008) or acetolactate synthase (ALS) inhibitors (Wisconsin Department of Natural Resources 2012). Resistance is an important consideration in use of any herbicide over a long period of time. In terrestrial applications, some plants have become resistant to glyphosate or the ALS inhibitors after many (over ten) years of use. Resistance is not necessarily the same across terrestrial and aquatic plants, and generally is species specific. However, because WHCP is a long-term control program, it will be prudent to increase the portfolio of herbicide active ingredients and of non-herbicide treatment options in order to reduce the potential for resistance. Rotating treatments after several years among herbicides with different modes of action reduces the potential for a plant to develop resistance. USDA-ARS, WHCP environmental scientists and Pest Control Advisors will evaluate water hyacinth response to program herbicides over time to identify potential resistance problems.

Crews will conduct treatments with hand-held sprayers applied from aluminum airboats or aluminum outboard motor boats. The work boats will be equipped with direct metering of herbicides, adjuvants, and water pump systems. The crews will spray the chemical mixture directly onto the plants utilizing pump-driven hand-held spray nozzles. The pump will mix calibrated amounts of herbicide, adjuvant, and water. The WHCP will apply the chemicals at the herbicide label-specified rates. Treatment crews will follow specific requirements, as described, to account for wind, DO, drinking water intakes, agricultural intakes, and total acres treated. Treatment crews will follow all label requirements, and implement the new Fish Passage Protocol (to ensure that migratory fish are not impacted by the WHCP).

WHCP will only treat those sites that have water hyacinth infestations, treating only the water hyacinth plants within those sites. WHCP may also be limited by time and resource constraints. Within a given treatment location, WHCP will treat according to current herbicide label requirements to limit potential for decaying plants to result in low DO levels.

Treatment sites within the Delta range from 6.5 acres to 1,707 acres in size, with an average of 219 acres. Thus, there may be several different water hyacinth infestations spread out within a site that require treatment. In these cases, WHCP will treat all water hyacinth mats in the site as time and resources allow. Repeat treatments may utilize a different herbicide, depending on conditions at the site.

When determining whether a given mat of water hyacinth will be treated again, WHCP crews will utilize the following guidelines:

1) Only one treatment will occur if after the herbicide has had time to take effect, the initial treatment was effective in killing the majority of water hyacinth plants at that site.

2) A second treatment will occur if buffer strips for fish passage were left untreated. In this case, CBDW will return to treat the remainder of the site (new or previously untreated plants) after the specified time between treatments (per herbicide requirements).

3) A second treatment of previously treated water hyacinth will occur if the first treatment was not effective in killing the plants. In this case, CDBW will not conduct the second treatment until the specified time period, per label directions.

4) The actual number of locations and numbered treatment sites that will be treated more than once depends on factors such as herbicide efficiency, growth of the water hyacinth plants and tidal movement that cannot be easily predicted. WHCP will seek to minimize the number of times that a given water hyacinth mat will be treated and will follow herbicide labels regarding total number of applications allowed.

Daily treatments occur Monday through Thursday when weather, wind-speed, and other environmental conditions are favorable for treatment to be maximized. On any given treatment day, treatment acres per day are limited by: (1) the number of crews available; (2) travel time to reach the site; (3) time required to set-up, conduct monitoring, and treat a site; (4) the amount of water hyacinth growing at a particular site; (5) the herbicide label restrictions; (6) fish passage protocols; and (7) weather and tide conditions. The crew can treat, on average, between 5 and 16 acres based on historical data from 2007 through 2011.

Herbicides used in WHCP

2,4-D

2,4-D is a systemic herbicide specific to broadleaf plants. The active ingredient in this phenoxy herbicide is 2, 4-Dichlorophenoxyacetic acid dimethylamine salt. 2,4-D is soluble in water and chemically stable. 2,4-D is absorbed through the leaves and takes approximately four to six hours to enter the phloem of the plant where it mimics plant regulating hormones leading to abnormal growth patterns and death of the plant. 2,4-D has a relatively short half-life and is rather immobile in the soil. Breakdown in soil and groundwater: 2, 4-D has low soil persistence. The half-life in soil is less than 7 days (Wauchope *et al.* 1992). Soil microbes are primarily responsible for its disappearance (Howard 1991). Despite its short half-life in soil and in aquatic environments, the compound has been detected in groundwater supplies in at least five States and in Canada (Howard 1991). Monitoring data indicates that concentrations of 2,4-D have been detected in ground, surface, and finished drinking water (EPA 2005).

Decomposition of herbicides in water depends on a number of characteristics, including: water quality, sediments in the water, temperature, and chemical properties of the herbicide. A review of 34 research papers concerning the persistence of 2,4-D in water under both laboratory and field conditions concluded that (1) under laboratory conditions, 2,4-D in water decomposed in periods of hours to days; and (2) under some warm water field conditions, 2,4-D has consistently been

shown to be reduced to non-detectable levels in closed water bodies in approximately one month; and (3) persistence of 2,4-D at extremely low levels may be encouraged by water movements in lakes, reservoirs, and streams (Gren 1983).

The chemical 2,4-D breaks down due to photodecomposition or by algal or bacterial decomposition (ESA/Madrone 1984). The aqueous half-life of 2,4-D (time in which one-half of the material is degraded) in a set of pools was 10 to 11 days. In a study with natural waters, 2,4-D half-life ranged from 0.5 to 6.6 days (HSDB 2001). Walters (1999) reported an aqueous photolysis half-life for 2,4-D, at 25C, of 13.0 days, and an aqueous aerobic half-life of 15.0 days. Breakdown in water: In aquatic environments, microorganisms readily degrade 2, 4-D. Rates of breakdown increase with increased nutrients, sediment load, and dissolved organic carbon. Under oxygenated conditions the half-life is one to several weeks (Howard 1991).

For treating water hyacinth, 2, 4-D will applied at a rate of between two and four quarts per acre, per label specifications. This is equivalent to 1.9 to 3.8 pounds of active ingredient per acre. It will be applied using a broadcast spray method.

For the majority of sites treated with 2,4-D, it will be preferable to conduct spot treatments directly onto water hyacinth leaves. For sites that are heavily vegetated, buffer strips will be created and another treatment will occur, if needed, after the treated vegetation has decayed. Treatment crews may return to a site to spray locations within a site that were not previously treated, or to retreat regrowth in previously treated plants only after plants killed in the initial treatment have decayed or floated away, no sooner than 21 days.

Glyphosate

Glyphosate is a broad spectrum, non-selective, systemic herbicide. The active ingredient is glyphosate isopropylamine salt. It is water soluble and mixes readily with water and non-ionic surfactants. Glyphosate moves through the plant from the foliage to the root system. Glyphosate prevents the synthesis of certain amino acids essential for plant survival. Visible effects on the plant occur within 3 or more weeks and include gradual wilting and yellowing of the plant, advancing to complete browning.

Glyphosate is moderately persistent in soil, with an estimated average half-life of 47 days (Weed Science Society 1994; Wauchope *et al.* 1992). Reported field half-life range from 1 to 174 days (Wauchope *et al.* 1992). It is strongly adsorbed to most soils, even those with lower organic and clay content (Wauchope *et al.* 1992 and Weed Science Society 1994). Thus, even though it is highly soluble in water, field and laboratory studies show it does not leach appreciably, and has low potential for runoff (except as adsorbed to colloidal matter) (Wauchope *et al.* 1992). One estimate indicated that less than 2 percent of the applied chemical is lost to runoff (Malik *et al.* 1989). Microbes are primarily responsible for the breakdown of the product, and volatilization or photodegradation losses will be negligible (Weed Science Society 1994).

Breakdown in water: In water, glyphosate is strongly adsorbed to suspended organic and mineral matter and is broken down primarily by microorganisms (Schuette 1998). Its half-life in pond water ranges from 35 to 63 days (Schuette 1999).

Breakdown in vegetation: Glyphosate may be translocated throughout the plant, including to the roots. It is extensively metabolized by some plants, while remaining intact in others (Kidd and James 1991).

For treating water hyacinth, glyphosate will be applied at a rate of three quarts per acre, per label requirements. This will be equivalent to 3 pounds active ingredient per acre. Glyphosate will be applied via a broadcast sprayer. The majority of the sites treated with glyphosate will be spot treatments. For the sites that are heavily vegetated, buffer strips will be created, and another treatment will occur, if needed.

The herbicide label requirements for glyphosate have no restrictions for use of treated water for irrigation, recreation, or domestic purposes. The herbicide label specifies that glyphosate is not to be applied within 0.5 miles of an active potable water intake; or intakes must be turned off for a minimum of 48 hours after the application, or until glyphosate concentrations are less than 0.7 ppm. When treating large infestations, the label recommends treating the area in strips to avoid oxygen depletion

Penoxsulam

Penoxsulam (2-(2,2-difluoroethoxy)-N-(5,8-dimethoxyl[1,2,4] triazolo [1,5-c] pyrimidin-2-yl)-6-trifluoromethyl)benzenesulfonamide) received USEPA approval through the reduced risk program for use on aquatic weeds from the USEPA in 2007 and from the California DPR in 2009. Penoxsulam was initially approved for use on rice crops by USEPA in 2004. Penoxsulam is a broad spectrum systemic herbicide in the triazolopyrimidine sulfonamide family. This herbicide inhibits the enzyme acetolactate synthase (ALS), which regulates the production of three essential amino acids: valine, leucine, and isoleucine (Washington DOE 2012).
ALS inhibitors such as penoxsulam slowly starve plants of these amino acids, eventually killing the plants by halting DNA synthesis. These biochemical pathways are not present in animals. Plants absorb penoxsulam through leaves, shoots, and roots. The herbicide affects new growth more rapidly than older plant tissue. Symptoms following treatment with penoxsulam include immediate growth inhibition, a chlorotic growing point with reddening, and slow plant death over a period of 60 to 120 days (Washington DOE 2012). Madsen and Wersal (2008) found that four weeks after treatment with 1.4 oz/acre, up to the maximum rate of 5.6 oz/acre, penoxsulam (with a surfactant) provided 95 percent control of water hyacinth in 100-gallon outdoor tanks. Langeland et al. (2009) identified penoxsulam as providing excellent control for water hyacinth in Florida.

Penoxsulam has low to moderate water solubility, and is very mobile in soil. The organic carbon sorption coefficient, Koc, of penoxsulam is between 13 and 305 in soil (indicating weak adsorption), with higher adsorption in sediment, Koc = 1,130 (USEPA 2007). Penoxsulam

follows two complex degradation pathways, and degrades into eleven major and two minor degradates, listed in Table 3-10, on the next page (USEPA 2007). None of these metabolites or degradates have been identified as having a higher toxicity potential than penoxsulam (Washington DOE 2012).

There was some concern in the first review of penoxsulam (USEPA 2004) that some of the major degradates of penoxsulam might pose phytoxicity concerns; however, additional testing found no observable injury by the eleven metabolites to pre-emergent seeds, and that only two caused injury to seedlings at high-levels (USEPA 2007).

In water, penoxsulam breaks down primarily by photolysis, with some microbial degradation. Water depth, water clarity, plant density, and season of application can influence photolytic degradation. Penoxsulam breaks down faster in higher water clarity and lower plant density. The water solubility of penoxsulam increases in more alkaline conditions. The half-life of penoxsulam in water ranges from 1.5 to 14 days (USEPA 2007). The total system half-life of penoxsulam is 16 to 38 days (Washington DOE 2012). In sediment, penoxsulam is expected to degrade rapidly through anaerobic degradation (USEPA 2007). Penoxsulam is adsorbed by soil and has low to moderate leaching potential in most soil types, where it is broken down by microbial degradation (The Dow Chemical Company 2008). However, California DPR has identified penoxsulam (along with many other herbicides including 2,4-D and glyphosate) as having the potential to pollute ground water. Penoxsulam has low vapor pressure, and will not dissipate by volatization.

For treating water hyacinth, penoxsulam will be applied at between 2.0 to 5.6 ounces per acre, per label requirements, with higher rates for denser plants and plants not at their peak growing phase. This will be equivalent to between 0.03125 and 0.0875 pounds of active ingredient per acre. Penoxsulam will be applied with a surfactant (at concentrations on the surfactant label), with a spray volume in accordance to label specifications.

There are no label restrictions for penoxsulam regarding DO, as the slow-acting nature of this herbicide should have minimal impact on DO levels (Washington DOE 2012). However, WHCP will maintain existing monitoring measures related to DO to evaluate potential reductions in DO.

Waters treated with penoxsulam will not to be used for food crop irrigation until concentrations are determined to be equal to, or less than, 1 ppb. Water samples will be collected using Enzyme-Linked Immunoassay (ELISA) or other approved analytical methods. There are no restrictions on consumption of treated water for potable use or by livestock, pets, or other animals, and no restrictions on the use of treated water for recreational use, including swimming and fishing. Penoxsulam will be used with a surfactant, and applied with a course high flow spray nozzle to avoid drift. Penoxsulam will not be applied when wind speeds are below 2 mph, or above 10 mph.

Imazamox

Imazamox is a relatively new aquatic herbicide active ingredient. The chemical structure of imazamox is illustrated in Figure 3-12, left. The aquatic formulation of imazamox, Clearcast®, received USEPA approval through the reduced risk program in 2008 (SERA 2010). The WHCP will initially utilize this imazamox active ingredient product.

CDPR approved imazamox for aquatic use in August, 2012. Imazamox was approved for terrestrial use by the USEPA in 1997, and by the California DPR, in 2002. Clearcast consists of 12.1 percent solution of the ammonium salt of imazamox (2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl]-5-(methyoxymethyl)-3-pyridinecarboxylic acid). It is in the imidazolinone herbicide family, along with imazapyr. The mode of action is similar to penoxsulam and imazapyr, inhibiting the acetolactate synthase (ALS) enzyme, blocking the synthesis of three essential amino acids, leucine, isoleucine, and valine (Washington DOE 2012). Imazamox is a relatively fast-acting systemic herbicide. It is rapidly absorbed into the foliage and translocated throughout the plant by phloem and xylem tissues (Washington DOE 2012).

Imazamox inhibits plant growth within the first 24 hours, with visual symptoms appearing about one week after treatment. Symptoms include yellowing leaves and general discoloration. Water hyacinth plants are dead within six weeks after treatment (Burns 2009). In one greenhouse study, Clearcast was more effective at controlling water hyacinth within five weeks (94 percent control) than Habitat® (imazapyr) (79 percent control), but slightly less effective than glyphosate (99 percent control). However, Clearcast and Habitat required less than 25 percent as much active ingredient as glyphosate treatment (Emerine et al. 2010). Langeland et al. (2009) identify imazamox as excellent in controlling water hyacinth in Florida.

Imazamox is highly soluble in water, and is mobile to highly mobile in soil (Washington DOE 2012; USEPA 2008). The organic carbon sorption coefficient, K_{oc}, of imazamox is between 5 and 143 (indicating weak adsorption). Volatization of imazamox is not significant (USEPA 1997). Imazamox has a low potential for bioaccumulation (Washington DOE 2012).

The primary method of degradation of imazamox in surface water is photolytic (Washington DOE 2012). Photolytic degradation is influenced by water depth, water clarity, and season, and continues via microbial action to carbon dioxide. The half-life in water ranges from five to fifteen days (Washington DOE 2012). CDPR identified imazamox as having the potential to pollute groundwater due to its high water solubility; however, in well-lit waters, imazamox breaks down quickly (Washington DOE 2012). US EPA concluded that even if imazamox persists in dark or turbid waters it is unlikely to present a risk to fish, invertebrates, birds, or mammals (Washington DOE 2012).

Imazamox is moderately persistent in soil, degrading aerobically to a non-herbicidal metabolite which is immobile or moderately mobile in soil (USEPA 1997). The primary metabolite is a demethylated parent chemical with intact ring structures and two carboxylic acid groups. A secondary metabolite is a demethylated, decarboxylated parent with intact rings and one

carboxylic acid group (USEPA 2008). Leaching of imazamox in field studies was very limited, and microbial breakdown products under aerobic soil conditions are not herbicidal. The range of half-lives in terrestrial field dissipation studies was fifteen to 130 days, with typical half-lives ranging from 35 to 50 days (USEPA 1997; USEPA 2008). Imazamox is unlikely to accumulate in sediments.

For treating water hyacinth, imazamox will be applied at a rate of 16 to 64 ounces per acre, per label requirements. This is equivalent to 0.125 to 0.5 pounds active ingredient per acre. Imazamox is most effective when applied to actively growing plants. Imazamox will be applied with an adjuvant at rate of one quart per 100 gallons of solution.

There are no label restrictions regarding DO; however, CDBW will follow the same monitoring approaches as for other herbicides to evaluate potential for low DO levels to impact endangered species. Waters treated with imazamox will not be used for irrigation until concentrations are less than 50 ppb. The label requires a 24 hour period after treatment to irrigate from still and quiescent waters. There are no wait restrictions for irrigation when imazamox is applied to flowing waters at a rate of less than or equal to 4 quarts (64 ounces) per acre to waters with an average depth of at least four feet. There are no restrictions on livestock watering, swimming, fishing, domestic use, or use of treated water for agricultural sprays (SePRO 2010). To reduce drift, imazamox will be used with a surfactant, and applied in a course spray with the nozzle height at approximately no more than four feet above the plant canopy. Imazamox will not to be applied in a temperature inversion, or when wind speeds are less than 2 miles per hour or greater than 10 miles per hour.

As imazamox will be a new WHCP herbicide, there are no prior test data regarding actual herbicide concentrations following water hyacinth treatment. The WHCP will conduct monitoring at the initial imazamox treatment sites to develop a baseline for expected herbicide concentrations in treatment sites and receiving waters following treatment.

Adjuvant used in the WHCP

The WHCP will utilize adjuvants with herbicides to ensure contact and translocation of herbicides. The WHCP will not utilize polyethoxylated tallow amine (POEA) surfactants, which are known to be toxic to amphibians, or nonylphenoloethoxylate (NPE) surfactants, which are known to be toxic to fish and some invertebrates. The WHCP will utilize two adjuvants. Agridex®, a crop oil concentrate adjuvant, has been used for several years by WHCP. Competitor®, a vegetable oil based adjuvant, will be incorporated into WHCP.

Agri-dex

Agri-dex (the active ingredients are Paraffin Base Petroleum Oil/Polyoxyethylate Polyol Fatty Acid Esters) is a non-ionic blend of surfactants and spray oil that is designed for use with a broad range of pesticides where oil concentrate adjuvant is recommended. Agri-Dex® improves pesticide application by modifying the wetting and deposition characteristics of the spray

solution, resulting in a more even and uniform spray deposit. It will be used with all three herbicides at a rate of approximately one to four pints per 100 gallons.

Competitor

Competitor is a modified vegetable oil containing a non-ionic emulsifier system. It may be used as an adjuvant with aquatically labeled pesticides. The active ingredients in Competitor are ethyl oleate, sorbitan alkylpolyethoxylate ester, and dialkyl polyoxyethylene glycol. These ingredients make up 98 percent by weight, with the remaining 2 percent constituents that are ineffective as spray adjuvant. Competitor will be used at a rate of one to four pints per acre (to a maximum of 1 percent volume/ volume ratio).

Mechanical Control Methods

Handpicking

Hand-picking of water hyacinth will be conducted primarily when or where chemical treatment cannot be made, and may occur throughout the year. As treatment crews survey for water hyacinth, they will conduct hand-picking in selected areas. The goals of the hand-picking aspect of the program are to aid in the control of water hyacinth and reduce impacts of chemical application by clearing areas that are not accessible to chemical treatment, subject to high infestation, nurseries, and within emergent vegetation. Crews will follow specific hand-picking protocols to ensure the protection of water quality and special status species. Reflecting a typical season of hand-picking, between October 15, 2007, and April 1, 2008, treatment crews collected over 4,000 thirty-gallon barrels of water hyacinth. Once collected, water hyacinth will be deposited on at authorized disposal sites, to decompose.

Herding

Herding refers to the moving of water hyacinth mats by pushing or pulling mats from one location to another. Mats will be moved to removal locations or to the main channel. Once in a main channel, the water hyacinth will flow out of the Delta, into saline waters and die. Water hyacinth cannot survive in waters of greater than 2 ppt to 2.5 ppt saline water (brackish water).

For herding water hyacinth out of the Delta, field supervisors will take into account tides, storm events, and dam releases to select appropriate days and times for herding to take place. Crews will not herd in areas where physical damage to emergent, native vegetation is likely to occur such as among stands of cattails (*Typha* spp.), *Phragmites* spp., bulrushes (*Scirpus* spp.), or native cordgrass (*Spartina foliosa*). In addition, the total amount of water hyacinth herded in one area will be limited to avoid impeding navigation. Due to timing and logistical limitations of herding activities, this method may not be used as frequently as handpicking.

Mechanical Removal

The WHCP will utilize two different mechanical removal approaches. The first approach will be to park a small excavator and dump truck on a concrete boat ramp and mechanically lift water hyacinth from the waterway surrounding the ramp. Crews will support the excavation by herding water hyacinth that is outside of the excavator's reach closer to the equipment. This mechanical removal approach will be used only in limited locations when water hyacinth growth is concentrated near a boat ramp. There may be relatively few locations within the Delta that are appropriate for excavation.

The second approach will utilize mechanical equipment designed specifically to safely remove aquatic weeds from waterways. This mechanical equipment utilizes cutters and conveyors to physically remove the plant from the water, and onto the bed of the equipment. The equipment will collect and unload vegetation using a conveyor system on a boom, adjustable to the appropriate cutting height (two to three feet below the surface for water hyacinth). Cutter bars will collect material and bring it aboard the vessel using the conveyor; when the vessel has reached capacity (between 2,000 and 15,000 pounds of plant material), the cut plant material will be offloaded to a dump truck parked at a nearby boat ramp to offload water hyacinth. Water hyacinth will be disposed of at an authorized location, typically utilizing nearby farm fields. Mechanical removal can be costly, it will be used to supplement chemical treatment and when immediate removal of weeds is required. Mechanical removal will primarily be utilized to remove dense mats of water hyacinth in locations where chemical treatment must be avoided, such as sites with many valley elderberry shrubs along the shoreline. WHCP environmental scientists will consult the IEP database and survey mechanical removal sites immediately prior to weed removal to ensure that no listed species are present. If listed species are present, mechanical removal operations at that site will be postponed. Similar mechanical equipment is regularly used to control water hyacinth in Florida and other Southeastern states.

The WHCP will implement an operation protocol similar to the protocol for chemical treatment prior to conducting mechanical removal. WHCP environmental scientists will check IEP monitoring data to ensure that salmon species are not present at the removal site. In addition, the equipment operator will utilize the same Environmental Checklist to evaluate presence of listed species or sensitive habitats. If listed species or sensitive habitats are present, the operator will not conduct mechanical removal at that site.

The WHCP has not utilized this method of mechanical removal in prior years. Studies of mechanical removal conducted during 2003 and 2004 in the Delta by the San Francisco Estuary Institute (SFEI) (Greenfield et al 2007; Spencer at al 2005; Greenfield and McNabb, 2005) raised concerns about the potential for water hyacinth plant cuttings from mechanical removal to grow and spread within the Delta.

WHCP Monitoring Program

The CDBW, with assistance from USDA-ARS and California Department of Food and Agriculture (CDFA), conducts extensive monitoring for the WHCP. The WHCP will conduct extensive monitoring for the program. The WHCP will be responsible for collecting water quality monitoring data, as well as collecting water samples for chemical residue testing.

Based on NPDES permit requirements, WHCP will follow a monitoring protocol. This protocol has historically fulfilled requirements of the Regional Water Quality Control Board, NOAA Fisheries, and USFWS. At each monitoring site, WHCP's environmental scientists will take samples immediately pre-application (upstream and adjacent to the water hyacinth mat), and immediately post-application (downstream of the treatment area). WHCP environmental scientists will also take samples one week following treatment (upstream, adjacent to, and downstream of the treatment area).

At each sampling event, environmental scientists will take samples from the following six locations:

1) Pre-treatment, in site
2) Pre-treatment, control
3) Immediately post-treatment, downstream
4) Within 7 days, in site
5) Within 7 days, downstream
6) Within 7 days, control

The WHCP will select monitoring sites that reflect a mix of water types (tidal, riverine, and tidal dead-end), herbicides, and different habitat types. The WHCP will revise the monitoring approach to comply with the new NPDES General Permit, as described below.

At each monitoring site, WHCP environmental scientists will monitor DO, turbidity, pH, and several other water quality measures. WHCP environmental scientists will collect water in bottles, packed in ice, and submit them to a Certified Analytical Laboratory to measure chemical residue levels.

Coordination between treatment crews and monitoring crews will be very structured. Treatment and monitoring plans will be established in advance. Before any treatment or monitoring, crews will confer to make sure both crews know what sites will be treated and monitored on that day. The treatment crew will stand by until the monitoring crew completes the pre-treatment sampling, at which time the monitoring crew will give the treatment crew the "all clear" to begin treatment. The treatment crew will contact the monitoring crew as soon as treatment is complete so post-treatment monitoring can begin as required. Treatment and monitoring crews will be in separate vessels. Monitoring vessels will not carry herbicide to minimize any contamination that might occur.

Environmental scientists plan to also conduct special monitoring of DO to determine the impact of water hyacinth and the WHCP on DO levels. For this study, crews will measure DO to evaluate the impact of water hyacinth and water hyacinth treatments on DO.
WHCP treatment crews will conduct daily monitoring, in addition to the extensive monitoring to be conducted by WHCP environmental scientists. Treatment crews will monitor and report pre- and post-treatment DO, wind speed, temperature, acres treated, quantity of herbicide and adjuvant, presence of elderberry shrubs or other species of concern, and coordinates of treatment location. The table below lists monitoring requirements for WHCP environmental scientists and WHCP treatment crews.

Table 2: WHCP Environmental Monitoring Requirements

Treatment Crews (for each site treated)	Environmental Scientists (for each sample event)
1. Water temperature (°C) 2. Dissolved oxygen (DO, mg/L or parts per million (ppm)) 3. Wind speed (mph) 4. Coordinates of treatment location 5. Presence of elderberry shrubs 6. Presence of species of concern 7. Acres treated 8. Quantity of herbicide and adjuvant	1. Water temperature (°C) 2. Dissolved oxygen (DO, mg/L or ppm) 3. Turbidity (NTU) 4. pH 5. Salinity (ppt) 6. Specific conductance (mS/cm) 7. Water depth (feet) 8. Tide cycle 9. Water samples (pre-treatment, post-treatment, control; submitted to a Certified Analytical Laboratory)

The State Water Quality Control Board is updating the NPDES General Permit, with a draft for public comment released on June 27, 2012, and a final version for Board approval expected in spring 2013. A copy of the draft NPDES General Permit is provided in the BA Binder. The new General Permit requires a sampling frequency of six application events per year for each environmental setting (flowing water and non-flowing water), per herbicide. Glyphosate will require sampling for only one application event per year, based on the low herbicide levels found in prior year sampling.

Once WHCP has provided the SWRCB with results from six consecutive application events showing concentrations that are less than the receiving water limitation/trigger for an active ingredient in a specific environmental setting, WHCP sampling shall be reduced to one application event per year for that active ingredient in that environmental setting. The Table above, provides the receiving water limits and monitoring triggers for the four potential WHCP herbicides. These maximum limitations are all above the calculated maximum concentrations for 2,4-D, glyphosate, penoxsulam, and imazamox and can be found in Appendix 1.

Conservation Measures

The CDBW proposes that this action may result in incidental take of delta smelt. Additionally, GGS and VELB, federally listed species, occur within the project area. The Service has determined GGS and VELB may be affected, but are not likely to be adversely affected by the project based on avoidance measures and the applicant's proposed conservation measures for GGS and VELB, which have been included below. CDBW proposes the following conservation measures be implemented into the project:

1) Personnel involved with the WHCP will participate in a worker environmental awareness program taught by a Service-approved biologist. Under this program, workers will be informed about the presence of delta smelt, GGS, VELB, and its associated habitat, and that unlawful take of the animal or destruction of its habitat is a violation of the Act. Prior to chemical application activities, a qualified biologist approved by the Service will instruct all personnel about:

    a. Species identification and adverse effect avoidance/minimization guidelines for delta smelt, GGS, and VELB;

    b. The life history of the delta smelt, GGS and VELB;

    c. The importance of delta smelt migratory routes, the importance of irrigation canals, marshes/wetlands, and seasonally flooded areas to GGS, the importance of elderberry shrubs as habitat for VELB and maps marking these areas will be created for WHCP personnel; and

    d. All terms and conditions of this biological opinion for protection, avoidance and minimization of adverse effects to protected species under the Act.

2) All herbicide applications will be made according to registered pesticide label specifications, California code of regulations, and NPDES guidelines.

3) Herbicide application near special status species and their associated habitat to include sensitive riparian and wetland habitat; and other biologically important resources will be avoided.

4) All treatment crews will implement best management practices to minimize the risk of spilling herbicides.

CDBW proposes the following avoidance and minimization measures to reduce possible effects to delta smelt and its critical habitat in the project areas:

1) USDA-ARS and CDBW will conduct a DO monitoring study to evaluate the ongoing impacts of water hyacinth and water hyacinth treatment on DO. During the 2013 treatment season, USDA-ARS and CDBW will place stationary logging DO meters at up to three pair locations (under a water hyacinth mat and at an adjacent open water site). Meters will be left in place for several weeks, including at least one week prior to treatment, and three weeks post-treatment. The DO meters will log DO and temperature every one-half hour during the entire period. Data will be summarized graphically and in a written report. The study will include, at a minimum, two sites with different characteristics, for example, one site in a dead-end slough, and one site with stronger tidal influence.

2) USDA-ARS will first coordinate with the Service to develop, and then implement a toxicological study plan relating to the effects of imazamox and penoxsulam on delta smelt, larvae, and eggs. The study will be approved by the Service and completed prior to the utilization of these herbicides in Areas 1 and 2.

3) Area 1 will be managed by the WHCP as follows:

    a. For WHCP treatment sites located in Area 1, the usage of the herbicides 2,4-D and Glyphosate, as well as the adjuvant Agri-dex, will be limited to the period between June 1 and November 30 to avoid and minimize adverse effects to delta smelt and/or their critical habitat.

4) Areas 2, 3, and 4 will be managed by the WHCP as follows:

    a. CDBW will begin conducting regular field surveys in late-February to identify re-growing water hyacinth (seen as re-greening of winter stunted plants). Surveys will focus on back-water and dead end locations and other known nursery areas. CDBW will document the locations and photograph the sites with areas of more than 100 square feet of re-growing water hyacinth.

    b. A CDBW environmental scientist will compare these surveyed locations to the most recent state and federal fish monitoring data.

    c. Between March 1 and July 1, A CDBW environmental scientist will prepare a weekly summary list for the Service's primary contact. If the Service has concerns or issue, the Service will contact DCBW. The information provided to the Service will include:

i. Site number(s), size of the water hyacinth mat, and map of potential early treatment sites

ii. Whether or not listed fish species are known to be present

d. For WHCP treatment sites located in Area 2, the usage of the herbicides 2,4-D and Glyphosate as well as the adjuvant Agri-dex will be limited, based on the above criteria, to the period between March 1 and November 30 to avoid and minimize effects to delta smelt and/or its critical habitat.

e. For WHCP treatment sites located in Area 3, the usage of the herbicides 2,4-D, Glyphosate, imazamox, and penoxsulam as well as the adjuvants Agri-dex and/or Competitor will be limited, based on the above criteria, to the period between March 1 and November 30 to avoid and minimize effects to delta smelt and/or its critical habitat.

f. For WHCP treatment sites located in Area 4, the usage of the herbicides 2,4-D, Glyphosate, imazamox, and penoxsulam as well as the adjuvants Agri-dex and/or Competitor will be limited, based on the above criteria, to the period between March 1 and November 30 to avoid and minimize effects to delta smelt and/or its critical habitat.

5) To provide a zone of passage through areas of low DO, the Fish Passage Protocol described below will be incorporated into WHCP operations:

a. In slow-moving and back-end sloughs infested with water hyacinth, CDBW will treat up to 30 percent of water hyacinth mats at one time. Mats will be treated in up to 3 acre strips, leaving at least 100 foot buffer strips between treated areas. The untreated buffer strips and remaining 70 percent of the water hyacinth mat will be treated at least three more times following the initial treatment (in 30 percent increments). Follow-up treatments will occur in three week intervals.

b. In Delta tidal waters, CDBW will treat up to 50 percent of the water hyacinth mat at one time. Mats will be treated in up to 3 acre strips, leaving at least 100 foot buffer strips between treated areas. The untreated buffer strips and remaining 50 percent of the mat will be treated three weeks following the initial treatment for 2,4-D treatments, and one week following initial treatment for other herbicides.

c. If DO levels in an area to be treated area at a level considered to be detrimental to fish species prior to treatment (below 3 mg/liter), the CDBW may treat the entire area (without the 3 area strips or buffer strips), therefore allowing the DO levels to increase to beneficial use levels once the water hyacinth is controlled.

d. For each treatment site and herbicide application, CDBW staff shall follow herbicide label requirements, as specified, to reduce the potential for low DO.

e. When follow-up herbicide applications of previously treated plants are required, CBDW staff shall follow herbicide label requirements, as specified, regarding the number of treatments and time between treatments.

6) The WHCP will operate under the regulations imposed by the NPDES. The WHCP will operate within the numeric limits of DO concentrations within the legal boundaries of the Delta, which are listed below:

a. 7.0 mg/l in the Sacramento River (below the I Street Bridge) and in all Delta waters west of the Antioch Bridge;

b. 6.0 mg/l in the San Joaquin river (between Turner Cut and Stockton), September 1 through November 30; and

c. 5.0 mg/l in all other Delta Waters.

CDBW proposes the following avoidance and minimization measures to reduce possible effects to GGS in the project areas:

1) Treatment crews will be provided electronic mapping tools that identify previously surveyed and sensitive areas for GGS.

2) Disturbance of upland GGS habitat will be conducted between May 1 and October 1. This is the "active season" for GGS and direct effects are lessened, because GGS are actively moving and avoiding danger.

3) Mechanical removal of water hyacinth in sensitive GGS habitat, or areas where GGS has been sighted in the past, will only be conducted outside of the May 1 and October 1 active GGS season.

4) The mechanical harvester will maintain a speed of 2 to 2 ½ knots in areas outside of sensitive GGS habitat, or areas where GGS has been sighted in the past, during the active season, making it likely if GGS were to be in the area, they would be able to move out of the way.

5) The mechanical harvester will stop and/or reverse the harvester if a snake is seen within water hyacinth during removal.

6) All water hyacinth collected by handpicking or mechanical removal outside of the active season (May 1- October 1) for GGS will be disposed of at an approved disposal facility to ensure no hibernating GGS are buried under piles of collected water hyacinth.

CDBW proposes the following avoidance and minimization measures to reduce possible effects to VELB in the project areas:

1) For most treatment sites, CDBW will maintain a 100 foot buffer between treatment sites and shoreline elderberry shrubs.

2) Currently numbered treatment sites with relatively large numbers of valley elderberry shrubs include: 10, 11, 46, 47, 48, 99, 234, 511, 529, 707, 708, and 710. At some of these sites, the 100 foot buffer requirement may preclude CDBW's ability to treat water hyacinth. In those cases, CDBW will utilize a 50 foot buffer between treatment sites and valley elderberry shrubs. However, when utilizing the 50 foot buffer, CDBW will only treat when winds are less than 3 mph. This will further minimize potential for drift.

3) All herbicide application will occur downwind of elderberry shrubs.

4) When utilizing the 100 foot buffer, no WHCP herbicide application will occur if the wind speed is greater than 10 mph, or 7 mph in Contra Costa County.

5) A coarse droplet size spray will be utilized to avoid the potential for drift.

6) Although it is unlikely that herbicide treatments will affect elderberry shrubs based on conservation measures implemented, pre- and post-treatment surveys of elderberry bushes will be conducted on an annual basis.

Status of the Species/Environmental Baseline

Delta Smelt

The Service proposed to list the delta smelt (*Hypomesus transpacificus*) as threatened with proposed critical habitat on October 3, 1991 (56 FR 50075). The Service listed the delta smelt as threatened on March 5, 1993 (58 FR 12854), and designated critical habitat for this species on December 19, 1994 (59 FR 65256). The delta smelt was one of eight fish species addressed in the *Recovery Plan for the Sacramento–San Joaquin Delta Native Fishes* (Service 1995). This recovery plan is currently under revision. A 5-year status review of the delta smelt was completed on March 31, 2004 (Service 2004). The 2004 review affirmed the need to retain the delta smelt as a threatened species. A 12-month finding on a petition to reclassify the delta smelt was completed on April 7, 2010 (75 FR 17667). After reviewing all available scientific and commercial information, the Service determined that re-classifying the delta smelt from a threatened to an endangered species was warranted but precluded by other higher priority listing actions (Service 2010).

Distribution

The delta smelt is endemic to the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta) in California, and is restricted to the area from San Pablo Bay upstream through the Delta in Contra Costa, Sacramento, San Joaquin, Solano, and Yolo counties (Moyle 2002). Their range extends from San Pablo Bay upstream to Verona on the Sacramento River and Mossdale on the San Joaquin River. The delta smelt was formerly considered to be one of the most common pelagic fish in the upper Sacramento-San Joaquin Estuary.

Description

Live delta smelt are nearly translucent with a steely-blue sheen to their sides and have been characterized to have a pronounced odor reminiscent of cucumber (Moyle 2002). Although delta smelt have been recorded to reach lengths of up to 120 mm (4.7 in) (Moyle 2002), mean fork length of the delta smelt from 1975 - 1991 was measured to be 64.1 ± 0.1 mm. Since then, catch data from 1992 - 2004 showed mean fork length decreased to 54.1 ± .01 mm (Bennett 2005; Sweetnam 1999). Delta smelt are also identifiable by their relatively large eye to head size. The eye can occupy approximately 25-30 percent of their head length (Moyle 2002). Delta smelt have a small, translucent adipose fin located between the dorsal and caudal fins. Occasionally one chromatophore (a small dark spot) may be found between the mandibles, but most often there is none (Moyle 2002).

Delta smelt are small slender bodied fish within the Osmeridae family of fishes (smelts) (Moyle 2002). The delta smelt is one of six species currently recognized in the *Hypomesus* genus (Bennett 2005). Genetic analyses have confirmed that *H. transpacificus* presently exists as a single intermixing population (Stanley et al. 1995; Trenham et al. 1998; Fisch et al. 2011). Within the genus, delta smelt is most closely related to surf smelt (*H. pretiosis*), a species

common along the western coast of North America. Despite morphological similarities, the delta smelt is less-closely related to the wakasagi (*H. nipponensis*), an anadromous western Pacific species introduced to Central Valley reservoirs in 1959, and may be seasonally sympatric with delta smelt in the estuary (Trenham et al. 1998). Allozyme studies have demonstrated that wakasagi and delta smelt are genetically distinct and presumably derived from different marine ancestors (Stanley et al. 1995). Genetic introgression among *H. transpacificus* and *H. nipponensis* is low.

Life History and Biology

Adults: Spawning

Adult delta smelt spawn during the late winter and spring months, with most spawning occurring during April through mid-May (Moyle 2002). Spawning occurs primarily in sloughs and shallow edge areas in the Delta. Delta smelt spawning has also been recorded in Suisun Marsh and the Napa River (Moyle 2002). Most spawning occurs at temperatures between 12-18°C. Although spawning may occur at temperatures up to 22°C, hatching success of the larvae is very low (Bennett 2005). Fecundity of females ranges from about 1,200 to 2,600 eggs, and is correlated with female size (Moyle 2002). Moyle et al. (1992) considered delta smelt fecundity to be "relatively low." However, based on Winemiller and Rose (1992), delta smelt fecundity is fairly high for a fish its size. In captivity, females survive after spawning and develop a second clutch of eggs (Mager et al. 2004); field collections of ovaries containing eggs of different size and stage indicate that this also occurs in the wild (Adib-Samii 2008). Captive delta smelt can spawn up to 4-5 times. While most adults do not survive to spawn a second season, a few (<5 percent) do (Moyle 2002; Bennett 2005). Those that do survive are typically larger (90-110 mm Standard Length [sdl]) females that may contribute disproportionately to the population's egg supply (Moyle 2002 and references therein). Two-year-old females may have 3-6 times as many ova as first year spawners.

Most of what is known about delta smelt spawning habitat in the wild is inferred from the location of spent females and young larvae captured in the California Department of Fish and Game Spring Kodiak Trawl (SKT) and 20-mm survey, respectively. In the laboratory, delta smelt spawned at night (Baskerville-Bridges et al. 2000; Mager et al. 2004). Other smelts, including marine beach spawning species and estuarine populations and the landlocked Lake Washington longfin smelt, are secretive spawners, entering spawning areas during the night and leaving before dawn. If this behavior is exhibited by delta smelt, then delta smelt distribution based on the SKT, which is conducted during daylight hours in offshore habitats, may reflect general regions of spawning activity, but not actual spawning sites.

Delta smelt spawning has only been directly observed in the laboratory and eggs have not been found in the wild. Consequently, what is known about the mechanics of delta smelt spawning is derived from laboratory observations and observations of related smelt species. Delta smelt eggs are 1 mm diameter and are adhesive and negatively buoyant (Moyle 1976, 2002; Mager et al. 2004; Wang 1986, 2007). Laboratory observations indicate that delta smelt are broadcast

spawners, discharging eggs and milt close to the bottom over substrates of sand and/or pebble in current (DWR and Reclamation 1994; Brown and Kimmerer 2002; Lindberg et al. 2003; Wang 2007). Spawning over gravel or sand can also aid in the oxygenation of delta smelt eggs. Eggs that may have been laid in silt or muddy substrates might get buried or smothered, preventing their oxygenation from water flow (Lindberg pers. comm. 2011). The eggs of surf smelts and other beach spawning smelts adhere to sand particles, which keeps them negatively buoyant but not immobile, as the sand may move ("tumble") with water currents and turbulence (Hay 2007). It is not known whether delta smelt eggs "tumble incubate" in the wild, but tumbling of eggs may moderately disperse them, which might reduce predation risk within a localized area.

The locations in the Delta where newly hatched larvae are present, most likely indicates spawning occurrence. The 20-mm trawl has captured small (~5 mm sdl) larvae in Cache Slough, the lower Sacramento River, San Joaquin River, and at the confluence of these two rivers (e.g., 20-mm trawl survey 1 in 2005). Larger larvae and juveniles (size > 23 mm sdl), which are more efficiently sampled by the 20-mm trawl gear, have been captured in Cache Slough (Sacramento River) and the Sacramento Deep Water Channel in July (e.g. 20-mm trawl survey 9 in 2008). Because they are small fish inhabiting pelagic habitats with strong tidal and river currents, delta smelt larval distribution depends on both the spawning area from which they originate and the effect of transport processes caused by flows. Larval distribution is further affected by water salinity and temperature. Hydrodynamic simulations reveal that tidal action and other factors may cause substantial mixing of water with variable salinity and temperature among regions of the Delta (Monson et al 2007). This could result in rapid dispersion of larvae away from spawning sites.

The timing of spawning may affect delta smelt population dynamics. Lindberg (2011) has suggested that smelt larvae that hatch early, around late February, have an advantage over larvae hatched during late spawning in May. Early season larvae have a longer growing season and may be able to grow larger faster during more favorable habitat conditions in the late winter and early spring. An early growing season may result in higher survivorship and a stronger spawning capability for that generation. Larvae hatched later in the season have a shorter growing season which effectively reduces survivorship and spawning success for the following spawning season.

Sampling of larval delta smelt in the Bay-Delta in 1989 and 1990 suggested that spawning occurred in the Sacramento River; in Georgiana, Prospect, Beaver, Hog, and Sycamore sloughs; in the San Joaquin River adjacent to Bradford Island and Fisherman's Cut; and possibly other areas (Wang 1991). However, in recent years, the densest concentrations of both spawners and larvae have been recorded in the Cache Slough/Sacramento Deepwater Ship Channel complex in the North Delta. Some delta smelt spawning occurs in Napa River, Suisun Bay and Suisun Marsh during wetter years (Sweetnam 1999; Wang 1991; Hobbs et al. 2007). Early stage larval delta smelt have also been recorded in Montezuma Slough near Suisun Bay (Wang 1986).

Larval Development

Mager et al. (2004) reported that embryonic development to hatching takes 11-13 days at 14-16° C for delta smelt, and Baskerville-Bridges et al. (2000) reported hatching of delta smelt eggs after 8-10 days at temperatures between 15-17° C. Lindberg et al. (2003) reported high hatching rates of delta smelt eggs in the laboratory at 15° C, and Wang (2007) reported high hatching rates at temperatures between 14-17° C. Hatching success peaks near 15° C (Bennett 2005) and swim bladder inflation occurring at 60-70 days post-hatch at 16-17° C (Mager et al. 2004). At hatching and during the succeeding three days, larvae are buoyant, swim actively near the water surface, and do not react to bright direct light (Mager et al. 2004). As development continues, newly hatched delta smelt become semi-buoyant and sink in stagnant water. However, larvae are unlikely to encounter stagnant water in the wild.

Growth rates of wild-caught delta smelt larvae are faster than laboratory-cultured individuals. Mager et al. (2004) reported growth rates of captive-raised delta smelt reared at near-optimum temperatures (16°C-17°C). Their fish were about 12 mm long after 40 days and about 20 mm long after 70 days. In contrast, analyses of otoliths indicated that wild delta smelt larvae were 15-25 mm, or nearly twice as long at 40 days of age (Bennett 2005). By 70 days, most wild fish were 30-40 mm long and beyond the larval stage. This suggests there is strong selective pressure for rapid larval growth in nature, a situation that is typical for fish in general (Houde 1987). The food available to larval fishes is constrained by mouth gape and status of fin development. Larval delta smelt cannot capture as many kinds of prey as larger individuals, but all life stages have small gapes that limit their range of potential prey. Prey availability is also constrained by habitat use, which affects what types of prey are encountered. Larval delta smelt are visual feeders. They find and select individual prey organisms and their ability to see prey in the water is enhanced by turbidity (Baskerville-Bridges et al. 2004). Thus, delta smelt diets are largely comprised of small crustacea that inhabit the estuary's turbid, low-salinity, open-water habitats (i.e., zooplankton). Larval delta smelt have particularly restricted diets (Nobriga 2002). They do not feed on the full array of zooplankton with which they co-occur; they mainly consume three copepods, *Eurytemora affinis*, *Pseudodiaptomus forbesi*, and freshwater species of the family Cyclopidae. Further, the diets of first-feeding delta smelt larvae are largely restricted to the larval stages of these copepods; older, larger life stages of the copepods are increasingly targeted as the delta smelt larvae grow, their gape increases, and they become stronger swimmers.

In the laboratory, a turbid environment (>25 Nephelometric Turbidity Units [NTU]) was necessary to elicit a first feeding response (Baskerville-Bridges et al. 2000; Baskerville-Bridges 2004). Successful feeding seems to depend on a high density of food organisms and turbidity, and increases with stronger light conditions (Baskerville-Bridges et al. 2000; Mager et al. 2004; Baskerville-Bridges et al. 2004). Laboratory-cultured delta smelt larvae have generally been fed rotifers at first-feeding (Baskerville-Bridges et al. 2004; Mager et al. 2004). However, rotifers rarely occur in the guts of wild delta smelt larvae (Nobriga 2002). The most common first prey of wild delta smelt larvae is the larval stages of several copepod species. These copepod 'nauplii' are larger and have more calories than rotifers. This difference in diet may enable the faster growth rates observed in wild-caught larvae.

The triggers for and duration of delta smelt larval movement from spawning areas to rearing areas are not known. Hay (2007) noted that eulachon larvae are probably flushed into estuaries from upstream spawning areas within the first day after hatching, but downstream movement of delta smelt larvae occurs much later. Most larvae gradually move downstream toward the two parts per thousand (ppt) isohaline (X2). X2 is scaled as the distance in kilometers from the Golden Gate Bridge (Jassby et al. 1995).

At all life stages, delta smelt are found in greatest abundance in the water column and usually not in close association with the shoreline. They inhabit open, surface waters of the Delta and Suisun Bay, where they presumably aggregate in loose schools where conditions are favorable (Moyle 2002). In years of moderate to high Delta outflow (above normal to wet water years), delta smelt larvae are abundant in the Napa River, Suisun Bay and Montezuma Slough, but the degree to which these larvae are produced by locally spawning fish versus the degree to which they originate upstream and are transported by tidal currents to the bay and marsh is uncertain.

Juveniles

Young-of-the-year delta smelt rear in the low salinity zone (LSZ) from late spring through fall and early winter. Once in the rearing area growth is rapid, and juvenile fish are 40-50 mm sdl long by early August (Erkkila et al. 1950; Ganssle 1966; Radtke 1966). They reach adult size (55-70 mm sdl) by early fall (Moyle 2002). Delta smelt growth during the fall months slows considerably (only 3-9 mm total), presumably because most of the energy ingested is being directed towards gonadal development (Erkkila et al. 1950; Radtke 1966).

Delta Smelt Population Dynamics and Abundance Trends

Channelization, conversion of Delta islands to agriculture, and water operations have substantially changed the physical appearance, water salinity, water clarity, and hydrology of the Delta. As a consequence of these changes, most life stages of the delta smelt are now distributed across a smaller area than historically (Arthur et al. 1996; Feyrer et al. 2007). Wang (1991) noted in a 1989 and 1990 study of delta smelt larval distribution that, in general, the San Joaquin River was used more intensively for spawning than the Sacramento River. Nobriga et al. (2008) found that delta smelt capture probabilities in the TNS are highest at specific conductance levels of 1,000 to 5,000 $\mu S\ cm^{-1}$ (approximately 0.6 to 3.0 practical salinity unit [psu]). Similarly, Feyrer et al. (2007) found a decreasing relationship between abundance of delta smelt in the FMWT and specific conductance during September through December. The location of the LSZ and changes in delta smelt habitat quality in the San Francisco Estuary can be indexed by changes in X2. The LSZ historically had the highest primary productivity and is where zooplankton populations (on which delta smelt feed) were historically most dense (Knutson and Orsi 1983; Orsi and Mecum 1986). However, this has not always been true since the invasion of the overbite clam (Kimmerer and Orsi 1996). The abundance of many local aquatic species has tended to increase in years when winter-spring outflow was high and X2 was pushed seaward (Jassby et al. 1995), implying that the quantity and quality (overall suitability) of estuarine habitat increases in years when

outflows are high. However, delta smelt is not one of the species whose abundance has statistically covaried with winter-spring freshwater flows (Stevens and Miller 1983; Moyle et al. 1992; Kimmerer 2002a; Bennett 2005).

The distribution of juvenile delta smelt has also changed over the last several decades. During the years 1970 through 1978, delta smelt catches in the TNS survey declined rapidly to zero in the Central and South Delta and have remained near zero since. A similar shift in FMWT catches occurred after 1981 (Arthur et al. 1996). This portion of the Delta has also had a long-term trend increase in water clarity during July through December (Arthur et al. 1996; Feyrer et al. 2007; Nobriga et al. 2008).

The California Department of Fish and Wildlife (CDFW) has conducted several long-term monitoring surveys that have been used to index the relative abundance of delta smelt. The 20-mm Survey has been conducted every year since 1995. This survey targets late-stage delta smelt larvae. Most sampling has occurred April-June. The Summer Townet Survey (TNS) has been conducted nearly every year since 1959. This survey targets 38-mm striped bass, but collects similar-sized juvenile delta smelt. Most sampling has occurred June-August. The Fall Midwater Trawl Survey (FMWT) has been conducted nearly every year since 1967. This survey also targets age-0 striped bass, but collects delta smelt > 40 mm in length. The FMWT samples monthly, September-December. The relative abundance index data and maps of the sampling stations used in these surveys are available at http://www.dfg.ca.gov/delta/. The methods that underlie the surveys have been described previously (Stevens and Miller 1983; Moyle and others 1992; Dege and Brown 2004). The delta smelt catch data and relative abundance indices derived from these sampling programs have been used in numerous publications (e.g., Stevens and Miller 1983; Moyle and others 1992; Jassby and others 1995; Kimmerer 2002b; Dege and Brown 2004; Bennett 2005; Feyrer and others 2007; Sommer and others 2007; Kimmerer and others 2008; Newman 2008; Nobriga and others 2008; Kimmerer and others 2009; Mac Nally and others 2010; Thomson and others 2010; Feyrer and others 2011; Maunder and Deriso 2011). These abundance index time series document the long-term decline of the delta smelt.

Early statistical assessments of delta smelt population dynamics concluded that at best, the relative abundance of the adult delta smelt population had only a very weak influence on subsequent juvenile abundance (Sweetnam and Stevens 1993). Thus, early attempts to describe abundance variation in delta smelt ignored stock-recruit effects and researchers looked for environmental variables that were directly correlated with interannual abundance variation (e.g., Stevens and Miller 1983; Moyle and others 1992; Sweetnam and Stevens 1993; Herbold 1994; Jassby and others 1995). Because delta smelt live in a habitat that varies in size and quality with Delta outflow, the authors cited above searched for a linkage between Delta outflow (or X2) and the TNS and FMWT indices. Generally, these analyses did not find strong support for an outflow-abundance linkage. These analyses led to a prevailing conceptual model that multiple interacting factors had caused the delta smelt decline (Moyle and others 1992; Bennett and Moyle 1996; Bennett 2005). It has also recently been noted that delta smelt's FMWT index is

partly influenced by concurrent environmental conditions (Feyrer and others 2007; 2011). This may be a partial explanation for why few analyses could consistently link springtime environmental conditions to delta smelt's fall index.

It is now recognized that delta smelt abundance plays an important role in subsequent abundance (Bennett 2005; Maunder and Deriso 2011). Bennett (2005) assessed (1) the influence of adult stock as indexed by the FMWT versus the next generation of juveniles indexed by the following calendar year's TNS; (2) the influence of the juvenile stock indexed by the TNS versus the subsequent adult stock indexed a few months later in the FMWT; (3) the influence of the FMWT on the following year's FMWT and on the FMWT two years later, and (4) he did the same for the TNS data. He concluded that (1) two-year-old delta smelt might play an important role in delta smelt population dynamics, (2) it was not clear whether juvenile production was a density-independent or density-dependent function of adult abundance, and (3) adult production was a density-dependent function of juvenile abundance and the carrying capacity of the estuary to support this life-stage transition had declined over time. These conclusions are also supported by Maunder and Deriso (2011).

The concept of density-dependence[1] and how it has affected the delta smelt is important because it may be used as a reason not to protect particular life stages from sources of mortality. Bennett (2005) concluded it was (statistically) unclear whether density-dependence occurs between generations. He also noted that the delta smelt indices strongly suggest that density-dependence has occurred, at least over the long-term, during the juvenile stage. The uncertainty about density-dependence between generations results because statistical assessments of the relationship between the adult stock and the next generation of recruits (juveniles) result in similar fits for linear (density-independent) and nonlinear (density-dependent) relationships (Bennett 2005; Maunder and Deriso 2011).

One reason for this is that delta smelt population dynamics may have changed over time. Previous papers have reported a delta smelt step-decline during 1981-1982 (Kimmerer 2002b; Thomson et al. 2010). Prior to this decline, the stock-recruit data are consistent with "Ricker" type density-dependence where increasing adult abundance resulted in decreased juvenile abundance. Since the decline, recruitment has been positively and essentially linearly related to prior adult abundance, suggesting that reproduction has been basically density-independent for about the past 30 years. This means that since the early 1980s, more adults translates into more juveniles and fewer adults translates into fewer juveniles without being 'compensated for' by density-dependence. In contrast to the transition among generations, the weight of scientific evidence strongly supports the hypothesis that, at least over the history of Interagency Ecological Program fish monitoring, delta smelt has experienced density-dependence during the juvenile stage of its life cycle, i.e., between the summer and fall (Bennett 2005; Maunder and Deriso 2011). This has been inferred because, statistically, the FMWT index does not increase linearly

1 Density-dependence refers to situations where vital rates like growth or survival change as a population's density changes (Rose et al. 2001). When vital rates do not vary with population density, they are considered to be density-independent. Density-dependence occurs in populations when one or more factors is in limited supply or when crowding results in predator aggregation or faster disease transmission.

with increases in the summer townet index. Rather, the best-fitting relationships between the summer townet index and the FMWT index show that the FMWT indices approach an asymptote as the summer townet increases or possibly even declines at the highest summer townet indices. From a species conservation perspective, the most relevant aspect of this juvenile density dependence is that the carrying capacity of the estuary for delta smelt has declined (Bennett 2005). Thus, the delta smelt population decline has occurred for two basic reasons. First, the compensatory density-dependence that historically enabled juvenile abundance to rebound from low adult numbers stopped happening. This change had occurred by the early 1980s as described above. The reason is still not known, but the consequence of the change is that for the past several decades, adult abundance drives juvenile production in a largely density-independent manner. Thus, if numbers of adults or adult fecundity decline, juvenile production will also decline (Kimmerer 2011). Second, because juvenile carrying capacity has declined, juvenile production hits a 'ceiling' at a lower abundance than it once did. This limits adult abundance and possibly per capita fecundity, which cycles around and limits the abundance of the next generation of juveniles. The mechanism causing carrying capacity to decline is likely due to the long-term accumulation of deleterious habitat changes – both physical and biological – during the summer-fall (Bennett and others 2008; Feyrer and others 2007; 2010; Maunder and Deriso 2011).

Stressors

Habitat

The existing physical appearance and hydrodynamics of the Delta have changed substantially from the environment in which native fish species like delta smelt evolved. The Delta once consisted of tidal marshes with networks of diffuse dendritic channels connected to floodplains of wetlands and upland areas (Moyle 2002). The in-Delta channels were further connected to drainages of larger and smaller rivers and creeks entering the Delta from the upland areas. In the absence of upstream reservoirs, freshwater inflow from smaller rivers and creeks and the Sacramento and San Joaquin Rivers were highly seasonal and more strongly and reliably affected by precipitation patterns than they are today. Consequently, variation in hydrology, salinity, turbidity, and other characteristics of the Delta aquatic ecosystem was greater in the past than it is today (Kimmerer 2002a). For instance, in the early 1900s, the location of maximum salinity intrusion into the Delta during dry periods varied from Chipps Island in the lower Delta to Stockton along the San Joaquin River and Merritt Island in the Sacramento River. Operations of upstream reservoirs have reduced spring flows while releases of water for Delta water export and increased flood control storage have increased late summer and fall inflows (Knowles 2002), though Delta outflows have been tightly constrained during late summer-fall for several decades. The following is a brief description of the changes that have occurred to delta smelt's habitat that are relevant to the environmental baseline for this consultation.

Changes to the LSZ

There have been documented changes to the delta smelt's low-salinity zone habitat that have led to present-day, baseline habitat conditions. The close association of delta smelt with the San Francisco estuary LSZ has been known for many years (Stevens and Miller 1983; Moyle et al. 1992). Peterson (2003) developed a conceptual model that hypothesized how, "stationary and dynamic components of estuarine habitats" interacted to influence fisheries production in tidal river estuaries. Peterson's model suggests that when the dynamic and static aspects of estuarine habitat sufficiently overlap, foraging, growth, density, and survival are all high, and that enables fish production to outpace losses to predators. The result is high levels of successful recruitment of new individuals. The model also hypothesizes that when the dynamic and static aspects of an estuarine habitat do not sufficiently overlap, foraging, growth, density, and survival are impaired such that losses to predators increase and recruitment of new individuals decreases. This model was developed specifically for species spawned in marine environments that were subsequently transported into estuaries. However, the concept of X2, which was developed in the San Francisco estuary to describe how freshwater flow affected estuarine habitat (Jassby et al. 1995), played a role in the intellectual development of Peterson's model. The Peterson model also provides a useful framework to conceptualize delta smelt's LSZ habitat.

Currently available information indicates that delta smelt habitat is most suitable for the fish when low-salinity water is near 20°C, highly turbid, oxygen saturated, low in contaminants, supports high densities of calanoid copepods and mysid shrimp (Moyle et al. 1992; Lott 1998; Nobriga 2002), and occurs over comparatively static 'landscapes' that support sandy beaches and bathymetric variation that enables the fish and their prey to aggregate (Kimmerer et al. 2002; Bennett et al. 2002; Hobbs et al. 2006). Almost every component listed above has been degraded over time (see below). The Service has determined that this accumulation of habitat change is the fundamental reason or mechanism that has caused delta smelt to decline.

Alterations to estuarine bathymetry and salinity distribution (~ 1850-present)

The position of the LSZ, where delta smelt rear, has changed over the years. The first major change in the LSZ was the conversion of the landscape over which tides oscillate and river flows vary (Moyle et al. 2010). The ancestral Delta was a large tidal marsh-floodplain habitat totally approximately 700,000 acres. Most of the historic wetlands were diked and reclaimed for agriculture or other human uses by 1920 (Atwater et al. 1979). Channels were dredged deep (~12 m) to accommodate shipping traffic from the Pacific Ocean and San Francisco Bay to ports in Sacramento and Stockton. These changes left Suisun Bay and the confluence of the Sacramento-San Joaquin Rivers as the largest and most bathymetrically variable places in the LSZ. This region remained a highly productive nursery for many decades (Stevens and Miller 1983; Moyle et al. 1992; Jassby et al. 1995). However, the deepened channels created to support shipping and flood control, requires more freshwater outflow to maintain the LSZ in the large Suisun Bay and River confluence than was once required (Gartrell 2010). The construction of the CVP and SWP not only provided water supply for urban, agricultural and industrial users, but also provided water needed to combat salinity intrusion into the Delta, which was observed by the early 20th

century. California's demand for freshwater (keeps) continues to increase, thus seasonal salinity intrusion perpetually reduces the temporal overlap of the LSZ (indexed by X2) within the Suisun Bay (region), especially in the fall (Feyrer et al. 2007; 2011). Consequently, the second major habitat change in the Delta has been in the frequency with which the LSZ is maintained in Suisun Bay for any given amount of precipitation. There was a step-decline in the LSZ in 1977 from which it has never recovered for more than a few years at a time. Based on model forecasts of climate change and water demand, this trend is expected to continue (Feyrer et al. 2011).

Summer and fall environmental quality has decreased overall in the Delta because outflows are lower and water transparency is higher. These changes may be due to increased upstream water diversions for flooding rice fields (Kawakami et. al. 2008). The confluence of the Sacramento and San Joaquin Rivers has, as a result, become increasingly important as a rearing location for delta smelt, with physical environmental conditions constricting the species range to a relatively narrow area (Feyrer et al. 2007; Nobriga et al. 2008). This has increased the likelihood that most of the juvenile population is exposed to chronic and cyclic environmental stressors, or catastrophic events. For instance, all seven delta smelt collected during the September 2007 FMWT survey were captured at statistically significantly higher salinities than what would be expected based upon historical distribution data generated by Feyrer et al. (2007). During the same year, the annual bloom of toxic cyanobacteria (*Microcystis aeruginosa*) spread far downstream to the west Delta and beyond during the summer (Peggy Lehman, pers comm). This has been suggested as an explanation for the anomaly in the distribution of delta smelt relative to water salinity levels (Reclamation 2008).

Turbidity

From 1999 to present, the Delta experienced a change in estuarine turbidity that culminated in an estuary-wide step-decline in 1999 (Schoellhamer 2011). For decades, the turbidity of the modified estuary had been sustained by very large sediment deposits resulting mainly from gold mining in the latter 19th century. Sediments continued to accumulate into the mid-20th century, keeping the water relatively turbid even as sediment loads from the Sacramento River basin declined due to dam and levee construction (Wright and Schoellhamer 2004). The flushing of the sediment deposits may also have made the estuary deeper overall and thus a less suitable nursery from the 'static' bathymetric perspective (Schroeter 2008).

Delta smelt associate with highly turbid waters; there is a negative correlation between the frequency of delta smelt occurrence in survey trawls during summer, fall and early winter and water clarity. For example, the likelihood of delta smelt occurrence in trawls at a given sampling station decreases with increasing Secchi depth at the stations (Feyrer et al. 2007, Nobriga et al. 2008). This is very consistent with behavioral observations of captive delta smelt (Nobriga and Herbold 2008). Few daylight trawls catch delta smelt at Secchi depths over one half meter and capture probabilities for delta smelt are highest at 0.40 m depth or less. Turbid waters are thought to increase foraging efficiency (Baskerville-Bridges et al. 2004) and reduce the risk of predation for delta smelt.

Temperature

Temperature also affects delta smelt distribution. Swanson and Cech (1995) and Swanson et al. (2000) indicate delta smelt tolerate temperatures (<8° C to >25° C), however warmer water temperatures >25° C restrict their distribution more than colder water temperatures (Nobriga and Herbold 2008). Delta smelt of all sizes are found in the main channels of the Delta and Suisun Marsh and the open waters of Suisun Bay where the waters are well oxygenated and temperatures are usually less than 25° C in summer (Nobriga et al. 2008). Currently, delta smelt are subjected to thermally stressful temperatures every summer, and all available regional climate change projections predict central California will be warmer still in the coming decades (Dettinger 2005). We expect warmer estuary temperatures to be yet another significant conservation challenge based on climate change models. Warmer water temperatures would increase delta smelt mortality and constrict suitable habitat throughout the Delta during the summer months. Higher temperatures would shrink delta smelt distribution into the fall, limiting their presence to Suisun Bay and in waters with less than optimal salinities (Brown et al. unpublished data 2011). Water temperatures are presently above 20°C for most of the summer in core habitat areas, sometimes even exceeding the nominal lethal limit of 25°C for short periods. Coldwater fishes begin to have behavioral impairments (Marine and Cech 2004) and lose competitive abilities (Taniguchi et al. 1998) prior to reaching their thermal tolerance limits. Thus, the estuary can already be considered thermally stressful to delta smelt and can only become more so if temperatures warm in the coming decades.

Foraging Ecology

Delta smelt feed primarily on small planktonic crustaceans, and occasionally on insect larvae (Moyle 2002). Juvenile-stage delta smelt prey upon copepods, cladocerans, amphipods, and insect larvae (Moyle 2002). Historically, the main prey of delta smelt was the euryhaline copepod *Eurytemora affinis* and the euryhaline mysid *Neomysis mercedis*. The slightly larger *Pseudodiaptomus forbesi* has replaced *E. affinis* as a major prey source of delta smelt since its introduction into the Bay-Delta, especially in summer, when it replaces *E. affinis* in the plankton community (Moyle 2002). Another smaller copepod, *Limnoithona tetraspina*, which was introduced to the Bay-Delta in the mid-1990s, is now one of the most abundant copepods in the LSZ, but not abundant in delta smelt diets. *Acartiella sinensis*, a calanoid copepod species that invaded the Delta at the same time as *L. tetraspina*, also occurs at high densities in Suisun Bay and in the western Delta over the last decade. Delta smelt eat these newer copepods, but *Pseudodiaptomus* remains their dominant prey (Baxter et al. 2008).

River flows influence estuarine salinity gradients and water residence times and thereby affect both habitat suitability for benthos and the transport of pelagic plankton upon which delta smelt feed. High tributary flow leads to lower residence time of water in the Delta, which generally results in lower plankton biomass (Kimmerer 2004). In contrast, higher residence times, which result from low tributary flows, can result in higher plankton biomass but water diversions, overbite clam grazing (Jassby et al. 2002) and possibly contaminants (Baxter et al. 2008) remove a lot of plankton biomass when residence times are high. These factors all affect food availability

for planktivorous fishes that utilize the zooplankton in Delta channels. Delta smelt cannot occupy much of the Delta anymore during the summer (Nobriga et al. 2008). Thus, there is the potential for mismatches between regions of high zooplankton abundance in the Delta and delta smelt distribution now that the overbite clam has decimated LSZ zooplankton densities.

The delta smelt compete with and are prey for several native and introduced fish species in the Delta. The introduced Mississippi silverside may prey on delta smelt eggs and/or larvae and compete for copepod prey (Bennett and Moyle 1995; Bennett 2005). Young striped bass also use the LSZ for rearing and may compete for copepod prey and eat delta smelt. Centrarchid fishes and coded wire tagged Chinook salmon smolts released in the Delta for survival experiments since the early 1980s may potentially also prey on larval delta smelt (Brandes and McLain 2001; Nobriga and Chotkowski 2000). Studies during the early 1960s found delta smelt were only an occasional prey fish for striped bass, black crappie and white catfish (Turner and Kelley 1966). However, delta smelt were a comparatively rare fish even then, so it is not surprising they were a rare prey. Striped bass appear to have switched to piscivorous feeding habits at smaller sizes than they historically did, following severe declines in the abundance of mysid shrimp (Feyrer et al. 2003). Nobriga and Feyrer (2008) showed that Mississippi silverside, which is similar in size to delta smelt, was only eaten by subadult striped bass less than 400 mm fork length. While largemouth bass are not pelagic, they have been shown to consume some pelagic fishes (Nobriga and Feyrer 2007).

Other Stressors

Aquatic Macrophytes

For many decades, the Delta's waterways were turbid and growth of submerged plants was apparently unremarkable. That began to change in the mid-1980s, when the Delta was invaded by the non-native plant, Egeria densa, a fast-growing aquatic macrophyte that has now taken hold in many shallow habitats throughout the Delta (Brown and Michnuik 2007; Hestir 2010). Egeria densa and other non-native species of submerged aquatic vegetation (SAV) grow most rapidly in the summer and late fall when water temperatures are warm ($> 20^0$C) and outflow is relatively low (Hestir 2010). The large canopies formed by these plants have physical and biological consequences for the ecosystem (Kimmerer et al. 2008). First, the dense nature of SAV promotes sedimentation of particulate matter from the water column which increases water transparency. Increased water transparency leads to a loss of habitat for delta smelt (Feyrer et al. 2007; Nobriga et al. 2008). Second, dense SAV canopies provide habitat for a suite of non-native fishes that occupy the littoral and shallow habitats of the Delta, displacing native fishes (Nobriga et al. 2005; Brown and Michniuk 2007). Finally, the rise in SAV colonization over the last three decades has led to a shift in the dominant trophic pathways that fuel fish production in the Delta. Until the latter 1980s, the food web of most fishes was often dominated by mysid shrimp (Feyrer et al. 2003) that were subsidized by phytoplankton food sources (Rast and Sutton 1989). Now, most littoral and demeral fishes of the Delta have diets dominated by the epibenthic amphipods that eat SAV detritus or the epiphytic algae attached to SAV (Grimaldo et al. 2009).

Egeria densa and other non-native submerged aquatic vegetation (e.g., *Myriophyllum spicatum*) can affect delta smelt in direct and indirect ways. Directly, submerged aquatic vegetation can overwhelm littoral habitats (inter-tidal shoals and beaches) where delta smelt may spawn making them unsuitable for spawning. Indirectly, submerged aquatic vegetation decreases turbidity (by trapping suspended sediment) which has contributed to a decrease in both juvenile and adult smelt habitat (Feyrer et al. 2007; Nobriga et al. 2008). Increased water transparency may delay feeding and may also make delta smelt more susceptible to predation pressure.

Predators

Delta smelt is a rare fish and has been a rare fish (compared to other species) for at least the past several decades (Nobriga and Herbold 2008). Therefore, it has also been rare in examinations of predator stomach contents. Delta smelt were occasional prey fish for striped bass, black crappie and white catfish in the early 1960s (Turner and Kelley 1966) but went undetected in a recent study of predator stomach contents (Nobriga and Feyrer 2007). Striped bass are likely the primary predator of juvenile and adult delta smelt given their spatial overlap in pelagic habitats. Despite major declines in age-0 abundance, there remains much more biomass of striped bass in the upper estuary than delta smelt. This means it is not possible for delta smelt to support any significant proportion of the striped bass population. It is unknown whether incidental predation by striped bass (and other lesser predators) represents a substantial source of mortality for delta smelt.

Nothing is known about the historic predators of delta smelt or their possible influence on delta smelt population dynamics. Fish eggs and larvae can be opportunistically preyed upon by many invertebrate and vertebrate animals. There has always been a very long list of potential predators of delta smelt's eggs and larvae. The eggs and newly-hatched larvae of delta smelt are thought to be prey for Mississippi silversides in littoral habitats (Bennett 2005). Other potential predators of eggs and larvae of smelt in littoral habitats are yellowfin goby, centrarchids, and Chinook salmon. Potential native predators of juvenile and adult delta smelt would also have included numerous bird and fish species and this may be reflected in delta smelt's annual life-history. Annual fish species, also known as "opportunistic strategists", are adapted to high mortality rates in the adult stage (Winemiller and Rose 1992). This high mortality is usually due to predation or highly unpredictable environmental conditions, both of which could have characterized the ancestral niche of delta smelt.

The introduction of striped bass into the San Francisco Estuary in 1879 added a permanently resident, large piscivorous fish to the low-salinity zone. The LSZ is a habitat not known to have had an equivalent predator prior to the establishment of striped bass (Moyle 2002). Striped bass likely changed predation rates on delta smelt, but there are no data available to confirm this hypothesis. For many decades the estuary supported higher striped bass and delta smelt numbers than it does currently (Moyle 2002). This is evidence that delta smelt is able to successfully coexist with striped bass.

The current influence of striped bass and other predators on delta smelt population dynamics is unknown, mainly because predator effects on rare prey are extremely difficult to quantify. Delta smelt were observed in the stomach contents of striped bass and other fishes in the 1960s (Stevens 1963; Turner and Kelley 1966), but have not been in more recent studies (Feyrer et al. 2003; Nobriga and Feyrer 2007). Predation is a common source of density-dependent mortality in fish populations (Rose et al. 2001). Thus, it is possible that predation was a mechanism that historically generated the density-dependence observable in delta smelt population dynamics that has been noted by Bennett (2005) and Maunder and Deriso (2011). As is the case with other fishes, the vulnerability of delta smelt to predators may be influenced primarily by habitat suitability. It is widely documented that pelagic fishes, including many smelt species, experience lower predation risks under turbid water conditions (Thetmeyer and Kils 1995; Utne-Palm 2002; Horpilla et al. 2004,). Growth rates, a result of feeding success plus water temperature, are also well known to affect fishes' cumulative vulnerability to predation (Sogard 1997).

Competition

It has been hypothesized that delta smelt are adversely affected by competition from other introduced fish species that use overlapping habitats, including Mississippi silversides, (Bennett and Moyle 1995) striped bass, and wakasagi (Sweetnam 1999). Laboratory studies show that delta smelt growth is inhibited when reared with Mississippi silversides (Bennett 2005) but there is no empirical evidence to support the conclusion that competition between these species is a factor that influences the abundance of delta smelt in the wild. There is some speculation that the overbite clam competes with delta smelt for copepod nauplii (Nobriga and Herbold 2008). It is unknown how intensively overbite clam grazing and delta smelt directly compete for food, but overbite clam consumption of shared prey resources does have other ecosystem consequences that appear to have affected delta smelt indirectly.

Microcystis

Large blooms of toxic blue-green alga, *Microcystis aeruginosa*, were first detected in the Delta during the summer of 1999 (Lehman et al. 2005). Since then, *M. aeruginosa* has bloomed each year, forming large colonies throughout most of the Delta and increasingly down into eastern Suisun Bay. Blooms typically occur between late spring and early fall (peak in the summer) when temperatures are above 20 °C. *Microcystis aeruginosa* can produce natural toxins that pose animal and human health risks if contacted or ingested directly. Preliminary evidence indicates that the toxins produced by local blooms are not toxic to fishes at current concentrations. However, it appears that *M. aeruginosa* is toxic to copepods that delta smelt eat (Ali Ger 2008 pers comm). In addition, *M. aeruginosa* could out-compete diatoms for light and nutrients. Diatoms are a rich food source for zooplankton in the Delta (Mueller-Solger et al. 2002). Studies are underway to determine if zooplankton production is compromised during *M. aerguinosa* blooms to an extent that is likely to adversely affect delta smelt. *Microcystis* blooms may also decrease DO to lethal levels for fish (Saiki et al. 1992), although delta smelt do not strongly overlap the densest *Microcystis* concentrations, so DO is not likely a problem. *Microcystis* blooms are a symptom of eutrophication and high ammonia to nitrate ratios in the water.

Contaminants

Contaminants can change ecosystem functions and productivity through numerous pathways. However, contaminant loading and its ecosystem effects within the Delta are not well understood. Although a number of contaminant issues were first investigated during the Pelagic Organism Decline (POD) years, concern over contaminants in the Delta is not new. There are long-standing concerns related to mercury and selenium levels in the watershed, Delta, and San Francisco Bay (Linville et al. 2002; Davis et al. 2003). Phytoplankton growth rate may, at times, be inhibited by high concentrations of herbicides (Edmunds et al. 1999). New evidence indicates that phytoplankton growth rate is chronically inhibited by ammonium concentrations in and upstream of Suisun Bay (Wilkerson et al. 2006, Dugdale et al. 2007). Contaminant-related toxicity to invertebrates has been noted in water and sediments from the Delta and associated watersheds (e.g., Kuivila and Foe 1995, Giddings et al. 2000, Werner et al. 2000, Weston et al. 2004). Undiluted drainwater from agricultural drains in the San Joaquin River watershed can be acutely toxic (quickly lethal) to fish and have chronic effects on growth (Saiki 1998). Evidence for mortality of young striped bass due to discharge of agricultural drainage water containing rice herbicides into the Sacramento River (Bailey et al. 1994) led to new regulations for water discharges. Bioassays using caged Sacramento sucker (*Catostomus occidentalis*) have revealed deoxyribonucleic acid strand breakage associated with runoff events in the watershed and Delta (Whitehead et al. 2004). Kuivila and Moon (2004) found that peak densities of larval and juvenile delta smelt sometimes coincided in time and space with elevated concentrations of dissolved pesticides in the spring. These periods of co-occurrence lasted for up to 2-3 weeks, but concentrations of individual pesticides were low and much less than would be expected to cause acute mortality. However, the effects of exposure to the complex mixtures of pesticides actually present are unknown.

Current science suggests a possible link between contaminants and POD, may be the effects of contaminant exposure on prey items, resulting in an indirect effect on the survival of POD species (Johnson et al. 2010). The POD investigators initiated several studies beginning in 2005 to address the possible role of contaminants and disease in the declines of Delta fish and other aquatic species. Their primary study consists of twice-monthly monitoring of ambient water toxicity at fifteen sites in the Delta and Suisun Bay. In 2005 and 2006, standard bioassays using the amphipod *Hyalella azteca* had low (<5 percent) frequency of occurrence of toxicity (Werner et al. 2008). The results indicated that 2007, a dry year, showed a higher incidence of toxic events than in the previous (wetter) year, 2006 (Werner et al. 2010). Parallel testing with the addition of piperonyl butoxide, an enzyme inhibitor, indicated that both organophosphate and pyrethroid pesticides may have contributed to the pulses of toxicity. Most of the tests that were positive for *H. azteca* toxicity have come from water samples from the lower Sacramento River. Pyrethroids are of particular interest because use of these insecticides has increased within the Delta watershed (Amweg et al. 2005, Oros and Werner 2005) as use of some organophosphate insecticides has declined. Urban source waters have shown toxicity to *H. azteca* with high mortality rates and swimming impairment in fishes due to pyrethroid pesticides (Weston and Lydy 2010). Toxicity of sediment-bound pyrethroids to macroinvertebrates has also been

observed in small, agriculture-dominated watersheds tributary to the Delta (Weston et al. 2004, 2005). The association of delta smelt spawning with turbid winter runoff and the association of pesticides including pyrethroids with sediment is of potential concern.

In conjunction with the POD investigation, larval delta smelt bioassays were conducted simultaneously with a subset of the invertebrate bioassays. The water samples for these tests were collected from six sites within the Delta during May-August of 2006 and 2007. Results from 2006 indicate that delta smelt are highly sensitive to high levels of ammonia, low turbidity, and low salinity. There is some preliminary indication that reduced survival may be due to disease organisms (Werner et al. 2008). No significant mortality of larval delta smelt was found in the 2006 bioassays, but there were two instances of significant mortality in June and July of 2007. In both cases, the water samples were collected from sites along the Sacramento River and had relatively low turbidity and salinity levels and moderate levels of ammonia. It is also important to note that no significant *H. azteca* mortality was detected in these water samples. While the *H. azteca* tests are very useful for detecting biologically relevant levels of water column toxicity for zooplankton, interpretation of the *H. azteca* test results with respect to fish should proceed with great caution. The relevance of the bioassay results to field conditions remains to be determined. Werner et al. (2010) conducted *in situ* testing in the laboratory and compared contaminant sensitivity of delta smelt to common bioassay organisms, including *H. azteca*. The investigations included contaminants commonly observed in the Delta, such as organophosphate and pyrethroid insecticides, copper, and total ammonia. In the laboratory, delta smelt were 1.8 to >11 times more sensitive than fathead minnow to ammonia, copper, and all insecticides tested (except permethrin). The invertebrates tested were more sensitive to contaminants than delta smelt or fathead minnows. *Eurytemora affinis* and *Ceriodaphnia dubia* were the most sensitive to total ammonia. *C. dubia* was the most sensitive to copper and organophosphates pesticides. *H. azteca* was the most sensitive test organism to pyrethroids. Toxicity was not detected for the Sacramento River at Hood or the San Joaquin River at Rough and Ready Island during the 2009 *in situ* testing period. Delta smelt survival was low in treatment and control waters. Werner et al. (2010) concluded that larval smelt may be too sensitive to salinity, temperature and transport stress for *in situ* exposures and recommended using surrogate species in future tests.

Persistent confinement of the spawning population of delta smelt to the Sacramento River increases the likelihood that a substantial portion of the spawners will be affected by a catastrophic event or localized chronic threat. For instance, large volumes of highly concentrated ammonia released into the Sacramento River from the Sacramento Regional County Sanitation District may affect embryo survival or inhibit prey production. Further, agricultural fields in the Yolo Bypass and surrounding areas are regularly sprayed by pesticides, and water samples taken from Cache Slough sometimes exhibited toxicity to *H. azteca* (Werner et al. 2008; 2010). The thresholds of toxicity for delta smelt for most of the known contaminants have not been determined, but the exposure to a combination of different compounds increases the likelihood of adverse effects. The extent to which delta smelt larvae are exposed to contaminants varies with

flow entering the Delta. Flow pulses during spawning increase exposure to many pesticides (Kuivila and Moon 2004) but decrease ammonia concentrations entering the Delta from wastewater treatment plants.

The POD investigations into potential contaminant effects also include the use of biomarkers that have been used previously to evaluate toxic effects on POD fishes (Bennett et al. 1995, Bennett 2005). The results to date have been mixed. A pathogen survey of 105 adult delta smelt, sampled from January through May, at several sites in the Delta, found that disease did not appear to overtly influence the health of the surveyed population for that year (Foott and Bigelow 2010). Histopathological and viral evaluation of young longfin smelt collected in 2006 indicated no histological abnormalities associated with exposure to toxics or disease (Foott and Stone 2007). There was also no evidence of viral infections or high parasite loads. Similarly, young threadfin shad showed no histological evidence of contaminant effects or of viral infections (Foott and Stone 2007). Parasites were noted in threadfin shad gills at a high frequency but the infections were not considered severe. Both longfin smelt and threadfin shad were considered healthy in 2006. Adult delta smelt collected from the Delta during the winter of 2005 also were considered healthy, showing little histopathological evidence for starvation or disease (Teh 2007). However, there was some evidence of low frequency endocrine disruption. In 2005, nine of 144 (six percent) of adult delta smelt males sampled were intersex, having immature oocytes in their testes (Teh 2007). Bennett (2005) reported that about 10% of the delta smelt analyzed for histopathological anomalies in 1999-2000 showed evidence of deleterious contaminant exposure. In contrast, 30%-60% of these fish had liver glycogen depletion consistent with food limitation. In contrast, preliminary histopathological analyses have found evidence of significant disease in other species and for POD species collected from other areas of the estuary. Massive intestinal infections with an unidentified myxosporean were found in yellowfin goby (*Acanthogobius flavimanus*) collected from Suisun Marsh. Severe viral infection was also found in Mississippi silverside and juvenile delta smelt collected from Suisun Bay during summer 2005. Lastly, preliminary evidence suggests that contaminants and disease may impair survival of age-0 striped bass. Baxter et al. (2008) found high occurrence and severity of parasitic infections, inflammatory conditions, and muscle degeneration in young striped bass collected in 2005; levels were lower in 2006. Several biomarkers of contaminant exposure including P450 activity (i.e., detoxification enzymes in liver), acetylcholinesterase activity (i.e., enzyme activity in brain), and vitellogenin induction (i.e., presence of egg yolk protein in blood of males) were also reported from striped bass collected in 2006 (Ostrach 2008). Delta smelt can also be exposed to other toxic substances. Recent toxicological research has provided dose-response curves for several contaminants (Connon et al. 2009; 2011; in review). This research has also shown that gene expression changes and impairment of delta smelt swimming performance occur at contaminant concentrations lower than levels that cause mortality.

Summary of Delta Smelt Status and Environmental Baseline

In summary, delta smelt's LSZ ecosystem has been changing and has changed very rapidly on several occasions during the past several decades. First, suitable land area was reduced, then water diversions increased, then the temporal overlap of low-salinity water with the best

remaining landscape was reduced, then the food web began dramatically changing, then the turbidity delta smelt are assumed to use to see their food as larvae (Baskerville-Bridges et al. 2004) and use to hide from predators at later life stages (sensu Gregory and Levings 1998) lessened. Water temperatures are expected to rise (Dettinger 2005), which can only generate greater areas of stressful or even lethal temperature conditions for longer periods. Modeled future conditions suggest difficult conservation challenges and choices lie ahead (Feyrer et al. 2011; Brown et al. unpublished data 2011).

Status of the Delta Smelt Critical Habitat

The Status of Critical Habitat and Environmental Baseline sections are combined into one section in this document. The Service designated critical habitat for the delta smelt on December 19, 1994 (Service 1994). The geographic area encompassed by the designation includes all water and all submerged lands below ordinary high water and the entire water column bounded by and contained in Suisun Bay (including the contiguous Grizzly and Honker Bays); the length of Goodyear, Suisun, Cutoff, First Mallard (Spring Branch), and Montezuma sloughs; and the existing contiguous waters contained within the legal Delta (as defined in section 12220 of the California Water Code) (Service 1994).

Conservation Role of Delta Smelt Critical Habitat

The Service's primary objective in designating critical habitat was to identify the key components of delta smelt habitat that support successful spawning, larval and juvenile transport, rearing, and adult migration. Delta smelt are endemic to the Bay-Delta and the vast majority only live one year. Thus, regardless of annual hydrology, the Delta must provide suitable habitat all year, every year. Different regions of the Delta provide different habitat conditions for different life stages, but those habitat conditions must be present when needed, and have sufficient connectivity to provide migratory pathways and the flow of energy, materials and organisms among the habitat components. The entire Delta and Suisun Bay are designated as critical habitat; over the course of a year, the entire habitat is occupied.

Description of the Primary Constituent Elements

In designating critical habitat for the delta smelt, the Service identified the following primary constituent elements essential to the conservation of the species:

Primary Constituent Element 1: Physical habitat" is defined as the structural components of habitat. Because delta smelt is a pelagic fish, spawning substrate is the only known important structural component of habitat. It is possible that depth variation is an important structural characteristic of pelagic habitat that helps fish maintain position within the estuary's LSZ (Bennett et al. 2002; Hobbs et al. 2006).

Primary Constituent Element 2: "Water" is defined as water of suitable quality to support various delta smelt life stages with the abiotic elements that allow for survival and reproduction. Delta smelt inhabit open waters of the Delta and Suisun Bay. Certain conditions of temperature, turbidity, and food availability characterize suitable pelagic habitat for delta smelt and are discussed in detail in the Status of the Species/Environmental Baseline section, above. Factors such as high entrainment risk and contaminant exposure can degrade this PCE even when the basic water quality is consistent with suitable habitat.

Primary Constituent Element 3: "River flow" is defined as transport flow to facilitate spawning migrations and transport of offspring to LSZ rearing habitats. River flow includes both inflow to and outflow from the Delta, both of which influence the movement of migrating adult, larval, and juvenile delta smelt. Inflow, outflow, and Old and Middle Rivers flow influence the vulnerability of delta smelt larvae, juveniles, and adults to entrainment at Banks and Jones (refer to Status of the Species/Environmental Baseline section, above). River flow interacts with the fourth primary constituent element, salinity, by influencing the extent and location of the highly productive LSZ where delta smelt rear.

Primary Constituent Element 4: "Salinity" is defined as the LSZ nursery habitat. The LSZ is where freshwater transitions into brackish water; the LSZ is defined as 0.5-6.0 psu (parts per thousand salinity; (Kimmerer 2004). The 2 psu isohaline is a specific point within the LSZ where the average daily salinity at the bottom of the water is 2 psu (Jassby et al. 1995). By local convention the location of the LSZ is described in terms of the distance from the 2 psu isohaline to the Golden Gate Bridge (X2); X2 is an indicator of habitat suitability for many San Francisco Estuary organisms and is associated with variance in abundance of diverse components of the ecosystem (Jassby et al. 1995; Kimmerer 2002). The LSZ expands and moves downstream when river flows into the estuary are high. Similarly, it contracts and moves upstream when river flows are low. During the past 40 years, monthly average X2 has varied from as far downstream as San Pablo Bay (45 km) to as far upstream as Rio Vista on the Sacramento River (95 km). At all times of year, the location of X2 influences both the area and quality of habitat available for delta smelt to successfully complete their life cycle. In general, delta smelt habitat quality and surface area are greater when X2 is located in Suisun Bay. Both habitat quality and quantity diminish the more frequently and further the LSZ moves upstream, toward the confluence.

Overview of Delta Smelt Habitat and the Primary Constituent Elements

As previously described in the Status of the Species/Environmental Baseline section, delta smelt live their entire lives in the tidally-influenced fresh- and brackish waters of the San Francisco Estuary (Moyle 2002). Delta smelt are an open-water, or pelagic, species. They do not associate strongly with structure. They may use nearshore habitats for spawning (PCE #1), but free-swimming life stages mainly occupy offshore waters (PCE #2). Thus, the distribution of the population is strongly influenced by river flows through the estuary (PCE #3) because the quantity of fresh water flowing through the estuary changes the amount and location of suitable low-salinity, open-water habitat (PCE #4). This is true for all life stages. During periods of high river flow into the estuary, delta smelt distribution can transiently extend as far west as the Napa

River and San Pablo Bay. Delta smelt distribution is highly constricted near the Sacramento-San Joaquin river confluence during periods of low river flow into the estuary (Feyrer et al. 2007). In the 1994 designation of critical habitat, the best available science held that the delta smelt population was responding to variation in spring X2. In the intervening 14 years, the scientific understanding of delta smelt habitat has improved. The current understanding is that X2 and the combined water flows of the Old River and Middle River both must be considered to manage entrainment and that X2 indexes important habitat characteristics throughout the year.

Alterations to Estuarine Bathymetry PCE # 1 (~ 1850-present)

The first major change in the LSZ was the conversion of the landscape over which tides oscillate and river flows vary (Nichols et al. 1986). The ancestral Delta was a large tidal marsh-floodplain habitat totaling approximately 300,000 acres. Most of the wetlands were diked and reclaimed for agriculture or other human use by the 1920s. The physical habitat modifications of the Delta and Suisun Bay were mostly due to land reclamation and urbanization. Water conveyance projects and river channelization have had some influence on the regional physical habitat by armoring levees with riprap, building conveyance channels like the Delta Cross Channel, storage reservoirs like Clifton Court Forebay, and by building and operating temporary barriers in the south Delta and permanent gates and water distribution systems in Suisun Marsh.

In the 1930s to 1960s, the shipping channels were dredged deeper (~12 m) to accommodate shipping traffic from the Pacific Ocean and San Francisco Bay to ports in Sacramento and Stockton. These changes left Suisun Bay and the Sacramento-San Joaquin river confluence region as the largest and most bathymetrically variable places in the LSZ. This region remained a highly productive nursery for many decades (Stevens and Miller 1983; Moyle et al. 1992; Jassby et al. 1995). However, the deeper landscape created to support shipping and flood control requires more freshwater outflow to maintain the LSZ in the large Suisun Bay/river confluence region than was once required (Gartrell 2010).

Seasonal salinity intrusion reduces the temporal overlap of the LSZ (indexed by X2) with the Suisun Bay region, especially in the fall (Feyrer et al. 2007, 2010). Thus, the second major change has been in the frequency with which the LSZ is maintained in Suisun Bay for any given amount of precipitation (DFG 2010). This metric showed a step-decline in 1977 from which it has never recovered for more than a few years at a time. Based on model forecasts of climate change and water demand, this trend is expected to continue (Feyrer et al. 2011). As such this alteration of PCE # 1 also affects the other PCEs, particularly PCE # 4. The major landscape factor affecting this interaction was the dredging of shipping channels.

Spawning delta smelt require all four PCEs, but spawners and embryos are the life stage that is believed to most require a specific structural component of habitat. Spawning delta smelt require sandy or small gravel substrates for egg deposition (Bennett 2005). The major invasive species effect on physical habitat is the dense growth of submerged aquatic vegetation in the Delta (described in more detail below). These plants carpet large areas in parts of the Delta such as Frank's Tract. The vegetation beds act as mechanical filters removing turbidity and possibly

other water quality components as the tides and river flows move water over them (Hestir 2010). Thus, the proliferation of submerged aquatic plants has likely also reduced the area of nearshore habitat suitable for delta smelt spawning.

Alterations to Water (PCE # 2)

PCE # 2 is primarily referring to a few key water quality components (other than salinity) that influence spawning and rearing habitat suitability for delta smelt. Research to date indicates that water quality conditions are more important than physical habitat conditions for predicting where delta smelt occur (Feyrer et al. 2007; Nobriga et al. 2008) – probably because delta smelt is a pelagic fish except during its egg/embryo stage. However, the interaction of water quality and bathymetry is thought to generally affect estuarine habitat suitability (Peterson 2003) and there is evidence that delta smelt habitat is optimized when appropriate water quality conditions overlap the Suisun Bay region (Moyle et al. 1992; Hobbs et al. 2006; Feyrer et al. 2011). This is discussed further in the section about PCE # 4 (salinity).

Reduced turbidity (1999-present)

The next major change was a change in estuarine turbidity that culminated in an estuary-wide step-decline in 1999 (Schoellhamer 2011). For decades, the turbidity of the modified estuary had been sustained by very large sediment deposits resulting mainly from gold mining in the latter 19th century. The sediments continued to accumulate into the mid-20th century, keeping the water relatively turbid even as sediment loads from the Sacramento River basin declined due to dam and levee construction (Wright and Schoellhamer 2004). The flushing of the sediment deposits may also have made the estuary deeper overall and thus a less suitable nursery from the 'static' bathymetric perspective (Schroeter 2008). Delta smelt larvae require turbidity to initiate feeding (Baskerville-Bridges et al. 2004), and as explained above, older fish are thought to use turbidity as cover from predators. Thus, turbidity is an aspect of PCE # 2 which is a necessary water quality aspect of delta smelt's critical habitat.

Dams and armored levees have contributed to the long-term decline in sediment load to the estuary (Wright and Schoellhamer 2004) and to the clearing of estuary water. This is a long-term effect that stemmed from building and maintaining infrastructure. Opportunities to substantively address this change are limited due to the extreme Central Valley flood and water supply risks that would result from decommissioning dams or removing levees.

Alterations of River Flows PCE # 3

This PCE refers to the transport flows that help guide young delta smelt from spawning habitats to rearing habitats, and to flows that guide adult delta smelt from rearing habitats to spawning habitats. Delta outflow also has some influence on delta smelt's supporting food web (Jassby et al. 2002; Kimmerer 2002) and it affects abiotic habitat suitability as well (Feyrer et al. 2007; 2011). The latter is expanded upon in the discussion of PCE # 4. The environmental driver with the strongest influence on PCE # 3 is highly dependent on the time-scale being considered. The

tide has the largest influence on flow velocities and directions in delta smelt's critical habitat at very short timescales (minutes to days), whereas interannual variation in precipitation and runoff has the largest influence on flows into and through the Delta at very long timescales (years to decades), and sometimes at shorter time scales (days to weeks) during major storm events. Changes to flow regimes can have the largest influence on PCE #3 at timescales of weeks to seasons. This is particularly true during periods of low natural inflow, for instance during the fall and during droughts, and in the south Delta where Old and Middle River flows are often managed using changes in export flow rates.

Salinity PCE # 4

The core delta smelt habitat, is the LSZ (Moyle et al. 1992; Bennett 2005). The LSZ is where freshwater transitions into brackish water, and is defined as the area of the estuary where salinity ranges from 0.5-6.0 psu (parts per thousand salinity; Kimmerer 2004). This area is always moving due to tidal and river flow variation. Larval delta smelt tend to reside somewhat landward (upstream) of X2 (Dege and Brown 2004), but the center of juvenile distribution tends to be very near X2 until the fish start making spawning migrations in the winter (Feyrer et al. 2011; Sommer et al. 2011). Because of this association between the distribution of salinity in the estuary and the distribution of the delta smelt population, the tidal and river flows that comprise

PCE # 3 affect PCE # 4.

The expansion and contraction of the LSZ affects the areal extent of abiotic habitat for delta smelt, both during spring (Kimmerer et al. 2009) and fall (Feyrer et al. 2007, 2011). In the spring, most delta smelt are larvae or young juveniles and the LSZ is typically maintained over the expansive Suisun Bay region. Thus, abiotic habitat "limitation" is unlikely and no consistent influence of spring X2 variation on later stage abundance estimates has been reported to date (Jassby et al. 1995; Bennett 2005; Kimmerer et al. 2009). Historical maxima in juvenile abundance according to CDFW's TNS occurred in low outflow years when abiotic habitat area was comparatively low (Kimmerer 2002; Kimmerer et al. 2009).

In contrast, during fall delta smelt are late stage juveniles and for the past decade or more, the LSZ has been persistently constricted by low Delta outflow. Fall habitat conditions affect delta smelt distribution and the concurrent FMWT abundance index (Feyrer et al. 2007, 2011). However, the quantitative life cycle models developed to date have not found evidence for a year over year effect of fall LSZ location on delta smelt population dynamics (Mac Nally et al. 2010; Thompson et al. 2010; Deriso 2011).

It is now recognized that some delta smelt occur year-around in the Cache Slough region including the Sacramento River Deep Water Shipping Channel and Liberty Island (Kimmerer 2011; Miller 2011; Sommer et al. 2011). The latter has been a consistently available habitat only since 1997. This region is often lower in salinity than 0.6 psu – the lower formal limit of the LSZ as defined by Kimmerer (2004). Delta smelt likely use it because it is one of the most turbid habitats remaining in the Delta (Nobriga et al. 2005). A recent population genetic study found no

evidence that delta smelt inhabiting this region are unique compared to delta smelt using the LSZ-proper (Fisch et al. 2011), therefore it is likely that individual delta smelt migrate between the LSZ and the Cache Slough region. This is consistent with the high summer water temperatures observed there, which might compel individual delta smelt to seek out cooler habitats within and outside the Cache Slough region.

Cumulative Effects

Cumulative effects include the effects of future State, Tribal, local, or private actions that are reasonably certain to occur in the area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section, because they require separate consultation pursuant to section 7 of the Act.

Within the action area, non-Federal diversions of water (e.g., municipal and industrial uses, as well as diversions through intakes serving numerous small, private agricultural lands) are on-going and likely to continue into the foreseeable future. These non-federal diversions are not likely to entrain very many delta smelt based on the results of a study by Nobriga et al. (2004). Nobriga et al. (2004) reasoned that the littoral location and low-flow operational characteristics of these diversions reduced their risk of entraining delta smelt. A study of the Morrow Island Distribution System by DWR produced similar results, with one demersal species and one species that associates with structural environmental features together accounting for 97-98 percent of entrainment; only one delta smelt was observed to be entrained during the two years of the study (DWR 2007). Although these non-federal diversions do not appear to entrain large numbers of delta smelt, they are a source of entrainment for delta smelt.

State or local levee maintenance may also destroy or adversely affect delta smelt spawning or rearing habitat and interfere with natural, long term spawning habitat-maintaining processes. Operation of flow-through cooling systems on the Mirant electrical power generating plants that draw water from and discharge into the action area may also adversely affect delta smelt in the form of entrainment and locally increased water temperatures.

Adverse effects to delta smelt and its critical habitat may result from point and non-point source chemical contaminant discharges within the action area. These contaminants include, but are not limited to ammonia and free ammonium ion, numerous pesticides and herbicides, and oil and gasoline product discharges. Oil and gasoline product discharges may be introduced into Delta waterways from shipping and boating activities and from urban activities and runoff. Implicated as potential stressors of delta smelt, these contaminants may adversely affect fish reproductive success and survival rates.

Other future, non-Federal actions within the action area that are likely to occur and may adversely affect delta smelt and its critical habitat include: the dumping of domestic and industrial garbage that decreases water quality; construction and maintenance of golf courses that reduce habitat and introduce pesticides and herbicides into the aquatic environment; oil and gas development and production that may affect aquatic habitat and may introduce pollutants into the

water; agricultural activities, including burning or removal of vegetation on levees that reduce riparian and wetland habitats that contribute to the quality of habitat used by delta smelt; and livestock grazing activities that may degrade or reduce riparian and wetland habitats that contribute to the quantity and quality of habitat used by delta smelt.

Climate Change

The global average temperature has risen by approximately 0.6 degrees centigrade during the 20th Century (International Panel on Climate Change 2001, 2007; Adger et al 2007). There is an international scientific consensus that most of the warming observed has been caused by human activities (International Panel on Climate Change 2001, 2007; Adger et al. 2007), and that it is "very likely" that it is largely due to increasing concentrations of greenhouse gases (carbon dioxide, methane, nitrous oxide, and others) in the global atmosphere from burning fossil fuels and other human activities (Cayan et al. 2005, EPA Global Warming webpage http://yosemite.epa.gov; Adger et al. 2007). Eleven of the twelve years between 1995 and 2006 rank among the twelve warmest years since global temperatures began in 1850 (Adger et al. 2007). The warming trend over the last fifty years is nearly twice that for the last 100 years (Adger et al. 2007). Under a high emissions scenario, the International Panel on Climate Change estimates that global temperatures will rise another four degrees centigrade by the end of this Century; even under a low emissions growth scenario, the International Panel on Climate Change estimates that the global temperature will go up another 1.8 degrees centigrade (International Panel on Climate Change 2001). The increase in global average temperatures affects certain areas more than others. The western United States, in general, is experiencing more warming than the rest of the Nation, with the 11 western states averaging 1.7 degrees Fahrenheit warmer temperatures than this region's average over the 20th Century (Saunders et al. 2008). California, in particular, will suffer significant consequences as a result of global warming (California Climate Action Team 2006).

In California, reduced snowpack will cause more winter flooding and summer drought, as well as higher temperatures in lakes and coastal areas. The incidence of wildfires in California will also increase and the amount of increase is highly dependent upon the extent of global warming. No less certain than the fact of global warming itself is the fact that global warming, unchecked, will harm biodiversity generally and cause the extinction of large numbers of species. If the global mean temperatures exceed a warming of two to three degrees centigrade above pre-industrial levels, twenty to thirty percent of plant and animal species will face an increasingly high risk of extinction (International Panel on Climate Change 2001, 2007).

The mechanisms by which global warming may push already imperiled species closer or over the edge of extinction are multiple. Global warming increases the frequency of extreme weather events, such as heat waves, droughts, and storms (International Panel on Climate Change 2001, 2007; California Climate Action Team 2006; Lenihan et al. 2003). Extreme weather events may cause mortality of individuals and significantly influence which species will remain extant or occur in natural habitats. Where populations are isolated, a changing climate may result in local extinctions, with range shifts precluded by lack of habitats.

The delta smelt is an obligate, aquatic species and its population could be negatively affected by climate change. Through the use of models and evidence of planetary warming due to greenhouse gasses, science can predict the possible ecological changes that might occur in the San Francisco Bay-Delta ecosystem in future years (Cloern et al. 2011). Dramatic weather changes could result in an increased frequency of drought within the legal Delta, increased air temperatures, reduced suitable aquatic habitat (Cloern et al. 2011) and also reduced native prey populations. Reductions in freshwater outflow can shift X2 upstream, where habitat conditions are less suitable. Shifts in X2 may have negative consequences for delta smelt breeding and survival. Conversely, climate change may lead to years where heavy rainfall and snow melt is common, causing more frequent flood events and sea level rise that may lead to drastic changes in water salinity levels appropriate for delta smelt survival.

There is currently no quantitative analysis of how ongoing climate change is currently affecting delta smelt and the Delta ecosystem. Climate change could have caused shifts in the timing of flows and water temperatures in the Delta which could lead to a change in the timing of migration of adult and juvenile delta smelt.

Effects of the Proposed Action

CDBW proposes to continue to utilize 2,4-D and Glyphosate along with the adjuvant Agri-dex during the 2013-2017 WHCP. Application of the adjuvant and these herbicides onto water hyacinth mats in the Delta may pose direct and indirect effects to delta smelt and its critical habitat. Although, based on toxicological studies conducted, it is anticipated that any direct effects to delta smelt are likely to be low.

CDBW proposes to begin utilizing penoxsulam and imazamox and the adjuvant Competitor only in Areas 3 and 4 between March 1 and November 30 for the 2013-2017 WHCP. Application of the adjuvant and the herbicides onto water hyacinth mats within the Delta may pose direct and indirect effects to delta smelt and its critical habitat. In Areas 3 and 4 it is anticipated that any direct effects to delta smelt are likely to be low because the herbicides will be applied where delta smelt habitat is considered to be of poor quality and the occurrence of delta smelt in those areas is low.

However, because of the timing and location of its use, it is anticipated that any direct effects to delta smelt are likely to be low.

No permanent effects to delta smelt critical habitat are likely to occur as a result of WHCP operations. Temporary effects to critical habitat include habitat loss caused by decreased DO levels (due to decaying water hyacinth), and decreases in the abundance of aquatic invertebrates that form the prey base of the delta smelt. Decreased DO below 5 mg/L could result in behavioral avoidance or physiological stress by adult delta smelt, or egg/larval mortality.

2,4-D and Glyphosate

Acute toxicological studies conducted on delta smelt were performed by CDFW-Aquatic Toxicology Laboratory. The results demonstrated that the environmental concentrations which would result from WHCP activities were less than toxicity thresholds for larval delta smelt (DFG 2004). Toxicological data and field studies suggest that 2,4-D, glyphosate, and Agri-Dex present low mortality risk to delta smelt.

Xie (2005) conducted monitoring of 2,4-D in a field application setting on juvenile rainbow trout which are used as surrogates for delta smelt because they are an established cold-water fish used for toxicity testing. The study observed no acute toxicity to juvenile rainbow trout but observed vitellogenin-induction levels higher than controls in laboratory exposures. The increased production of vitellogenin, an egg yolk precursor, indicates that 2,4-D could cause endocrine disruption at EPA-permitted application rates (Xie 2005). The estrogenic activity of 2,4-D is concerning as the metabolic consequences of increase in unneeded egg yolk precursor production in females or the production of any egg yolk precursors in males is unknown. Endocrine disruption could alter the development, growth or reproduction of delta smelt. No additional studies have further linked 2,4-D to endocrine disruption in aquatic species since Xie (2005). The extent to which individual delta smelt may be affected by 2, 4-D in this manner or whether such effects would have population level consequences cannot be determined with currently available scientific information.

Indirect ecosystem level effects from broad spectrum herbicide application include; decreased productivity for food web production within lower tropic levels, increased areas with low DO, and multiple chemical exposures to delta smelt at low doses. Although studies of 2,4-D, glyphosate, and Agri-Dex have not shown individual pronounced toxicological effects on delta smelt, or their eggs or larvae, it is not clear how these herbicides will interact when combined with other contaminants present within the delta. In the spring and summer months, there are several sources of pesticides within the Delta including external and within-delta inputs (Kuivilia and Moon 2004). Interactions between pesticides, herbicides, and other contaminants within the Delta may cause harm to delta smelt and/or their food web. Zooplankton is a key food source for delta smelt. Richards *et al.* (2004) linked reduced zooplankton diversity within the Delta to increased contaminants, which could be an important factor in the decrease of delta smelt populations (Kuivila and Foe 1995).

Most delta smelt spawning occurs from April through mid-May (Moyle 2002) with larvae development coinciding with the proposed April 1 start date of WHCP herbicide treatments within the delta. Contaminants and physiochemical stressors (i.e. low DO levels or high carbon dioxide levels) can deteriorate the health of delta smelt leaving them more vulnerable to harm and/or harassment caused by predation and disease, particularly during their development, as larval and juvenile smelt are more sensitive to environmental stressors than adult delta smelt (Teh 2007). Environmental stressors such as decreased levels of DO caused by decaying water hyacinth following herbicide treatment, can particularly affect delta smelt eggs and larvae. Delta

smelt larvae are semi-buoyant and subject to hydrology and could be directed by river flows into areas of low DO which could cause direct mortality, harm and/or harassment to the larvae.

Penoxsulam and Imazamox

The newly proposed herbicides penoxsulam and imazamox included for the 2013-2017 WHCP program have only recently been registered in California. Because the herbicides are newly registered, little or no independent toxicity data is available other than that generally produced during the registration process. Due to recent registration, very little additional toxicological data is available. Longer aqueous half-lives and increased mobility for penoxsulam and imazamox as compared to 2,4-D and glyphosate suggest the potential for increased aquatic environmental risk. Immunofuction and endocrine effects from exposures are also unknown. Concerns about potential risks may be addressed by bioassays on delta smelt. Proposed future toxicity tests will clarify the risk of penoxsulam and imazamox on larval and adult delta smelt from their use. Prior to the proposed future toxicity tests being conducted on delta smelt, the WHCP is proposing to only utilize penoxsulam and imazamox in Areas 3 and 4 from March 1 to November 30 when delta smelt are unlikely to be present in the area to further reduce any possible risks to delta smelt.

Acute toxicology data for the newly registered penoxsulam and imazamox are available only from the EPA pesticide registration process and thus very few peer reviewed studies are available. Toxicity tests on other fishes showed penoxsulam and imazamox to be practically nontoxic with LC50's above 100 mg/L. Penoxsulam and imazamox have bluegill EC50's of >103 and >120 mg/L which are lower in comparison to 2,4-D and Glyphosate, 2600 and >1000 mg/L respectively, indicative of higher toxicity (Fairchild 2011). Despite higher toxicities, the reduced environmental risk of penoxsulam and imazamox comes from the reduced application volume required during treatment. The EPA's Ecological Risk Assessment for penoxsulam found that for two fish species, risk did not exceed concern levels for aquatic organisms or endangered species (USEPA 2007). No EPA Ecological Risk Assessment has been conducted for imazamox. Acute or chronic data on the effects of exposures of penoxsulam or imazamox on delta smelt are not yet available.

The registration toxicity data for standard toxicity when testing fish species suggests that environmental concentrations from the WHCP activities with the proposed chemicals would be less than the toxicity thresholds. Although toxicity thresholds for these two herbicides are lower than for 2,4-D or glyphosate (implying they are more toxic), risk from their use is reduced because the WHCP proposes to apply them at lower concentrations than the existing program herbicides. This available data suggest that there would be no effect on delta smelt from their use.

Adjuvants: Agri-Dex and Competitor

Acute toxicity studies by the Washington State University have indicated that Agri-Dex® (the active ingredients are Paraffin Base Petroleum Oil/Polyoxyethylate Polyol Fatty Acid Esters)

is practically non-toxic and is significantly less toxic to rainbow trout than the previously used adjuvant R-11® (Smith et al. 2004). Competitor®, a vegetable oil-based adjuvant, is slightly toxic with a rainbow trout LC50 of 95 mg/L (WSDA 2005) as compared to >1000 mg/L for Agridex with similar application rates.

Conclusion

After reviewing the current status of the delta smelt and its critical habitat, the environmental baseline for the project action area, the effects of the proposed project, the applicant's proposed conservation measures, and cumulative effects, it is the Service's opinion that the WHCP, as proposed, is not likely to jeopardize the continued existence of the delta smelt or result in the destruction or adverse modification of its critical habitat. This determination was based on the temporary nature of the effects proposed, WHCP treatment restrictions, the applicant's proposed conservation measures, and the non-toxicity of 2,4-D, glyphosate and Agri-dex® at the levels used in the 2013-2017 WHCP.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding or sheltering. Harm is defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by impairing behavioral patterns including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act, provided that such taking is in compliance with this Incidental Take Statement.

The measures described below are nondiscretionary for listed species in this biological opinion and must be implemented by USDA-ARS so they become binding conditions of any grant or permit issued to the applicant, as appropriate, in order for the exemption in section 7(o)(2) to apply. USDA-ARS has a continuing duty to regulate the activity that is covered by this incidental take statement. If the Federal agency (1) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, and/or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

Amount or Extent of Take

Delta Smelt

The Service anticipates that incidental take of delta smelt in the form of harassment, harm, and mortality may occur. However, take is expected to be low. The Service anticipates difficulty in detecting take and cannot provide precise numbers of delta smelt that could be harassed, harmed, or killed by 2013-2017 WHCP operations. Delta smelt have a relatively small body size and they are relatively cryptic. Their presence in the Delta coincides with relatively turbid conditions, and their presence in aquatic vegetation makes them difficult to detect. Accordingly, the Service is quantifying take incidental to the project as all delta smelt located within the acres of water where hyacinth mats are being treated within the Delta and upland tributaries.

The Service anticipates that annually from March 1 to November 30 during the years of 2014 to 2017 as much as 3,500 acres (5,000 acres for the 2013 treatment season only) of water hyacinth mats located within the Delta which is designated as delta smelt critical habitat could be temporarily impacted as a result of chemical control of water hyacinth. Delta smelt distribution will shift throughout the year, depending on timing and life stage. As such, it can be assumed that not all of the 3,500 acres of water hyacinth mats within the Delta will have delta smelt occurring within the area during the time of application. Numerous sites within the WHCP treatment area are situated outside of delta smelt range (Areas 3 and 4) and/or are in areas that do not contain essential PCE's of delta smelt critical habitat. Additional sites are located outside of areas where delta smelt are likely to be found or in areas considered low quality delta smelt habitat due to low flow and/or low DO levels. The Service anticipates that in 2013 from March 1 to November 30, as much as 5,000 acres of water hyacinth mats located within the Delta which is designated as delta smelt critical habitat could be temporarily impacted as a result of chemical control of the water hyacinth.

The Service concludes that all delta smelt inhabiting areas surrounding up to 5,000 acres of water hyacinth mats in 2013, and as much as 3,500 acres of water hyacinth mats annually from 2014 to 2017, within delta smelt habitat may be harassed, harmed or killed by the temporary modification and degradation of habitat as a result of WHCP operations. This is the maximum acreage of water hyacinth mats that could potentially be treated through the proposed action. However, the Service believes that the actual acres of water hyacinth mats within habitat that could support delta smelt subject to WHCP operational activities will be less than the maximum acreage estimated above and that actual take in the form of harassment, harm or mortality will be minimal.

The Service has made this determination based on the applicant's proposed Conservation Measures, the number of treatment areas that do not contain essential PCE's for delta smelt or are considered to be of low quality habitat to delta smelt (caused by existing DO levels and slow or no flow, or are outside of delta smelt range), and delta smelt's varied distribution throughout the year which reduces the probability they would occur near or within the area at the time of treatment.

Upon implementation of the following reasonable and prudent measures, incidental take associated with WHCP operations in the form of harm, harassment, the USDA-ARS and CDBW will become exempt from the prohibitions described under section 9 of the Act.

Effect of the Take

The Service has determined that this level of anticipated take is not likely to result in jeopardy to the delta smelt. We base this determination on the temporary nature of the effects, proposed WHCP treatment restrictions, and the non-toxicity of 2,4-D, Glyphosate, and Agri-dex® at the levels used in habitat containing PCE's of delta smelt (within Areas 1 and 2) of the WHCP. Areas 3 and 4 are considered to be located outside of delta smelt range and the habitat does not contain PCE's for delta smelt. Therefore the WHCP treatment in areas 3 and 4 is not expected to have effect on delta smelt. Delta smelt critical habitat will not be adversely modified or destroyed by the proposed action.

Reasonable and Prudent Measures

The following reasonable and prudent measures are necessary and appropriate to minimize the effects of the WHCP project to the delta smelt:

1. The USDA-ARS shall ensure CDBW complies with this biological opinion.

2. The USDA-ARS shall ensure CDBW minimizes effects to delta smelt and its critical habitat.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, the USDA-ARS shall ensure CDBW complies with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are non-discretionary.

1) The following terms and conditions implement Reasonable and Prudent Measure Number One (1) and Two (2):

    a. The USDA-ARS shall ensure CDBW implements the Conservation Measures proposed by CDBW and as described in the Project Description (page 21) of this biological opinion.

Reporting Requirements

The Service is to be notified immediately of the finding of any listed species or any unanticipated take or suspected take of species addressed in this opinion. Injured delta smelt must be cared for by a qualified person such as the Service-approved biologist. Dead individuals of this species

shall be placed in a zip-lock® plastic bag or jar with appropriate preservative solution containing a piece of paper with the date, time, location where the animal was found, and who found it written in permanent ink. The plastic bag should be placed in a freezer in a secure location. The Service and CDFW must be notified within twenty-four (24) hours of discovery of death or injury to delta smelt or GGS that occurs due to project related activities or is observed at the project site. The notification must include the date, time, and location of the incident or of the finding of a dead or injured animal and be clearly indicated on a USGS 7.5 minute quadrangle and other maps at a finer scale. The Service contacts are Kim S. Turner, Assistant Field Supervisor, at telephone (916) 930-5604 and Dan Crum, Resident Agent-in-Charge of the Service's Law Enforcement Division, at telephone (916) 414-6660. The CDFW contact person is Andrea Boertien, Environmental Scientist, at telephone (209) 942-6070.

The USDA-ARS and the CDBW will submit to the Service an annual project review and monitoring report by January 31st annually. The annual report will detail the following:

a. The date, time and number of times an individual site was treated;
b. Amount and type of chemical used at each site;
c. Treatment methods utilized throughout the year;
d. Whether listed species or its habitat were present;
e. All environmental scientist and treatment crew monitoring results; and
f. Results of the 2013 DO Monitoring Study.

The USDA-ARS and the CDBW will submit to the Service weekly field surveys beginning in late February to identify re-growing water hyacinth compared with the location of the most recent state and Federal fish monitoring data.

In addition, upon completion of toxicological testing of the herbicides imazamox and penoxsulam on delta smelt, all reporting, methodologies, and results will be provided to the Service.

Unless new information reveals effects of the proposed action may affect listed species to an extent not considered in this document or a new species or critical habitat is designated that may be affected by the proposed action, no further action pursuant to the Act is necessary. Any actions or proposed actions that are modified in a manner that causes an effect to listed species or critical habitat that was not considered in this consultation will require re-initiation.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities that can be implemented to further the purposes of the Act, such as preservation of endangered species habitat, implementation of recovery actions, or development of information and data bases.

1. The Service recommends CDBW and USDA-ARS work to increase public awareness of potential threats to proper ecosystem function by exotic species introductions such as water hyacinth and increase public awareness of the importance of native flora and fauna of the Delta and its tributaries.

2. The Service recommends CDBW and USDA-ARS work to assist the Service in implementing recovery actions identified in the recovery plans for the valley elderberry longhorn beetle, GGS, and Sacramento-San Joaquin Delta native fishes.

To be kept informed of actions minimizing or avoiding adverse effects or benefiting listed and proposed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION - CLOSING STATEMENT

This concludes formal consultation with USDA-ARS for the proposed 2013-2017WHCP. As provided in 50 CFR 402.16, re-initiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the proposed action 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 to listed species or critical habitat that was not considered in this opinion; or (4) a new species or critical habitat is designated that may be affected by the proposed action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending re-initiation.

Please address any questions or concerns regarding this response to Tiffany Heitz, Fish and Wildlife Biologist, at Tiffany_Heitz@fws.gov or (916) 930-5627. Please refer to Service file number 81410-2013-F-0005 in any future correspondence regarding this project.

Sincerely,

Michael Chotkowski
Field Supervisor

cc: NMFS, Garwin Yip
DFW, Jim Starr
CDBW, Director

Literature Cited

Adger, N., P. Aggarwal, S. Agrawala, J. Alcamo, A. Allali, O. Anisimov, N. Arnell, M. Boko, O. Canziani, T. Carter, G. Casassa, U. Confalonieri, R. V. Cruz, E. de Alba Alcaraz, W. Easterling, C. Field, A. Fischlin, B. B. Fitzharris, C. G. Carcia, C. Hanson, H. Harasawa, K. Hennessy, S. Huq, R. Jones, L. K. Bogataj, D. Karoly, R. Klein, Z. Kundzewicz, M. Lal, R. Lasco, G. Love, X. Lu, G. Magrin, L.J. Mata, R. McLean, B. Menne, G. Midgley, M.Q. Mizra, J. Moreno, L. Mortsch, I. Niang-Diop, R. Nicholls, B. Novaky, L. Nurse, A. Nyong, M. Oppneheimer, J. Palutikof, M. Parry, A. Patwardhan, P. R. Lankao, C. Rosenzweig, S. Schneider, S. Semenov, J. Smith J. Stone, J. van Ypersele, D. Vaughan, C. Vogel, T. Wilbanks, P.P. Wong, S. Wu, and G. Yohe. 2007. Working Group II Contribution to the Intergovernmental Panel on Climate Change 4th Assessment Report. Climate Change 2007: Climate change, impacts, adaptation, and vulnerability. Brussels, Belgium.

Amweg, E.L., D.P. Weston, & N.M. Ureda. 2005. Use and toxicity of pyrethroid pesticides in the Central Valley, California, USA. Environmental Toxicology and Chemistry 24: 966–972.

Arthur, J.F., M. D. Ball, and S.Y. Baughman. 1996. Summary of federal and State water project impacts in the San Francisco Bay-Delta estuary, California. Pages 445-495 in J. T. Hollibaugh (editor) San Francisco Bay: the ecosystem. AAAS, San Francisco, CA.

Atwater B.F, S.G. Conard, J.N. Dowden, C.W. Hedel, R.L. MacDonald, and W. Savage. 1979. History, landforms, and vegetation of the estuary's tidal marshes. Pages 347-386 in San Francisco Bay: The Urbanized Estuary – Investigations into the Natural History of San Francisco Bay and Delta With Reference to the Influence of Man. Pacific Division of the American Association for the Advancement of Science. San Francisco, CA.

Bailey, H. C., C. Alexander, C. DiGiorgio, M. Miller, S. I. Doroshov, and D. E. Hinton. 1994. The effect of agricultural discharge on striped bass (Morone saxatilis) in California's Sacramento-San Joaquin drainage. Ecotoxicology 3: 123-142.

Baskerville-Bridges, B., J.C. Lindberg, J.V. Eenennaam and S. Doroshov. 2000. Contributed Paper to the IEP: Progress and development of delta smelt culture: Year-end report 2000. IEP Newsletter, Winter 2001, 14(1): 24-30. Available at < http://www.water.ca.gov/iep/newsletters/2001/IEPNewsletterWinter2001.pdf#page=24>.

Baskerville-Bridges, B., J. C. Lindberg, and S.I. Doroshov. 2004. The effect of light intensity, alga concentration, and prey density on the feeding behavior of delta smelt larvae. Pages 219-228 *in* F. Feyrer, L.R. Brown, R.L. Brown and J.J. Orsi, eds. Early fife history of fishes in the San Francisco Estuary and watershed. Am. Fish. Soc. Symp. 39, Bethesda, MD, USA.

Baxter, R., R. Breuer, L. Brown, M. Chotkowski, F. Feyrer, M. Gingras, B. Herbold, A. Mueller-Solger, M. Nobriga, T. Sommer, and K. Souza. 2008. Pelagic organism decline progress report: 2007 synthesis of results. Available at: <http://www/science.calwater.ca.gov/pdf/workshops/POD/IEP_POD_2007_synthesis_report_031408.pdf>.

Bennett, W.A. and P.B. Moyle. 1996. Where have all the fishes gone? Interactive factors producing fish declines. Pages 519-541 in Hollibaugh, JT, editor. San Francisco Bay: the ecosystem. Pacific Division of the American Association for the Advancement of Science. San Francisco, CA.

Bennett, W.A., W.J. Kimmerer, and J.R. Burau. 2002. Plasticity in vertical migration by native and exotic fishes in a dynamic low-salinity zone. Limnology and Oceanography 47:1496-1507.

Bennett, W.A. 2005. Critical assessment of the delta smelt population in the San Francisco Estuary, California. San Francisco Estuary and Watershed Science Available at <http://repositories.cdlib.org/jmie/sfews/vol3/iss2/art1>.

Bennett, W.A., J.A. Hobbs, and S. Teh. 2008. Interplay of environmental forcing and growth-selective mortality in the poor year-class success of delta smelt in 2005. Final Report to the Interagency Ecological Program.

Brandes, Patricia L. and J.S. McLain. 2001. Juvenile Chinook salmon abundance, distribution, and survival in the Sacramento-San Joaquin Estuary. Contributions to the biology of Central Valley salmonids. Fish Bulletin 179(2). 100 pp.

Brown, R.L. and W.J. Kimmerer. 2002. Delta smelt and CALFED's Environmental Water Account: A summary of the 2002 delta smelt workshop. Prepared for the CALFED Science Program, October 2002.

Brown, L.R. and D. Michniuk. 2007. Littoral fish assemblages of the alien-dominated Sacramento-San Joaquin Delta, California, 1980-1983 and 2001-2003. Estuaries and Coasts 30:186-200.

Brown, L. R., W. A. Bennett, R. W. Wagner, T. Morgan-King, N. Knowles, F. Feyrer, D. H. Schoellhamer, M.T. Stacey, and M. Dettinger. 2011. Implications for future survival of delta smelt from four climate change scenarios for the Sacramento-San Joaquin Delta, California, unpublished data.

Burns, Bo. 2009. Clearcase herbicide technical information (presentation). BASF Chemical Corporation.

CALFED Bay Delta Program. 2000. Ecosystem Restoration Program (ERP Volume 1. Sacramento, California: Prepared for the CALFED Bay Delta Program. CD-ROM Version.

California Climate Action Team. 2006. Climate action team report to Governor Schwarzenegger and the legislature. California Environmental Protection Agency, Sacramento, California.

California Department of Fish and Game. 2011a. http://www.delta.dfg.ca.gov/data/20mm/

California Department of Fish and Game. 2011b. Spring Kodiak Trawl Survey. http://www.delta.dfg.ca.gov/data/skt/

California Department of Fish and Game. 2011c. Summer Tow Net Survey. http://www.delta.dfg.ca.gov/data/townet/

Cayan, D. 2005. Northern hemisphere spring warming during the past five decades: links to snow cover losses. Presented at the 16th conference on climate variability and change. Scripps Institute of Oceanography, University of California, San Diego, January 13, 2005.

Cloern, J.E, N. Knowles L.R. Brown, D. Cayan, and M.D. Dettinger. 2011. Projected evolution of California's San Francisco Bay-Delta-River System in a century of climate change. PLoS ONE 6(9): e24465.

Connon, R. E., L.A. Deanovic, E.B. Fritsch, L.S. D'Abronzo, and I.Werner. 2011. Sublethal responses to ammonia exposure in the endangered delta smelt; *Hypomesus transpacificus* (Fam. Osmeridae). Aquatic Toxicology 105: 369-377.

Connon, R. E., J. Geist, J. Pfeiff, A.V. Loguinov, L.S. D'Abronzo, H. Wintz, C.D. Vulpe, and I. Werner. 2009. Linking mechanistic and behavioral responses to sublethal esfenvalerate exposure in the endangered delta smelt; *Hypomesus transpacificus* (Fam. Osmeridae). BMC Genomics 10: 608. 18 pp.

Culberson, S.D., C.B. Harrison., C. Enright, and M.L. Nobriga. 2004. Sensitivity of larval fish transport to location, timing, and behavior using a particle tracking model in Suisun Marsh, California. Pages 257-267 *in* F. Feyrer, L.R. Brown, R.L. Brown and J.J. Orsi, eds. Early life history of fishes in the San Francisco Estuary and watershed. Am. Fish. Soc. Symp. 39, Bethesda, MD, USA.

Davis, J.A., D. Yee, J.N. Collins, S.E. Schwarzbach, and S.N. Luoma. 2003. Potential for Increased Mercury Accumulation in the Estuary Food Web. San Francisco Estuary and Watershed Science. Vol. 1.

Dege, M. and L.R. Brown. 2004. Effect of outflow on spring and summertime distribution and abundance of larval and juvenile fishes in the upper San Francisco Estuary. Am. Fish. Soc. Symposium 39: 49-65.

Dettinger, M.D. 2005. From climate-change spaghetti to climate-change distributions for 21st Century California. San Francisco Estuary and Watershed Science 3: http://repositories.cdlib.org/jmie/sfews/vol3/iss1/art4.

Dugdale, R.C., F.P. Wilkerson, V.E. Hogue, and A. Marchi. 2007. The role of ammonium and nitrate in spring bloom development in San Francisco Bay. Estuarine, Coastal, and Shelf Science 73:17-29.

Dow Chemical Company. 2008. Product safety assessment, penoxsulam. 233-00438-MM-0908.

DWR Delta Overview. http://baydeltaoffice.water.ca.gov/sdbtbp/deltaoverview/delta_overview.pdf

DWR and Reclamation (California Department of Water Resources and U.S. Bureau of Reclamation). 1994. Biological Assessment - Effects of the Central Valley Project and State Water Project on Delta Smelt and Sacramento Splittail. Prepared for U.S. Fish and Wildlife Service, Sacramento, CA. 230 pp.

DWR 2007. Morrow Island Distribution System fish entrainment study. Interim data summary report, Division of Environmental Services, Sacramento, CA.

Edmunds, J.L., K.M. Kuivila, B.E. Cole, and J.E. Cloern. 1999. Do herbicides impair phytoplankton primary production in the Sacramento-San Joaquin River Delta? In: USGS Toxic Substances Hydrology Program Technical Meeting Proceedings, Charleston, SC, March 8-12, 1999.

Emerine, Sherrie E., R.J. Richardson, S.L. True, A.M. West, and R.L. Roten. 2010. Greenhouse response of six aquatic invasive weeds to imazamox. J. Aquat. Plant. Management. 48.105-111.

Erkkila, L.F., J.F. Moffett, O.B. Cope, B.R. Smith, and R.S. Nelson. 1950. Sacramento-San Joaquin Delta fishery resources: effects of Tracy pumping plant and delta cross channel. U.S. Fish and Wildlife Services Special Report. Fisheries 56. 109 pp.

ESA/Madrone. 1984. Environmental data report, Water hyacinth control plan for the Sacramento-San Joaquin Delta. Sacramento, California. Prepared for the U.S. Army Corps of Engineers.

Feyrer, F, B. Herbold, S.A. Matern, and P.B. Moyle. 2003. Dietary shifts in a stressed fish assemblage: consequences of a bivalve invasion in the San Francisco Estuary. Environmental Biology of Fishes 67:277-288.

Feyrer, F., M.L. Nobriga, and T.R. Sommer. 2007. Multi-decadal trends for three declining fish species: habitat patterns and mechanisms in the San Francisco Estuary, California, USA. Canadian Journal of Fisheries and Aquatic Sciences 64:723-734.

Feyrer, F., K. Newman, M.L. Nobriga and T.R. Sommer. 2011. Modeling the effects of future outflow on the abiotic habitat of an imperiled estuarine fish. Estuaries and Coasts: 34(1):120-128.

Fisch, K. M., J.M. Henderson, R.S. Burton and B. May. 2011. Population genetics and conservation implications for the endangered delta smelt in the San Francisco Bay-Delta. Conservation Genetics. Published online 1 July 2011.

Foott, J. S. and J. Bigelow. 2010. Pathogen survey, gill Na-K-ATPase activity, and leukocyte profile of adult delta smelt. California Department of Fish and Game 96(4): 223-231.

Foott, J. S. and R. Stone. 2007. Histological Evaluation and Viral Survey of Juvenile Longfin Smelt (*Spirinchus thaleichthys*) and Threadfin Shad (*Dorosoma petenense*) collected from the Sacramento-San Joaquin River Delta. U.S. Fish and Wildlife Service, California Nevada Fish Health Center FY 2007 Investigational Report. April-November 2007. 16 pp.

Ganssle, D. 1966. Fishes and decapods of San Pablo and Suisun bays. Pages 64-94 in D.W. Kelley (editors) Ecological studies of the Sacramento-San Joaquin Estuary, Part 1.

Gartrell, G. 2010. Delta Flow Criteria informational proceeding. State Water Resources Control Board, Contra Costa Water District. 14 pp.

Giddings, J.M., L.W. Hall, Jr, and K.R. Solomon. 2000. Ecological risks of diazinon from agricultural use in the Sacramento - San Joaquin River Basins, California. Risk Analysis 20:545–572.

Grimaldo, L.F., A. R. Stewart, and W. Kimmerer. 2009. Dietary segregation of pelagic and littoral fish assemblages in a highly modified tidal freshwater estuary. In review Marine and Coastal Fisheries.

Hallock, R.J. and W. Van Woert. 1959. A survey of anadromous fish losses in irrigation diversions from the Sacramento and San Joaquin rivers. California Fish and Game 45: 227-521.

Hay, D. 2007. Spawning biology of eulachons, longfins and some other smelt species Sacramento, November 15, 2007, Powerpoint presentation. Available on the internet at <http://www.science.calwater.ca.gov/pdf/workshops/workshop_smelt_presentation_Hay_111508.pdf>.

Herbold, B. 1994. Habitat requirements of delta smelt. Interagency Ecological Studies Program Newsletter, Winter 1994. California Department of Water Resources, Sacramento, California.

Hestir, E. 2010. Trends in estuarine water quality and submerged aquatic vegetation invasion. PhD dissertation, University of California, Davis.

Hobbs, J.A., W.A. Bennett, and J. Burton. 2006. Assessing nursery habitat quality for native smelts (Osmeridae) in the low-salinity zone of the San Francisco Estuary. Journal of Fish Biology 69: 907-922.

Hobbs, J.A, W.A. Bennett, J. Burton, and M. Gras. 2007. Classification of larval and adult delta smelt to nursery areas by use of trace elemental fingerprinting. Transactions of the American Fisheries Society 136:518-527.

Houde, E.D. 1987. Subtleties and episodes in the early life of fishes. Journal of Fish Biology 35 (Suppl A): 29-38.

Horpilla, J., A. Liljendahl-Nurminen, and T. Malinen. 2004. Effects of clay turbidity and light on the predator–prey interaction between smelts and chaoborids. Canadian Journal of Fisheries and Aquatic Sciences. 61: 1862-1870.

Howard, P. H., Ed. 1991. Handbook of Environmental Fate and Exposure Data for Organic Chemicals. Vol. III: Pesticides. Lewis Publishers, Chelsea, MI,7-21, 10-10.

Greenfield, B.K. and T.P. McNabb. 2005. Chapter 2: Control costs, operation, and permitting issues for non-chemical plant control: case studies in the San Francisco Bay-Delta region, California. Journal of Aquatic Plant Management. In: Aquatic Pesticide Monitoring Program Nonchemical Alternatives Year 3 Report. Oakland, California. San Francisco Estuary Institute. 15-24.

Greenfield, Ben K., Geoffrey S. Siemering, Joy C. Andrews, Michael Rajan, Stephen P. Andrews Jr., and David F. Spencer. 2007. Mechanical shredding of water hyacinth *(Eichhornia crassipes)*: effects on water quality in the Sacramento-San Joaquin River Delta, California. Estuaries and Coasts. 30(4):627-640.

Gren, G.G. 1983. Office report. Jacksonville, Florida. United States Army Corps of Engineers. August 3, 1983.

HSBD. 2001. U.S. National Library of Medicine. 2001. Hazardous Substances Databank. Bethesda, MD, 10-9 pp.

International Panel on Climate Change (IPCC). 2001. Climate Change 2001: The scientific basis. Contribution of the Working Group I to the 3rd Assessment Report of the Intergovernmental Panel on Climate Change. Houghton, J. T., Ding, D. J., Griggs, M., Noguer, P. J., van der linden, X. Dai, K. Maskell and C. A. Johnson (editors). Cambridge University Press, Cambridge, United Kindgom and New York, New York. 881 pp. Available at <http;//www.ipcc.ch/>.

_____. 2007. Climate Change 2007: The scientific basis. Contribution of the Working Group I to the 4th Assessment Report of the Intergovernmental Panel on Climate Change. Alley, R., T. Bernsten, N. L. Bindoff, Z. Chen, A. Chidthaisong, P. Friedlingstein, J. Gregory, G. Hegerl, M. Heimann, B. Hewiston, B. Hoskins, F. Joos, J. Jouzel, V. Kattsov, U. Lohmann, M. Manning, T. Matsumo, M. Molina, N. Nicholls, J. Overpeck, D. Qin, G. Raga, V. Ramaswamy, J. Ren, M. Rusticucci, S. Solomon, R. Somerville, T. F. Socker, P. Stott, R. F. Souffer, P. Whetton, R. A. Wood, D. Wratt. 21 pp. Available at <http;//www.ipcc.ch/>.

Jassby, A.D., W.J. Kimmerer, S.G. Monismith, C. Armor, J.E. Cloern, T.M. Powell, J.R.Schubel, and T.J. Vendlinski. 1995. Isohaline position as a habitat indicator for estuarine populations. Ecol. Appl. 5(1): 272-289.

Jassby, A.D., J.E. Cloern, and B.E. Cole. 2002. Annual primary production: patterns and mechanisms of change in a nutrient-rich tidal ecosystem. Limnology and Oceanography 47:698-712.

Johnson, M. L., I. Werner, S. Teh, and F. Loge. 2010. Evaluation of chemical, toxicological, and histopathologic data to determine their role in the pelagic organism decline. University of California, Davis. Davis, California.

Kawakami, B.T., R.A. Denton, and G. Gartrell. 2008. Investigation of the Basis for Increases in Delta Fall Salinity. CALFED Science Conference Poster Presentation.

Kimmerer, W.J. and J.J. Orsi. 1996. Causes of long-term declines in zooplankton in the San Francisco Bay estuary since 1987. Pages 403-424 in J. T. Hollibaugh (editor) San Francisco Bay: the ecosystem. AAAS, San Francisco, CA.

Kimmerer, W.J. 2002a. Physical, biological and management responses to variable freshwater flow into the San Francisco Estuary. Estuaries 25: 1275-1290.

_____. 2002b. Effects of freshwater flow on abundance of estuarine organisms: physical effects or trophic linkages. Marine Ecology Progress Series 243:39-55.

_____. 2004. Open water processes of the San Francisco Estuary: from physical forcing to biological processes. San Francisco Estuary and Watershed Science. Available on the internet at <http://repositories.cdlib.org/jmie/sfews/vol2/iss1/art1>.

_____. 2008. Losses of Sacramento River Chinook salmon and delta smelt to entrainment in water diversions in the Sacramento-San Joaquin Delta. San Francisco Estuary and Watershed Science 6:2 (2). Available on the internet at <http://repositories.cdlib.org/jmie/sfews/vol6/iss2/art2>.

Kimmerer, W.J., E.S. Gross, and M.L. MacWilliams. 2009. Is the response of estuarine nekton to freshwater flow in the San Francisco Estuary explained by variation in habitat volume? Estuaries and Coasts (32): 375-389.15 pp. DOI 10.1007/s12237-008-9124-x.

Kimmerer, W.J. 2011. Modeling delta smelt losses at the South Delta export facilities. San Francisco Estuary and Watershed Science 9: Issue 1 [April 2011], article 6.

Knowles, N. 2002. Natural and human influences on freshwater inflows and salinity in the San Francisco Estuary at monthly to interannual scales. Water Resources Research 38(12): 1289. Available on the internet at < http://sfbay.wr.usgs.gov/publications/pdf/knowles_2002_sf_estuary.pdf>

Knutson Jr., A.C. and J.J. Orsi. 1983. Factors regulating abundance and distribution of the shrimp *Neomysis mercedis* in the Sacramento-San Joaquin Estuary. T. Am. Fish. Soc. 112: 476-485.

Kuivila, K. M. and C. G. Foe. 1995. Concentrations, transport, and biological effects of dormant spray pesticides in the San Francisco Estuary, California. Environmental Toxicology and Chemistry 14: 1141-1150.

Kuivila, K.M. and G.E. Moon. 2004. Potential exposure of larval and juvenile delta smelt to dissolved pesticides in the Sacramento-San Joaquin Delta, California. American Fisheries Society Symposium 39:229-242.

Langeland, K., M. Netherland, and W. Haller. 2009. Efficacy of herbicide active ingredients against aquatic weeds. University of Florida IFAS Extension. SS-AGR-44.

Lehman, P.W., G. Boyer, C. Hall, S. Waller, and K. Gehrts. 2005. Distribution and toxicity of a new colonial *Microcystis aeruginosa* bloom in the San Francisco Bay Estuary, California. Hydrobiologia 541:87-99.

Lenihan, J. R., Drapek, D. Bachelet, and R. Neilson. 2003. Climate change effects on vegetation distribution, carbon and fire in California. Ecological Applications 13(6): 1667-1681.

Lindberg, J. C., B. Baskerville-Bridges, and S.I. Doroshov. 2003. "Two Reproductive Concerns Tested in Captive Delta Smelt, *Hypomesus transpacificus*, 2002: I. Effect of substrate and water velocity on spawning behavior.

Linville, R.G., S.N. Luoma, L. Cutter, and G.A. Cutter. 2002. Increased selenium threat as a result of invasion of the exotic bivalve *Potamocorbula amurensis* into the San Francisco Bay-Delta. Aquatic Toxicology 57: 51-64.

Lott, J. 1998. Feeding habits of juvenile and adult delta smelt from the Sacramento-San Joaquin River Estuary. Interagency Ecological Program Newsletter 11(1):14-19. Available at <http://iep.water.ca.gov/report/newsletter/>.

Mac Nally, R., Thomson, J.R., Kimmerer, W. J., Feyrer, F., Newman, K.B., Sih, A., Bennett, W.A., Brown, L., Fleishman, E., Culberson, S.D., and G. Castillo. 2010. Analysis of pelagic species decline in the upper San Francisco Estuary using multivariate autoregressive modeling (MAR). Ecological Applications 20(5): 1417–1430.

Madsen. J.D., and R.M. Wersal. 2008. Herbicide formulations for managing free-floating aquatic plants. 2008 Proceedings, Southern Weed Science Society. 61:210.

Mager, R.C., S.I. Doroshov, J.P. Van Eenennaam, and R.L. Brown. 2004. Early life stages of delta smelt. Pages 169-180 *in* F. Feyrer, L.R. Brown, R.L. Brown and J.J. Orsi, eds. Early fife history of fishes in the San Francisco Estuary and watershed. Am. Fish. Soc. Symp. 39, Bethesda, MD, USA.

Malik, J., Barry, G. and Kishore, G. Minireview. 1989. The herbicide glyphosate. BioFactors. 2(1): 17 25, 10-100.

Marine, K.R. and J.J. Cech Jr. 2004. Effects of high water temperature on growth, smoltification, and predator avoidance in juvenile Sacramento River Chinook salmon. North American Journal of Fisheries Management: 24(1):198–210.

Maunder, M.N and R. B. Deriso. 2011. A state–space multistage life cycle model to evaluate population impacts in the presence of density dependence: illustrated with application to delta smelt (*Hypomesus transpacificus*). Can. J. Fish. Aquat. Sci. 68: 1285–1306.

Miller, W. J. 2011. Revisiting assumptions that underlie estimates of proportional entrainment of delta smelt by state and federal water diversions from the Sacramento-San Joaquin Delta. San Francisco Estuary and Watershed Science, 9(1). Available at <http://escholarship.org/uc/item/5941x1h8>.

Monson, N.E., J.E. Cloern, and J.R. Burau. 2007. Effects of flow diversion on water and habitat quality: examples from California's highly manipulated Sacramento-San Joaquin.

Moyle, P.B. 2002. Inland fishes of California. University of California Press, Berkeley and Los Angeles, Ca.

Moyle, P.B., B. Herbold, D.E. Stevens, and L.W. Miller. 1992. Life history and status of delta smelt in the Sacramento-San Joaquin Estuary, California. Transactions of the American Fisheries Society 121:67-77.

Mueller-Solger, A.B., A.D. Jassby, and D.C. Mueller-Navarra. 2002. Nutritional quality of food resources for zooplankton (Daphnia) in a tidal freshwater system (Sacramento?San Joaquin River Delta), Limnol. Oceanogr. 47(5), 2002, 1468-1476.

Newman K.B. 2008. Sample design-based methodology for estimating delta smelt abundance. San Francisco Estuary and Watershed Science 6(3): article 3.Available at: <http://repositories.cdlib.org/jmie/sfews/vol6/iss3/art3>.

Nichols, F.H., J.E. Cloern, S.N. Luoma, and D.H. Peterson 1986. The modification of an Estuary. Science 231:567-573.

Nobriga, M. and M. Chotkowski 2000. Recent historical evidence of centrarchid increases and tule perch decrease in the Delta. Interagency Ecological Program Newsletter 13(1):23-27. Available at <http://www.iep.ca.gov/report/newsletter>.

Nobriga, M.L. 2002. Larval delta smelt diet composition and feeding incidence: environmental and ontogenetic influences. California Fish and Game 88:149-164.

Nobriga, M. L., Z. Matica, and Z.P. Hymanson 2004. Evaluating Entrainment Vulnerability to Agricultural Irrigation Diversions: A Comparison among Open-Water Fishes. Pages 281-295 in F. Feyrer, L.R. Brown, R.L. Brown, and J.J. Orsi, editors. Early Life History of Fishes in the San Francisco Estuary and Watershed. American Fisheries Society, Symposium 39, Bethesda, Maryland.

Nobriga, M.L., F. Feyrer, R.D. Baxter, and M. Chotkowski. 2005. Fish community ecology in an altered river delta: spatial patterns in species composition, life history strategies and biomass. Estuaries 28:776-785.

Nobriga, M.L. and F. Feyrer. 2007. Shallow-water piscivore-prey dynamics in California's Sacramento-San Joaquin Delta. San Francisco Estuary and Watershed Science 5: Available at <http://repositories.cdlib.org/jmie/sfews/vol5/iss2/art4>.

Nobriga, M. L. and F. Feyrer . 2008. Diet composition of San Francisco Estuary striped bass: does trophic adaptability have its limits? Environmental Biology of Fishes. 83: 495-503.

Nobriga, M. and B. Herbold. 2008. Conceptual model for delta smelt (*Hypomesus transpacificus*) for the Delta Regional Ecosystem Restoration and Implementation Plan (DRERIP).

Nobriga, M.L., T.R. Sommer, F. Feyrer, and K. Fleming. 2008. Long-term trends in summertime habitat suitability for delta smelt, *Hypomesus transpacificus*. San Francisco Estuary and Watershed Science 6: Available at <http//repositories.cdlib.org/jmie/sfews/vol6/iss1/art1>.

Odum, W. E. 1988. Comparative ecology of tidal freshwater and salt marshes. Ann. Rev. Ecol. Syst. 19:147-176.

Oros, D.R. and I. Werner. 2005. Pyrethroid Insecticides: an analysis of use patterns, distributions, potential toxicity and fate in the Sacramento-San Joaquin Delta and Central Valley. White Paper for Interagency Ecological Program. SFEI Contribution 415. San Francisco Estuary Institute, Oakland, CA.

Orsi, J.J. and W. L. Mecum. 1996. Food limitation as the probable cause of a long-term decline in the abundance of Neomysis mercedis the oppossum shrimp in the Sacramento-San Joaquin estuary. Pages 375-401 in Hollibaugh, JT (ed), San Francisco Bay: the ecosystem. American Association for the Advancement of Science, San Francisco.

Ostrach, D. 2008. Multiple stressors and their effects on the striped bass population in the San Francisco estuary. Presented at Interagency Ecological Program 2008 Annual Workshop, Pacific Grove, CA, February 26-29, 2008.

Peterson, M. S., 2003. A conceptual view of environment-habitat-production linkages in Tidal Riverine Estuaries. Review in Fisheries Science 11(4): 291-313.

Powles, Stephen B. 2008. Evolved glyphosate-resistant weeds around the world: lessons to be learnt. Pest Management Science. 64(4)360-365.

Radtke, L.D. 1966. Distribution of smelt, juvenile sturgeon, and starry flounder in the Sacramento-San Joaquin Delta with observations on food of sturgeon, in Ecological studies of the Sacramento-San Joaquin Delta, Part II. In: S.L. Turner and D.W. Kelley (Eds.), Ecological Studies of the Sacramento–San Joaquin Estuary, pp. 115-129. California Department of Fish and Game Fish Bulletin 136.

Rast, W. and J. Sutton. 1989. Stable isotope analysis of striped bass food chain in Sacramento-San Joaquin Estuary, California, April-September, 1986. Water Resources Investigations Rept. 88-4164, U.S. Geological Survey, Sacramento, California. 62 pp.

Reclamation 2008. OCAP Biological Assessment on the Continued Long-term Operations of the Central Valley Project and the State Water Project.

Rose, K.A., J.H. Cowan, K.O. Winemiller, R.A. Myers, and R. Hilborn. 2001. Compensatory density-dependence in fish populations: importance, controversy, understanding, and prognosis. Fish and Fisheries 2: 293-327.

Ruhl, C.A., P.E. Smith, J.J. Simi, and J.R. Burau. 2006. The pelagic organism decline and long-term trends in Sacramento-San Joaquin Delta hydrodynamics. Presentation at the 4th Biennial 2006 CALFED Science Conference, October 23-25, 2006, Sacramento, California.

Saiki, M.K., M.R. Jennings, and R.H. Wiedmeyer. 1992. Toxicity of agricultural subsurface drainwater from the San Joaquin River, California, to juvenile Chinook salmon and striped bass. Transactions of the American Fisheries Society 121:78-93.

Saiki, M.K. 1998. An ecological assessment of the Grassland Bypass Project on fishes inhabiting the Grassland Water District, California. Final report submitted to U.S. Fish and Wildlife Service, Sacramento, CA. 72 pp.

San Francisco Estuary Institute (SFEI). 2004. *Syntheses of Scientific Knowledge for Maintaining and Improving Functioning of the South Bay Ecosystem and Restoring Tidal Salt Marsh and Associated Habitats over the Next 50 Years at Pond and Pond-Complex Scales.* Draft Final Report. Oakland, CA.

Schoellhamer, D. H. 2011. Sudden clearing of estuarine waters upon crossing the threshold from transport as an erodible sediment pool is depleted: San Francisco Bay, 1999. Estuaries and Coasts 34: 885-899.

Schroeter, RE. 2008. Biology and long-term trends of alien hydromedusae and striped bass in a brackish tidal marsh in the San Francisco Estuary. PhD dissertation, UC Davis.

Schuette, Jeff. 1998. Environmental fate of glyphosate. California Department of Pesticide Regulation. 13 pp.

SePRO 2010. Clearcast aquatic herbide label. SePRO Corporation. Indiana.

Slater, Steven. unpublished data California Department of Fish and Game.

Sogard, S. M. 1997. Size-selective mortality in the juvenile stage of teleost fishes: a review. Bulletin of Marine Science 60: 1129-1157.

Sobczak, W. V., J. E. Cloern, A. D. Jassby, and A. B. Muller-Solger. 2002. Bioavailability of organic matter in a highly disturbed estuary: The role of detrital and algal resources. Proceedings of the National Academy of Sciences 99, no. 12: 8101-8105.

Sommer, T.R., C. Armor, R. Baxter, R. Breuer, L. Brown, M. Chotkowski, S. Culberson, F. Feyrer, M. Gingras, B. Herbold, W. Kimmerer, A. Mueller-Solger, M. Nobriga, and K. Souza. 2007. The collapse of pelagic fishes in the upper San Francisco Estuary. Fisheries 32(6):270-277.

Sommer, T., F.H. Mejia, M.L. Nobriga, F. Feyrer, and L. Grimaldo. 2011. The Spawning Migration of Delta Smelt in the Upper San Francisco Estuary. San Francisco Estuary and Watershed Science 9(2)., 17 pages.

Spaar, S. 1994. Delta agricultural diversion evaluation1992 pilot study. California Department of Water Resources, Interagency Ecological Program Technical Report 3, Sacramento, California.

Spencer, D.F. and G.G. Ksander. 2005. Seasonal growth of water hyacinth in the Sacramento/San Joaquin Delta, California. Journal of Aquatic Plant Management. 43:91-94.

Stanley S.E., P.B. Moyle, and H.B. Shaffer. 1995. Allozyme analysis of delta smelt, *Hypomesus transpacificus*, and longfin smelt, *Spirinchus thaleichthys*, in the Sacramento-San Joaquin estuary. Copeia 1995:390–396.

Stevens, D.E. 1963. Food habits of striped bass, *Roccus saxatilis* (Walbaum), in the Sacramento-Rio Vista area of the Sacramento River. Master's Thesis. University of California, Davis.

Stevens, D.E. and L.W. Miller. 1983. Effects of river flow on abundance of young Chinook salmon, American shad, longfin smelt, and delta smelt in the Sacramento-San Joaquin river system. North American Journal of Fisheries Management 3:425-437.

Sullivan et al., unpublished information.

Swanson, C. and J.J. Cech Jr. 1995. Environmental tolerances and requirements of the delta smelt, *Hypomesus transpacificus*. Final Report. California Department of Water Resources Contracts B-59499 and B-58959. Davis, California. July 20, 1995.

Swanson, C., T. Reid, P.S. Young, and J.J. Cech Jr. 2000. Comparative environmental tolerances of threatened delta smelt (*Hypomesus transpacificus*) and introduced wakasagi (*H. nipponensis*) in an altered California estuary. Oecologia 123: 384-390.

Sweetnam, D.A. and D.E. Stevens 1993. Report to the Fish and Game Commission: A status review of the delta smelt (*Hypomesus transpacificus*) in California. Candidate Species Status Report 93-DS. Sacramento, California. 98 pp plus appendices.

Sweetnam, D.A. 1999. Status of delta smelt in the Sacramento-San Joaquin Estuary. California Fish and Game 85:22-27.

Syracuse Environmental Research Associates, Inc. (SERA). 2010. Imazamox – Human Health and Ecological Risk Assessment Final Report. For USDA, Forest Service. New York. 158pp.

Taniguchi, Y., F.J. Rahel, D.C. Novinger, and K.G. Gerow.1998. Temperature mediation of competitive interactions among three fish species that replace each other along longitudinal stream gradients. Canadian Journal of Fisheries and Aquatic Sciences 55:1894-1901.

Teh, S. J. 2007. Final report of histopathological evaluation of starvation and/or toxic effects on pelagic fishes. UC Davis. 28 pages.

Thetmeyer. H. and U. Kils. 1995. To see and not be seen: the visibility of predator and prey with respect to feeding behaviour. Mar. Ecol. Prog. Ser. 126: 1-8.

Thomson, J.R., W.J. Kimmerer, L.R. Brown, K.M. Newman, Mac Nally, R., Bennett, W.A., Feyrer, F. and E. Fleishman. 2010. Bayesian change point analysis of abundance trends for pelagic fishes in the upper San Francisco Estuary. Ecological Applications 20(5): 1431–1448.

Trenham, P.C., H.B. Shaffer, and P.B. Moyle. 1998. Biochemical identification and assessment of population subdivision in morphometrically similar native and invading smelt species (*Hypomesus*) in the Sacramento-San Joaquin Estuary, California. T. Am. Fish. Soc. 127: 417-424.

Turner, J. L. and H. K. Chadwick 1972. Distribution and abundance of young-of-the-year striped bass, Morone saxatilis, in relation to river flow in the Sacramento-San Joaquin estuary. Transactions of the American Fisheries Society 101: 442-452.

Turner, J.L., Kelley, DW (editors). 1966. Ecological studies of the Sacramento-San Joaquin Delta, part II, fishes of the Delta. California Department of Fish and Game Fish Bulletin 136.

United States Environmental Protection Agency (USEPA). May 1997. Pesticide fact sheet, imazamox (Raptor herbicide). Office of Prevention, Pesticides, and Toxic Substances. Washington D.C..

_____2004. Ecological Risk Assessment for the Section 3 Registration of the New Chemical Penoxsulam for Uses on Rice. Environmental Fate and Effects Division (EFED). Washington DC. 55pp.

_____ 2005. Reregistration eligibility decision for 2,4-D. EPA 738-R-05-002. Prevention, Pesticides and Toxic Substance (7508C). 320 pp.

_____2007. Ecological Risk Assessment: Section 3, New Uses on Turf and for Control of Aquatic Vegetation in Aquatic Environments, Penoxsulam. Environmental Fate and Effects Division (EFED). Washington DC. 188pp.

USEPA Environmental Fate and Effects Division (EFED). September 2008. Ecological Risk Assessment Evaluating Imazamox for the Proposed New Use on Clearfield Rice. Washington DC. 85pp

United States Fish and Wildlife Service. 1991. Endangered and threatened wildlife and plants: Proposed threatened status for the delta smelt, October 3, 1991. Federal Register 56(192): 50075-50084.

_____. 1993. Endangered and threatened wildlife and plants: Determination of threatened status for the delta smelt. March 5, 1993. Federal Register 58(42):12854-12864.

_____. 1994a. Endangered and threatened wildlife and plants: Critical habitat determination for the delta smelt. December 19, 1994. Federal Register 59(242): 65256-65279.

_____. 1994b. Formal consultation on the 1994 operation of the Central Valley Project and State Water Project: Effects on delta smelt. Sacramento, California. 34 pp., plus figures.

_____. 1995. Formal consultation and conference on the effects of long-term operation of the Central Valley Project and State Water Project on the threatened delta smelt, delta smelt critical habitat, and proposed threatened Sacramento splittail. Sacramento, California. 52 pages, plus figures and attachment.

_____. 1996. Sacramento-San Joaquin Delta Native Fishes Recovery Plan. Portland, Oregon.

_____. 2004. Five Year Status Review for the Delta Smelt. Sacramento, California. 50 pp.

_____.2010. Endangered and Threatened Wildlife and Plants; 12-Month Finding on a Petition to Reclassify the Delta Smelt From Threatened to Endangered Throughout its Range. Federal Register 75(66):17667-17680.

Utne-Palm, A.C., and J.E. Stiansen. 2005. Effect of larval ontogeny, turbulence and light on prey attack rate and swimming activity in herring larvae. Journal of Experimental Marine Biology and Ecology 268(2):147-170.Available at <http://jeb.biologists.org/cgi/content/full/208/5/831>.

Walters, C. 1997. Challenges in adaptive management of riparian and coastal ecosystems. Conservation Ecology [online]1(2):1. Available at: <http://www.consecol.org/vol1/iss2/art1/>.

Walters, J. 1999. Environmental fate of 2,4-Dichlorophenoxyacetic acid. Sacramento, California. Department of Pesticide Regulation, Environmental Monitoring Program. 12pp.

Wang, J.C.S. 1986. Fishes of the Sacramento-San Joaquin Estuary and adjacent waters, California: a guide to the early life stages. Interagency Ecological Studies Program Technical Report 9. Sacramento.

Wang, J.C.S. 1991. Early life stages and early life history of the delta smelt, *Hypomesus transpacificus*, in the Sacramento-San Joaquin Estuary, with comparison of early life stages of the longfin smelt, *Spirinchus thaleichthys*. Interagency Ecological Studies Program Technical Report 28, August 1991.

Wang, J.C.S. 2007. Spawning, early life stages, and early life histories of the Osmerids found in the Sacramento-San Joaquin Delta of California. Tracy Fish Facilities Studies California Volume 38. U.S. Bureau of Reclamation, Mid-Pacific Region.

Washington Department of Agriculture. 2009. Summary of aquatic acute toxicity data for spray adjuvants allowed for use on aquatic sites in Washington. Pesticide Management Division.

Washington Department of Ecology (DOE). January 2012. Environmental impact statement for penoxsulam, imazamox, bispyribac-sodium, flumioxazin, & carfentrazone-ethy. State of Washington. Publiciation no. 00-10-04-Addendum1. 98pp.

Wauchope, R. D., Buttler, T. M., Hornsby A. G. , Augustijn Beckers, P. W. M. and Burt, J. P. 1992. SCS/ARS/CES Pesticide properties database for environmental decision making. Rev. Environ. Contam. Toxicol. 123: 1-157, 7-22

Weed Science Society of America. 1994. Herbicide Handbook, 7th Edition. Champaign, IL. 59pp.

Werner, I., L.A. Deanovic, V. Conner, V. de Vlaming, H.C. Bailey, and D.E. Hinton. 2000. Insecticide-caused toxicity to *Ceriodaphnia dubia* (Cladocera) in the Sacramento-San Joaquin River Delta, California, USA. Environ. Tox. Chem. 19(1): 215-227.

Werner, I, L. Deanovic, D. Markiewicz, M. Stillway, N. Offer, R. Connon, and S. Brander. 2008. Pelagic organism decline (POD): Acute and chronic invertebrate and fish toxicity testing in the Sacramento-San Joaquin Delta, 2006-2007. Final report to the Interagency Ecological Program, April 30, 2008.

Werner, I., D. Markiewicz, L. Deanovic, R. Connon, S. Beggel, S. Teh, M. Stillway, C. Reece. 2010. Pelagic organism decline (POD): Acute and chronic invertebrate and fish toxicity testing in the Sacramento-San Joaquin Delta, 2008-2010. Final Report. U.C. Davis-Aquatic Toxicology Laboratory, Davis, California.

Weston, D.P., J. You, and M.J. Lydy. 2004. Distribution and toxicity of sediment-associated pesticides in agriculture-dominated water bodies of California's Central Valley. Environmental Science and Technology 38: 2752-2759.

Weston, D.P, R.W. Holmes, J. You, and M.J. Lydy. 2005. Aquatic toxicity due to residential use of pyrethroid insecticides. Environmental Science and Technology 39: 9778-9784.

Weston, B.P. and M.J. Lydy. 2010. Urban and agricultural sources of pyrethroid insecticides to the Sacramento-San Joaquin Delta of California. Environmental Science and Technology 44:1833-1840.

Whitehead, A., K.M. Kuivila, J.L. Orlando, S. Kotelevtsev, and S.L. Anderson. 2004. Genotoxicity in native fish associated with agricultural runoff events. Environmental Toxicology and Chemistry: 23:2868–2877.

Wilkerson, F.P., R.C. Dugdale, V.E. Hogue, and A. Marchi. 2006. Phytoplankton blooms and nitrogen productivity in San Francisco Bay. Estuaries and Coasts 29:401-416.

Winemiller, K.O. and Rose, K.A. 1992. Patterns of life-history diversification in North American fishes: implications for population regulation. Canadian Journal of Fisheries and Aquatic Sciences 49:2196-2218.

Wisconsin Department of Natural Resources. 2012. Penoxsulam Chemical Fact Sheet. Madison, WI. DNR PUB-WT-977 2012.

Wright, S. A., and D.H. Schoellhamer. 2005. Estimating sediment budgets at the interface between rivers and estuaries with application to the Sacramento–San Joaquin River Delta. Water Resources Research 41. Available on the internet at <http://sfbay.wr.usgs.gov/publications/pdf/wright_2005_River EstuarySedBudgets.pdf>.

Personal Communications

Adib-Samii 2008. Personal communication via e-mail with Victoria Poage, USFWS, re: water temperature thresholds for collection of delta smelt in routine survey sampling, October 8, 2008

Ali-Ger 2008 Personal communication during the CALFED Science Conference

Lindberg, Joan. 2011. Personal communication during a meeting conducted by Brian Hansen, USFWS. 2011.

Appendix 1

Calculated* Maximum Concentrations of 2,4-D, Immediately Following WHCP Treatment

Concentration of:	**2,4-D** *(Active Ingredient)*
1.Chemical directly out of spray nozzle	2,300 ppm
2.Chemical in 1 meter deep water, @ 100% water contact	0.43 ppm
3.Chemical in 2 meter deep water, @ 100% water contact	0.21 ppm
4.Chemical in 1 meter deep water, @ 20% water contact	85 ppb
5.Chemical in 2 meter deep water, @ 20% water contact	43 ppb

*The concentrations above are based on the pounds of active ingredient in maximum specified application rate per acre, and an appropriate dilution factor based on the volume of water in the tank mix, or within one or two meter-acres.

Calculated* Maximum Concentrations of Glyphosate Immediately Following WHCP Treatment

Concentration of:	**Glyphosate***(Active Ingredient)*
1.Chemical directly out of spray nozzle	3,600 ppm
2.Chemical in 1 meter deep water, @ 100% water contact	0.34 ppm
3.Chemical in 2 meter deep water, @ 100% water contact	0.17 ppm
4.Chemical in 1 meter deep water, @ 20% water contact	67 ppb
5.Chemical in 2 meter deep water, @ 20% water contact	34 ppb

*The concentrations above are based on the pounds of active ingredient in maximum specified application rate per acre, and an appropriate dilution factor based on the volume of water in the tank mix, or within one or two meter-acres.

Calculated* Maximum Concentrations of Penoxsulam Immediately Following WHCP Treatment

Concentration of:	**Penoxsulam***(Active Ingredient)*
1.Chemical directly out of spray nozzle	105 ppm
2.Chemical in 1 meter deep water, @ 100% water contact	9.8 ppb
3.Chemical in 2 meter deep water, @ 100% water contact	4.9 ppb
4.Chemical in 1 meter deep water, @ 20% water contact	2 ppb
5.Chemical in 2 meter deep water, @ 20% water contact	1 ppb

*The concentrations above are based on the pounds of active ingredient in maximum specified application rate per acre, and an appropriate dilution factor based on the volume of water in the tank mix, or within one or two meter-acres.

Calculated* Maximum Concentrations of Imazamox Immediately Following WHCP Treatment

Concentration of:	**Imazamox** *(Active Ingredient)*
1. Chemical directly out of spray nozzle	600 ppm
2. Chemical in 1 meter deep water, @ 100% water contact	56 ppb
3. Chemical in 2 meter deep water, @ 100% water contact	28 ppb
4. Chemical in 1 meter deep water, @ 20% water contact	11.2 ppb
5. Chemical in 2 meter deep water, @ 20% water contact	5.6 ppb

*The concentrations above are based on the pounds of active ingredient in maximum specified application rate per acre, and an appropriate dilution factor based on the volume of water in the tank mix, or within one or two meter-acres.

Calculated* Maximum Concentrations of Agridex Immediately Following WHCP Treatment

Concentration of:	**Agridex** *(Active Ingredient)*
1. Chemical directly out of spray nozzle	5,000 ppm
2. Chemical in 1 meter deep water, @ 100% water contact	1.24 ppb
3. Chemical in 2 meter deep water, @ 100% water contact	0.62 ppb
4. Chemical in 1 meter deep water, @ 20% water contact	0.25 ppb
5. Chemical in 2 meter deep water, @ 20% water contact	0.12 ppb

*The concentrations above are based on the pounds of active ingredient in maximum specified application rate per acre, and an appropriate dilution factor based on the volume of water in the tank mix, or within one or two meter-acres.

Calculated* Maximum Concentrations of Competitor Immediately Following WHCP Treatment

Concentration of:	**Competitor** *(Active Ingredient)*
1. Chemical directly out of spray nozzle	5,000 ppm
2. Chemical in 1 meter deep water, @ 100% water contact	1.24 ppb
3. Chemical in 2 meter deep water, @ 100% water contact	0.62 ppb
4. Chemical in 1 meter deep water, @ 20% water contact	0.25 ppb
5. Chemical in 2 meter deep water, @ 20% water contact	0.12 ppb

*The concentrations above are based on the pounds of active ingredient in maximum specified application rate per acre, and an appropriate dilution factor based on the volume of water in the tank mix, or within one or two meter-acres.

STATE WATER RESOURCES CONTROL BOARD

1001 I Street, Sacramento, California 95814
http://www.waterboards.ca.gov/water_issues/programs/npdes/aquatic.shtml

WATER QUALITY ORDER NO. 2013-0002-DWQ
GENERAL PERMIT NO. CAG990005

STATEWIDE GENERAL NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT FOR RESIDUAL AQUATIC PESTICIDE DISCHARGES TO WATERS OF THE UNITED STATES FROM ALGAE AND AQUATIC WEED CONTROL APPLICATIONS

The following Dischargers may apply for coverage under this General Permit in compliance with the waste discharge requirements as set forth in this General Permit:

Table 1. Discharger Information

Dischargers	Any entity that discharges residual algaecides and aquatic herbicide and their degradation byproducts to waters of the United States* from algae and aquatic weed control applications.

Table 2. Administrative Information

This General Permit was adopted by the State Water Resources Control Board (hereinafter State Water Board) on:	**March 5, 2013**
This General Permit shall become effective on:	**December 1, 2013**
This General Permit shall expire on:	**November 30, 2018**
The U.S. Environmental Protection Agency (U.S. EPA) and the State Water Board have classified this discharge as a **minor** discharge.	

I, Jeanine Townsend, Clerk to the Board, do hereby certify that this General Permit with all attachments is a full, true, and correct copy of the General Permit adopted by the State Water Board on March 5, 2013.

AYE: Vice Chair Frances Spivy-Weber
Board Member Tam M. Doduc
Board Member Steven Moore
Board Member Felicia Marcus

NAY: None

ABSENT: None

ABSTAIN: Chairman Charles R. Hoppin

Jeanine Townsend
Clerk to the Board

Table of Contents

List of Tables

List of Attachments

I. DISCHARGE INFORMATION

Pesticide formulations may include "active ingredients"* and "inert ingredients."* Adjuvants* or surfactants may be added to the ingredients in the application equipment used in delivery of the pesticide. As part of the registration process of pesticides for use in California, U.S. EPA and the California Department of Pesticide Regulation (DPR) evaluate data submitted by registrants to ensure that a product used according to label instructions will cause no harm or adverse impact on non-target organisms that cannot be reduced or mitigated with protective measures or use restrictions. The Clean Water Act (CWA) section 301(a) broadly prohibits the discharge of any pollutant to waters of the United States, except in compliance with an NPDES permit. Residual pesticides* discharged into surface waters constitute pollutants within the meaning of the CWA even if the discharge is in compliance with the registration requirements of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). Therefore, coverage under an NPDES permit is required.

The discharge of algaecides and aquatic herbicides and their residues to surface waters for algae and aquatic weed control throughout the State of California may pose a threat to existing and potential beneficial uses of waters of the United States if not properly controlled and regulated.

This General Permit regulates the discharge of aquatic pesticides* (algaecides and aquatic herbicides) used for algae and aquatic weed control to waters of the United States. These are algaecides and aquatic herbicides with registration labels that explicitly allow direct application to water bodies.

II. PERMIT COVERAGE AND APPLICATION REQUIREMENTS

A. General Permit Coverage

Except for discharges on tribal lands that are regulated by a federal permit, this General Permit covers the point source* discharge to waters of the United States of residues resulting from pesticide applications using products containing 2,4-D, acrolein, copper, diquat, endothall, fluridone, glyphosate, imazamox, imazapyr, penoxsulam, sodium carbonate peroxyhydrate, and triclopyr-based algaecides and aquatic herbicides, and adjuvants containing ingredients represented by the surrogate nonylphenol. This General Permit covers only discharges of algaecides, and aquatic herbicides that are currently registered for use in California, or that become registered for use and contain the above-listed active ingredients and ingredients represented by the surrogate of nonylphenol.

* An asterisk means the term is defined in Attachment A. This applies to all sections of this General permit.

This General Permit does not cover agricultural storm water discharges or return flows from irrigated agriculture because these discharges are not defined as “point sources” and do not require coverage under an NPDES permit. This General Permit also does not cover other indirect or nonpoint source discharges from applications of algaecides and aquatic herbicides, including discharges of pesticides to land that may be conveyed in storm water or irrigation runoff.

As shown in Table 1, this General Permit becomes effective on December 1, 2013. To obtain coverage under this General Permit on or after that date, Dischargers must submit their application for coverage as set forth in Section II.C below, at least 90 days prior to their first pesticide application.

B. Discharger

A Discharger under this General Permit includes any entity involved in the application of algaecides and aquatic herbicides that results in a discharge of algaecides and aquatic herbicides and their residues and degradation byproducts to waters of the United States, and meets either or both of the following two criteria:

The entity has control over the financing for or the decision to perform algaecide and aquatic herbicide applications that result in discharges, including the ability to modify those decisions; or

The entity has day-to-day control of algaecide and aquatic herbicide applications or performs activities that are necessary to ensure compliance with this General Permit. For example, the entity is authorized to direct workers to carry out activities required by this General Permit or perform such activities themselves.

C. General Permit Application

To obtain authorization under this General Permit, Dischargers must submit to the State Water Board a complete application that consists of the following:

1. A Notice of Intent (NOI) shown as Attachment E, signed in accordance with the signatory requirements of the Standard Provisions in Attachment B;
2. An application fee. A fee is required only for new Dischargers. Dischargersenrolled under Order No. 2004-0009-DWQ and applying for coverage under this Permit will be billed during the regular billing cycle; and
3. An Aquatic Pesticide* Application Plan (APAP).

Within 90 days of receipt of an application, the State Water Board's Deputy Director of the Division of Water Quality (Deputy Director) will either issue a Notice of Applicability (NOA) or deny the application. The NOA will specify the permitted algaecide and aquatic herbicide active ingredients that may be used, and any region-specific conditions and requirements not stated in this General Permit. Any such region-specific conditions and requirements shall be enforceable. The Discharger is authorized to discharge starting on the date of the NOA.

Alternatively, the Deputy Director or a Regional Water Board Executive Officer may issue a Notice of Exclusion (NOE),[1] which either terminates the permit coverage or requires submittal of an application for an individual permit or alternative general permit.

D. Fees

The fee for enrollment under this General Permit shall be based on section 2200(b)(9) category 3 of title 23, California Code of Regulations, which is available at http://www.waterboards.ca.gov/resources/fees/docs/fy1112fee_schdl_npdes_prmt.pdf and is payable to the State Water Board.

E. Terminating Coverage

To terminate permit coverage, a Discharger must submit a complete and accurate Notice of Termination (NOT) provided in Attachment F. The Discharger's authorization to discharge under this General Permit terminates on the day of the coverage termination letter issued by the Deputy Director. Prior to the termination effective date, the Discharger is subject to the terms and conditions of this General Permit and is responsible for submitting the annual fee and all reports associated with this General Permit.

A Discharger must submit an NOT when one of the following conditions occurs:

1. A new operator has taken over responsibility of the Discharger's algae or aquatic weed control activities covered under an existing NOA;
2. The Discharger has ceased all discharges from the application of algaecides and aquatic herbicide for which it obtained General Permit coverage and does not expect to discharge during the remainder of this General Permit term; or
3. The Discharger has obtained coverage under an individual permit or an alternative general permit for all discharges required to be covered by an NPDES permit.

III. FINDINGS

The Fact Sheet (Attachment D), which contains the background information and rationale for the requirements in this General Permit, is hereby incorporated into this General Permit and constitutes its findings. All other attachments (A, B, C, and E through G) are also incorporated into this General Permit.

[1] An NOE is a one-page notice that indicates and justifies why the Discharger or proposed Discharger is not eligible for coverage under this General Permit and states the reason why. This justification can include, but is not limited to, necessity to comply with a total maximum daily load or to protect sensitive water bodies. The NOE can also indicate that the coverage is denied if feasible alternatives to the selected pesticide application project are not analyzed.

THEREFORE, IT IS HEREBY ORDERED that this General Permit supersedes Order No. 2004-0009-DWQ except for enforcement purposes, and in order to meet the provisions contained in division 7 of the Water Code (commencing with §13000) and regulations adopted thereunder, and the provisions of the CWA and regulations and guidelines adopted thereunder, the Discharger shall comply with the requirements in this Order.

IV. DISCHARGE PROHIBITIONS

A. The discharge of residual algaecides and aquatic herbicides in a manner different from that described in this General Permit is prohibited.

B. The discharge of residual algaecides and aquatic herbicides shall not create a nuisance as defined in section 13050 of the California Water Code.

C. The discharge shall not cause, have a reasonable potential to cause, or contribute to an in-stream excursion above any applicable standard or criterion promulgated by U.S. EPA pursuant to section 303 of the CWA, or water quality objective adopted by the State or Regional Water Boards.

D. All pesticides are prohibited from the waters of the Lahontan Region (Region 6). The use of this permit is invalid in the Lahontan Region unless the discharger has requested a prohibition exemption from the Lahontan Water Board and the Lahontan Water Board has granted an exemption for the use of algaecides or aquatic herbicides.

V. EFFLUENT LIMITATIONS

A. The discharge of residual algaecides and aquatic herbicides must meet applicable water quality standards; and

B. Dischargers shall implement Best Management Practices (BMPs) when applying aquatic algaecides and aquatic herbicides. The BMPs must be provided in the APAP which is described in Section VIII.C below.

VI. RECEIVING WATER LIMITATIONS

The discharge shall not result in any of the following:

A. The discharge of residual algaecides and aquatic herbicides shall not cause or contribute to an exceedance of the following limitations in the receiving water:*

Table 3. Receiving Water Limitations

Constituent/ Parameter	BENEFICIAL USE[1]				Basis
	MUN, µg/L	WARM or COLD, µg/L	Other than MUN, WARM, or COLD, µg/L	All Designations	
2,4-D	70				U.S. EPA MCL
Acrolein[2]	320	21	780		U.S. EPA Water Quality Criteria, 1986.
Copper[2]				Dissolved Freshwater[3] Copper Chronic = 0.960exp{0.8545 [ln(hardness[4])] – 1.702} [5, 6] Dissolved saltwater[3] Copper Chronic = 0.83exp{0.8545 [ln(hardness[4])] – 1.702} [5,6]	California Toxics Rule
Diquat	20				U.S. EPA MCL
Endothall	100				U.S. EPA MCL
Fluridone	560				U.S. EPA Integrated Risk Information System
Glyphosate	700				U.S. EPA MCL
Nonylphenol				Freshwater Chronic Criterion = 6.6 µg/L Saltwater Chronic Criterion = 1.7 µg/L	U.S. EPA National Recommended Ambient Water Quality Criteria
Toxicity	Algaecide and aquatic herbicide applications shall not cause or contribute to toxicity in receiving water(s).				Regional Water Boards' Basin Plans

Notes:
1. See Regional Water Boards' Water Quality Control Plans (Basin Plans) for beneficial use definitions.
2. Public entities and mutual water companies* listed in Attachment G are not required to meet these limitations in receiving waters during the exception period described in the APAP and Section VIII.C.10 below.
3. For waters in which the salinity is equal to or less than 1 part per thousand 95% or more of the time, the freshwater criteria apply. For waters in which the salinity is equal to or greater than 10 parts per thousand 95% or more of the time, saltwater criteria apply. For waters in which the salinity is between 1 and 10 parts per thousand, the applicable criteria are the more stringent of the freshwater or saltwater criteria.
4. For freshwater aquatic life criteria, waters with a hardness 400 mg/L or less as calcium carbonate, the actual ambient hardness of surface water shall be used. For waters with a hardness of over 400 mg/L as calcium carbonate, a hardness of 400 mg/L as calcium carbonate shall be used with a default Water-Effect Ratio of 1.
5. Values should be rounded to two significant figures.
6. This limitation does not apply to the Sacramento River and its tributaries above the State Highway 32 Bridge at Hamilton City. See Table III-1 of the Basin Plan for the Sacramento and San Joaquin River Basins for copper limitation.

B. **Dissolved Oxygen.** Dissolved oxygen to be below the Regional Water Board Basin Plans' dissolved oxygen objectives for the receiving water.

C. **Floating Material.** Floating material to be present in the amounts that cause nuisance or adversely affect beneficial uses.

D. **Settleable Substances.** Settleable substances to be present in concentrations that result in the deposition of material that causes nuisance or adversely affects beneficial uses.

E. **Suspended Material.** Suspended material to be present in concentrations that cause nuisance or adversely affect beneficial uses.

F. **Taste and Odors.** Taste- or odor-producing substances to be present in concentrations that impart undesirable tastes or odors to fish flesh or other edible products of aquatic origin, or that cause nuisance, or otherwise adversely affect beneficial uses or domestic or municipal water supplies.

G. **Toxic Pollutants.** Toxic pollutants to be present in the water column, sediments, or biota in concentrations that adversely affect beneficial uses; that produce detrimental response in human, plant, animal, or aquatic life; or that bioaccumulate in aquatic resources at levels which are harmful to human health.

H. **Color.** Esthetically undesirable discoloration.

I. **Aquatic Communities.** Aquatic communities and populations, including vertebrates, invertebrates, and non-target plant species to be degraded.

VII. RECEIVING WATER MONITORING TRIGGERS

In the absence of Receiving Water Limitations, the Receiving Water Monitoring Triggers shown in Table 4 below will be used to assess compliance with the narrative receiving water toxicity limitation. However, exceeding the monitoring trigger does not constitute a violation of this General Permit as long as the Discharger performs the following actions: (1) initiates additional investigations for the cause of the exceedance; (2) implements additional BMPs to reduce the algaecide and aquatic herbicide residue concentration to be below the monitoring triggers in future applications; and (3) evaluates the appropriateness of using alternative products.

Table 4. Receiving Water Monitoring Triggers

Ingredient	Unit	Instantaneous Maximum Monitoring Trigger	Basis
Imazapyr	mg/L	11.2	U.S. EPA Office of Pesticides *Ecotoxicity Database*
Triclopyr Triethylamine	mg/L	13.0	U.S. EPA Office of Pesticides *Ecotoxicity Database*

VIII. AQUATIC PESTICIDE USE REQUIREMENTS

A. Application Schedule

The Discharger shall provide a phone number or other specific contact information to all persons who request the Discharger's application schedule. The Discharger shall provide the requester with the most current application schedule and inform the requester if the schedule is subject to change. Information may be made available by electronic means, including posting prominently on a well-known website.

B. Public Notice Requirements

Every calendar year, at least 15 days prior to the first application of algaecide or aquatic herbicide, the Discharger shall notify potentially affected public agencies. The Discharger shall post the notification on its website if available. The notification shall include the following information:

1. A statement of the discharger's intent to apply algaecide or aquatic herbicide(s);
2. Name of algaecide and aquatic herbicide(s);
3. Purpose of use;
4. General time period and locations of expected use;
5. Any water use restrictions or precautions during treatment; and
6. A phone number that interested persons may call to obtain additional information from the Discharger.

C. Aquatic Pesticides Application Plan (APAP)

Dischargers shall submit an APAP at least 90 days before the expected day of permit coverage. The APAP shall contain, but not be limited to, the following elements sufficient to address each proposed treatment area:*

1. Description of the water system to which algaecides and aquatic herbicides are being applied;
2. Description of the treatment area in the water system;
3. Description of types of weed(s) and algae that are being controlled and why;
4. Algaecide and aquatic herbicide products or types of algaecides and aquatic herbicides expected to be used and if known their degradation byproducts, the method in which they are applied, and if applicable, the adjuvants and surfactants used;
5. Discussion of the factors influencing the decision to select algaecide and aquatic herbicide applications for algae and weed control;
6. If applicable, list the gates or control structures to be used to control the extent of receiving waters potentially affected by algaecide and aquatic herbicide application and provide an inspection schedule of those gates or control structures to ensure they are not leaking;
7. If the Discharger has been granted a short-term or seasonal exception under State Water Board *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays,* and Estuaries of California* (Policy) section 5.3 from meeting acrolein and copper receiving water limitations, provide the beginning and ending dates of the exception period, and justification for the needed time for the exception. If algaecide and aquatic herbicide applications occur outside of the exception period, describe plans to ensure that receiving water criteria are not exceeded because the Dischargers must comply with the

acrolein and copper receiving water limitations for all applications that occur outside of the exception period;

8. Description of monitoring program;
9. Description of procedures used to prevent sample contamination from persons, equipment, and vehicles associated with algaecide and aquatic herbicide application;
10. Description of the BMPs to be implemented. The BMPs shall include, at the minimum:
    a. Measures to prevent algaecide and aquatic herbicide spill and for spill containment during the event of a spill;
    b. Measures to ensure that only an appropriate rate of application consistent with product label requirements is applied for the targeted weeds or algae;
    c. The Discharger's plan in educating its staff and algaecide and aquatic herbicide applicators on how to avoid any potential adverse effects* from the algaecide and aquatic herbicide applications;
    d. Discussion on planning and coordination with nearby farmers and agencies with water rights diversion so that beneficial uses of the water (irrigation, drinking water supply, domestic stock water, etc.) are not impacted during the treatment period; and
    e. A description of measures that will be used for preventing fish kill when algaecides and aquatic herbicides will be used for algae and aquatic weed controls.
11. Examination of Possible Alternatives. Dischargers should examine the alternatives to algaecide and aquatic herbicide use to reduce the need for applying algaecides and herbicides. Such methods include:
    a. Evaluating the following management options, in which the impact to water quality, impact to non-target organisms including plants, algaecide and aquatic herbicide resistance, feasibility, and cost effectiveness should be considered:
        i. No action;
        ii. Prevention;
        iii. Mechanical or physical methods;
        iv. Cultural methods;
        v. Biological control agents; and
        vi. Algaecides and aquatic herbicides;

        If there are no alternatives to algaecides and aquatic herbicides, Dischargers shall use the minimum amount of algaecides and aquatic herbicides that is necessary to have an effective control program and is consistent with the algaecide and aquatic herbicide product label requirements.

b. Using the least intrusive method of algaecide and aquatic herbicide application; and

c. Applying a decision matrix concept to the choice of the most appropriate formulation.

D. APAP Processing, Approval, and Modifications

Upon receipt of an APAP, staff will post it on the State Water Board's website for a 30-day public comment period[2] and will distribute a notice via the State Water Board's Lyris list that an APAP has been posted. Staff will coordinate with Regional Water Board staff in reviewing the application package for completeness and applicability to this General Permit. If no comments are received and State and Regional Water Board staff deem the APAP complete, the Deputy Director will issue an NOA within five (5) working days of closure of the comment period. If comments are received, staff will work with Regional Water Board staff and the Discharger to address the comments to allow the Deputy Director to issue an NOA as expeditiously as possible. Permit coverage will begin when the Discharger receives the NOA.

Major changes to the APAP shall be submitted to the Deputy Director for approval. Examples of major changes include using a different product other than what is specified in the APAP, changing an application method that may result in different amounts of pesticides being applied, or adding or deleting BMPs.

E. Algaecide and Aquatic Herbicide Application Log

The Discharger shall maintain a log for each algaecide and aquatic herbicide application. The application log shall contain, at a minimum, the following information:

1. Date of application;
2. Location of application;
3. Name of applicator;
4. Type and amount of algaecide and aquatic herbicide used;
5. Application details, such as flow and level of water body, time application started and stopped, algaecide and aquatic herbicide application rate and concentration;
6. Visual monitoring assessment; and
7. Certification that applicator(s) followed the APAP.

[2] See Waterkeeper Alliance, Inc. v. EPA, 399 F.3d 486 (2nd Cir. 2005).

IX. PROVISIONS

A. Standard Provisions

1. All Dischargers authorized to discharge under this General Permit shall comply with the Federal Standard Provisions included in Attachment B of this General Permit.
2. This General Permit does not authorize the discharge of residual algaecides and aquatic herbicides or their degradation byproducts to waters of the United States that are impaired by the active ingredient of the algaecides and herbicides used. Impaired waters are those waters not meeting water quality standards pursuant to section 303(d) of the CWA. California impaired waters are listed on: http://www.waterboards.ca.gov/water_issues/programs/tmdl/2010state_ir_reports/2010_combo303d.xls.
3. This General Permit does not authorize any take of endangered species. The discharge is prohibited from adversely impacting biologically sensitive or critical habitats, including, but not limited to, habitat of species listed under federal or state endangered species laws. To ensure that endangered species issues are raised to the responsible agencies, the State Water Board has notified the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and the California Department of Fish and Wildlife of this General Permit.
4. The State Water Board may use this General Permit to regulate the discharge of algaecides and aquatic herbicides and their residues to a surface water classified as Outstanding National Resource Waters or as a water body impaired by unknown toxicity only after the following conditions are satisfied: (1) the proposed project will comply with the limitations and discharge requirements specified in the General Permit; and (2) if required, the proposed algaecide and aquatic herbicide application qualifies for and has been granted a Basin Plan prohibition exception prior to discharge. The two bodies of water that are classified as Outstanding National Resource Waters in California are Lake Tahoe and Mono Lake.
5. The Discharger must follow all FIFRA pesticide label instructions and any Restricted Material Use Permits issued by a County Agricultural Commissioner.
6. All adjuvants used with the algaecides and aquatic herbicides must be labeled for aquatic use.
7. The Discharger must comply with effluent and receiving water limitations and must develop and implement an APAP.
8. To reduce the potential impacts to water quality, Dischargers shall implement the feasible alternatives to algaecide and aquatic herbicide use that are identified in the APAP.
9. All Dischargers authorized to discharge under this General Permit shall comply with discharge prohibitions and other requirements contained in Basin Plans, as implemented by the State and the nine Regional Water Boards.

10. All Dischargers authorized to discharge under this General Permit shall comply with the following provisions:

    a. After notice and opportunity for a hearing, this General Permit may be terminated or modified for cause, including, but not limited to:

        i. Violation of any term or condition contained in this General Permit;

        ii. Obtaining this General Permit by misrepresentation or by failing to disclose fully all relevant facts;

        iii. A change in any condition that requires either a temporary or permanent reduction or elimination of the authorized discharge; and

        iv. A material change in the character, location, or volume of discharge (if applicable).

    b. The provisions of this General Permit are severable. If any provision of this General Permit is found invalid, the remainder of this General Permit shall not be affected.

    c. The Discharger shall maintain a copy of this General Permit and make it available at all times to operating personnel. Key operating personnel shall be familiar with its content.

    d. Laboratories that perform sample analyses must be identified in all monitoring reports submitted to the State and Regional Water Boards.

    e. All monitoring and analysis instruments and devices used by the Discharger to fulfill the prescribed monitoring program shall be properly maintained and calibrated based on manufacturer's recommendations to ensure their continued accuracy.

    f. Each Discharger shall file with the State Water Board and the appropriate Regional Water Board technical reports on self monitoring* performed according to the detailed specifications contained in the Monitoring and Reporting Program attached to this General Permit.

    g. The State and Regional Water Board are authorized to enforce the terms of this General Permit under provisions of the California Water Code, including, but not limited to, sections 13385, 13386, and 13387.

B. Monitoring and Reporting Program Requirements

The Discharger shall comply with the Monitoring and Reporting Program, and future revisions thereto, in Attachment C of this General Permit.

C. Special Provisions

1. Reopener Provisions

This General Permit may be reopened for modification and reissuance in accordance with the provisions contained in title 40 Code Federal Regulation (40 C.F.R.) section 122.62, and for the following reasons:

a. **Addition to the Public Entity List**. This General Permit may be reopened to modify Attachment G if any additional entity becomes qualified for a Policy section 5.3 exception.

b. **Addition of Aquatic Pesticide Active Ingredients**. This General Permit may be reopened to add additional algaecide and aquatic herbicide active ingredients if new active ingredients are registered by U.S. EPA and DPR.

c. **Acute and Chronic Toxicity.** If the State Water Board revises the Policy toxicity control provisions that would require new implementation procedures including the establishment of numeric chronic toxicity limitations, this General Permit may be reopened to include numeric acute and/or chronic toxicity receiving water limitations based on the new provisions.

d. **Receiving Water Limitations.** This General Permit may be reopened to add numeric Receiving Water Limitations for the residual algaecide and aquatic herbicides* exceeding the triggers if the additional investigation results show necessary.

e. **Endangered Species Act**. If U.S. EPA develops biological opinions regarding algaecides and aquatic herbicides included in this General Permit, this General Permit may be re-opened to add or modify Receiving Water Limitations/Monitoring Triggers for aquatic herbicides and algaecides and their residues of concern, if necessary.

2. **Change of Discharger**

In the event of any change in the Discharger that has obtained coverage under this General Permit, the previous Discharger shall notify the new Discharger of the existence of this General Permit by letter. A copy of the letter shall be immediately forwarded to the Deputy Director. After receipt of the letter, the Deputy Director will terminate the permit coverage to the previous Discharger. The new Discharger shall complete and submit to the Deputy Director a revised NOI form (Attachment E), and any revisions to the APAP prepared by the previous control entity or a new APAP.

3. **Application Package**

Dischargers who seek coverage under this General Permit shall file a complete application package at least 90 days before the expected date of algaecide and aquatic herbicide application. The application package shall include an NOI, APAP, and application fee. Enrolled Dischargers will be billed annually thereafter.

4. **Special Studies, Technical Reports, and Additional Monitoring Requirements**

a. **Additional Investigation**

Each Discharger must conduct additional investigations when the chemical monitoring shows exceedance of any receiving water limitation or monitoring trigger. The additional investigations shall identify corrective actions to

eliminate exceedance of receiving water limitations or monitoring triggers caused by the algaecide and aquatic herbicide application. The investigation shall include, but not be limited to evaluating the need to implement one or more of the following actions: revising and improving the existing BMPs, revising the mode of application, using less toxic algaecide and aquatic herbicide products, or selecting alternative methods for algae and aquatic weed control.

b. **Qualified Biologist Certification Following Project Completion**

Upon completion of an algaecide and aquatic herbicide project, public entities and mutual water companies listed in Attachment G of this General Permit shall provide certification by a qualified biologist* that beneficial uses of receiving waters have been restored.

5. **Corrective Action**

a. **Exceedance of Receiving Water Limitations or Monitoring Triggers.**

If a Receiving Water Limitation in Table 3 or a Monitoring Trigger in Table 4 is exceeded in the Event or Post-Event sample, the Discharger shall perform the following actions: (1) initiate additional investigations for the cause of the exceedance, (2) implement appropriate BMPs to reduce the algaecide and aquatic herbicide concentration to be below the applicable receiving water limitation or monitoring triggers in future applications, and (3) evaluate the appropriateness of using alternative products.

b. **Revision of Control Measures.**

If any of the following situations occur, the Discharger must review and, as necessary, revise the evaluation and selection of the control measures to ensure that the situation is eliminated and will not be repeated in the future:

i. An unauthorized release or discharge associated with the application of algaecides and aquatic herbicides (e.g., spill, leak, or discharge not authorized by this or another NPDES permit) occurs;

ii. The Discharger becomes aware, or the State Water Board concludes, that the control measures are not adequate/sufficient for the discharge to meet applicable water quality standards;

iii. Any monitoring activities indicate that the Discharger failed to:

a) Follow the label instructions for the product used;

b) Use the minimum amount of algaecide and aquatic herbicide product per application and optimum frequency of algaecide and aquatic herbicide applications that are necessary for an effective control program consistent with reducing the potential for development of resistance and the algaecide and aquatic herbicide product label requirements;

c) Perform regular maintenance activities to reduce leaks, spills, or other unintended discharges of algaecides and aquatic herbicides

associated with the application of algaecides and aquatic herbicides covered under this General Permit; or

d) Maintain algaecide and aquatic herbicide application equipment in proper operating condition by adhering to any manufacturer's conditions and industry practices, and by calibrating, cleaning, and repairing such equipment on a regular basis to ensure effective algaecide and aquatic herbicide application and algae and aquatic weed control. The Discharger must ensure that the equipment's rate of algaecide and aquatic herbicide application is calibrated to deliver the minimum quantity of algaecides and aquatic herbicides that is needed to have an effective control program and is consistent with the algaecide and aquatic herbicide product label requirements.

c. **Corrective Action Deadlines**

If the Discharger determines that changes to the control measures are necessary to eliminate any situation identified above, the Discharger shall make such changes within 60 days. The Discharger shall take the corrective action before any further discharge of the algaecides and aquatic herbicides and their residues will be allowed.

d. **Effect of Corrective Action**

The occurrence of a situation identified in Section C.5.b above may constitute a violation of this General Permit. Correcting the situation according to Corrective Action Section C.5.c above does not absolve the Discharger of liability for any original violation. However, failure to comply with any Corrective Action as required by Section C.5.c above constitutes an additional permit violation. The State and Regional Water Boards will consider the appropriateness and promptness of corrective action in determining enforcement responses to permit violations.

The State Water Board and the appropriate Regional Water Boards may impose additional requirements and schedules of compliance, including requirements to submit additional information concerning the condition(s) triggering corrective action or schedules and requirements more stringent than specified in this General Permit. Those requirements and schedules will supersede those in the Corrective Action Section above if such requirements conflict.

6. **Adverse Incident to Threatened or Endangered Species or Critical Habitat**

If the Discharger becomes aware of an adverse incident* to a federally-listed threatened or endangered species or its federally-designated critical habitat, that may have resulted from the Discharger's algaecides and aquatic herbicides application, the Discharger must immediately notify the National Marine Fisheries Service (NMFS) Santa Rosa office by phone at (707) 575-6050 in the case of an anadromous or marine species, or the U.S. Fish and Wildlife Service (FWS) at (916) 414-6600 in the case of a terrestrial or freshwater species. This notification must be made by telephone immediately when the Discharger becomes aware of the adverse incident and must include at least the following information:

a. The caller's name, telephone number, and e-mail address;

b. Applicator name and mailing address;

c. The name of the affected species;

d. How and when the Discharger became aware of the adverse incident;

e. Description of the location of the adverse incident;

f. Description of the adverse incident, including the U.S. EPA pesticide registration number for each product applied in the area of the adverse incident; and

g. Description of any steps that have been taken or will be taken to alleviate the adverse impact to the species.

Additional information on federally-listed threatened or endangered species and federally-designated critical habitat is available from NMFS (www.nmfs.noaa.gov) for anadromous or marine species or FWS (www.fws.gov) for terrestrial or freshwater species.

X. COMPLIANCE DETERMINATION

Compliance with receiving water limitations and monitoring triggers shall be determined through event and post-event monitoring results.

Attachment A – Definitions

Active Ingredient
Active ingredients are ingredients disclosed by manufacturers that yield toxic effects* on target organisms.

Adjuvants
Adjuvants are ingredients that are mixed with herbicides prior to an application event and are often trade secrets. These ingredients are chosen by the Discharger, based on site characteristics, and typically increase the effectiveness of pesticides on target organisms.

Adverse Incident
Adverse Incident means a situation where the Discharger observes upon inspection or becomes aware of in which**:**

- A person or non-target organism may have been exposed to an algaecide or aquatic herbicide residue; and
- The person or non-target organism suffered an adverse or toxic effect.

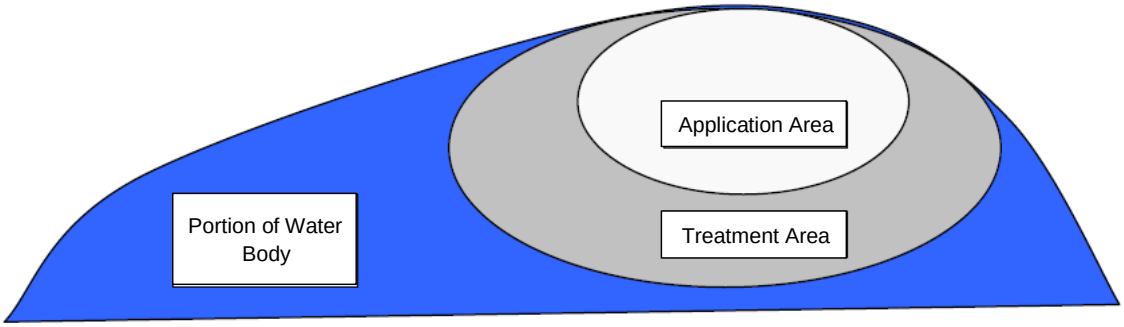
Adverse or Toxic Effect
An “adverse or toxic effect” includes any impact that occurs within waters of the United States on non-target organisms as a result of algaecide or aquatic herbicide residue discharge. Examples of these effects may include:

- Distressed or dead juvenile and small fishes
- Washed up or floating fish
- Fish swimming abnormally or erratically
- Fish lying lethargically at water surface or in shallow water
- Fish that are listless or nonresponsive to disturbance
- Stunting, wilting, or desiccation of non-target submerged or emergent aquatic plants
- Other dead or visibly distressed non-target aquatic organisms (amphibians, turtles, invertebrates, etc.)

An “adverse or toxic effect” also includes any adverse effects to humans (e.g., skin rashes) or domesticated animals that occur either directly or indirectly from a discharge to waters of the United States that are temporally and spatially related to exposure to an algaecide and aquatic herbicide residue (e.g., vomiting, lethargy).

Algae Control
Algae control means the treatment of filamentous algae, cyanobacteria (blue-green algae), or algal species that have the potential to affect human or environmental health.

Application Area
The application area is the area to which aquatic pesticides are directly applied.



Application Event
The application event is the time that introduction of the algaecide or aquatic herbicide to the treatment area takes place, not the length of time that the environment is exposed to the algaecide or aquatic herbicide.

Aquatic Pesticides
Aquatic pesticides in this General Permit are limited to algaecides and aquatic herbicides labeled for aquatic use to control aquatic weeds or algae.

Beneficial Uses
Beneficial uses of the waters of the state that may be protected against quality degradation include, but are not limited to, domestic, municipal, agricultural and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves.

Coalition
Specifically refers to a monitoring coalition which is a collaborative monitoring partnership of dischargers to develop a monitoring plan that addresses the monitoring requirements of this General Permit. The Coalition's monitoring plan will be submitted for Coalition members in lieu of individual monitoring plans from each member.

Enclosed Bays
Enclosed Bays means indentations along the coast that enclose an area of oceanic water within distinct headlands or harbor works. Enclosed bays include all bays where the narrowest distance between the headlands or outermost harbor works is less than 75 percent of the greatest dimension of the enclosed portion of the bay. Enclosed bays do not include inland surface waters or ocean waters.

Estuaries
Estuaries means waters, including coastal lagoons, located at the mouths of streams that serve as areas of mixing for fresh and ocean waters. Coastal lagoons and mouths of streams that are temporarily separated from the ocean by sandbars shall be considered estuaries. Estuarine waters shall be considered to extend from a bay or the open ocean to a point upstream where there is no significant mixing of freshwater and seawater. Estuaries do not include inland surface waters or ocean waters.

Half-Life
Half-life is the time required for half of the compound introduced into an ecosystem to be eliminated or disintegrated by natural processes.

Inert Ingredients
Inert ingredients are additional ingredients and are often trade secrets; therefore, they are not always disclosed by the manufacturer.

Mutual Water Company
A mutual water company is defined in the Public Utilities Code, section 2725 as “[a]ny private corporation or association organized for the purpose of delivering water to its stockholders and members at cost, including use of works for conserving, treating, and reclaiming water."

Point Source
Any discernible, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock concentrated animal feeding operation, landfill leachate collection system, or vessel or other floating craft from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture or agricultural storm water runoff.

Priority Pollutants
Priority pollutants are listed within the California Toxics Rule in 40 Code of Federal Regulations, section 131.38(b)(1). Criteria to protect aquatic life and human health are set for priority pollutants in the California Toxics Rule.

Public Entity
Public entity includes the federal government or a state, county, city and county, city, district, public authority, or public agency.

Qualified Biologist
A qualified biologist is a biologist who has the knowledge and experience in the ecosystem where the algaecide or aquatic herbicide is applied so that he or she can adequately evaluate whether the beneficial uses of the receiving waters have been protected and/or restored upon completion of the algaecide and aquatic herbicide application project.

Receiving Waters
Receiving waters are waters of the United States anywhere outside of the treatment area at anytime and anywhere inside the treatment area after completion of the treatment event.

Representative Monitoring Location
To be considered “representative,” at a minimum, a location must be similar in hydrology, algaecide or aquatic herbicide use, and other factors that affect the residual discharge to the areas being represented in that environmental setting.

Residual Algaecide and Aquatic Herbicide
Residual algaecide and aquatic herbicide are those portions of the pesticides that remain in

the water after the application and its intended purpose (injury or elimination of targeted pests) have been completed.

Self Monitoring
Sampling and analysis performed by the Discharger or Coalition to determine compliance with the Permit. All laboratory analyses must be conducted by a laboratory certified by the California Department of Public Health.

Treatment Area
The treatment area is the area being treated by the algaecide or aquatic herbicide for algae and aquatic weed control and, therefore, the area being targeted to receive an appropriate rate of application consistent with product label requirements of algaecide or aquatic herbicide. It is the responsibility of the Discharger to define the treatment area for each specific algaecide and aquatic herbicide application.

Waters of the United States
1. All waters which are currently used, were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide;
2. All interstate waters, including interstate “wetlands;”
3. All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sand flats, “wetlands,” sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds the use, degradation, or destruction of which would affect or could affect interstate or foreign commerce including any such waters:
   a. Which are or could be used by interstate or foreign travelers for recreational or other purposes;
   b. From which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or
   c. Which are used or could be used for industrial purposes by industries in interstate commerce.
4. All impoundments of waters otherwise defined as waters of the United States under this definition;
5. Tributaries of waters identified in items1 through 4 of this definition;
6. The territorial sea; and
7. "Wetlands" adjacent to waters (other than waters that are themselves wetlands) identified in paragraphs (1) through (6) of this definition. Waste treatment systems, including treatment ponds or lagoons designed to meet the requirements of CWA (other than cooling ponds as defined in 40 C.F.R. section 423.11(m) which also meet the criteria of this definition) are not waters of the United States. This exclusion applies only to manmade bodies of water which neither were originally created in waters of the United States (such as disposal area in wetlands) nor resulted from the impoundment of waters of the United States [See Note 1 of this Section.] Waters of the United States do not include prior converted cropland. Notwithstanding the determination of an area's status as prior converted cropland by any other federal agency, for the purposes of the Clean Water Act, the final authority regarding Clean Water Act jurisdiction remains with U.S. EPA.

Attachment B – Standard Provisions

I. STANDARD PROVISIONS – PERMIT COMPLIANCE (IF APPLICABLE)

A. Duty to Comply

1. The Discharger must comply with all of the conditions of this General Permit. Any noncompliance constitutes a violation of the CWA and the California Water Code and is grounds for enforcement action, for permit termination, revocation and reissuance, or modification; or denial of a permit renewal application. (40 C.F.R. §122.41(a).)
2. The Discharger shall comply with effluent standards or prohibitions established under section 307(a) of the CWA for toxic pollutants within the time provided in the regulations that establish these standards or prohibitions, even if this General Permit has not yet been modified to incorporate the requirement. (40 C.F.R. §122.41(a)(1).)

B. Need to Halt or Reduce Activity Not a Defense

It shall not be a defense for a Discharger in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this General Permit. (40 C.F.R. §122.41(c).)

C. Duty to Mitigate

The Discharger shall take all reasonable steps to minimize or prevent any discharge in violation of this General Permit that has a reasonable likelihood of adversely affecting human health or the environment. (40 C.F.R. §122.41(d).)

D. Proper Operation and Maintenance

The Discharger shall at all times properly operate and maintain all facilities and systems of control (and related appurtenances) which are installed or used by the Discharger to achieve compliance with the conditions of this General Permit. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. (40 C.F.R. §122.41(e).)

E. Property Rights

1. This General Permit does not convey any property rights of any sort or any exclusive privileges. (40 C.F.R. §122.41(g).)
2. The issuance of this General Permit does not authorize any injury to persons or property or invasion of other private rights, or any infringement of state or local law or regulations. (40 C.F.R. §122.5(c).)

F. Inspection and Entry

The Discharger shall allow the Regional Water Board, State Water Board, United States Environmental Protection Agency (U.S. EPA), and/or their authorized

representatives (including an authorized contractor acting as their representative), upon the presentation of credentials and other documents, as may be required by law, (40 C.F.R. §122.41(i); Water Code, §13383) to:

1. Enter upon the Discharger's premises where a regulated facility or activity is located or conducted, or where records are kept under the conditions of this General Permit;
2. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this General Permit;
3. Inspect and photograph, at reasonable times, any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this General Permit; and
4. Sample or monitor, at reasonable times, for the purposes of assuring General Permit compliance or as otherwise authorized by the CWA or the Water Code, any substances or parameters at any location.

II. STANDARD PROVISIONS – PERMIT ACTION

A. General

This General Permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by the Discharger for modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not stay any General Permit condition. (40 C.F.R. §122.41(f).)

B. Duty to Reapply

If the Discharger wishes to continue an activity regulated by this General Permit after the expiration date of this General Permit, the Discharger must apply for and obtain authorization as required by the new permit. (40 C.F.R. §122.41(b).)

C. Transfers

This General Permit is not transferable to any person except after notice to the State Water Board. The State Water Board may require modification or revocation and reissuance of the General Permit to change the name of the Discharger and incorporate such other requirements as may be necessary under the CWA and the Water Code. (40 C.F.R. §122.41(l)(3); §122.61.)

D. Continuation of this Permit

If this permit is not reissued or replaced prior to the expiration date, it will be administratively continued in accordance with 40 C.F.R. section 122.6 and remain in full force and effect.

III. STANDARD PROVISIONS – MONITORING

Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity. (40 C.F.R. §122.41(j)(1).)

Monitoring results must be conducted according to test procedures under 40 C.F.R. part 136 unless other test procedures have been specified in this General Permit. (40 C.F.R. §122.41(j)(4); §122.44(i)(1)(iv).)

IV. STANDARD PROVISIONS – RECORDS

A. Records Retention

The Discharger shall retain records of all monitoring information, including all calibration and maintenance records, copies of all reports required by this General Permit, and records of all data used to complete the application for this General Permit, for a period of at least three (3) years from the date of the sample, measurement, report or application. This period may be extended by request of the the State Water Board's Deputy Director of the Division of Water Quality (Deputy Director) at any time. (40 C.F.R. §122.41(j)(2).)

B. Records of monitoring information shall include:

1. The date, exact place, and time of sampling or measurements (40 C.F.R. §122.41(j)(3)(i).);
2. The individual(s) who performed the sampling or measurements (40 C.F.R. §122.41(j)(3)(ii).);
3. The date(s) analyses were performed (40 C.F.R. §122.41(j)(3)(iii).);
4. The individual(s) who performed the analyses (40 C.F.R. §122.41(j)(3)(iv).);
5. The analytical techniques or methods used (40 C.F.R. §122.41(j)(3)(v).); and
6. The results of such analyses. (40 C.F.R. §122.41(j)(3)(vi).)

C. Claims of confidentiality for the following information will be denied (40 C.F.R. §122.7(b).):

1. The name and address of any permit applicant or Discharger (40 C.F.R. §122.7(b)(1).); and
2. Permit applications and attachments, permits and effluent data. (40 C.F.R. §122.7(b)(2).)

V. STANDARD PROVISIONS – REPORTING

A. Duty to Provide Information

The Discharger shall furnish to the Regional Water Board, State Water Board, or U.S. EPA within a reasonable time, any information which the Regional Water Board, State Water Board, or U.S. EPA may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this General Permit or to determine compliance with this General Permit. Upon request, the Discharger shall also furnish to the Regional Water Board, State Water Board, or U.S. EPA copies of records required to be kept by this General Permit. (40 C.F.R. §122.41(h); Wat. Code, §13267.)

B. Signatory and Certification Requirements

1. All applications, reports, or information submitted to the Regional Water Board, State Water Board, and/or U.S. EPA shall be signed and certified in accordance with Standard Provisions – Reporting V.B.2, V.B.3, V.B.4, V.B.5, and V.B.6 below. (40 C.F.R. §122.41(k).)

2. **For a corporation.** By a responsible corporate officer. For the purpose of this section, a responsible corporate officer means: (i) A president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who perfoms similar policy- or decision-making functions for the corporation, or (ii) the manager of one or more manufacturing, production, or operating facilities, provided, the manager is authorized to make management decisions which govern the operation of the regulated facility including having the explicit or implicit duty of making major capital investment recommendations, and initiating and directing other comprehensive measures to assure long term environmental compliance with environmental laws and regulations; the manager can ensure that the necessary systems are established or actions taken to gather complete and accurate information for permit application requirements; and where authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures.

3. **For a partnership or sole proprietorship.** By a general partner or the proprietor, respectively;

4. **For a municipality, state, federal, or other public agency:** All permit applications shall be signed by either a principal executive officer or ranking elected official. For purposes of this provision, a principal executive officer of a federal agency includes: (i) the chief executive officer of the agency, or (ii) a senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency (e.g., Regional Administrators of U.S. EPA). (40 C.F.R. §122.22(a)(3).)

5. All reports required by this General Permit and other information requested by the Regional Water Board, State Water Board, or U.S. EPA shall be signed by a person described in Standard Provisions – Reporting V.B.1 above, or by a duly authorized representative of that person. A person is a duly authorized representative only if:

    a. The authorization is made in writing by a person described in Standard Provisions – Reporting V.B.1 above (40 C.F.R. §122.22(b)(1).);

    b. The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity or an individual or a position having overall responsibility for environmental matters for the company. (A duly authorized representative may thus be either a named individual or any individual occupying a named position.) (40 C.F.R. §122.22(b)(2).); and

    c. The written authorization is submitted to the Regional Water Board and State Water Board. (40 C.F.R. §122.22(b)(3).)

6. If an authorization under Standard Provisions – Reporting V.B.1 above is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of Standard Provisions – Reporting V.B.1 above must be submitted to the Regional Water Board and State Water Board prior to or together with any reports, information, or applications, to be signed by an authorized representative. (40 C.F.R. §122.22(c).)

   Any person signing a document under Standard Provisions – Reporting V.B.1 or V.B.3 above shall make the following certification:

   "I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations." (40 C.F.R. §122.22(d).)

C. Monitoring Reports

1. Monitoring results shall be reported at the intervals specified in the Monitoring and Reporting Program (Attachment C) in this General Permit. (40 C.F.R. §122.22(l)(4).)
2. Monitoring results must be reported on a Self Monitoring* Report (SMR) form as agreed to by the Deputy Director and the Discharger.
3. If the Discharger monitors any pollutant more frequently than required by this General Permit using test procedures approved under 40 C.F.R part 136 or as specified in this General Permit, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the SMR or a reporting form specified by the State Water Board. (40 C.F.R. §122.41(l)(4)(ii).)
4. Calculations for all limitations, which require averaging of measurements, shall utilize an arithmetic mean unless otherwise specified in this General Permit. (40 C.F.R. §122.41(l)(4)(iii).)

D. Compliance Schedules

Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule of this General Permit, shall be submitted no later than 14 days following each schedule date. (40 C.F.R. §122.41(l)(5).)

E. Planned Changes

The Discharger shall give notice to the State and the Regional Water Board as soon as possible of any planned physical alterations or additions to the permitted activity or discharge. Notice is required under this provision (40 C.F.R. §122.41(l)(1)) only when

the alteration or addition could significantly change the nature or increase the quantity of pollutants discharged. This notification applies to pollutants that are subject neither to effluent limitations in this General Permit nor to notification requirements under 40 C.F.R. section 122.42(a)(1).

F. Anticipated Noncompliance

The Discharger shall give advance notice to the State and Regional Water Boards of any planned changes in the permitted discharge or activity that may result in noncompliance with General Permit requirements. (40 C.F.R. §122.41(l)(2).)

G. Other Noncompliance

The Discharger shall report all instances of noncompliance not reported under Standard Provisions – Reporting V.C, V.D, and V.E above at the time monitoring reports are submitted. The reports shall contain the information listed in Standard Provision – Reporting V.F above. (40 C.F.R. §122.41(l)(7).)

H. Other Information

When the Discharger becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or in any report to the State Water Board, Regional Water Board, or U.S. EPA, the Discharger shall promptly submit such facts or information. (40 C.F.R. §122.41(l)(8).)

VI. STANDARD PROVISIONS – ENFORCEMENT

The State and the Regional Water Boards are authorized to enforce the terms of this General Permit under several provisions of the Water Code, including, but not limited to, sections 13385, 13386, and 13387.

Attachment C – Monitoring and Reporting Program

Table of Contents

List of Tables

ATTACHMENT C – MONITORING AND REPORTING PROGRAM

Section 122.48 of title 40 of the Code of Federal Regulations (40 C.F.R. §122.48) requires that all NPDES permits specify monitoring and reporting requirements. California Water Code sections 13267 and 13383 also authorize the State Water Resources Control Board (the State Water Board) and the Regional Water Quality Control Board (Regional Water Board) to require technical and monitoring reports. This Monitoring and Reporting Program (MRP) establishes monitoring and reporting requirements which implement federal and California State laws and regulations.

This MRP is designed to address the two key questions shown below. It also encourages Dischargers to form monitoring coalitions with others doing similar applications within a given watershed or doing applications of similar environmental settings (flowing water and non-flowing water). The Coalition or Discharger may select sites representing worst case scenarios or high-use areas for each active ingredient in each environmental setting. If the Discharger elects in its Aquatic Pesticide Application Plan (APAP) to undertake monitoring and reporting through a Coalition, then the Coalition will prepare and implement an MRP (pursuant to this Attachment C) and act on behalf of the Discharger with respect to monitoring and reporting. Otherwise, the Discharger will prepare and implement an individual MRP.

Question No. 1: Does the residual algaecides and aquatic herbicides discharge cause an exceedance of receiving water limitations?

Question No. 2: Does the discharge of residual algaecides and aquatic herbicides, including active ingredients, inert ingredients, and degradation byproducts, in any combination cause or contribute to an exceedance of the “no toxics in toxic amount” narrative toxicity objective?

If the Discharger elects in its APAP to undertake monitoring and reporting through a Coalition, the APAP should reference and attach the Coalition’s monitoring plan.

I. GENERAL MONITORING PROVISIONS

A. Samples and measurements taken as required herein shall be representative of the nature of the monitored discharge. All samples shall be taken at the anticipated monitoring locations specified in the Discharger’s or Coalition’s APAP.

B. All laboratory analyses shall be conducted at a laboratory certified for such analyses by the California Department of Public Health in accordance with California Water Code section 13176. Laboratories that perform sample analyses shall be identified in all monitoring reports. The Discharger shall institute a Quality Assurance-Quality Control Program for any onsite field measurements such as electric conductivity, pH, turbidity, and temperature. A manual containing the steps followed in this program must be kept in the laboratory and shall be available for inspection by the State Water Board and the appropriate Regional Water Board staff. The Quality Assurance-Quality Control Program must conform to United States Environmental Protection Agency (U.S. EPA) guidelines or to procedures approved by the State Water Board and the appropriate Regional Water Board.

C. All analyses shall be conducted in accordance with the latest edition of "Guidelines Establishing Test Procedures for Analysis of Pollutants," promulgated by the U.S. EPA in title 40 Code Federal Regulation (40 C.F.R.) 136 or equivalent methods that are commercially and reasonably available and that provide quantification of sampling parameters and constituents sufficient to evaluate compliance with applicable effluent limits and to perform reasonable potential analysis. Equivalent methods must be more sensitive than those specified in 40 C.F.R. 136 if the method is available in the 40 C.F.R. 136, and must be approved for use by the Regional Water Board Executive Officer.

Any procedures to prevent the contamination of samples as described in the monitoring program in the APAP shall be implemented.

D. Records of monitoring information shall include the following:

1. The date, exact place, and time of sampling or measurements;
2. The individuals who performed the sampling or measurements;
3. The dates analysis were performed;
4. The individuals who performed the analyses;
5. The analytical techniques or methods used; and
6. Results of analyses.

E. All monitoring instruments and devices used to fulfill the prescribed monitoring program shall be properly maintained and calibrated as necessary to ensure their accuracy.

F. Monitoring results, including noncompliance, shall be reported at intervals and in a manner specified in this MRP.

II. MONITORING LOCATIONS AND SAMPLE TYPES

A. Monitoring Locations

Each Discharger or Coalition shall establish monitoring locations specified in the APAP to demonstrate compliance with the receiving water limitations, discharge specifications, and other requirements in this General Permit. The number and location of samples shall be selected to answer the two key questions. A Discharger or Coalition may use representative monitoring locations* to characterize water quality for all waters of the United States within the Discharger's or Coalition's boundaries for each environmental setting (flowing water and non-flowing water). However, the Discharger or Coalition must provide justification for the selection of the representative monitoring locations. To be considered "representative," at a minimum, a location must be similar in hydrology, algaecides and aquatic herbicides use, and other factors that affect the discharge of algaecides and aquatic herbicides and their residues to surface waters as a result of applications to the areas being represented in that environmental setting. Each Discharger or Coalition must provide technical justification and identify which areas are to be considered representative. Monitoring location information shall include a description of the treatment area, GPS

coordinates if feasible, and algaecides and aquatic herbicides being applied. The specific monitoring locations initially identified as representative monitoring locations may be changed based on surveillance of the Discharger or Coalition.

B. Sample Types

The following monitoring is required for each sampling:

1. **Background Monitoring.** Background monitoring samples shall be collected upstream at the time of the application event* or in the application area* just prior to (up to 24 hours in advance of) the application event.
2. **Event Monitoring.** Event monitoring samples shall be collected immediately downstream of the treatment area in flowing waters or immediately outside of the treatment area in non-flowing waters, immediately after the application event, but after sufficient time has elapsed such that treated water would have exited the treatment area.
3. **Post-Event Monitoring.** Post-event monitoring samples shall be collected within the treatment area within one week after application.

III. RECEIVING WATER MONITORING REQUIREMENTS – SURFACE WATER

A. General Monitoring Requirements

The monitoring program described in the APAP shall be designed to answer the two key questions stated above. The monitoring program in the APAP shall describe the tasks and time schedules in which these two key questions will be addressed. Monitoring shall take place at locations that are being planned to be applied or may be applied as described in the Discharger's APAP.

The monitoring program described in the APAP must consider watershed specific attributes and waste constituents, based on the characteristics of applications within the Coalition's or Discharger's area, as well as the receiving water quality conditions. Developing the details of a monitoring design requires clearly defining several inputs to the design and then organizing these in a logical framework that supports effective decision making about indicators, monitoring locations, and monitoring frequency. The logical framework should describe:

1. The basic geographic and hydrographic features of the area, particularly application points and the pathways(s) of residue flows;
2. Algaecides and aquatic herbicides application practices and how they are distributed in space and time;
3. Relevant knowledge about the transport, fates, and effects of algaecides and aquatic herbicides, including best- and worst-case scenarios;
4. Description of the designated beneficial uses in each water body;
5. Relevant knowledge about the action of cumulative and indirect effects;

6. Mechanisms through which algaecides and aquatic herbicides applications could lead to designated use impacts, given the basic features of the area;
7. Known and potential impacts of algaecides and aquatic herbicides applications on water quality, ranked in terms of relative risk, based on factors such as magnitude, frequency and duration;
8. Sufficient number of sampling areas to assess the entire Discharger's or Coalition's area of influence; and
9. A description of sampling methods and a sampling schedule.

In conducting the receiving water sampling, a log shall be kept of the receiving water conditions throughout the reach bounded by the treatment area. Attention shall be given to the presence or absence of:

1. Floating or suspended matter;
2. Discoloration;
3. Bottom deposits;
4. Aquatic life;
5. Visible films, sheens, or coatings;
6. Fungi, slimes, or objectionable growths; and
7. Potential nuisance conditions.

Notes on receiving water conditions shall be summarized in the monitoring report.

B. Visual, Physical, and Chemical Monitoring Requirements

Monitoring shall take place at locations that are described and scheduled in the Coalition's or Discharger's APAP. Monitoring for all active ingredients must include frequent and routine monitoring on a pre-determined schedule, as summarized in the Table C-1 below:

Table C-1. Monitoring Requirements

Sample Type	Constituent/Parameter	Units	Sample Method	Minimum Sampling Frequency	Sample Type Requirement	Required Analytical Test Method
Visual	1. Monitoring area description (pond, lake, open waterway, channel, etc.) 2. Appearance of waterway (sheen, color, clarity, etc.) 3. Weather conditions (fog, rain, wind, etc.)	Not applicable	Visual Observation	[1]	Background, Event and Post-event Monitoring	Not applicable
Physical	1. Temperature[2]	ºF	Grab[4]	[5]	Background, Event and Post-event Monitoring	[6]
	2. pH[3]	Number				
	3. Turbidity[3]	NTU				
	4. Electric Conductivity[3] @ 25°C	µmhos/cm				
Chemical	1. Active Ingredient[7]	µg/L	Grab[4]	[5]	Background, Event and Post-event Monitoring	[6]
	2. Nonylphenol[8]	µg/L				
	3. Hardness (if copper is monitored)	mg/L				
	4. Dissolved Oxygen[2]	mg/L				

[1] All applications at all sites.
[2] Field testing.
[3] Field or laboratory testing.
[4] Samples shall be collected at three feet below the surface of the water body or at mid water column depth if the depth is less than three feet.
[5] Collect samples from a minimum of six application events for each active ingredient in each environmental setting (flowing water and non-flowing water) per year, except for glyphosate. If there are less than six application events in a year, collect samples during each application event for each active ingredient in each environmental setting (flowing water and non-flowing water). If the results from six consecutive sampling events show concentrations that are less than the receiving water limitation/trigger for an active ingredient in an environmental setting, sampling shall be reduced to one application event per year for that active ingredient in that environmental setting. If the yearly sampling event shows exceedance of the receiving water limitation/trigger for an active ingredient in an environmental setting, then sampling shall return to six application events for that active ingredient in each environmental setting. For glyphosate, collect samples from one application event from each environmental setting (flowing water and non-flowing water) per year.
[6] Pollutants shall be analyzed using the analytical methods described in 40 C.F.R. part 136.
[7] 2,4-D, acrolein, dissolved copper, diquat, endothall, fluridone, glyphosate, imazamox, imazapyr, penoxsulam, and triclopyr.
[8] It is required only when a surfactant is used.

IV. REPORTING REQUIREMENTS

A. General Monitoring and Reporting Requirements

1. The Coalition or Discharger shall comply with all Standard Provisions (Attachment B) related to monitoring, reporting, and recordkeeping.

2. Upon written direction of the State Water Board or the Regional Water Board, the Coalition or Discharger shall submit information as specified.

3. The Coalition or Discharger shall report to the State Water Board and appropriate Regional Water Board any toxic chemical release data that are reported to the State Emergency Response Commission within 15 days of reporting the data to the Commission pursuant to section 313 of the "Emergency Planning and Community Right to Know Act" of 1986 (42 U.S.C. §11001 et. seq.).

B. Annual Information Collection

The Coalition or Discharger shall complete and retain all information on the previous reporting year beginning January 1 and ending December 31. When requested by the Deputy Director or Executive Officer of the applicable Regional Water Board, the Coalition or Discharger shall submit the annual information which must include the following:

1. An executive summary discussing compliance or violation of this General Permit and the effectiveness of the APAP to reduce or prevent the discharge of pollutants associated with algaecide and aquatic herbicide applications;

2. A summary of monitoring data, including the identification of water quality improvements or degradation as a result of the algaecide or aquatic pesticide application, if appropriate, and recommendations for improvements to the APAP [including proposed best management practices (BMPs)] and monitoring program based on the monitoring results. All receiving water monitoring data shall be compared to receiving water limitations and receiving water monitoring triggers;

3. Identification of BMPs currently in use and a discussion of their effectiveness in meeting the requirements in this General Permit;

4. A discussion of BMP modifications addressing violations of this General Permit;

5. A map showing the location of each treatment area;

6. Types and amounts of algaecides and aquatic herbicides used at each application event;*

7. Information on surface area and/or volume of treatment areas and any other information used to calculate dosage, concentration, and quantity of each algaecide and aquatic herbicide used;

8. Sampling results shall indicate the name of the sampling agency or organization, detailed sampling location information (including latitude and longitude or township/range/section if available), detailed map or description of each sampling area (address, cross roads, etc.), collection date, name of constituent/parameter and its concentration detected, minimum levels, method detection limits for each constituent analysis, name or description of water body sampled, and a comparison with applicable water quality standards, description of analytical QA/quality control plan. Sampling results shall be tabulated so that they are readily discernible; and

9. Summary of algaecide and aquatic herbicide application log.

C. Annual Report

The Coalition or Discharger shall submit to the Deputy Director and the appropriate Regional Water Board Executive Officer an annual report consisting of a summary of the past year's activities, and certify compliance with all requirements of this General Permit. If there is no discharge of algaecides and aquatic herbicides, their residues, or their degradation byproducts, the Coalition or Discharger shall provide the Deputy Director and the appropriate Regional Water Board Executive Officer a certification that algaecide and aquatic herbicide application activities did not result in a discharge to any water body. The annual report shall contain the following information:

1. An executive summary discussing compliance or violation of this General Permit and the effectiveness of the APAP; and
2. A summary of monitoring data, including the identification of water quality improvements or degradation as a result of the algaecide or aquatic pesticide application,
3. Dischargers shall submit the annual report according to the following schedule:

Table C-2. Reporting Schedule

Reporting Frequency	Reporting Period	Annual Report Due
Annual	January 1 through December 31	March 1

D. Electronic Reporting

At any time during the term of this General Permit, the State Water Board or the appropriate Regional Water Board may notify the Coalition or Discharger of the requirement to submit electronically Self Monitoring Reports (SMRs) using the State Water Board's California Integrated Water Quality System (CIWQS) Program (http://www.waterboards.ca.gov/ciwqs/index.html). Until such notification is given, the Coalition or Discharger shall submit hardcopy SMRs. The CIWQS website will provide additional directions for SMR submittal in the event there will be service interruption for electronic submittal.

The Coalition or Discharger shall report the results for all monitoring specified in this MRP in the SMR. The Coalition or Discharger shall submit annual SMRs including the results of all required monitoring using U.S. EPA-approved test methods or other test methods specified in this General Permit. If the Coalition or Discharger monitors any pollutant more frequently than required by this General Permit, the results of this monitoring shall be included in the calculations and reporting of the data submitted in the SMR.

E. Reporting Protocols

The Coalition or Discharger shall report with each sample result the applicable reported Minimum Level (ML) and the current Minimum Detection Limit, as determined by the procedure in 40 C.F.R. part 136.

The Coalition or Discharger shall report the results of analytical determinations for the presence of chemical constituents in a sample using the following reporting protocols:

1. Sample results greater than or equal to the reported ML shall be reported as measured by the laboratory (i.e., the measured chemical concentration in the sample).
2. Sample results less than the Report Limit, but greater than or equal to the laboratory's MDL, shall be reported as "Detected, but Not Quantified," or DNQ. The estimated chemical concentration of the sample shall also be reported.

   For the purposes of data collection, the laboratory shall write the estimated chemical concentration next to DNQ as well as the words "Estimated Concentration" (may be shortened to "Est. Conc."). The laboratory may, if such information is available, include numerical estimates of the data quality for the reported result. Numerical estimates of data quality may be percent accuracy (plus a percentage of the reported value), numerical ranges (low to high), or any other means considered appropriate by the laboratory.
3. Sample results less than the laboratory's MDL shall be reported as "<" followed by the MDL.
4. The Coalition or Discharger shall instruct laboratories to establish calibration standards so that the ML value (or its equivalent if there is differential treatment of samples relative to calibration standards) is the lowest calibration standard. At no time is the Coalition or Discharger to use analytical data derived from extrapolation beyond the lowest point of the calibration curve.
5. Multiple Sample Data: If two or more sample results are available, the Coalition or Discharger shall compute the arithmetic mean unless the data set contains one or more reported determinations of DNQ or "Not Detected" (ND). In those cases, the Coalition or Discharger shall compute the median in place of the arithmetic mean in accordance with the following procedure:
   a. The data set shall be ranked from low to high, ranking the reported ND determinations lowest, DNQ determinations next, followed by quantified values (if any). The order of the individual ND or DNQ determinations is unimportant.
   b. The median value of the data set shall be determined. If the data set has an odd number of data points, then the median is the middle value. If the data set has an even number of data points, then the median is the average of the two values around the middle unless one or both of the points are ND or DNQ, in which case the median value shall be the lower of the two data points where DNQ is lower than a value and ND is lower than DNQ.
6. The annual report shall comply with the following requirements:
   a. The Coalition or Discharger shall arrange all reported data in a tabular format. The data shall be summarized to clearly illustrate whether the algaecide and aquatic herbicide applications are conducted in compliance

with effluent and receiving water limitations. The Coalition or Discharger is not required to duplicate the submittal of data that are entered in a tabular format within CIWQS. When electronic submittal of data is required and CIWQS does not provide for entry into a tabular format within the system, the Coalition or Discharger shall submit electronically the data in a tabular format as an attachment.

b. The Coalition or Discharger shall attach a cover letter to the annual report that clearly identifies violations of the permit; discusses corrective actions taken or planned; and provides a time schedule for corrective actions. Identified violations must include a description of the requirement that was violated and a description of the violation.

c. The annual report must be submitted to the State Water Board and the appropriate Regional Water Board, signed and certified as required by the Standard Provisions (Attachment B).

F. Other Reporting Requirements

1. Twenty-Four Hour Report

The Coalition or Discharger shall report to the State Water Board and appropriate Regional Water Board any noncompliance, including any unexpected or unintended effect of an algaecide or aquatic herbicide use that may endanger health or the environment. Any information shall be provided orally within 24 hours from the time the Coalition or Discharger becomes aware of the circumstances and must include the following information:

a. The caller's name and telephone number;

b. Applicator name and mailing address;

c. Waste Discharge Identification (WDID) number;

d. The name and telephone number of a contact person;

e. How and when the Coalition or Discharger become aware of the noncompliance;

f. Description of the location of the noncompliance;

g. Description of the noncompliance identified and the U.S. EPA pesticide registration number for each product the Discharger applied in the area of the noncompliance; and

h. Description of any steps that the Coalition or Discharger has taken or will take to correct, repair, remedy, cleanup, or otherwise address any adverse effects.

If the Coalition or Discharger is unable to notify the State and the appropriate Regional Water Board within 24 hours, the Coalition or Discharger must do so as soon as possible and also provide the rationale for why the Discharger was unable to provide such notification within 24 hours.

2. **Five-Day Written Report**

The Coalition or Discharger shall also provide a written submission within five (5) days of the time the Discharger becomes aware of the noncompliance. The written submission shall contain the following information:

a. Date and time the Coalition or Discharger contacted the State Water Board and the appropriate Regional Water Board notifying of the noncompliance and any instructions received from the State and/or Regional Water Board; information required to be provided in Section D.1 (24-Hour Reporting);

b. A description of the noncompliance and its cause, including exact date and time and species affected, estimated number of individual and approximate size of dead or distressed organisms (other than the pests to be eliminated);

c. Location of incident, including the names of any waters affected and appearance of those waters (sheen, color, clarity, etc);

d. Magnitude and scope of the affected area (e.g. aquatic square area or total stream distance affected);

e. Algaecide and aquatic herbicide application rate, intended use site (e.g., banks, above, or direct to water), method of application, and name of algaecide and herbicide product, description of algaecide and herbicide ingredients, and U.S. EPA registration number;

f. Description of the habitat and the circumstances under which the noncompliance activity occurred (including any available ambient water data for aquatic algaecides and aquatic herbicides applied);

g. Laboratory tests performed, if any, and timing of tests. Provide a summary of the test results within five days after they become available;

h. If applicable, explain why the Coalition or Discharger believes the noncompliance could not have been caused by exposure to the algaecides or aquatic herbicides from the Coalition's or Discharger's application; and

i. Actions to be taken to prevent recurrence of adverse incidents.

The State Water Board staff or Regional Water Board staff may waive the above-required written report under this provision on a case-by-case basis if an oral report has been received within 24 hours.

Attachment D – Fact Sheet

Table of Contents

List of Tables

Attachment D – Fact Sheet

As described in Section III, Findings, of this General Permit, the State Water Resources Control Board (State Water Board) incorporates this Fact Sheet as findings of the State Water Board that support the issuance of this General Permit. This Fact Sheet includes the legal requirements and technical rationale that serve as the basis for the requirements of this General Permit.

This General Permit has been prepared under a standardized format to accommodate a broad range of discharge requirements for Dischargers in California.

I. PERMIT INFORMATION

A. Background

1. The Regulatory Background

In 1972, the Federal Water Pollution Control Act (also referred to as the Clean Water Act or CWA) was amended to provide that the discharge of pollutants to waters of the United States from any point source is effectively prohibited unless the discharge is in compliance with a National Pollutant Discharge Elimination System (NPDES) Permit.

On September 22, 1989, the U.S. Environmental Protection Agency (U.S. EPA) granted the State of California, through the State Water Resources Control Board (State Water Board) and the Regional Water Quality Control Boards (Regional Water Boards), the authority to issue general NPDES permits pursuant to title 40 Code of Federal Regulations (40 C.F.R.) 122 and 123.

Section 122.28 of 40 C.F.R. provides for issuance of general permits to regulate a category of point sources if the sources involve the same or substantially similar types of operations; discharge the same type of waste; require the same type of effluent limitations or operating conditions; require similar monitoring; and are more appropriately regulated under a general permit rather than individual permits.

On March 12, 2001, the Ninth Circuit Court of Appeals held that discharges of pollutants from the use of aquatic pesticides in waters of the United States require coverage under an NPDES permit. (*Headwaters, Inc. v. Talent Irrigation District).*[3] The *Talent* decision was issued just prior to the major season for applying aquatic pesticides.

Because of the serious public health, safety, and economic implications of delaying pesticide applications, in 2001 the State Water Board adopted Water Quality Order (Order) No. 2001-12-DWQ, Statewide General NPDES Permit for

[3] 243 F.3d 526 (9th Cir., 2001).

Discharges of Aquatic Pesticides to Waters of the United States on an emergency basis to provide immediate NPDES permit coverage for broad categories of aquatic pesticide use in California.

Order No. 2001-12-DWQ imposed requirements on any discharge of aquatic pesticides by public entities to waters of the United States in accordance with the Policy which establishes procedures for implementing water quality standards for priority pollutants* in NPDES permits.

Section 5.3 of the State Water Board Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (Policy) allows for short-term or seasonal exceptions from its requirements for resource or pest management conducted by public entities or mutual water companies. In order to qualify for an exception from meeting priority pollutant standards, a public entity must fulfill the requirements listed in section 5.3 and the State Water Board must decide to grant the exception. Among other requirements, entities seeking an exception to complying with water quality standards for priority pollutants must submit documents in compliance with California Environmental Quality Act (CEQA).[4] Because of the emergency adoption of Order No. 2001-12-DWQ, the State Water Board invoked an exemption to the requirements of section 5.3 of the Policy and issued the permit incorporating a categorical exception to water quality standards for priority pollutants.

Order No. 2001-12-DWQ required that Dischargers develop a best management practices (BMPs) plan that minimizes adverse impacts to receiving waters and a monitoring and reporting plan that is representative of each type of aquatic pesticide application.

In August 2001, Waterkeepers Northern California (Waterkeepers) filed a lawsuit against the State Water Board challenging several aspects of Order No. 2001-12-DWQ. Major aspects of the challenge included the emergency adoption of the Order without compliance with CEQA and other exception requirements of the Policy; failure to address cumulative impacts; and failure to comply with the California Toxics Rule (CTR).[5]

In a settlement of the Waterkeepers' lawsuit, the State Water Board agreed to fund a comprehensive aquatic pesticide monitoring program that would assess receiving water toxicity caused by aquatic pesticides and alternatives for pesticide use. The State Water Board contracted with the San Francisco Estuary Institute (SFEI) to conduct the program. SFEI published the final report on February 5, 2004.

In November 2002, the Ninth Circuit issued another opinion concerning the need for an NPDES permit for pesticide application. (*League of Wilderness Defenders*

[4] Cal. Pub. Resources Code § 21000 et. seq.
[5] 40 C.F.R. Section 131.38.

v. Forsgren.[6]) In this case, the court held that the USDA Forest Service must obtain an NPDES permit before it sprays insecticides* from an aircraft directly into or over rivers as part of silviculture activities. The court found that the insecticides are pollutants under the CWA. The court also defined the exemption for silvicultural pest control from the definition of "point source" in U.S. EPA's regulations to be limited to pest control activities from which there is natural runoff.

Also in 2002, the Second Circuit issued an unpublished decision regarding the need for an NPDES permit for application of pesticides for mosquito control in federal wetland areas. (*Altman v. Town of Amherst*.) The lower court had dismissed a citizens' suit, holding that pesticides, when used for their intended purpose, do not constitute a "pollutant" for purposes of the CWA, and are more appropriately regulated under Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). The appeals court vacated the trial court's decision and remanded the matter. In its unpublished decision, the Second Circuit expressed concern that: "[u]ntil the EPA articulates a clear interpretation of current law - among other things, whether properly used pesticides released into or over waters of the United States can trigger the requirements for NPDES permits - the question of whether properly used pesticides can become pollutants that violate the [Clean Water Act] will remain open."

Order No. 2001-12-DWQ expired on January 31, 2004. In 2004, it was replaced by two general permits: a vector control permit for larvicides (Order No. 2004-0008-DWQ) and a weed control permit (Order No. 2004-0009-DWQ). The State Water Board determined that adoption of these two permits was consistent with the Ninth Circuit decisions.

In 2005, the Ninth Circuit held that a pesticide that is applied consistent with FIFRA is not a "chemical waste" (*Fairhurst v. Hagener),*[7] but also stated that it would not change its decision in *Headwaters.* The court stated that whether an NPDES permit was required depends on whether there was any "residue or unintended effect" from application of the pesticide. In *Fairhurst*, the court found neither residue nor unintended effect was present. Therefore, the pesticide application at issue did not require an NPDES permit.

U.S. EPA's Final Rule: On November 20, 2006, U.S. EPA adopted a final regulation providing that NPDES permits are not required for pesticide applications as long as the Discharger follows FIFRA label instructions. According to the regulation, pesticides applied under the following two circumstances are not pollutants and, therefore, are not subject to NPDES permitting requirements:

a. The application of pesticides directly to waters of the United States in order to control pests. Examples of such applications include applications to control

[6] 309 F.3d 1181 (9th Cir., 2002).
[7] 422 F.3d 1146 (9th Cir., 2005).

mosquito larvae, aquatic weeds, or other pests that are present in waters of the United States; and

b. The application of pesticides to control pests that are present over waters of the United States, including near such waters, where a portion of the pesticides will unavoidably be deposited to waters of the United States in order to target the pests effectively; for example, when insecticides are aerially applied to a forest canopy where waters of the United States may be present below the canopy or when pesticides are applied over or near water for control of adult mosquitoes or other pests.

Lawsuits Against U.S. EPA's Final Rule: After U.S. EPA's new regulation was adopted in 2006, lawsuits were filed by both the pesticide industry and environmental groups in 11 of the 13 Circuits, including the Ninth Circuit Court, challenging U.S. EPA's Final Rule.

The National Cotton Council of America v. U.S. EPA: [8] The petitions for review were consolidated in the Sixth Circuit Court by an order of the Judicial Panel on Multidistrict Litigation.

On January 11, 2009, the Sixth Circuit Court of Appeals determined that U.S. EPA's Final Rule is not a reasonable interpretation of the CWA and vacated the Final Rule. U.S. EPA did not request reconsideration of the decision, but did file a motion for a two-year stay of the effect of the decision in order to provide agencies time to develop, propose, and issue NPDES general permits for pesticide applications covered by the ruling. On June 8, 2009, the Sixth Circuit granted the motion, such that the U.S. EPA exemption was to remain in place until April 9, 2011. Subsequently, U.S. EPA was granted an extension of the stay, which allowed the exemption to continue until October 31, 2011.

2. **Related Pesticide Regulation Information**

Pesticide formulations may include "active ingredients" and "inert ingredients." Adjuvants or surfactants may be added to the ingredients in the application equipment that is used in the delivery of the aquatic pesticide.

As part of the registration process of pesticides for use in California, U.S. EPA and the California Department of Pesticide Regulation (DPR) evaluate data submitted by registrants to ensure that a product used according to label instructions will cause no harm or adverse impact on non-target organisms that cannot be reduced or mitigated with protective measures or use restrictions. Registrants are required to submit data on the effects of pesticides on target pests (efficacy) as well as non-target effects. Data on non-target effects include plant effects (phytotoxicity), fish and wildlife hazards (ecotoxicity), impacts on endangered species, effects on the environment, environmental fate, degradation byproducts, leachability, and persistence. Requirements that are specific to use in California are included in many pesticide labels that are approved by U.S. EPA.

[8] 553 F.3d 927 (6th Cir., 2009).

Use must be reported to the County Agricultural Commissioner where required by law or by agreement with DPR.

The CWA, at section 301(a), broadly prohibits the discharge of any pollutant to waters of the United States, except in compliance with an NPDES permit. Since FIFRA is not necessarily as protective of water quality as the CWA, pesticides discharged into surface waters may constitute pollutants within the meaning of the CWA even if the discharge is in compliance with the registration requirements of FIFRA, thus, requiring coverage under a valid NPDES permit.

DPR and the County Agricultural Commissioners regulate the sale and use of pesticides in California. Pesticide applications subject to this General Permit must be consistent with permits issued by County Agricultural Commissioners and the pesticide label instructions approved by U.S. EPA under FIFRA. According to federal law, pesticide label language is under the sole jurisdiction of U.S. EPA. Label language and any changes thereto must be approved by U.S. EPA before the product can be sold in this country. DPR cannot require manufacturers to make changes on labels; however, DPR can refuse to register products unless manufacturers address unmitigated hazards by amending the pesticide label.

State regulations require that the County Agricultural Commissioners determine if a substantial adverse environmental impact will result from the proposed use of a restricted material. If the County Agricultural Commissioner determines that this is likely, the commissioner may deny the restricted pesticide use permit or may issue it under the condition that site-specific use practices be followed (beyond the label and applicable regulations) to mitigate potentially adverse effects. DPR conducts scientific evaluations of potential health and environmental impacts and provides commissioners with information in the form of suggested permit conditions. DPR's suggested permit conditions reflect minimum measures necessary to protect people and the environment. County Agricultural Commissioners use this information and its evaluation of local conditions to set site-specific limits in permits.

B. General Criteria

1. This General Permit serves as a general NPDES Permit for the discharge of residual algaecides and aquatic herbicides to surface waters as a result of algaecides and aquatic herbicides applications for algae and aquatic weed controls.

2. Dischargers who submit a complete application under this General Permit are not required to submit an individual permit application. The State Water Board's Deputy Director of the Division of Water Quality (Deputy Director) may request additional information or determine that a Discharger is not eligible for coverage under this General Permit and would be better regulated under an individual permit or other general NPDES permit adopted by the appropriate Regional Water Board. If the discharge becomes covered by an individual or another general permit, the applicability of this General Permit to the specified discharge

will be immediately terminated on the effective date of the individual permit or coverage under the other general permit.

II. NOTIFICATION REQUIREMENTS

A. General Permit Application

To obtain authorization under this General Permit, Dischargers must submit to the State Water Board a complete application at least 90 days prior to their first application of the season. This is to allow posting of the Aquatic Pesticide Application Plan (APAP) for a 30-day comment period, staff to review APAP and respond to comments, and the Deputy Director to issue the Notice of Applicability (NOA). Following are the application information requirements:

1. A Notice of Intent (NOI shown as Attachment E) signed in accordance with the signatory requirements of the Standard Provisions in Attachment B;
2. An application fee. A fee is required only for new Dischargers. Dischargers that are enrolled under Order No. 2004-0009-DWQ and are applying for coverage under this Permit will be billed during the regular billing cycle; and
3. An APAP.

State Water Board staff will post the APAP on the State Water Board's website for 30 days for public review. In the meantime, the State and Regional Water Board staff will review the application package for completeness and applicability to this General Permit. After the application has been deemed complete, the Deputy Director will issue an NOA. The NOA will specify the permitted active ingredients of algaecides and aquatic herbicides that may be used, and any Regional Water Board specific conditions and requirements not stated in this General Permit. Any such region-specific conditions and requirements shall be enforceable. The Discharger is authorized to discharge starting on the date of the NOA. If comments are received, staff will immediately work to resolve them in order to issue an NOA within 90 days of receipt of the application.

This General Permit specifices an effective date of December 1, 2013. The effective date is delayed because, with the impending start of the 2013 application season, Dischargers may be unable to comply with the requirement to submit their applications 90 days prior to their first pesticide application.The delay will allow enrollees under Water Quality Order No. 2004-0009-DWQ to have continued permit coverage throughout the 2013 application season while preparing their new application for coverage under this General Permit; new enrollees to prepare and submit their applications as well; and Water Boards' staff to process the applications and issue NOAs.

Alternatively, the Deputy Director may issue a Notice of Exclusion**,** which either terminates permit coverage or requires submittal of an application for an individual permit or alternative general permit.

B. Fee

The annual fee for enrollment under this General Permit, shall be based on Category 3 in section 2200(b)(9) of title 23, California Code of Regulations (Cal. Code Regs.). This category is appropriate because algaecide and aquatic herbicide applications incorporate BMPs to control potential impacts to beneficial uses, and this General Permit prohibits pollutant discharge associated with algaecide and aquatic herbicide applications from causing exceedance of CTR criteria or water quality objectives. Information concerning the applicable fees can be found at http://www.waterboards.ca.gov/resources/fees/docs/fy1112fee_schdl_npdes_prmt.pdf

C. Public Notification

The State Water Board has notified interested agencies and persons of its intent to prescribe waste discharge requirements in this General Permit and provided them with an opportunity to submit their written comments and recommendations.

III. DISCHARGE DESCRIPTION

This General Permit covers the point source discharge to waters of the United States of pesticide residues resulting from applications using products containing 2,4-D, acrolein, copper, diquat, endothall, fluridone, glyphosate, imazamox, imazapyr, penoxsulam, sodium carbonate peroxyhydrate, and triclopyr-based algaecides and aquatic herbicides, and adjuvants containing ingredients represented by the surrogate nonylphenol. This General Permit covers only discharges of algaecides, aquatic herbicides, and adjuvants that are currently registered for use in California, or that become registered for use and contain the above-listed active ingredients and ingredients represented by the surrogate of nonylphenol.

A. Existing Discharge Description

As of January 11, 2013, there were 153 active enrollees under Water Quality Order No. 2004-0009-DWQ, Statewide General National Pollutant Discharge Elimination System Permit for the Discharge of Aquatic Pesticides for Aquatic Weed Control in Waters of the United States, General Permit No. CAG990005 (Order No. 2004-0009-DWQ). Most of the enrollees are local public agencies such as cities and irrigation, flood control, or reclamation districts. The other enrollees include six state of California agencies: the Departments of Boating and Waterways, Fish and Wildlife, Food and Agriculture, Parks and Recreation, Transportation, and Water Resources; a federal agency, U.S. Department of Fish and Wildlife Service; and a few private entities such as home owner associations and mobile home park owners.

The State Water Board granted exceptions to public agencies and mutual water companies that met the criteria stated in section 5.3 of the Policy for short-term or seasonal exceptions from meeting the receiving water limitations for priority pollutants of acrolein and copper.

Order No. 2004-0009-DWQ permits the discharge of aquatic pesticides with the following active ingredients: 2,4-D, acrolein, copper, diquat, endothall, fluridone, glyphosate, and triclopyr. The State Water Board reopened Order No. 2004-0009-DWQ after its adoption to add two more active ingredients: (1) imazapyr, a non-selective herbicide, for control of cordgrass and broadleaf weeds and other emergent aquatic species; and (2) sodium carbonate peroxyhydrate as an alternative to copper for algae control.*

B. Annual Report Review

State Water Board staff reviewed annual reports from 2004 through 2008[9] submitted under Order No. 2004-0009-DWQ. The data are summarized in Table D-1 below. As shown in Table D-1, all constituent concentrations from post-event application samples were below receiving water limitations except for the following: three exceedances each for acrolein and glyphosate and 82 exceedances for copper out of 288 monitoring events. For glyphosate, it is likely that the three exceedances were not the result of aquatic pesticide applications because the pre-application samples also showed exceedances and the remaining 151 sampling events showed no exceedance. For copper, 43 of the 82 exceedances were from public agencies or mutual water companies that were excepted from meeting priority pollutant limitations during the exception period. Thus, staff did not consider these exceedances as violations of the receiving water limitations. However, 39 of the exceedances were from entities that did not have a Policy exception. Therefore, staff considered these exceedances as true violations of the receiving water limitations.

Table D-1. Monitoring Data Summary, 2004-2008, Order No. 2004-0009-DWQ

Pollutant	Number of Samples	Number of Exceedance
2,4-D	3	0
Acrolein	213	3
Copper	288	85
Diquat	17	0
Endothall	6	0
Fluridone	12	0
Glyphosate	154	3
Nonylphenol	53	0

Under Order No. 2004-0009-DWQ, the most commonly used aquatic pesticide products contained copper, acrolein, and glyphosate in descending order.

[9] The data are submitted to the Regional Water Boards per Order No. 2004-0009-DWQ. When State Water Board staff started collecting data from the Regional Water Boards, the data available covered only this period.

C. Receiving Water Description

The annual reports showed that most algae and aquatic weed control applications were performed in fresh inland surface waters such as lakes, ponds, flood control and drainage channels, or canals. Some applications were performed in coastal waters, marina lagoons, and slough with brackish water.

IV. APPLICABLE PLANS, POLICIES, AND REGULATIONS

The requirements contained in this General Permit are based on the applicable plans, policies, and regulations identified below.

A. Legal Authorities

This General Permit is issued pursuant to section 402 of the federal Clean Water Act (CWA) and implementing regulations adopted by the U.S. Environmental Protection Agency (U.S. EPA) and chapter 5.5, division 7 of the California Water Code, commencing with section 13370. It shall serve as an NPDES permit for point source discharges of residual algaecides and aquatic herbicides to surface waters. This General Permit also serves as WDRs pursuant to article 4, chapter 4, division 7 of the California Water Code (commencing with §13260).

This General Permit shall serve as a General NPDES permit for point source discharges of residues from algaecides and aquatic herbicide applications for algae and aquatic weed control. This General Permit also serves as general Waste Discharge Requirements pursuant to article 4, chapter 4, and division 7 of the California Water Code (commencing with §13260).

B. California Environmental Quality Act (CEQA)

Pursuant to California Water Code section 13389, State and Regional Water Boards are exempt from the requirement to comply with Chapter 3, Division 13 of the Public Resources Code when adopting NPDES permits.

C. State and Federal Regulations, Policies, and Plans

1. Water Quality Control Plans (Basin Plans)

The Regional Water Boards have adopted Basin Plans that designate beneficial uses, establish water quality objectives, and contain implementation programs and policies to achieve those objectives for all waters addressed through the plans. In addition, the Basin Plans implement State Water Board Resolution No. 88-63, which established state policy that all waters, with certain exceptions, should be considered suitable or potentially suitable for municipal or domestic supply. The Basin Plans identify typical beneficial uses as follows: municipal and domestic supply, agricultural irrigation, stock watering, process supply, service supply, hydropower supply, water contact recreation, canoeing and rafting recreation, other non-contact water recreation,* warm freshwater aquatic habitat, cold freshwater habitat,* warm fish migration habitat, cold fish migration habitat,

warm and cold spawning habitat, wildlife habitat, navigation, rare, threatened, or endangered species habitat, groundwater recharge,* and freshwater replenishment.

Requirements of this General Permit implement provisions contained in the applicable Basin Plans.

2. **National Toxics Rule (NTR) and California Toxics Rule (CTR)**

U.S. EPA adopted the NTR on December 22, 1992, and later amended it on May 4, 1995 and November 9, 1999. About 40 criteria in the NTR applied in California. On May 18, 2000, U.S. EPA adopted the CTR. The CTR promulgated new toxics criteria for California and, in addition, incorporated the previously adopted NTR criteria that were applicable in the state. The CTR was amended on February 13, 2001. These rules contain water quality criteria for priority pollutants.

3. **State Implementation Policy (Policy)**

On March 2, 2000, the State Water Board adopted the *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California* (Policy). The Policy became effective on April 28, 2000 with respect to the priority pollutant criteria promulgated for California by U.S. EPA through the NTR and to the priority pollutant objectives established by the Regional Water Board in the Basin Plans. The Policy became effective on May 18, 2000 with respect to the priority pollutant criteria promulgated by U.S. EPA through the CTR. The State Water Board adopted amendments to the Policy on February 24, 2005 that became effective on July 13, 2005. The Policy establishes implementation provisions for priority pollutant criteria and objectives and provisions for chronic toxicity control. Requirements of this General Permit implement the Policy.

Policy Exception

The Policy provides categorical exceptions allowing short-term or seasonal exceptions from meeting the priority pollutant criteria/objectives if it is determined to be necessary to implement control measures for resource or pest management conducted by public entities or mutual water companies to fulfill statutory requirements. The Policy specifically refers to vector or weed control, pest eradication, or fishery management as the basis for categorical exceptions. The exceptions are only granted to public entities or mutual water companies that have adequately provided the following information as required by the Policy:

a. A detailed description of the proposed action which includes the proposed method of completing the action;

c. A time schedule;

d. A discharge and receiving water monitoring plan that specifies monitoring prior to application events,* during application events, and after completion with the appropriate quality control procedures;

e. CEQA documentation including notifying potentially affected public and government agencies; and

f. Any necessary contingency plans.

The public entities and mutual water companies listed in Attachment G have met the above requirements before the issuance or during the term of the Order No. 2004-0009-DWQ.

The final Negative Declaration or Mitigated Negative Declarations (ND/MND) prepared by the public entities or mutual water companies have determined that the water quality impacts identified in the environmental assessments of the ND/MND from algaecide and aquatic herbicide applications are less than significant, and would not have a significant effect on the environment. The boards of each public entity and mutual water company*, as the lead agencies under CEQA, approved the final ND/MND. Therefore, each public entity or mutual water company is not required to meet priority pollutant criteria during the exception period.

During the issuance of the Order No. 2004-0009-DWQ, as required in section 15096 of the CEQA Guidelines, the State Water Board, as a Responsible Agency under CEQA, considered the ND/MND approved by the board of each public entity or mutual water company. The State Water Board found that the projects will have less than significant water quality impact if the Dischargers meet the requirements in this General Permit. Accordingly, the Policy 5.3 exception granted previously will continue to be valid under this Order.

Any Discharger not listed in Attachment G is required to meet all applicable priority pollutant criteria for receiving waters.

4. **Antidegradation Policy**

Section 131.12 of 40 C.F.R. requires that the state water quality standards include an antidegradation policy consistent with the federal policy. The State Water Board established California's antidegradation policy in State Water Board Resolution No. 68-16. Resolution No. 68-16 incorporates the federal antidegradation policy where the federal policy applies under federal law. Resolution No. 68-16 requires that existing water quality be maintained unless degradation is justified based on specific findings. The Basin Plans implement, and incorporate by reference, both the state and federal antidegradation policies.

The permitted discharge must be consistent with the antidegradation provision of 40 C.F.R. section 131.12 and Resolution No. 68-16. The conditions of this General Permit require residual algaecide and aquatic herbicide discharges to meet applicable water quality objectives. Specifically, the General Permit sets receiving water limitations for 2,4-D, acrolein, copper, diquat, endothall, fluridone glyphosate, and nonylphenol. It also sets receiving water monitoring triggers for imazapyr and triclopyr triethylamine (TEA).

The BMPs and other controls required pursuant to the General Permit constitute Best Available Technology Economically Achievable (BAT) and Best Conventional Pollutant Control Technology (BCT).

The General Permit requirements are protective of the broad range of beneficial uses set forth in basin plans throughout the state, constituting best control available consistent with the purposes of the algaecide and aquatic herbicide application in order to ensure that pollution or nuisance will not occur. The nature of pesticides is to be toxic in order to protect beneficial uses such as human health or long-term viability of aquatic life. For example, blue-green algae are bacteria that live in both fresh and marine waters. In California, certain forms of blue-green algae have been a particular problem in the Klamath River watershed and on the Central Coast. Blooms of these bacteria can poison livestock, wildlife, and humans; they can also damage drinking water sources. The use of an algaecide is one of the effective ways to control the harmful blooms of blue-green algae. Although algaecide application will temporarily degrade the water quality and result in short-term toxicity in the receiving water, it prevents the toxicities in the entire water body for a long period of time. While surface waters may be temporarily degraded; water quality standards and objectives will not be exceeded after project completion.

Another example of benefits of pesticide application is the control of aquatic weeds in flood control channels. Aquatic herbicides used to control emerging aquatic weeds in a flood control channel will effectively prevent full growth and bloom of aquatic weeds that may block the channel and cause flooding in the surrounding communities. Although the water quality is temporarily degraded while the herbicide is taking its effect in eliminating the weeds, the water quality will not be exceeded after the project is completed. In addition, the receiving water limitations and other requirements of this General Permit will ensure maintenance of the highest water quality consistent with maximum benefit to the people of the state.

Given the nature of a General Permit and the broad range of beneficial uses to be protected across the state, data analysis of specific water bodies is infeasible. While surface waters may be temporarily degraded, water quality standards and objectives will not be exceeded. The nature of pesticides is to be toxic in order to protect human health and water resources. However, compliance with receiving water limitations is required. Therefore, this General Permit is consistent with state and federal antidegradation policies.

5. **Endangered Species Act**

This General Permit does not authorize any act that results in the taking of a threatened or endangered species or any act that is now prohibited, or becomes prohibited in the future, under either the California Endangered Species Act (Fish and Game Code §2050 et. seq) or the Federal Endangered Species Act (16 U.S.C.A. §1531 et. seq). This General Permit requires compliance with effluent limitations, receiving water limitations, and other requirements to protect the beneficial uses of waters of the state. The Discharger is responsible for meeting all requirements of the applicable Endangered Species Act.

6. **Impaired Water Bodies on CWA 303(d) List**

   This General Permit does not authorize the discharge of residual algaecides and aquatic herbicides and their degradation byproducts to waters of the United States that are impaired by the same active ingredients and their degradation byproducts. The links to California's impaired waters bodies are provided at http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtm.

7. **Other Plans, Policies, and Regulations**

   The State Water Board adopted the *Water Quality Control Policy for the Enclosed Bays and Estuaries of California*. The requirements within this General Permit are consistent with the policy.

V. RATIONALE FOR EFFLUENT LIMITATIONS AND DISCHARGE SPECIFICATIONS

Effluent limitations and toxic and pretreatment effluent standards established pursuant to sections 301 (Effluent Limitations), 302 (Water Quality Related Effluent Limitations), 304 (Information and Guidelines), and 307 (Toxic and Pretreatment Effluent Standards) of the CWA and amendments thereto are applicable to the discharge.

The control of pollutants discharged is established through effluent limitations and other requirements in NPDES permits. There are two principal bases for effluent limitations: (1) 40 C.F.R. section 122.44(a) requires that permits include applicable technology-based limitations and standards; and (2) 40 C.F.R. section 122.44(d) requires that permits include water quality-based effluent limitations to attain and maintain applicable numeric and narrative water quality criteria to protect the beneficial uses of the receiving water where numeric water quality objectives have not been established.

The CWA mandates the implementation of effluent limitations that are as stringent as necessary to meet water quality standards established pursuant to state or federal law (33 U.S.C., §1311(b)(1)(C); 40 C.F.R. §122.44(d)(1)). NPDES permits must incorporate discharge limits necessary to ensure that water quality standards are met. This requirement applies to narrative criteria as well as to numeric criteria specifying maximum amounts of particular pollutants. Pursuant to 40 C.F.R. section 122.44(d)(1)(i), NPDES permits must contain limits that control all pollutants that "*are or may be discharged at a level which will cause, have the reasonable potential to cause, or contribute to an excursion above any state water quality standard, including state narrative criteria for water quality*." Section 122.44(d)(1)(vi) of 40 C.F.R. further provides that "[w]*here a state has not established a water quality criterion for a specific chemical pollutant that is present in an effluent at a concentration that causes, has the reasonable potential to cause, or contributes to an excursion above a narrative criterion within an applicable State water quality standard, the permitting authority must establish effluent limits.*"

The CWA requires point source dischargers to control the amount of conventional, non-conventional, and toxic pollutants that are discharged into the waters of the United States. The control of pollutants discharged is established through effluent limitations and other requirements in NPDES permits. There are two principal bases for effluent limitations: 40 C.F.R. section 122.44(a) requires that permits include applicable technology-based

limitations and standards; and section 122.44(d) requires that permits include water quality-based effluent limitations to attain and maintain applicable numeric and narrative water quality criteria to protect the beneficial uses of the receiving water where numeric water quality objectives have not been established.

With respect to narrative objectives, the State Water Board must establish effluent limitations using one or more of three specified sources: (1) U.S. EPA's published water quality criteria; (2) a proposed state criterion (i.e., water quality objective) or an explicit state policy interpreting its narrative water quality criteria; or (3) an indicator parameter (i.e., 40 C.F.R. §122.44(d)(1)(vi)(A), (B) or (C)). Basin Plans contain a narrative objective requiring that: "*All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life.*" Basin Plans require the application of the most stringent objective necessary to ensure that surface water and groundwater do not contain chemical constituents, discoloration, toxic substances, radionuclides, or taste and odor producing substances that adversely affect beneficial uses. Basin Plans state that material and relevant information, including numeric criteria, and recommendations from other agencies and scientific literature will be utilized in evaluating compliance with the narrative toxicity objective. Basin Plans also limit chemical constituents in concentrations that adversely affect surface water beneficial uses. Basin Plans further state that, to protect all beneficial uses, the Regional Water Board may apply limits more stringent than MCLs.

A. Discharge Prohibitions

1. The discharge of residual algaecides, residual aquatic herbicides, and their degradation byproducts in a manner different from that described in this General Permit is prohibited.

   This prohibition is based on 40 C.F.R. 122.21(a), "Duty to Apply," and California Water Code section 13260, which requires filing a Report of Waste Discharge before discharges can occur. Discharges not described in the NOI, and subsequently not discharged in the manner permitted by this General Permit, are prohibited.

2. The discharge of residual algaecides, residual aquatic herbicides, and their degradation byproducts shall not create a nuisance as defined in section 13050 of the California Water Code.

   This prohibition is based on California Water Code section 13050 for water quality control for achieving water quality objectives.

3. The discharge shall not cause, have a reasonable potential to cause, or contribute to an in-stream excursion above any applicable standard or criterion promulgated by U.S. EPA pursuant to section 303 of the CWA, or water quality objective adopted by the State or Regional Water Boards.

   This prohibition is based on CWA section 301 and California Water Code.

4. All pesticides are prohibited from the waters of the Lahontan Region (Region 6). The use of this permit is invalid in the Lahontan Region unless the discharger has

requested a prohibition exemption from the Lahontan Water Board and the Lahontan Water Board has granted an exemption for the use of algaecides or aquatic herbicides.

This prohibition is based on the Lahontan Water Board's region-wide waste discharge prohibition for pesticides in water with exemption criteria to allow certain uses of aquatic pesticides.

B. Effluent Limitations

1. Technology-Based Effluent Limitations

The intent of technology-based effluent limitations in NPDES permits is to require a minimum level of treatment of pollutants based on available treatment technologies while allowing the Discharger to use any available control technique to meet the limitations. For industrial and other non-municipal facilities, technology-based effluent limitations are derived by using: (1) national effluent limitations guidelines and standards established by U.S. EPA; or best professional judgment on a case-by-case basis in the absence of national effluent limitations guidelines and standards. In the case of pesticide applications, U.S. EPA has not developed guidelines and standards other than the requirement to follow the labels when applying pesticides. At this point, it is not appropriate to establish technology-based effluent limitations other than following the label when applying algaecides and aquatic herbicides.

Therefore, the effluent limitations contained in this General Permit are narrative and include requirements to develop and implement an APAP that describes appropriate BMPs, including compliance with all algaecide and aquatic herbicide label instructions, and to comply with numeric receiving water limitations and actions required if monitoring triggers are exceeded.

The BMPs required herein constitute BAT and BCT and will be implemented to minimize the area and duration of impacts caused by the discharge of algaecides and aquatic herbicides in the treatment area and to allow for restoration of water quality and protection of beneficial uses of the receiving waters to pre-application quality following completion of an application event.* In addition, for those enrollees that have been granted an exception to meeting receiving water limitations for acrolein and copper, in accordance with the Policy, this General Permit requires that upon completion of a pesticide application project, the Discharger shall provide certification by a qualified biologist that the receiving water beneficial uses have been restored.

The development of BMPs provides the flexibility necessary to establish controls to minimize the area extent and duration of impacts caused by the discharge of algaecides and aquatic herbicides. This flexibility allows Dischargers to implement appropriate BMPs for different types of applications and different types of waters.

Much of the BMP development has been incorporated into the algaecide and aquatic herbicide regulation process by U.S. EPA, DPR, and County Agricultural

Commissioners. The Dischargers must be licensed by DPR if such licensing is required for the algaecide and aquatic herbicide application project. The algaecide and aquatic herbicide use must be consistent with the algaecide and aquatic herbicide label instructions and any Restricted Material Use Permits issued by County Agricultural Commissioners.

U.S. EPA and DPR scientists review algaecide and aquatic herbicide labels to ensure that a product used according to label instructions will cause no harm (or "adverse impact") on non-target organisms that cannot be reduced (or "mitigated") with protective measures or use restrictions. Many of the label directions constitute BMPs to protect water quality and beneficial uses. Label directions may include: precautionary statements regarding toxicity and environmental hazards; directions for proper handling, dosage, application, and disposal practices; prohibited activities; spill prevention and response measures; and restrictions on type of water body and flow conditions.

A Restricted Material Use Permit issued by the County Agricultural Commissioner incorporates applicable suggested permit conditions from DPR and local site-specific conditions necessary to protect the environment. State regulations require that specific types of information be provided in an application to the County Agricultural Commissioners for a Restricted Material Use Permit. The County Agricultural Commissioners review the application to ensure that appropriate alternatives were considered and that any potential adverse effects are mitigated. The County Agricultural Commissioners also conduct pre-project inspections on at least five percent of projects.

This General Permit requires that Dischargers use BMPs when implementing control programs in order to mitigate effects to water quality resulting from algaecide and aquatic herbicide applications. Dischargers are required to consider alternative control measures to determine if there are feasible alternatives to the selected algaecide and aquatic herbicide application project that could reduce potential water quality impacts. If the Discharger identifies alternative control measures to the selected algaecide and aquatic herbicide application project that could reduce potential water quality impacts and that are also feasible, practicable, and cost-effective, the Discharger shall implement the identified alternative measures. The selection of control measures that use non-toxic and less toxic alternatives is an example of an effective BMP.

2. **Water Quality-Based Effluent Limitations (WQBELs)**

a. **Scope and Authority**

Section 122.44(d)(1)(i) of 40 C.F.R. mandates that permits include effluent limitations for all pollutants that are or may be discharged at levels that have the reasonable potential to cause or contribute to an exceedance of a water quality standard, including numeric and narrative objectives within a standard. Where reasonable potential has been established for a pollutant, but there is no numeric criterion or objective for the pollutant, WQBELs must be established using: (1) U.S. EPA criteria under CWA section 304(a), supplemented where necessary by other relevant information; (2) an

indicator parameter for the pollutant of concern; or (3) a calculated numeric water quality criterion, such as a proposed state criterion or policy interpreting the state's narrative criterion, supplemented with other relevant information, as provided in 40 C.F.R. section 122.44(d)(1)(vi).

The process for determining reasonable potential and calculating WQBELs when necessary is intended to protect the designated uses of the receiving water as specified in the Basin Plans, and achieve applicable water quality objectives and criteria that are contained in other state plans and policies, or any applicable water quality criteria contained in the CTR and NTR.

Section 122.44(k)(3) of 40 C.F.R. allows the use of other requirements such as BMPs in lieu of numeric effluent limits if the latter are infeasible. It is infeasible for the State Water Board to establish numeric effluent limitations in this General Permit because:

i. The application of algaecides and aquatic herbicides is not necessarily considered a discharge of pollutants according to the *National Cotton Council of America v. U.S. EPA*[10] and other applicable case law. The Sixth Circuit Court of Appeals ruled that residual pesticides associated with the application of pesticides at, over, or near water constitute pollutants within the meaning of the CWA and that the discharge must be regulated under an NPDES permit;

ii. This General Permit regulates the discharge of residual algaecides and aquatic herbicides used for algae and aquatic weed control to waters of the United States. These are algaecides and herbicides with registration labels that explicitly allow direct application to water bodies. In algaecides and aquatic herbicides applications to control pests, any algaecides and aquatic herbicides residue or degradation byproduct that is deposited in waters of the United States is a pollutant. However, at what point the algaecides and aquatic herbicides become a residue is not precisely known and varies depending on the type of algaecides and aquatic herbicides, application method and quantity, water chemistry, etc. Therefore, in the application of algaecides and aquatic herbicides, the exact effluent is unknown;

iii. It would be impractical to provide effective treatment of the algaecides and aquatic herbicides residue to protect water quality, given typically, algaecides and aquatic herbicides applications consist of numerous short duration intermittent algaecides and aquatic herbicides residue releases to surface waters from many different locations; and

iv. Treatment may render the algaecides and aquatic herbicides useless for algae and aquatic weed control.

[10] 553 F.3d 927 (6th Cir., 2009)

Therefore, as stated in Technology-Based Effluent Limitations, Section V.B.1 above, the effluent limitations contained in this General Permit are narrative and include requirements to develop and implement an APAP that describes appropriate BMPs, including compliance with all algaecides and aquatic herbicides label instructions, and to comply with narrative receiving water limitations and triggers.

b. **Receiving Water Beneficial Uses**

Algaecide and aquatic herbicide applications for algae and aquatic weed control may potentially deposit residual algaecides and aquatic herbicides to surface waters. Beneficial uses of receiving waters are as follows: municipal and domestic supply, agricultural irrigation, agricultural stock watering, process water supply, service water supply, and hydropower supply, water contact recreation, canoeing and rafting recreation, other non-contact water recreation, warm freshwater aquatic habitat, cold freshwater aquatic habitat, warm fish migration habitat, cold fish migration habitat, warm and cold spawning habitat, wildlife habitat, navigation, groundwater recharge, and freshwater replenishment. Requirements of this General Permit implement the applicable Basin Plans.

c. **Determining the Need for WQBELs**

Water quality standards include Regional Water Board Basin Plan beneficial uses and narrative and numeric water quality objectives, State Water Board-adopted standards, and federal standards, including the CTR and NTR, as well as antidegradation policies. The Basin Plans include numeric site-specific water quality objectives and narrative objectives for toxicity, chemical constituents, and tastes and odors. The narrative toxicity objective states: "*All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life*." With regard to the narrative chemical constituent objective, the Basin Plans state that waters shall not contain chemical constituents in concentrations that adversely affect beneficial uses. At minimum, "…*water designated for use as domestic or municipal supply (MUN) shall not contain concentrations of chemical constituents in excess of the maximum contaminant levels (MCLs)" in title 22 of CCR.* The narrative tastes and odors objective states: *"Water shall not contain taste- or odor-producing substances in concentrations that impart undesirable tastes or odors to domestic or municipal water supplies or to fish flesh or other edible products of aquatic origin, or that cause nuisance, or otherwise adversely affect beneficial uses*."

Federal regulations require effluent limitations for all pollutants that are or may be discharged at a level that will cause or have the reasonable potential to cause, or contribute to an in-stream excursion above a narrative or numerical water quality standard.

d. **Antidegradation Policy**

The permitted discharge is consistent with the antidegradation provisions of 40 C.F.R. section 131.12 and State Water Board Resolution No. 68-16. Compliance with these requirements will result in the use of best practicable treatment or control of the discharge. Due to the low volume of discharge expected from discharges regulated under this General Permit, the impact on existing water quality will be insignificant. Dischargers seeking authorization to discharge under this General Permit are required to demonstrate compliance with receiving water limitations during the application. If, however, the appropriate Regional Water Board, subsequent to review of any application, finds that the impact of a discharge will be significant, then authorization for coverage under this General Permit will be denied and coverage under an individual permit will be required (including preparation of an antidegradation analysis).

VI. RATIONALE FOR RECEIVING WATER LIMITATIONS AND MONITORING TRIGGERS

A. Groundwater

[Not Applicable]

B. Surface Water

CWA section 303(a-c), requires states to adopt water quality standards, including criteria necessary to protect beneficial uses. Regional Water Boards adopted water quality criteria as water quality objectives in the Basin Plans. The Basin Plans state that "[t]*he numerical and narrative water quality objectives define the least stringent standards that the Regional Water Board will apply to regional waters in order to protect the beneficial uses.*" The Basin Plans include numeric and narrative water quality objectives for various beneficial uses and water bodies. This General Permit contains receiving water limitations based on the Basin Plans' numerical and narrative water quality objectives for bio-stimulatory substances, chemical constituents, color, temperature, floating material, settleable substances, suspended material, tastes and odors, and toxicity. This General Permit also requires compliance with any amendment or revision to the water quality objectives contained in the Basin Plans adopted by Regional Water Boards subsequent to adoption of this General Permit.

Once algaecides and aquatic herbicides have been applied to a treatment area, the algaecide and aquatic herbicide product can actively control pests within the treatment area. The discharge of algaecides and aquatic herbicides, their residues, and their degradation byproducts from the applications to surface water must meet applicable water quality criteria and objectives. The receiving water limitations ensure that an application event* does not result in an exceedance of a water quality standard in the receiving water.

To protect all designated beneficial uses of the receiving water, the most protective (lowest) and appropriate (to implement the CTR criteria and WQOs in the Basin

Plans) criteria should be selected as the permit limitation for a particular water body and constituent. In many cases, water quality standards include narrative, rather than numerical, water quality objectives. In such cases, numeric water quality limits from the literature or publicly available information may be used to ascertain compliance with water quality criteria.

Algaecide and aquatic herbicide formulations contain disclosed "active" ingredients that yield toxic effects* on target organisms and may also have toxic effects on non-target organisms. Algaecide and aquatic herbicide active ingredients that do not contain pollutants for which there are applicable numeric CTR criteria may still have toxic effects on receiving water bodies. In addition, the inactive or "inert" ingredients of algaecides and aquatic herbicides, which are trade secrets and have not been publicly disclosed, may also contain toxic pollutants or pollutants that could affect water quality.

DPR is responsible for reviewing toxic effects of product formulations and determining whether an algaecide or aquatic herbicide is suitable for use in California's waters. In this General Permit, inert ingredients are also considered on a constituent-by-constituent basis. U.S. EPA regulates pesticide use through strict labeling requirements in order to mitigate negative impacts to human health and the environment, and DPR environmental and medical toxicologists review toxicity data on formulations and can deny registration or work with registrants or County Agricultural Commissioners to impose additional requirements in order to protect human health or the environment.

U.S. EPA and DPR require that pesticides undergo toxicity testing and meet specific toxicity requirements before registering the pesticide for application to surface waters. U.S. EPA has found that the application of properly registered pesticides pose a minimal threat to people and the environment. In addition, the effects of these pesticides on water quality will be mitigated through compliance with FIFRA label requirements, application of BMPs, and monitoring.

Basin Plan water quality objectives to protect the beneficial uses of surface water and groundwater include numeric objectives and narrative objectives, including objectives for chemical constituents, toxicity, and tastes and odors. The toxicity objective requires that surface water and groundwater be maintained free of toxic substances in concentrations that produce detrimental physiological responses in humans, plants, animals, or aquatic life. The chemical constituent objective requires that surface water and groundwater shall not contain chemical constituents in concentrations that adversely affect any beneficial use or that exceed the MCLs set forth in title 22, Cal. Code Regs. The tastes and odors objective states that surface water and groundwater shall not contain taste- or odor-producing substances in concentrations that cause nuisance or adversely affect beneficial uses. The Basin Plans require the application of the most stringent objective necessary to ensure that surface water and groundwater do not contain chemical constituents, toxic substances, radionuclides, or taste and odor producing substances in concentrations that adversely affect domestic drinking water supply, agricultural supply, or any other beneficial use.

1. **Receiving Water Limitations**

The instantaneous maximum receiving water limitations are based on promulgated water quality criteria such as those provided in the CTR, water quality objectives adopted by the State and Regional Water Boards in their Basin Plans, water quality criteria adopted by the California Department of Fish and Wildlife, water quality standards such as drinking water standards adopted by U.S. EPA or the California Department of Public Health (CDPH), or U.S. EPA National Recommended Ambient Water Quality Criteria.

This General Permit provides receiving water limitations based on the lowest water quality criteria/objectives to protect all designated beneficial uses of the receiving water. The receiving water limitations in this General Permit are the same as those in Order No. 2004-0009-DWQ. The rationale for each limitation is summarized below.

Table D-2. Summary of Receiving Water Limitations

Constituent/ Parameter	BENEFICIAL USE[1]				Basis
	MUN, µg/L	WARM or COLD, µg/L	Other than MUN, WARM, or COLD, µg/L	All Designations	
2,4,-D	70				U.S. EPA MCL
Acrolein[2]	320	21	780		U.S. EPA Water Quality Criteria, 1986.
Copper[2]				Dissolved Freshwater[3] Copper Chronic = 0.960exp{0.8545 [ln(hardness[4])] – 1.702} [5, 6] Dissolved saltwater[3] Copper Chronic = 0.83exp{0.8545 [ln(hardness[4])] – 1.702} [5,6]	California Toxics Rule
Diquat	20				U.S. EPA MCL
Endothall	100				U.S. EPA MCL
Fluridone	560				U.S. EPA Integrated Risk Information System
Glyphosate	700				U.S. EPA MCL
Nonylphenol				Freshwater Chronic Criterion = 6.6 µg/L Saltwater Chronic Criterion = 1.7 µg/L	U.S. EPA National Recommended Ambient Water Quality Criteria
Toxicity	Algaecide and aquatic herbicide applications shall not cause or contribute to toxicity in receiving water(s).				Regional Water Boards' Basin Plans

Notes
1. See Regional Water Boards' Water Quality Control Plans (Basin Plans) for beneficial use definitions.
2. Public entities and mutual water companies listed in Attachment G are not required to meet this receiving water limitation during the exception period described in Section VIII.C.10, Limitations and Discharge Requirements, Aquatic Pesticides Application Plan (APAP).

3. For waters in which the salinity is equal to or less than 1 part per thousand 95% or more of the time, the freshwater criteria apply. For waters in which the salinity is equal to or greater than 10 parts per thousand 95% or more of the time, saltwater criteria apply. For waters in which the salinity is between 1 and 10 parts per thousand, the applicable criteria are the more stringent of the freshwater or saltwater criteria.
4. For freshwater aquatic life criteria, waters with a hardness 400 mg/L or less as calcium carbonate, the actual ambient hardness of surface water shall be used. For waters with a hardness of over 400 mg/L as calcium carbonate, a hardness of 400 mg/L as calcium carbonate shall be used with a default Water-Effect Ratio of 1.
5. Values should be rounded to two significant figures.
6. This limitation does not apply to the Sacramento River and its tributaries above the State Highway 32 Bridge at Hamilton City. See Table III-1 of the Basin Plan for the Sacramento and San Joaquin River Basins for copper limitation.

The copper limitation in Order No. 2004-0009-DWQ was based on the CTR's Criteria Continuous Concentration (CCC) expressed in total recoverable concentration. This General Permit also uses CCC from the CTR as the basis of the copper limitations; however, the copper limitation is now expressed in dissolved concentration. Since the copper criterion in the CTR is expressed in dissolved concentration, the receiving water limitation must also be expressed in dissolved rather than total concentration since it is the dissolved portion of copper that is bioavailable to aquatic life.

Based on Policy section 5.3, this General Permit grants public entities and mutual water companies listed in Attachment G a short-term or seasonal exception from meeting receiving water limitations for acrolein and copper during treatment. As a condition of the exception, this General Permit requires Dischargers to provide the length and justification of required exception periods in their APAPs. There is no discrete definition for short-term; but the intent is to allow the exception to apply during the treatment period. It is up to the Discharger to make this demonstration.

The receiving water dissolved oxygen limitation is based on the Regional Water Board Basin Plans' dissolved oxygen objectives.

2. **Receiving Water Monitoring Triggers**

In algaecide or aquatic herbicide applications, it is reasonable to conclude that some residual algaecides or aquatic herbicides will remain in the receiving waters. These residual algaecides or aquatic herbicides may cause toxicity to aquatic life. However, information regarding the specific amount of algaecide or aquatic herbicide residues (described below) in the receiving water as a result of direct applications for weed control is not adequate to develop receiving water limitations for these algaecides and aquatic herbicides. Therefore, this General Permit only contains Receiving Water Monitoring Triggers and/or monitoring requirements for these algaecides or aquatic herbicides. The monitoring triggers and monitoring data will be used to assess whether the discharges of these algaecide or aquatic herbicide residues have the reasonable potential to cause or contribute to an excursion of a water quality standard, including numeric and narrative objectives within a standard.

In the absence of adopted criteria, objectives, or standards, the State Water Board used U.S. EPA's Ambient Criteria for the Protection of Freshwater Aquatic

Life (Ambient Water Quality Criteria) which are directly applicable as a regulatory level to implement narrative toxicity limitations included in all Regional Water Board Basin Plans. Where adopted criteria, objectives, standards, or Ambient Water Quality Criteria are unavailable, the State Water Board used data from U.S. EPA's *Ecotoxicity Database* to develop the Receiving Water Monitoring Triggers to protect all beneficial uses of the receiving water.

For constituents that do not have Ambient Water Quality Criteria, the Instantaneous Maximum Receiving Water Monitoring Trigger is based on one-tenth of the lowest 50 Percent Lethal Concentration (LC50) from U.S. EPA's *Ecotoxicity Database*. Using one-tenth of the lowest LC50 as the receiving water monitoring trigger is consistent with the Central Valley Regional Water Board's Basin Plan approach when developing the Daily Maximum Limitation for algaecides or aquatic herbicides that do not have water quality criteria.

This General Permit may be re-opened to add receiving water limitations to the algaecides or aquatic herbicides listed below if the monitoring triggers are exceeded or the monitoring data indicate re-opening of the permit is appropriate. The following is a detailed discussion of toxicity data, applicable water quality criteria, and Receiving Water Monitoring Triggers, if applicable, for these algaecide or aquatic herbicide:

a. Imazamox

Imazamox is a derivative of the active ingredient, ammonium salt of imazamox for the aquatic herbicide Clearcast, which DPR registered for use in California in October 2012. It is labeled for application to water for the control of submerged aquatic plants species and some emergent and floating species.

Imazamox is an herbicide that inhibits an enzyme in aquatic plants that is essential for the synthesis of three-branched chain amino acids.

Staff obtained toxicity data for imazamox from U.S. EPA's *Ecotoxicity Database* to assess its toxicity to freshwater aquatic life. However, U.S. EPA's *Ecotoxicity Database* contains toxicity data only for imazamox, but not for its salt. Table D-3 summarizes the toxicity data for imazamox below.

Table D-3. Toxicity Data Summary for Imazamox (CAS# 114311-32-9)

Type of Organism	Study Length	Study Date	LC50 (mg/L)
Mysid	96 h	1998	> 100
		1998	> 94.3
Bluegill sunfish	96 h	1994	> 119
Rainbow trout	96 h	1994	> 122
Sheephead mino	96 h	1998	> 94.2
		1998	> 94.2
Lowest LC50/10 > 9.4 mg/L			

Ambient Water Quality Criteria are unavailable for imazamox and imazamox salt. Table D-3 shows that one-tenth of the lowest LC50 to protect the most sensitive freshwater aquatic life for imazamox is greater than 9.4 mg/l.

Due to the absence of water quality criteria for imazamox and its low toxicity to aquatic life as indicated in U.S. EPA's *Ecotoxicity Database*, this General Permit does not have a receiving water monitoring trigger for imazamox. However, this General Permit requires receiving water monitoring for imazamox to collect data, which will provide information on whether the use of imazamox has water quality impacts.

b. Imazapyr

The active ingredient imazapyr is marketed by the trade names Arsenal, Chopper, and Assault. Upon contact, imazapyr can interfere with DNA synthesis and cell growth of the plants. The target weed species are grasses, broad-leaves, vines, brambles, shrubs and trees, and riparian and emerged aquatics. The result of exposure is death of new leaves. It was first registered in the United States in 1984.

Imazapyr is a slow-acting amino acid synthesis inhibitor. It has an average water half-life* of four days with photodegradation as the primary form of degradation in water. Imazapyr acts more quickly and is less toxic than other low-volume herbicides. According to the San Francisco Estuary* Invasive Spartina Project's May 4, 2005 report titled *Use of Imazapyr Herbicide to Control Invasive Cordgrass (Spartina spp.) in the San Francisco Estuary*, imazapyr in water rapidly degrades via photolysis. The report further states that a number of field studies demonstrated that imazapyr rapidly dissipated from water within several days, and no detectable residues of imazapyr were found in either water or sediment within two months; in estuarine systems, dilution of imazapyr with the incoming tides contributes to its rapid dissipation, suggesting that imazapyr is not environmentally persistent in the estuarine environment and does not result in significant impacts to water quality. The report concludes that imazapyr herbicides can be a safe, highly effective treatment for control and eradication of non-native *Spartina* species in the San Francisco Estuary and offers an improved risk scenario over the existing treatment regime with glyphosate herbicides. On August 30, 2005, DPR registered imazapyr for aquatic application as an aquatic herbicide.

Toxicity data for imazapyr were obtained from U.S. EPA's *Ecotoxicity Database* to assess the toxicity of imazapyr to freshwater aquatic life. Tables D-4 and D-5 summarize the toxicity data for imazapyr and imazapyr salt.

Table D-4. Toxicity Data Summary for Imazapyr (CAS#81334-34-1)

Type of Organism	Study Length	Study Date	LC50 (mg/L)
Pink shrimp	96 h	1988	> 189
Atlantic silverside	96 h	1988	> 184
Bluegill sunfish	96 h	1983	> 100
		1983	> 100

Type of Organism	Study Length	Study Date	LC50 (mg/L)
Channel catfish	96 h	1983	> 100
Rainbow trout	96 h	1983	> 100
		1995	> 110
Lowest LC50/10 > 10			

Table D-5. Toxicity Data Summary for Imazapyr Isopropylamine Salt (CAS#81510-83-0)

Type of Organism	Study Length	Study Date	LC50 (mg/L)
Water flea	48 h	1984	350
Rainbow trout	96 h	1984	**112**
Bluegill sunfish	96 h	1984	> 1000
Lowest LC50/10 = 11.2			

Ambient Water Quality Criteria are unavailable for imazapyr and imazapyr salt. Tables D-4 and D-5 show that the lowest one-tenth of LC50 to protect the most sensitive freshwater aquatic life for imazapyr is 11.2 mg/l.

Due to its safe use in the environment and low toxicity to aquatic life as indicated in U.S. EPA's *Ecotoxicity Database*, this General Permit does not have a receiving water limitation for imazapyr. However, this General Permit contains a monitoring trigger of 11.2 mg/l based on one-tenth of the lowest LC50 from U.S. EPA's *Ecotoxicity Database* and requires receiving water monitoring to collect data, which will provide information on whether imazapyr has water quality impacts.

c. Penoxsulam

Penoxsulam is the active ingredient for Galleon SC, a selective systemic aquatic herbicide for management of freshwater aquatic vegetation in ponds, lakes, reservoirs, marshes, wetlands, non-irrigation canals, slow-moving water bodies, etc. Penoxsulam is a post-emergence acetolactate synthase (ALS) inhibitor developed by Dow AgroSciences to be used as a foliar spray on dry-seeded rice crops. The mode of action is to inhibit the acetolactate synthases enzyme in the target weed.

The U.S. EPA Pesticide Fact Sheet states that penoxsulam is expected to be very mobile, but not very persistent, in either aqueous or terrestrial environments. Penoxsulam exists almost exclusively in a disassociated state at pH values normally found in rice paddy water (averaging about eight), but not in terrestrial environments where lower pH values may be found. Penoxsulam degrades by two different transformation mechanisms, producing 13 different identified transformation products, 11 of which meet

the criteria to be classified as major degradation byproducts,[11] six of which reached peak concentrations at study termination, indicating a greater degree of persistence than penoxsulam and a potential to reach concentrations even greater than those reported at study termination. The results of the screening-level risk assessment suggest that penoxsulam will not pose a threat to aquatic or terrestrial animals, however, this conclusion must be tempered by the fact that testing has not been conducted on several major degradation byproducts.

Toxicity data for penoxsulam were obtained from U.S. EPA's *Ecotoxicity Database* to assess the toxicity of penoxsulam to freshwater aquatic life. Table D-6 summarizes the toxicity data for penoxsulam.

Table D-6. Toxicity Data Summary for Penoxsulam (CAS#219714-96-2)

Type of Organism	Study Length	Study Date	LC50 (mg/L)
Bluegill sunfish	96 h	2000	> 103
Common carp fish	96 h	2001	> **101**
Mysid	96 h	2000	> 114
Rainbow trout	96 h	2002	> 147
		2000	> 102
Scud	96 h	2000	> 126
Lowest LC50/10 > 10.1			

Ambient Water Quality Criteria are unavailable for penoxsulam. Table D-6 shows that the lowest one-tenth of LC50 to protect the most sensitive freshwater aquatic life for penoxsulam is greater than 10.1 mg/l.

Due to its safe use in the environment, low toxicity to aquatic life as indicated in U.S. EPA's *Ecotoxicity Database,* and lack of accurate toxicity value, this General Permit does not have a receiving water monitoring trigger. However, this General Permit requires receiving water monitoring to collect data, which will provide information on whether penoxsulam has water quality impacts.

d. Sodium Carbonate Peroxyhydrate

Sodium carbonate hydroxyhydrate has been registered as an algaecide since early 2006. The most common brand names are PAK 27, Phycomycin, and Green Clean. It is an alternative to traditional copper based algaecides. It acts as an oxidizing agent and thus kills the target algae. When it is

[11] U.S. EPA defines major degradation byproducts to be BSA, 2-amino-TP, TPSA, BSTCA methyl, BSTCA, 2-amino-TCA,5-OH-penoxsulam, SFA, sulfonamide, 5,8-di-OH and 5-OH, 2 aminoTP.

applied into water, the compound quickly breaks down into hydrogen peroxide (H_2O_2) and sodium carbonate. The hydrogen peroxide oxidizes and thus kills the target pests. After contact, the hydrogen peroxide breaks down into water and oxygen.

U.S. EPA has waived toxicity testing for freshwater fish and invertebrate during the registration process. According to the U.S. EPA fact sheet, when the pesticide is applied in accordance with directions on the label, no harm is expected to freshwater fish or freshwater invertebrates.

There are no toxicity data for sodium carbonate peroxyhydrate in U.S. EPA's *Ecotoxicity Database.* Therefore, this General Permit does not have a monitoring trigger or a monitoring requirement for sodium carbonate peroxyhydrate.

e. Triclopyr Triethylamine (TEA) Salt

Triclopyr TEA is a systemic herbicide used to control broad-leaf weeds and woody plants.

U.S. EPA concluded in its re-registration document that triclopyr TEA is practically non-toxic to freshwater fish and aquatic invertebrates on an acute basis and triclopyr TEA is slightly toxic to practically non-toxic to estuarine/marine fish and invertebrates on an acute basis.

Triclopyr produces the metabolite or degradate 3,5,6-trichloro-2-pyridinol (TCP). Based on its analysis, U.S. EPA concludes that the existing uses of triclopyr are unlikely to result in acute or chronic dietary risks from TCP. Based on limited available data and modeling estimates, with less certainty, the U.S. EPA concluded that existing uses of triclopyr are unlikely to result in acute or chronic drinking water risks from TCP.

Toxicity data for triclopyr TEA were obtained from U.S. EPA's *Ecotoxicity Database* to assess the toxicity of triclopyr TEA to freshwater aquatic life. Table D-7 summarizes the toxicity data for Triclopyr TEA.

Table D-7. Toxicity Data Summary for Triclopyr TEA Salt (CAS#57213-69-1)

Type of Organism	Study Length	Study Date	LC50 (mg/L)
Bluegill sunfish	96 h	1978	891
	96 h	1973	471
Fathead minnow	96 h	1978	947
	96 h	1983	546
	96 h	1983	279
Grass shrimp	96 h	1992	326
Inland Silverside fish	96 h	1989	**130**
Pink shrimp	96 h	1975	895
Rainbow trout	96 h	1973	240
	96 h	1978	552

Type of Organism	Study Length	Study Date	LC50 (mg/L)
Lowest LC50/10 = 13.0			

Ambient Water Quality Criteria are unavailable for triclopyr TEA. Table D-7 shows that the lowest one-tenth of LC50 to protect the most sensitive freshwater aquatic life for triclopyr TEA is 13 mg/l.

Due to its safe use in the environment and low toxicity to aquatic life as indicated in U.S. EPA's *Ecotoxicity Database*, this General Permit does not have a receiving water limitation for triclopyr TEA. However, this General Permit contains a monitoring trigger of 13.0 mg/l based on one-tenth of the lowest LC50 from U.S. EPA's *Ecotoxicity Database* and requires receiving water monitoring to collect data, which will provide information on whether triclopyr TEA has water quality impacts.

VII. RATIONALE FOR MONITORING AND REPORTING REQUIREMENTS

A. MRP Goals

Section 122.48 of 40 C.F.R. requires that all NPDES permits specify requirements for recording and reporting monitoring results. Water Code sections 13267 and 13383 authorize the State and Regional Water Boards to require technical and monitoring reports. The Monitoring and Reporting Program (MRP) in Attachment C of this General Permit establishes monitoring and reporting requirements to implement federal and state requirements.

The goals of the MRP are to:

1. Identify and characterize algaecide or aquatic herbicide application projects conducted by the Discharger;
2. Determine compliance with the receiving water limitations and other requirements specified in this General Permit;
3. Measure and improve the effectiveness of the APAP;
4. Support the development, implementation, and effectiveness of BMPs;
5. Assess the chemical, physical, and biological impacts on receiving waters resulting from algaecide or aquatic herbicide applications;
6. Assess the overall health and evaluate long-term trends in receiving water quality;
7. Demonstrate that water quality of the receiving waters following completion of resource or weed management projects are equivalent to pre-application conditions; and
8. Ensure that projects that are monitored are representative of all algaecide or aquatic herbicide and application methods used by the Discharger.

The MRP in the Attachment C of this General Permit is considered as baseline monitoring requirements. Monitoring plans proposed by Dischargers in their APAP must meet the minimum requirements prescribed in the MRP. Public entities and mutual water companies that have a Policy section 5.3 exception should comply with the MRP in this General Permit as well as monitoring plan proposed in their CEQA document where the two plans differ.

B. Effluent Monitoring

Pursuant to the requirements of 40 C.F.R. section 122.44(i), effluent monitoring is required for all constituents with effluent limitations. Effluent monitoring is necessary to assess compliance with effluent limitations, assess the effectiveness of the treatment process, and assess the impacts of the discharge on the receiving water and groundwater.

The application of pesticides for pest control is not necessarily considered a discharge of pollutants according to the *National Cotton Council of America v. U.S. EPA* decision and other applicable case law. The regulated discharge is the discharge of residual pesticides. At what point the pesticide becomes a residue is not precisely known. Therefore, in the application of pesticides, the exact effluent is unknown. Thus, the effluent monitoring requirement is not applicable for algaecide or aquatic herbicide applications.

C. Toxicity Testing Requirements

The State Water Board, pursuant to the Porter-Cologne Act and the federal CWA, customarily requires the Discharger to conduct toxicity monitoring. In fact, both Acts anticipate Discharger self monitoring. However, this General Permit does not require toxicity testing based on the 2004 toxicity study funded by the State Water Board and data collected from 2004 to 2008. The toxicity study found the following: (1) There was no toxicity with the use of 2,4-D, glyphosate, and triclopyr; (2) Toxicity testing was difficult for acrolein due to its volatility; (3) Results were inconclusive for diquat and fluridone; and (4) Peak copper concentrations did not exceed toxicity values. The monitoring data collected under Order No. 2004-0009-DWQ from 2004 to 2008 showed that all constituent concentrations from post-event application samples were below receiving water limitations except for the following: three exceedances each for acrolein and glyphosate and 82 exceedances for copper out of 288 monitoring events. For glyphosate, it is likely that the three exceedances were not the result of aquatic herbicide applications because the pre-application samples also showed exceedances and the remaining 151 samples showed no exceedance. For copper, 43 of the 82 exceedances were from public agencies or mutual water companies that were excepted from meeting priority pollutant limitations during the exception period. The Policy allows the exception. Thus, staff did not consider these exceedances as violations of the receiving water limitations. However, 39 of the exceedances were from entities that did not have a Policy exception. Although staff considered these exceedances as true violations of the receiving water limitations, staff is not aware of any long-term impacts from these exceedances. Long-term impacts from

exceedances are likely not going to occur for the following reasons: (1) water quality criteria, which are used directly as receiving water limitations in this General Permit, have built-in factors of safety; (2) as shown in the 2004 toxicity study, the actual peak concentrations after applications of copper did not exceed toxicity values; and (3) the applications are short-term in duration. All of the foregoing information indicates that widespread acute ecosystem impacts will not occur from algaecide or aquatic herbicides applied according to their label instructions and requirements of this General Permit. Therefore, toxicity monitoring requirements are not necessary.

D. Receiving Water Monitoring

Receiving water monitoring is necessary to determine the impacts of the discharge on the receiving stream.

All forms of testing have some degree of uncertainty associated with them. The more limited the amount of test data available, the larger the uncertainty. The intent of this General Permit's sampling program is to select a number that will detect most events of noncompliance without requiring needless or burdensome monitoring.

Staff also used EPA's Technical Support Document for Water Quality-Based Toxics Control (TSD) to determine the appropriate number of samples that would be needed to characterize the impacts of the residual pesticide discharge from pesticide applications. Page 53 of the TSD recommends using a coefficient of variation (CV) 0.6 when the data set contains less than 10 samples. Table 3-1 of the TSD shows that with a CV of 0.6, the multiplying factors used to determine whether a discharge causes, has the reasonable potential to cause, or contributes to an excursion above a state water quality standard begin to stabilize when the sample number is six. Thus, this General Permit requires six samples per year for each active ingredient in each environmental setting (flowing water and non-flowing water) to characterize the effects of residual pesticide discharge from pesticide applications. However, after a Discharger or Coalition has provided results from six consecutive sampling events showing concentrations that are less than the receiving water limitation/trigger for an active ingredient in a specific environmental setting, sampling shall be reduced to one application event per year for that active ingredient in that environmental setting.

Similarly, this General Permit contains a reduced monitoring frequency of once per year (instead of six) at each environmental setting for glyphosate. The reduced monitoring frequency is based on staff's review of available data from 2004 to 2008 that showed no exceedance of the permit limitation for glyphosate under Order No. 2004-0009-DWQ.

VIII. RATIONALE FOR AQUATIC PESTICIDE USE REQUIREMENTS

A. Application Schedule

The Discharger shall provide a phone number or other specific contact information for all persons who request the Discharger's application schedule.

B. Application Notification Requirements

The Policy section 5.3, Categorical Exception, requires public agencies and mutual water companies that have been granted the short-term or seasonal exception for compliance with priority pollutant limitations to notify potentially affected public and government agencies of algaecide or aquatic herbicide application.

C. APAP

This General Permit contains narrative effluent limitations, which include implementing BMPs described in the APAP, which is a requirement of this General Permit. See Section VI, Rationale for Effluent Limitations and Discharge Specifications, for more detailed explanation of the need for an APAP.

D. APAP Processing, Approval, and Modifications

Upon receipt of a new or an amended APAP, staff will post it on the State Water Board's website. Major changes to the APAP shall be submitted to the Deputy Director for approval. Examples of major changes include using a different product other than what is specified in the APAP, changing an application method that may result in different amounts of algaecide or aquatic herbicides being applied, or adding or deleting BMPs. Since the APAP shall include ALL (1) the water bodies or water body systems in which algaecide or aquatic herbicides are being planned to be applied or may be applied to control algae and aquatic weeds and (2) the application areas and the target areas in the system that are being planned to be applied or may be applied, changes in monitoring locations are not considered major changes. However, these changes need to be reported in the annual report.

In preparing for the reissuance of the General Permit, staff will evaluate review periods and comments received during the life of this permit and look for efficiencies. Based on this information, staff will propose revisions to the public comment process for APAPs.

E. Aquatic Pesticide Application Log

An application log to record all algaecide or aquatic herbicide applications is necessary. This application log will help Dischargers and the Water Boards' staff to investigate any exceedance of receiving water limitations or receiving water monitoring triggers.

IX. RATIONALE FOR PROVISIONS

A. Standard Provisions

1. Standard Provisions in Attachment B

Standard Provisions, which apply to all NPDES permits in accordance with 40 C.F.R. section 122.41, and additional conditions applicable to specified categories of permits in accordance with 40 C.F.R. section 122.42, are provided

in Attachment B. The Discharger must comply with applicable standard provisions and with those additional conditions that are applicable under 40 C.F.R. section 122.42.

Sections 122.41(a)(1) and (b) through (n) of 40 C.F.R. establish conditions that apply to all state-issued NPDES permits. These conditions must be incorporated into the permits either expressly or by reference. If incorporated by reference, a specific citation to the regulations must be included in the General Permit. Section 123.25(a)(12) of 40 C.F.R. allows the state to omit or modify conditions to impose more stringent requirements. In accordance with 40 C.F.R. Section 123.25, this General Permit omits federal conditions that address enforcement authority specified in 40 C.F.R. section 122.41(j)(5) and (k)(2) because the enforcement authority under the California Water Code is more stringent. In lieu of these conditions, this General Permit incorporates by reference California Water Code section 13387(e).

2. **Discharge to Impaired Water Bodies**

Impaired water bodies are water quality limited segments listed under CWA 303(d) listings. The water bodies on these lists do not meet water quality standards, even if the discharge itself meets water quality standards. The Basin Plans state that "*Additional treatment beyond minimum federal standards will be imposed on dischargers to Water Quality Limit Segments. Dischargers will be assigned or allocated a maximum allowable load of critical pollutants so that water quality objectives can be met in the segment.*" The allocated loads are Discharger and receiving water specific. It is infeasible to assign a uniform load in a statewide general permit. Therefore, this General Permit does not authorize the discharge of active ingredients of algaecides or aquatic herbicides, their residues, and their degradation byproducts to water bodies that are already impaired due to the same product active ingredients, their residues, and their degradation byproducts.

B. Special Provisions

1. **Reopener Provisions**

The reopener provisions allow future modification to this General Permit in accordance with 40 C.F.R. section 122.62.

a. Addition to Policy Exception List in Attachment G

This General Permit may be reopened to add a public entity or a mutual water company which may not otherwise meet the receiving water limitations for acrolein and copper and meets the requirements for an exception from meeting those limitations, consistent with section 5.3 of the Policy.

b. Addition of Aquatic Pesticide Active Ingredients

This General Permit may be reopened to add newly registered algaecide or aquatic herbicide active ingredients so that Dischargers can be covered by this General Permit when they apply the algaecide or aquatic herbicide products with the new active ingredients.

c. Acute and Chronic Toxicity

When the State Water Board revises the Policy's toxicity control provisions that would require the establishment of numeric chronic toxicity limitations or other actions, this General Permit may be reopened to comply with those requirements.

d. Receiving Water Limitations

If monitoring data for residual pesticides show exceedance of monitoring triggers, the Discharger or Coalition shall conduct additional investigations to determine the cause of exceedance. At a minimum, the Discharger or Coalition shall evaluate its application methods, BMPs, and the appropriateness of using alternative products. As a result of the evaluation, this General Permit may be re-opened to add numeric Receiving Water Limitations for the residual pesticides exceeding the triggers.

e. Endangered Species Act

If U.S. EPA develops biological opinions regarding pesticides included in this General Permit, this General Permit may be re-opened to add or modify Receiving Water Limitations/Monitoring Triggers for residual pesticides of concern, if necessary.

2. **Special Studies, Technical Reports, and Additional Monitoring Requirements**

a. Additional Investigation

This General Permit requires Dischargers to conduct additional investigations if the monitoring results exceed the receiving water monitoring limitations. These investigations are necessary in order to address the exceedance caused by the algaecide or aquatic herbicide application and meet the General Permit's limitations and requirements including Basin Plans' narrative water quality objective of no toxics in toxic amount.

b. Qualified Biologist Certification Following Project Completion

The requirement is retained from Order No. 2004-0009-DWQ and is based on Policy section 5.3 exception.

3. **Corrective Action**

When receiving water limitations or triggers are exceeded, Dischargers are expected to assess the cause of exceedance and take appropriate actions as necessary to prevent recurrence of the problem.

X. COMPLIANCE DETERMINATION

This General Permit specifies that compliance be based on event and post-event sampling results. The event sample results will determine if exceedance occurred outside the Treatment Area* during treatment. Post-event samples will determine if exceedance occurred in the Application or Treatment Area after treatment. Since the minimum effective concentration and time needed to effectively kill or control target weeds or algae vary due

to site specific conditions, such as flow, target species, water chemistry, and type of algaecides or aquatic herbicides, this General Permit allows Dischargers to determine when treatment is completed.

XI. PUBLIC PARTICIPATION

The State Water Board is considering the issuance of WDRs that will serve as a general NPDES permit for algaecide or aquatic herbicide applications. As a step in the WDR adoption process, the State Water Board staff has developed tentative WDRs. The State Water Board encourages public participation in the WDR adoption process.

A. Notification of Interested Parties

The State Water Board has notified interested agencies, parties, and persons of its intent to prescribe general WDRs for algaecide or aquatic herbicide applications and has provided them with an opportunity to submit their written comments and recommendations. Notification was provided to interested parties through specific mailings and publication in major newspapers throughout California. The State Water Board, in a public meeting, heard and considered all comments pertaining to discharges to be regulated by this General Permit. Details of the Public Hearing are provided in the Fact Sheet of this General Permit.

B. Written Comments

Interested persons were invited to submit written comments concerning this tentative WDR. Comments were due at the State Water Board offices by 12:00 noon on **August 21, 2012**. Seven comment letters were received.

C. Public Hearing and Meeting

The State Water Board held a public hearing on the tentative WDRs during its regular Board meeting on **August 7, 2012**. The State Water Board will consider adoption of the WDRs at a public meeting on the following date, time, and location:

Date: **February 19, 2013**
Time: 9:00 a.m.
Location: State Water Resources Control Board
1001 I Street
Sacramento, CA 95814

Interested persons are invited to attend. At the public meeting, the State Water Board will hear comments, if any, limited to changes on the draft General Permit.

Please be aware that dates and venues may change. The State Water Board's website address is www.waterboards.ca.gov where you can access the current agenda for changes in dates and locations.

D. Information and Copying

The tentative effluent limitations, receiving water limitations, and special provisions, comments received, and other information are on file and may be inspected at the address above at any time between 8:30 a.m. and 4:45 p.m., Monday through Friday. Copying of documents may be arranged through the State Water Board by calling (916) 379-9152.

E. Register of Interested Persons

Any person interested in being placed on the mailing list for information regarding this general WDR and NPDES permit should contact the State Water Board, reference the general WDR and NPDES permit, and provide a name, address, and phone number.

F. Additional Information

Requests for additional information or questions regarding this General Permit should be directed to NPDES_Wastewater@waterboards.ca.gov.

Attachment E – Notice of Intent

WATER QUALITY ORDER NO. 2013-0002-DWQ
GENERAL PERMIT NO. CAG990005

STATEWIDE GENERAL NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT FOR RESIDUAL AQUATIC PESTICIDE DISCHARGES TO WATERS OF THE UNITED STATES FROM ALGAE AND AQUATIC WEED CONTROL APPLICATIONS

I. NOTICE OF INTENT STATUS (see Instructions)

Mark only one item A. New Applicator B. Change of Information: WDID# _____ C. ☐ Change of ownership or responsibility: WDID# _____

II. DISCHARGER INFORMATION

A. Name			
B. Mailing Address			
C. City	D. County	E. State	F. Zip
G. Contact Person	H. E-mail address	I. Title	J. Phone

III. BILLING ADDRESS (Enter Information *only* if different from Section II above)

A. Name			
B. Mailing Address			
C. City	D. County	E. State	F. Zip
G. E-mail address	H. Title	I. Phone	

IV. RECEIVING WATER INFORMATION

A. Algaecide and aquatic herbicides are used to treat (check all that apply):

1. ☐ Canals, ditches, or other constructed conveyance facilities owned and controlled by Discharger.
   Name of the conveyance system: _____
2. ☐ Canals, ditches, or other constructed conveyance facilities owned and controlled by an entity other than the Discharger.
   Owner's name:_____
   Name of the conveyance system: _____
3. Directly to river, lake, creek, stream, bay, ocean, etc.
   Name of water body: _____

B. Regional Water Quality Control Board(s) where treatment areas are located (REGION 1, 2, 3, 4, 5, 6, 7, 8, or 9): Region _____
(List all regions where algaecide and aquatic herbicide application is proposed.)

V. ALGAECIDE AND AQUATIC HERBICIDE APPLICATION INFORMATION

A. Target Organisms: ____

B. Algaecide and Aquatic Herbicide Used: List Name and Active ingredients

C. Period of Application: Start Date_____ End Date_____

D. Types of Adjuvants Used:

VI. AQUATIC PESTICIDE APPLICATION PLAN

Has an Aquatic Pesticide Application Plan been prepared and is the applicator familiar with its contents?
☐ Yes ☐ No

If not, when will it be prepared? _____

VII. NOTIFICATION

Have potentially affected public and governmental agencies been notified? ☐ Yes ☐ No

VIII. FEE

Have you included payment of the filing fee (for first-time enrollees only) with this submittal?
☐ YES ☐ NO ☐ NA

IX. CERTIFICATION

"I certify under penalty of law that this document and all attachments were prepared under my direction and supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine or imprisonment. Additionally, I certify that the provisions of the General Permit, including developing and implementing a monitoring program, will be complied with."

A. Printed Name: _____

B. Signature: _____ **Date:** _____

C. Title: _____

XI. FOR STATE WATER BOARD STAFF USE ONLY

WDID:	**Date NOI Received:**	**Date NOI Processed:**
Case Handler's Initial:	**Fee Amount Received:** **$**	**Check #:**
☐ **Lyris List Notification of Posting of APAP**	**Date** _____	**Confirmation Sent** _____

INSTRUCTIONS FOR COMPLETING NOI

WATER QUALITY ORDER NO. 2013-0002-DWQ
GENERAL PERMIT NO. CAG990005

STATEWIDE GENERAL NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT FOR RESIDUAL AQUATIC PESTICIDE DISCHARGES TO WATERS OF THE UNITED STATES FROM ALGAE AND AQUATIC WEED CONTROL APPLICATIONS

These instructions are intended to help you, the Discharger, to complete the Notice of Intent (NOI) form for the Statewide General NPDES permit. **Please type or print clearly when completing the NOI form**. For any field, if more space is needed, submit a supplemental letter with the NOI.

Send the completed and signed form along with the filing fee and supporting documentation to the Division of Water Quality, State Water Resources Control Board. Please also send a copy of the form and supporting documentation to the appropriate Regional Water Quality Control Board (Regional Water Board).

Section I – Notice of Intent Status

Indicate whether this request is for the first time coverage under this General Permit or a change of information for the discharge already covered under this General Permit. Dischargers that are covered under Order No. 2004-0009-DWQ before effective date of this General Permit should check the box for change of information. For a change of information or ownership, please supply the eleven-digit Waste Discharge Identification (WDID) number for the discharge.

Section II – Discharger Information

Enter the name of the Discharger.
Enter the street number and street name where correspondence should be sent (P.O. Box is acceptable).
Enter the city that applies to the mailing address given.
Enter the county that applies to the mailing address given.
Enter the state that applies to the mailing address given.
Enter the zip code that applies to the mailing address given.
Enter the name (first and last) of the contact person.
Enter the e-mail address of the contact person.
Enter the contact person's title.
Enter the daytime telephone number of the contact person

Section III – Billing Address

Enter the information **only** if it is different from Section II above.

A. Enter the name (first and last) of the person who will be responsible for the billing.

B. Enter the street number and street name where the billing should be sent (P.O. Box is acceptable).
C. Enter the city that applies to the billing address.
D. Enter the county that applies to the billing address.
E. Enter the state that applies to the billing address.
F. Enter the zip code that applies to the billing address.
G. Enter the e-mail address of the person responsible for billing.
H. Enter the title of the person responsible for billing.
I. Enter the daytime telephone number of the person responsible for billing.

Section IV – Receiving Water Information

Please be reminded that this General Permit does not authorize any act that results in the taking of a threatened or endangered species or any act that is now prohibited, or becomes prohibited in the future, under either the California Endangered Species Act (Fish and Game Code §2050 et. seq) or the Federal Endangered Species Act (16 U.S.C.A. §1531 et. seq). This General Permit requires compliance with effluent limitations, receiving water limitations, and other requirements to protect the beneficial uses of waters of the state. The Discharger is responsible for meeting all requirements of the applicable Endangered Species Act.

Additional information on federally-listed threatened or endangered species and federally-designated critical habitat is available from NMFS (www.nmfs.noaa.gov) for anadromous or marine species or FWS (www.fws.gov) for terrestrial or freshwater species.

A. Check all boxes that apply. At least one box must be checked.
1. Check this box if the treatment area is a canal, ditch, or other constructed conveyance system owned and controlled by Discharger. Print the name of the conveyance system.
2. Check this box if the treatment area is a canal, ditch, or other constructed conveyance system owned and controlled by an entity other than the Discharger. Print the owner's name and names of the conveyance system.
3. Check this box if the treatment area is not a constructed conveyance system (including application to river, lake, creek, stream, bay, or ocean) and enter the name(s) of the water body(s).

B. List all Regional Water Board numbers where algaecide and aquatic herbicide application is proposed. Regional Water Board boundaries are defined in section 13200 of the California Water Code. The boundaries can also be found on our website at http://www.waterboards.ca.gov/waterboards_map.shtml

Regional Water Board Numbers	Regional Water Board Names
1	North Coast
2	San Francisco Bay
3	Central Coast

Regional Water Board Numbers	Regional Water Board Names
4	Los Angeles
5	Central Valley (Includes Sacramento, Fresno, Redding Offices)
6	Lahontan (South Lake Tahoe, Victorville offices)
7	Colorado River Basin
8	Santa Ana
9	San Diego

Section V – Algaecide and Aquatic Herbicide Application Information

- **A.** List the appropriate target organism(s).
- **B.** List the name and active ingredients of each algaecide and aquatic herbicide to be used.
- **C.** List the start and end date of proposed aquatic algaecide and aquatic herbicide application event.
- **D.** List the name(s) and type(s) of adjuvants that will be used.

The Discharger must submit a new NOI if any information stated in this section will be changed. If the Discharger plans to use an algaecide and aquatic herbicide product not currently covered under its Notice of Applicability (NOA), and the algaecide and aquatic herbicide product may be discharged to a water of the United States as a result of algaecide and aquatic herbicide application, the Discharger must receive a revised NOA from the State Water Board's Deputy Director of the Division of Water Quality before using that product.

Section VI – Aquatic Pesticide Application Plan

The Coalition or Discharger must prepare and complete an Aquatic Pesticide Application Plan (APAP). The minimum contents of APAP are specified in the permit under Section VIII.C, Limitations and Discharge Requirements, of the General Permit. The Discharger must ensure that its applicator is familiar with the APAP contents before algaecide and aquatic herbicide application.

If an APAP is not complete at the time of application, enter the date by which it will be completed.

Section VII – Notification

Indicate if you have notified potentially affected public and governmental agencies, as required under item VIII.B of the General Permit.

Section VIII – Fee

The amount of Annual fee shall be based on Category 3 discharge specified in section 2200(b)(9) of title 23, California Code of Regulations. Fee information can be found at http://www.waterboards.ca.gov/resources/fees/docs/fy1112fee_schdl_npdes_prmt.pdf.

Check the YES box if you have included payment of the annual fee. Check the NO box if you have not included this payment. **NOTE:** You will be billed annually and payment is required to continue coverage.

Section IX– Certification

- **A.** Print the name of the appropriate official. The person who signs the NOI must meet the signatory and certification requirements stated in Attachment B Standard Provisions item V.B.
- **B.** The person whose name is printed above must sign and date the NOI.
- **C.** Enter the title of the person signing the NOI.

Attachment F – Notice of Termination

WATER QUALITY ORDER NO. 2013-0002-DWQ
GENERAL PERMIT NO. CAG990005

STATEWIDE GENERAL NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT FOR RESIDUAL AQUATIC PESTICIDE DISCHARGES TO WATERS OF THE UNITED STATES FROM ALGAE AND AQUATIC WEED CONTROL APPLICATIONS

I. WDID

WDID# _____

II. DISCHARGER INFORMATION

A. Name			
B. Mailing Address			
C. City	D. County	E. State	F. Zip
G. Contact Person	H. E-mail address	I. Title	J. Phone

III. BASIS FOR TERMINATION

IV. CERTIFICATION

"I certify under penalty of law that 1) I am not required to be permitted under this General Permit No.CAG990005, and 2) this document and all attachments were prepared under my direction and supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine or imprisonment. Additionally, I understand that the submittal of this Notice of Termination does not release an algaecide or aquatic herbicide applicator from liability for any violations of the Clean Water Act."

A. Printed Name: _____

B. Signature: _____ **Date:** _____

C. Title: _____

V. FOR STATE WATER BOARD USE ONLY

☐ **Approved for Termination** ☐ **Denied and Returned to the Discharger**

A. Printed Name: _____

B. Signature: _____

C. Date: _____

NOT Effective Date: / /

Attachment G – Exception List

LIST OF PUBLIC AGENCIES AND MUTAL WATER COMPANIES GRANTED AN EXCEPTION PURSUANT TO STATE WATER RESOURCES CONTROL BOARD POLICY FOR IMPLEMENTATION OF TOXICS STANDARDS FOR INLAND SURFACE WATERS, ENCLOSED BAYS, AND ESTUARIES OF CALIFORNIA

The public entities and mutual water companies listed herein have prepared Initial Studies, Negative Declarations (ND), Mitigated Negative Declarations (MND), and Notices of Determination for the discharge of algaecides and aquatic herbicides in accordance with the California Environmental Quality Act (CEQA (Public Resources Code § 21000 et seq.)) to comply with the exception requirements of section 5.3 of the Policy. The boards of each public entity, as the lead agencies under CEQA, approved the Final ND/MND and determined that the discharge of algaecides and aquatic herbicides in their respective projects would not have a significant effect on the environment. These public entities and mutual water companies have determined that the water quality or related water quality impacts identified in the environmental assessments of the ND/MND are less than significant.

In addition to submitting the CEQA documentation, these public entities and mutual water companies have also complied with the other exception requirements of section 5.3 of the Policy.

As required in section 15096 of the CEQA Guidelines, the State Water Resources Control Board (State Water Board), as a Responsible Agency under CEQA, considered the ND/MND approved by the board of each public entity and finds that the projects will have less than significant water quality impact if the waste discharge requirements in this General Permit are followed. Accordingly, the public entities and mutual water companies listed herein are hereby granted an exception pursuant to section 5.3 of the Policy.

1. Byron-Bethany Irrigation District
2. City of Antioch Department of Public Works
3. Contra Costa Water District
4. Contra Costa County Flood Control and Water Conservation District
5. Department of Food and Agriculture
6. Department of Water Resources
7. Friant Water Users Authority
8. Glenn-Colusa Irrigation District
9. Maine Prairie Water District
10. Marin Municipal Water District
11. Metropolitan Water District of Southern California
12. Modesto Irrigation District
13. Nevada Irrigation District

14. North Marin Water District
15. Oakdale Irrigation District
16. Placer County Water Agency
17. Potter Valley Irrigation District
18. Princeton-Cordora-Glenn Irrigation District
19. Provident Irrigation District
20. Reclamation District 1004
21. Santa Cruz Water Department
22. Solano Irrigation District
23. South Feather Water and Power Agency
24. South Sutter Water District
25. Tehama Colusa Canal Authority
26. Turlock Irrigation District
27. Woodbridge Irrigation District
28. Yolo County Flood Control and Water Conservation District

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,

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

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

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:

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

List of Tables and Figures and Forms

TABLE OF CONTENTS

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 $1/8^{th}$ 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).

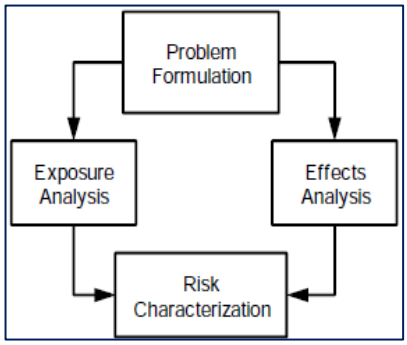


Figure 1. Ecological risk assessment process for chemical stressor. From USEPA (2004).

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.

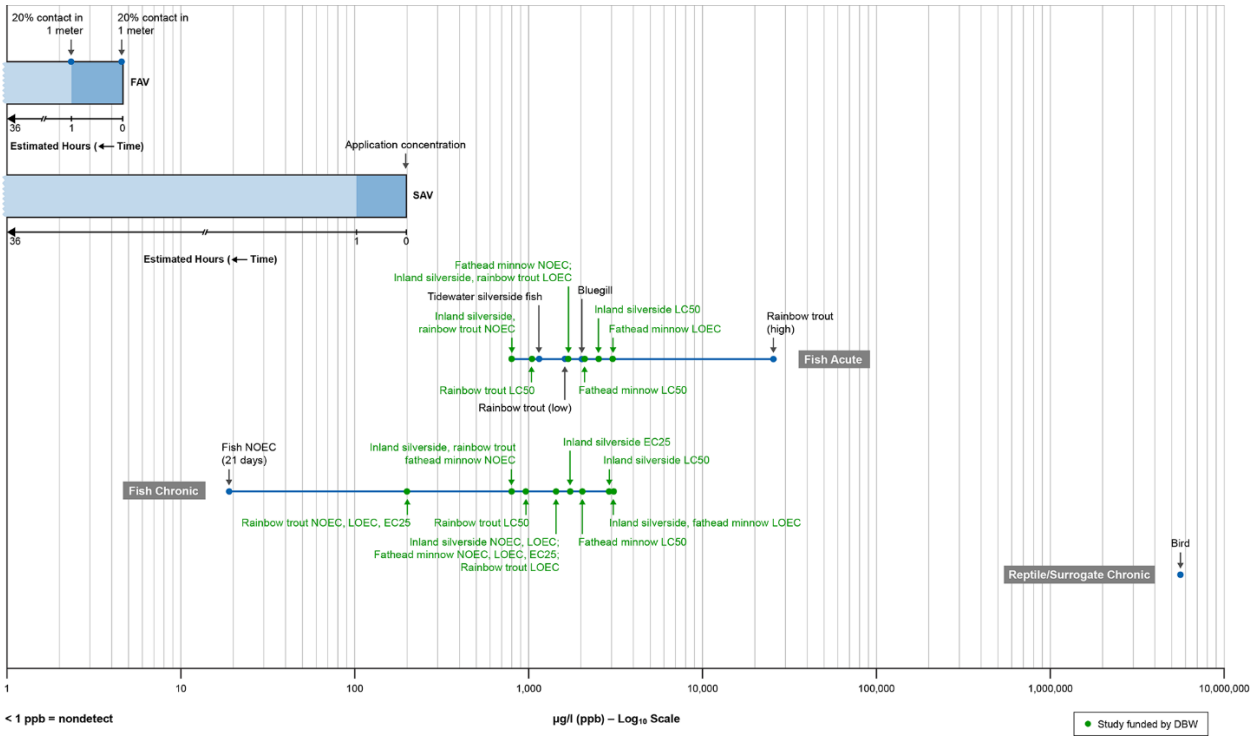


Figure 2. Exposure concentrations for amphibian surrogate and fish species endpoint effects for carfentrazone-ethyl (µg/L or ppb, CDBW 2017).

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.

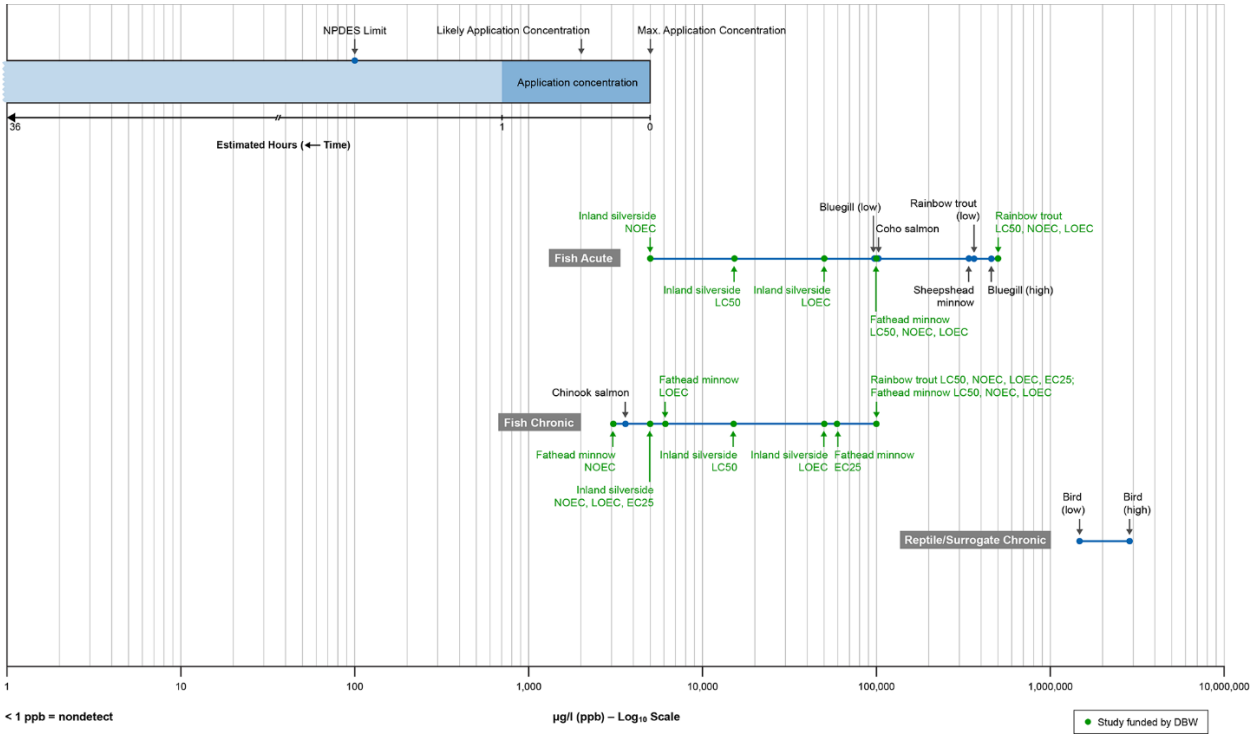


Figure 3. Exposure concentrations for amphibian surrogate and fish species endpoint effects for endothall (µg/L or ppb, CDBW 2017).

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.

Flumioxazin

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.

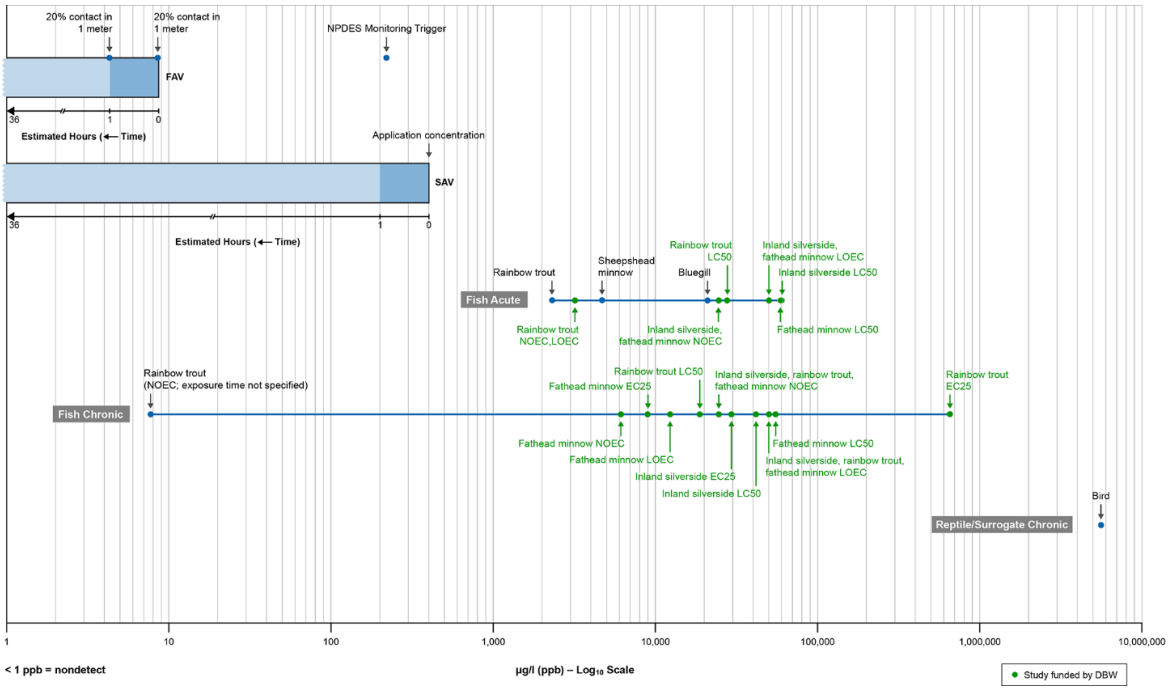


Figure 4. Exposure concentrations for amphibian surrogate and fish species endpoint effects for flumioxazin (µg/L or ppb, CDBW 2017).

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.

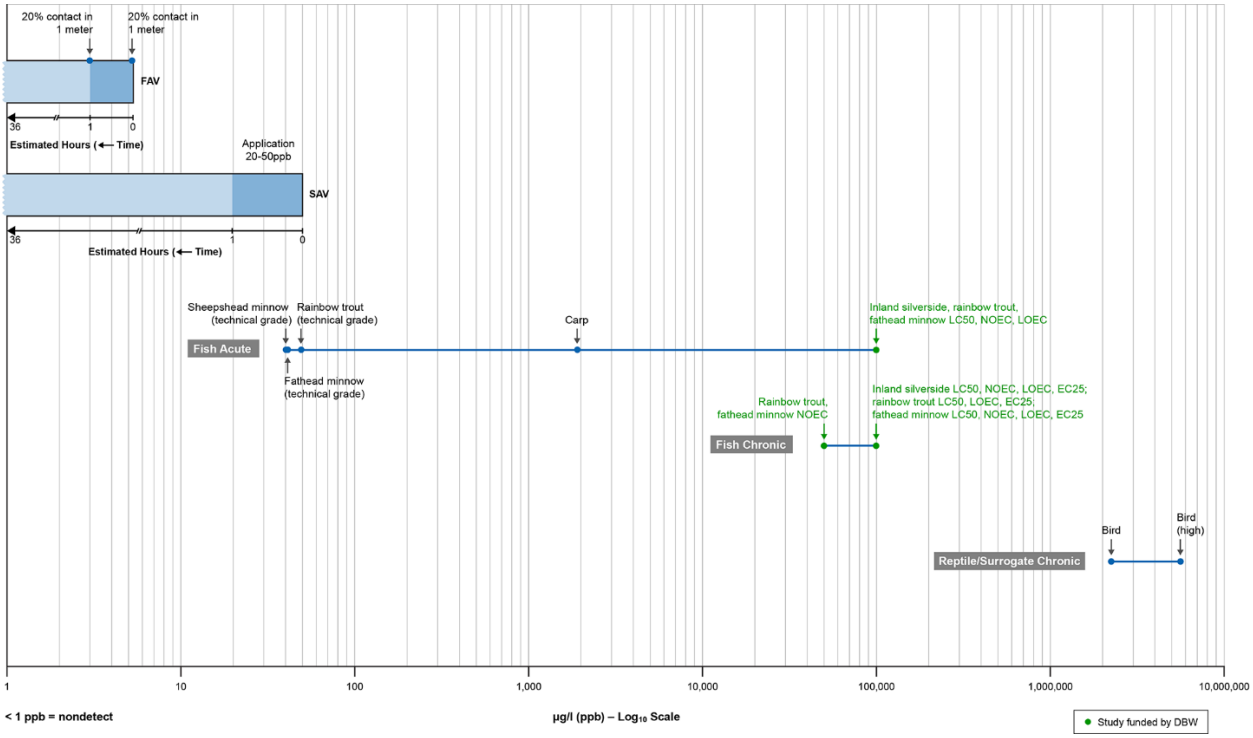


Figure 5. Exposure concentrations for amphibian surrogate and fish species endpoint effects for florpyrauxifen-benzyl (µg/L or ppb, CDBW 2017).

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).

Bioaccumulation of Herbicides and Adjuvants

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:

Herbicide Control Methods

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.

5. REFERENCES

Akers, R. P., R. Weaver., and M. J. Pitcairn, In review. Biological Control of Water hyacinth in California's Sacramento-San Joaquin River Delta: Observations on Establishment and Spread.

Bakke, D. 2007. Analysis of Issues Surrounding the use of Spray Adjuvants with Herbicides. U.S. Forest Service, Pacific Southwest Region. 61pp.

Bayer Crop Science. 2004. Agridex Non-ionic Surfactant Material Safety Data Sheet. www.bayercropscience.com.au.

Beechie, T., H. Imaki, J. Greene, A. Wade, H. Wu, G. Pess, P. Roni, J. Kimball, J. Stanford, P. Kiffney, and N. Mantua. 2012. Restoring Salmon Habitat for a Changing Climate. River Research and Applications.

Brown, L. R. 2003. Will Tidal Wetland Restoration Enhance Populations of Native Fishes? San Francisco Estuary and Watershed Science 1, no.1 (October 2003), 1-42.

California Department of Fish and Game. 1990. Status and Management of Spring-Run Chinook Salmon. Inland Fisheries Division, 33 pp.

California Department of Fish and Game. 1998. A Status Review of the Spring-Run Chinook Salmon (*Oncorhynchus tshawytscha*) in the Sacramento River Drainage. Candidate Species Status Report 98-01. California Department of Fish and Game, 394 pp.

California Department of Fish and Game. 2012. Grandtab Spreadsheet of Adult Chinook Escapement in the Central Valley. http://www.calfish.org/tabid/104/Default.aspx.

California Department of Fish and Wildlife. 2014. Salvage Ftp Site Report. 432 pp.

California Department of Fish and Wildlife. 2016. Grandtab Spreadsheet of Adult Chinook Escapement in the Central Valley.

California Department of Fish and Wildlife. 2017. Grandtab Spreadsheet of California Central Valley Chinook Population Database Report.

Cavallo, B., R. Brown, D. Lee, J. Kindopp, and R. Kurth. 2011. Hatchery and Genetic Management Plan for Feather River Hatchery Spring-Run Chinook Program. Prepared for the National Marine Fisheries Service.

Center, T. D. and F. A. Dray Jr. 1992. Associations Between Water hyacinth weevils (*Neochetina eichhorniae* and *N. bruchi*) and Phenological Stages of *Eichornia crassipes* in Southern Florida. Florida Entomology 75, 196-211.

Center, T. D. and F. A. Dray, Jr. 2010. Bottom-up Control of Water hyacinth weevil Populations: do the Plants Regulate the Insects? Journal of Applied Ecology 47, 329-337

Center, T. D., F. A. Dray Jr., G. P. Jubinsky, and M. J. Grodowitz. 1999a. Biological Control of Water hyacinth Under Conditions of Maintenance Management: Can Herbicides and Insects be Integrated? Environmental Management 23, 241-256.

Center, T. D., F. A. Dray Jr., G. P. Jubinsky and A. J. Leslie. 1999b. Water hyacinth weevils (*Neochetina eichhorniae* and *N. bruchi*) Inhibit Water hyacinth Colony Development. Biological Control 15, 39-50.

Champion, P. D. and C. C. Tanner. 2000. Seasonality of Macrophytes and Interaction with Flow in a New Zealand Lowland Stream. Hydrobiologia, 441(1): 1-12.

Chase, R. 2010. Lower American River Steelhead (*Oncorhynchus mykiss*) Spawning Surveys - 2010. Shasta Lake, CA.

Clark, G. H. 1929. Sacramento-San Joaquin Salmon (*Oncorhynchus tshawytscha*) Fishery of California. Fish Bulletin 17.

Cohen, S. J., K. A. Miller, A. F. Hamlet, and W. Avis: 2000. Climate Change and Resource Management in the Columbia River Basin. Water International. 25, 253–272.

Conrad, J. L., K. L. Weinersmith, M. J. Young, A. J. Bibian, P. B. Moyle, and A. Sih. 2011. Invaders Helping Invaders: Expansion of Largemouth Bass in the Sacramento-San Joaquin Delta Facilitated by Brazilian Waterweed, *Egeria densa*. American Fisheries Society National Meeting, September 6, 2011.

Cramer Fish Sciences. 2011. Memo: Green Sturgeon Observations at Daguerre Point Dam, Yuba River, CA. Auburn, CA.

del Rosario, R. B., Y. J. Redler, K. Newman, P. L. Brandes, T. Sommer, K. Reece, and R. Vincik. 2013. Migration Patterns of Juvenile Winter-Run-Sized Chinook Salmon (*Oncorhynchus tshawytscha*) through the Sacramento–San Joaquin Delta. San Francisco Estuary and Watershed Science 11(1):1-22.

Dettinger, M. D. and D. R. Cayan. 1995: Large-scale Atmospheric Forcing of Recent Trends Toward Early Snowmelt Runoff in California. Journal of Climate 8, 606-623.

Dettinger, M. D., D. R. Cayan, M. K. Meyer, and A. E. Jeton. 2004. Simulated Hydrologic Responses to Climate Variations and Change in the Merced, Carson, and American River Basins, Sierra Nevada, California, 1900–2099, Climate Change 62, 283–317.

Dettinger, M. D. 2005. From Climate-change Spaghetti to Climate-change Distributions for 21st Century California. San Francisco Estuary and Watershed Science, 3(1).

Dimacali, R. L. 2013. A Modeling Study of Changes in the Sacramento River Winter-Run Chinook Salmon Population Due to Climate Change. California State University, Sacramento.

Donley Marineau, E., M. J. Perryman, J. Hernandez, and S. Lawler. 2017. Are there non-target impacts of invasive water hyacinth management for aquatic invertebrate communities in the Sacramento-San Joaquin River Delta? Ch. 3 in Aquatic Invertebrate Dynamics in Two Systems of Conservation Concern. Doctoral Thesis. Department of Entomology and Nematology, University of California, Davis, CA.

Drexler, J. 2006. Effects of the Invasive Aquatic Plant, *Egeria densa*, on Native Fish Habitat in the Sacramento-San Joaquin Delta (Proposal), U.S. Geological Survey.

DuBois, J. and R. Mayfield. 2009. Field Season Summary for the Adult Sturgeon Population Study. Field Season August 10, 2009 - October 27, 2009. California Department of Fish and Game, Bay Delta Region (Stockton).

DuBois, J., T. Matt, and T. MacColl. 2011. Sturgeon Fishing Report Card: Preliminary Data Report. California Department of Fish and Game, 14 pp.

Emmett, R. L., S. A. Hinton, S. L. Stone, and M. E. Monaco. 1991. Distribution and Abundance of Fishes and Invertebrates in West Coast Estuaries Volume II: Species Life History Summaries. ELMR Report Number 8, Rockville, MD.

Engel, S. 1995. Eurasian Watermilfoil as a Fishery Management Tool. Fisheries 20(3):20-27.

Evonik. 2016a. Break-Thru SP 133 Nonionic Spreader/Penetrant Label.

Evonik. 2016b. Break-Thru SP 133 Safety Data Sheet.

EXTOXNET. 1995. Endothall. Pesticide Information Project of Cooperative Extension Offices of Cornell University, Michigan State University, Oregon State University, and University of California at Davis.. pmep.cce.cornell.edu/profiles/extoxnet. Accessed November 3, 2016.

Fitzgerald, D. and P. W. Tipping. 2013. Effect of Insect Density and Host Plant Quality on Wing-form in Megamelus scutellaris (Hemiptera: Delphacidae). Florida Entomology 96, 124–130.

Franks, S. E. 2015. Spring-Running Salmon in the Stanislaus and Tuolumne Rivers and an Overview of Spring-Run Recovery. National Marine Fisheries Service Sacramento, CA.

Garza, J. C. and D. E. Pearse. 2008. Population Genetic Structure of *Oncorhynchus mykiss* in the California Central Valley: Final Report for California Department of Fish and Game. University of California, Santa Cruz, and National Marine Fisheries Service, Santa Cruz, California.

Good, T. P., R. S. Waples, and P. Adams. 2005. Updated Status of Federally Listed ESUs of West Coast Salmon and Steelhead. NOAA Technical Memorandum NMFS-NWFSC-66.

Grue, C. and L. Crosson. 2017. Confirming the Safety of the Aquatic Herbicide, Procellacor, to Juvenile Chinook Salmon. Final report submitted to M. Heilman, SePRO Corporation, dated 30 June 2017.

Haag, K. H. 1986. Effects of Herbicide Application on Mortality and Dispersive Behavior of the Water hyacinth weevils, *Neochetina eichhorniae* and *Neochetina bruchi* (Coleoptera: Curculionidae). Environmental Entomology 15, 1192-1198.

Habig, C. 2004. An Evaluation of Potential Effects of Fluridone on Pacific Salmon in the California Delta. .

Haller, W. T. and R. K. Stocker. 2003. Toxicity of 19 Adjuvants to Juvenile *Lepomis macrochirus* (bluegill sunfish). Environmental Toxicology and Chemistry 22(3), pp. 615–619.

Hamelink, J. L., D. R., Buckler, F. L. Mayer, D. U. Palawski, and H. O. Sanders. 1986. Toxicity of Fluridone to Aquatic Invertebrates and Fish. Environmental Toxicology and Chemistry 5(1):87-94.

Hannon, J. and B. Deason. 2008. American River Steelhead (*Oncorhynchus mykiss*) Spawning 2001 – 2007. U.S. Department of the Interior, Bureau of Reclamation, Mid-Pacific Region.

Hannon, J., M. Healey, and B. Deason. 2003. American River Steelhead (*Oncorhynchus mykiss*) Spawning 2001 – 2003. U.S. Bureau of Reclamation and California Department of Fish and Game, Sacramento, CA.

Hopper, J. V., P. D. Pratt, K. F. McCue, M. J. Pitcairn, P. J. Moran, and J. D. Madsen. 2017. Spatial and Temporal Wariation of Biological Control Agents Associated with *Eichhornia crassipes* in the Sacramento-San Joaquin River Delta, California. Biological Control 111:13-22.

Israel, J. A., K. J. Bando, E. C. Anderson, and B. May. 2009. Polyploid Microsatellite Data Reveal Stock Complexity among Estuarine North American Green Sturgeon (*Acipenser medirostris*). Canadian Journal of Fisheries and Aquatic Sciences 66(9):1491-1504.

Jackson, Z. J. and J. P. Van Eenennaarn. 2013. San Joaquin River Sturgeon Spawning Survey 2012, Final Annual Report.34.

Jadhav, A., M. P. Hill, and M. Byrne. 2008. Identification of a Retardant Dose of Glyphosate with Potential for Integrated Control of Water hyacinth, *Eichhornia crassipes* (Mart.) Solms-Laubach. Biological Control. 47:154-158.

James, W. F., J. W. Barko, and H. L. Eakin. 2000. Macrophyte Management via Mechanical Shredding: Effects on Water Quality in Lake Champlain (Vermont-New York). APCRP

Technical Notes Collection ERDC TN-APCRP-MI-05), U.S. Army Engineer Research and Development Center, Vicksburg, MS

Jones, C., J. Lawton, and M. Shachak. 1994. Organisms as Ecosystem Engineers. Oikos 69: 373-386.

Laetz, C. A., D. H. Baldwin, T. K. Collier, V. Hebert, J. D. Stark, and N. L. Scholz. 2009a. The Synergistics Toxicity of Pesticides Mixtures: Implications for Risk Assessment and the Conservation of Endangered Pacific Salmon. Environmental Health Perspectives 117(3):348-353.

Laetz, C. A., D. H. Baldwin, T. K. Collier, V. Hebert, J. D. Stark, and N. L. Scholz. 2009b. The Synergistics Toxicity of Pesticides Mixtures: Implications for Risk Assessment and the Conservation of Endangered Pacific Salmon. Environmental Health Perspectives 117(3):348-353.

Lindley, S. 2008. California Salmon in a Changing Climate.

Lindley, S. T., R. S. Schick, B. P. May, J. J. Anderson, S. Greene, C. Hanson, A. Low, D. McEwan, R. B. MacFarlane, C. Swanson, and J. G. Williams. 2004. Population Structure of Threatened and Endangered Chinook Salmon ESUs in California's Central Valley Basin.

Lindley, S. T., R. S. Schick, A. Agrawal, M. Goslin, T. E. Pearson, E. Mora, J. J. Anderson, B. May, S. Greene, C. Hanson, A. Low, D. McEwan, R. B. MacFarlane, C. Swanson, and J. G. Williams. 2006. Historical Population Structure of Central Valley Steelhead and Its Alteration by Dams. San Francisco Estuary and Watershed Science 4(1):19.

Lindley, S. T., R. S. Schick, E. Mora, P. B. Adams, J. J. Anderson, S. Greene, C. Hanson, B. P. May, D. McEwan, R. B. MacFarlane, C. Swanson, and J. G. Williams. 2007. Framework for Assessing Viability of Threatened and Endangered Chinook Salmon and Steelhead in the Sacramento-San Joaquin Basin. San Francisco Estuary and Watershed Science 5(1):26.

Lindley, S. T., M. L. Moser, D. L. Erickson, M. Belchik, D. W. Welch, E. L. Rechisky, J. T. Kelly, J. Heublein, and A. P. Klimley. 2008. Marine Migration of North American Green Sturgeon. Transactions of the American Fisheries Society 137(1):182-194.

Lindley, S. T., M. S. M. C. B. Grimes, W. Peterson, J. Stein, J. T. Anderson,, L.W. Botsford, D. L. Bottom, C. A. Busack, T. K. Collier, J. Ferguson, J. C. Garza,, D. G. H. A. M. Grover, R. G. Kope, P. W. Lawson, A. Low, R. B. MacFarlane,, M. P.-Z. K. Moore, F. B. Schwing, J. Smith, C. Tracy, R. Webb, B. K. Wells and T.H. Williams. 2009. What Caused the Sacramento River Fall Chinook Stock Collapse?

Lindley, S. T., D. L. Erickson, M. L. Moser, G. Williams, O. P. Langness, B. W. McCovey, M. Belchik, D. Vogel, W. Pinnix, J. T. Kelly, J. C. Heublein, and A. P. Klimley. 2011. Electronic Tagging of Green Sturgeon Reveals Population Structure and Movement among Estuaries. Transactions of the American Fisheries Society 140(1):108-122.

Macneale, K. H., P. M. Kiffney, and N. L. Scholz. 2010. Pesticides, Aquatic Food Webs, and the Conservation of Pacific Salmon. Frontiers in Ecology and the Environment 8:475-482.

Madsen, J. 2000. Advantages and Disadvantages of Aquatic Plant Management Techniques. US Army Engineer Research and Development Center Environmental Laboratory. Originally in North America Lake Management Society, LakeLine. 20 (1):22-34. www.aquatics.org/pubs/madsen2.htm.

Matala, A. P., S. R. Narum, W. Young, and J. L. Vogel. 2012. Influences of Hatchery Supplementation, Spawner Distribution, and Habitat on Genetic Structure of Chinook Salmon in the South Fork Salmon River, Idaho. North American Journal of Fisheries Management 32(2):346-359.

Matthiessen, P., G. F. Whale, R. J. Rycroft, and D. A. Sheahan. 1988. The Joint Toxicity of Pesticide Tank-Mixes to Rainbow Trout. Aquatic Toxicology 13(1):61-75.

McClure, M. M. 2011. Climate Change. P. 261-266 In: Ford, M. J. (Ed.). Status Review Update for Pacific Salmon and Steelhead Listed under the Endangered Species Act: Pacific Northwest. N. F. S. Center, 281 pp

McClure, M. M., M. Alexander, D. Borggaard, D. Boughton, L. Crozier, R. Griffis, J. C. Jorgensen, S. T. Lindley, J. Nye, M. J. Rowland, E. E. Seney, A. Snover, C. Toole, and V. A. N. H. K. 2013. Incorporating Climate Science in Applications of the U.S. Endangered Species Act for Aquatic Species. Conservation Biology 27(6):1222-1233.

McCullough, D., S. Spalding, D. Sturdevant, and M. Hicks. 2001. Issue Paper 5. Summary of Technical Literature Examining the Physiological Effects of Temperature on Salmonids. Prepared as Part of U.S. EPA, Region 10 Temperature Water Quality Criteria Guidance Development Project.

McEwan, D. R. 2001. Central Valley Steelhead. Fish Bulletin 179(1):1-44.

McEwan, D. and T. A. Jackson. 1996. Steelhead Restoration and Management Plan for California. California Department of Fish and Game, 246 pp.

Michel, A., R. D. Johnson, S. O. Duke, and B. E. Scheffler. 2004. Dose-Response Relationships between Herbicides with Different Modes of Action and Growth of Lemna Paucicostata: An Improved Ecotoxicological Method. Environmental Toxicology and Chemistry 23(4):1074-1079.

Mora, E. A., S. T. Lindley, D. L. Erickson, and A. P. Klimley. 2015. Estimating the Riverine Abundance of Green Sturgeon Using a Dual-Frequency Identification Sonar. North American Journal of Fisheries Management 35(3):557-566.

Moran, P. J. 2005. Leaf Scarring by the Weevils *Neochetina eichhorniae* and *N. bruchi* Enhances Infection by the Fungus *Cercospora piaropi* on Water hyacinth, *Eichhornia crassipes*. BioControl 50:511-524.

Moran, P. J. 2012. Influence of Biological Control Damage on Efficacy of Penoxsulam and Two Other Herbicides on Water hyacinth. Journal of Aquatic Plant Management 50:32-38.

Moran, P. J., M. J. Pitcairn, and B. Villegas. 2016. First Establishment of the Planthopper, *Megamelus scutellaris* Berg, 1883 (Hemiptera: Delphacidae), Released for Biological Control of Water hyacinth in California. Pan-Pacific Entomology 92:32-43.

Moser, M. L. and S. T. Lindley. 2006. Use of Washington Estuaries by Subadult and Adult Green Sturgeon. Environmental Biology of Fishes 79(3-4):243-253.

Mosser, C. M., L. C. Thompson, and J. S. Strange. 2013. Survival of Captured and Relocated Adult Spring-Run Chinook Salmon *Oncorhynchus tshawytscha* in a Sacramento River Tributary after Cessation of Migration. Environmental Biology of Fishes 96(2-3):405-417.

Moyle, P. B. 2002. Inland Fishes of California. University of California Press, Berkeley and Los Angeles.

National Marine Fisheries Service. 2010a. Federal Recovery Outline North American Green Sturgeon Southern Distinct Population Segment U.S. Department of Commerce, 23 pp.

National Marine Fisheries Service. 2010b. Environmental Assessment for the Proposed Application of Protective Regulations under Section 4(d) of the Endangered Species Act for the Threatened Southern Distrinct Population Segment of North American Green Sturgeon. 101 pp.

National Marine Fisheries Service. 2011a. 5-Year Review: Summary and Evaluation of Sacramento River Winter-Run Chinook Salmon. U.S. Department of Commerce, 38 pp.

National Marine Fisheries Service. 2011b. 5-Year Review: Summary and Evaluation of Central Valley Spring-Run Chinook Salmon. U.S. Department of Commerce, 34 pp.

National Marine Fisheries Service. 2011c. Endangered Species Act Section 7 Consultation Draft Conference and Biological Opinion for United States Environmental Protection Agency Registration of 2, 4-D, Triclopyr Bee, Diuron, Linuron, Captan, and Chlorothalonil.

National Marine Fisheries Service. 2013. Endangered Species Act Section 7 Consultation Draft Conference and Biological Opinion for United States Environmental Protection Agency Registrations of Pesticides Containing Diflurbenzuron, Fenbutatin Oxide, and Propargite.

National Marine Fisheries Service. 2014. Central Valley Recovery Plan for Winter-Run Chinook Salmon, Central Valley Spring-Run Chinook Salmon and California Central Valley Steelhead. W. C. R. National Marine Fisheries Service, 427 pp.

National Marine Fisheries Service. 2015. 5-Year Review: Summary and Evaluation of Southern Distinct Population Segment of the North American Green Sturgeon, 42 pp.

National Marine Fisheries Service. 2016a. 5-Year Status Review: Summary and Evaluation of Sacramento River Winter-Run Chinook Salmon ESU, 40 pp

National Marine Fisheries Service. 2016b. 5-Year Review: Summary and Evaluation of California Central Valley Steelhead Distinct Population Segment,

National Marine Fisheries Service. 2016c. 5-Year Review: Summary and Evaluation of Central Valley Spring-Run Chinook Salmon ESU (2016), 41 pp.

National Marine Fisheries Services. 2017. Biological Opinion for the California WaterFix. June 16, 2017. Sacramento, CA.

National Marine Fisheries Service. 2018. Draft Recovery Plan for the Southern Distinct Population Segment of North American Green Sturgeon (Acipenser medirostris). National Marine Fisheries Service, Sacramento, CA

National Research Council. 2013. Assessing Risks to Endangered and Threatened Species from Pesticides. The National Academic Press:176.

Nielsen, L. W. and I. Dahllöf. 2007. Direct and Indirect Effects of Herbicides Glyphosate, Bentazone and Mcpa on Eelgrass (*Zostera marina*). Aquatic Toxicology 82(1):47-54.

Nielsen, J. L., S. Pavey, G. K. Sage, and I. Williams. 2003. Genetic Analyses of Central Valley Trout Populations 1999-2003. CDFG, USFWS, Anchorage, Alaska.

Nobriga, M. and P. Cadrett. 2001. Differences Among Hatchery and Wild Steelhead: Evidence from Delta Fish Monitoring Programs. IEP Newsletter 14(3):30-38.

Pacific Fishery Management Council (PFMC). 2005. Pacific Coast Groundfish Fishery Management Plan, Appendix D: Nonfishing Effects on West Coast Groundfish Essential Fish Habitat and Recommended Conservation Measures.

Pacific Fishery Management Council and National Marine Fisheries Service. 2014. Environmental Assessment and Regulatory Impact Review Pacific Coast Salmon Plan Amendment 18: Incorporating Revisions to Pacific Salmon Essential Fish Habitat.

Phillis, C. C., A. M. Sturrock, R. C. Johnson, and P. K. Weber. 2018. Endangered winter-run Chinook salmon rely on diverse rearing habitats in a highly altered landscape. Biological Conservation 217:358-362.

Piper, R. G., I. B. McElwain, L. E. Orme, J. P. McCraren, L. G. Fowler, and J. R. Leonard. 1982. Fish Hatchery Management. U.S. Department of Interior., U.S. Fish and Wildlife Service. 517 pp.

Poytress, W. R. and F. D. Carrillo. 2011. Brood-Year 2008 and 2009 Winter Chinook Juvenile Production Indices with Comparisons to Juvenile Production Estimates Derived from Adult Escapement., 51 pp.

Relyea, R. A. 2009. A Cocktail of Contaminants: How Mixtures of Pesticides at Low Concentration Affect Aquatic Communities. Oecologia 159(2):363-376.

Richter, A. and S. A. Kolmes. 2005. Maximum Temperature Limits for Chinook, Coho, and Chum Salmon, and Steelhead Trout in the Pacific Northwest. Reviews in Fisheries Science 13(1):23-49.

Roos, M. 1987. Possible Changes in California Snowmelt Patterns. Proceedings of the 4th Pacific Climate Workshop, Pacific Grove, California, 22–31.

Roos, M. 1991. A Trend of Decreasing Snowmelt Runoff in Northern California. Proceedings of the. 59th Western Snow Conference, Juneau, AK, 29-36.

Rutter, C. 1904. Notes on Fishes from the Gulf of California, with the Description of a New Genus and Species. Pages 251-254 Proceedings of the California Academy of Sciences Third Series Zoology, San Francisco, CA.

Schlenk, D., R. Lavado, J. E. Loyo-Rosales, W. Jones, L. Maryoung, N. Riar, I. Werner, andD. Sedlak. 2012. Resconstitution Studies of Pesticides and Surfactants Exploring the Cause of Estrgoenic Activity Observed in Surface Waters of the San Francisco Bay Delta. Environmental Science and Technology 46(16):9106-9111.

Scholz, N. L., E. Fleishman, I. W. L. Brown, M. L. Johnson, M. L. Brooks, C. L. Mitchelmore, and a. D. Schlenk. 2012. A Perspective on Modern Pesticides, Pelagic Fish Declinces, and Unknown Ecological Resilience in Highly Managed Ecosystems. Biosciences 62(4):428-434.

Schultz, R. and E. Dibble. 2012. Effects of Invasive Macrophytes on Freshwater Fish and Macroinvertebrate Communities: The Role of Invasive Plant Traits. Hydrobiologia 684:1-14

Seesholtz, A. M., M. J. Manuel, and J. P. Van Eenennaam. 2014. First Documented Spawning and Associated Habitat Conditions for Green Sturgeon in the Feather River, California. Environmental Biology of Fishes 98(3):905-912.

SePRO. 2015. Stingray Aquatic Herbicide Safety Data Sheet. SePRO Corporation. Indiana.

SERA. 2009. Endothall Human Health and Ecological Risk Assessment Final Report. For the USDA/Forest Service, Southern Region. Atlanta, GA.

Sosa, A. J., M. D. R. Lenicov, R. Mariani and H. A. Cordo. 2005. Life History of Megamelus Scutellaris with Description of Immature Stages (Hemiptera: Delphacidae). Annual. Entomology Society America 98(1):66–72.

Stillway, M., K. C. Hoffmann, W. Ramirez-Duarte, P. Triana Garcia, T. Kurobe, and S. Teh. 2017a. Final Draft Report for California Department of Boarding and Waterways. Project Name: Acute and Chronic Toxicity Testing of New Herbicides and Adjuvants on Delta Smelt, *Hypomesus transpacificus*. UC Davis Aquatic Health Program Laboratory. Submitted June 30, 2017.

Stillway, M., K. Callinan Hoffmann, W. Ramirez-Duarte, P. Triana Garcia, t. Kurobe, and S. Teh. 2017b. Final Draft Report for California Department of Boarding and Waterways. Project Name: Acute and Chronic Toxicity Testing of New Herbicides and Adjuvants on Delta Smelt, Hypomesus transpacificus. UC Davis Aquatic Health Program Laboratory. Submitted June 30, 2017.

Stone, L. 1872. Report of Operations During 1872 at the United States Salmon-Hatching Establishment on the Mccloud River, and on the California Salmonidae Generally; with a List of Specimens Collected.

Tipping, P. W., M. R. Martin, E. N. Pokorny, K. R. Nimmo, D. L. Fitzgerald, F. A. Dray, Jr. and T. D. Center. 2014. Current Levels of Suppression of Water hyacinth in Florida, USA. Biological. Control 71:65–69.

Thompson, L. C., M. I. Escobar, C. M. Mosser, D. R. Purkey, D. Yates, and P. B. Moyle. 2011. Water Management Adaptations to Prevent Loss of Spring-Run Chinook Salmon in California under Climate Change. Journal of Water Resources Planning and Management 138(5):465-478.

U.S. Army Corps of Engineers (Corps). 2013. Biological Assessment for the U.S. Army Corps of Engineers Authorized Operation and Maintenance of Existing Fish Passage Facilities at Daguerre Point Dam on the Lower Yuba River.

U.S. Bureau of Reclamation (USBR). 2008. Biological Assessment on the Continued Long-Term Operations of the Central Valley Project and the State Water Project. Department of the Interior, 64 pp.

U.S. Environmental Protection Agency (USEPA). 2004. Overview of the Ecological Risk Assessment Process in the Office of Pesticide Programs-Endangered and Threatened Species Effects Determinations.

U.S. Fish and Wildlife Service (USFWS). 2000. Impacts of Riprapping to Ecosystem Functioning, Lower Sacramento River, California. U.S. Fish and Wildlife Service, Sacramento Field Office, Sacramento, California. Prepared for US Army Corps of Engineers, Sacramento

U.S. Fish and Wildlife Service. 2015. Clear Creek Habitat Synthesis Report, 22 pp.

Vanrheenen, N. T., A. W. Wood, R. N. Palmer, and D. P. Lettenmaier. 2004. Potential Implications of PCM Climate Change Scenarios for Sacramento-San Jaoquin River Basin Hydrology and Water Resources. Climate Change 62:257-281.

Warner, R. E. 1970. *Neochetina eichhorniae*, A New Species of Weevil from Water hyacinth, and Biological Notes on it and *N. bruchi*. Proceedings Entomology Society Washington 72: 487-496.

Wilbur-Ellis. 2010. Competitor label and material safety data sheet. Fresno, CA.

Williams, J. G. 2006. Central Valley Salmon: A Perspective on Chinook and Steelhead in the Central Valley of California. San Francisco Estuary and Watershed Science 4(3):416

Wright, A. D. and A. S. Bourne 1990. Effect of 2,4-D on the Quality of Water hyacinth as Food for Insects. Plant Protocol Quarterly 5:139-141.

Yates, D., H. Galbraith, D. Purkey, A. Huber-Lee, J. Sieber, J. West, S. Herrod-Julius, and B. Joyce. 2008. Climate Warming, Water Storage, and Chinook Salmon in California's Sacramento Valley. Climatic Change 91(3-4):335-350.

Yoshiyama, R. M., F. W. Fisher, and P. B. Moyle. 1998. Historical Abundance and Decline of Chinook Salmon in the Central Valley Region of California. North American Journal of Fisheries Management 18:485-521.

Yoshiyama, R. M., E. R. Gertstung, F. W. Fisher, and P. B. Moyle. 2001. Historical and Present Distribution of Chinook Salmon in the Central Valley Drainage of California. Fish Bulletin 179(1):71-176.

Federal Register Notices Cited:

58 FR 33212. June 16, 1993. Designated Critical Habitat: Sacramento River Winter-Run Chinook Salmon. 8 pp.

70 FR 37160. June 28, 2005. Final Listing Determinations for 16 ESUs of West Coast Salmon, and Final 4(d) Protective Regulations for Threatened Salmonid ESUs. 46 pp.

70 FR 52488. September 2, 2005. Designation of Critical Habitat for Seven Evolutionarily Significant Units of Pacific Salmon and Steelhead in California; Final Rule. 141 pp.

71 FR 834. January 5, 2006. Endangered and Threatened Species Final Listing Determinations for 10 Distinct Population Segments of West Coast Steelhead. 28 pp.

71 FR 17757. April 7, 2006. Threatened Status for Southern Distinct Population Segment of North American Green Sturgeon. 10 pp.

74 FR 52300. October 9, 2009. Final Rulemaking to Designate Critical Habitat for the Threatened Southern Distinct Population Segment of North American Green Sturgeon. 53 pp.

81 FR 7214. February 11, 2016. Interagency Cooperation—Endangered Species Act of 1973, as Amended; Definition of Destruction or Adverse Modification of Critical Habitat. 13 pp.

81 FR 7414; February 11, 2016. Listing Endangered and Threatened Species and Designated Critical Habitat; Implementing Changes to the Regulations for Designating Critical Habitat. 26 pp.

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. USDA Environmental Review: 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. NMFS Review and Approval Process: 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. Treatment Operational Management Plan: 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. Conservation Measures and Integrated Pest Management Practices for AIPCP Projects: 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. Demonstration Investigation Zone: 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.

California Department of Parks and Recreation
Division of Boating and Waterways

Fish Passage Protocol

Original: October 17, 2012 ● **Updated:** April 30, 2014

Background

Invasive species are generally defined as non-indigenous species that adversely affect economics, environments, ecological relationships, and/or habitats where they have been introduced. The Delta is among the most invaded ecosystems worldwide, with over 200 invasive, non-native species. Invasive plants in the Delta include the water hyacinth, *Egeria densa*, and spongeplant.

The Division of Boating and Waterways (DBW) is designated as the lead agency of the state for the purpose of cooperating with agencies of the United States and other public agencies in controlling water hyacinth, *Egeria densa*, and spongeplant in the Sacramento-San Joaquin delta, its tributaries, and the Suisun marsh. DBW's aquatic weed program includes the Water Hyacinth Control Program (WHCP), *Egeria densa* Control Program (EDCP), and Spongeplant Control Program (SCP).

Water Hyacinth

Water hyacinth (Eichhornia crassipes) is a non-native, free-floating aquatic macrophyte. Water hyacinth was first reported in California in 1904, and by the early 1980s this invasive weed had become a significant problem for agriculture, boating and recreation, and wildlife in the Sacramento-San Joaquin Delta (Delta) and its tributaries. Water hyacinth is characterized by showy lavender flowers and thick, highly glossy leaves up to ten inches across. The plant grows from 1 ½ to 5 feet in height, and the floating portion of the plant can grow to more than four feet in diameter. In the Delta, the plant is found in sloughs, connecting waterways, and tributary rivers. The growing season for water hyacinth in the Delta is typically from March to early December. Water hyacinth spreads and grows rapidly under favorable temperature and nutrient conditions such as those found in the Delta in the summer months, and mats may double in surface area in six to fifteen days.

SB 1344 (Garamendi, Chapter 263, Statutes of 1982) amended the California Harbors and Navigation Code to designate DBW as the lead agency for controlling water hyacinth in the Delta, its tributaries, and the Suisun Marsh. DBW developed an interagency task force to coordinate the control activities of federal, state, and local interests and to resolve problems and concerns associated with public health and safety, and environmental impacts. DBW initiated the WHCP in 1983. The WHCP's primary treatment method has been chemical, supported by hand-picking, herding and biological controls.

Egeria densa

Egeria densa Planchon (Brazilian Elodea) is a submersed, non-native aquatic plant (submersed aquatic vegetation or SAV), introduced into the Delta approximately sixty years ago. This fast growing weed obstructs waterways, crowds out native plants, impedes anadromous fish migration and boat navigation, slows water flows, entraps sediments, and clogs agricultural and municipal water intakes. *Egeria densa* negatively impacts delta smelt by reducing turbidity and overwhelming littoral (near shore) habitats. *Egeria densa* infests almost twenty percent of the Delta's 61,619 surface acres, and is spreading at approximately 100 acres per year. Stems of *Egeria densa* are usually one to two feet long, but can be much shorter or longer, growing to over 9 feet long. The leaves are small and strap-shaped, typically about one-inch long and one-quarter inch wide. Flowers are on short stalks about one inch above the water, having white petals that are about ¾ inch across. *Egeria densa* reproduces asexually or vegetatively,

through fragmentation. Severed plant fragments regenerate into new plants capable of establishing themselves at new locations. Most of *Egeria densa*'s biomass is produced near the water surface.

AB 2193 (Rainey, Chapter 728, Statutes of 1996) authorized DBW to develop a control program for *Egeria densa*. DBW began treating *Egeria densa* in the Delta in 2001, in collaborations with the United States Department of Agriculture, Agricultural Research Service (USDA-ARS), after completing an Environmental Impact Report (EIR) and obtaining the required National Pollutant Discharge Elimination System (NPDES) permit and National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) biological opinions. The EDCP's primary treatment method has been chemical, supported by diver assisted handpicking, diver-operated suction harvesting and benthic barriers.

Spongeplant

South American spongeplant (*Limnobium laevigatum*) is a non-native, prolific, floating, flowering plant in the "frogbit" family (Hydrocharitacaea). Spongeplant was first seen in California in 1996, and was discovered in the San Joaquin River in 2007. In 2013, spongeplant was identified in twenty locations within the Delta. Spongeplant is a floating aquatic plant that grows in dense floating mats or rooted in mud or wetland edges. Spongeplant consists of leafy rosettes in a complex branching system. Leaves have pads of aerenchyma (spongy air spaces) on the undersides that provides buoyancy. Leaves are generally one to three inches across. Mature plants may be 8 to 12 inches in height. Spongeplant reproduces both vegetatively and through seed production (abundant seed pods and seedlings), with flowing and seed production appearing heaviest during the warmer temperatures in May and June. In 2013, most mats in the Delta were small (less than 30 feet), and many were inter-mixed with other aquatic plants (mixed in, and under, other plants).

AB 1540 (Buchanan, Chapter 188, Statutes of 2012) was approved by the Legislature on August 15, 2012, and was signed by the Governor on August 27, 2012. AB 1540 added responsibility for an additional invasive plant to DBW and USDA-ARS' existing programs (i.e., WHCP and EDCP). The SCP is a new program to address the infestation of spongeplant, with treatments started in 2013. The SCP's primary treatment method is chemical, supported by hand removal with nets, herding and mechanical removal.

Program Operations

Current DBW aquatic weed control program herbicides include 2,4-Dichlorophenoxyacetic acid, dimethlyamine salt (2,4-D), glyphosate, fluridone, penoxsulam, imazamox and diquat. Chemical treatment is typically conducted with hand-held sprayers (liquid chemical treatment for floating weeds), injection spray equipment (liquid chemical treatment typically for submerged weed), or broadcast spreaders (pellet treatment), from aluminum air or outboard motor boats. The boats are equipped for direct metering of herbicides, adjuvants, and water into pump delivery systems. Trained field crews spray the chemical mixture directly onto the plants for the WHCP and SCP. For the EDCP, field crews injection spray, or most commonly broadcast spread, herbicide pellets. DBW's aquatic weed control programs are intended to support beneficial uses under the Clean Water Act, and there have been no known measurable water quality or environmental degradation effects, including no known impacts to fish.

DBW and cooperating counties halted the WHCP in 2000 after a legal action from the *Delta Keepers* claimed that DBW must obtain a NPDES permit from the Central Valley Regional Water Quality Control Board (CVRWQCB) under the 9th Circuit Court's Headwaters Inc. v. Talent Irrigation District decision. DBW applied for the newly required NPDES permit in January 2000, and the CVRWQCB developed permit conditions in October 2000, but did not issue a permit. In March 2001, the State Water Board issued DBW a NPDES permit for the WHCP, incorporating most of the conditions

developed by the CVRWQCB. One of the conditions of WHCP's NPDES permit required DBW to develop a protocol to be followed to ensure that the WHCP operations provided a zone of passage to fish at all times. The original WHCP Fish Passage Protocol was developed in 2001 and implemented by the WHCP ever since. The original protocol was incorporated into the 2009 WHCP Programmatic Environmental Impact Report (PEIR), and had been a component of WHCP operations since 2001.

Conditions and requirements have changed since the 2001 Fish Passage Protocol was developed. In March 2006, the CVRWQCB issued a NPDES General Permit for Aquatic Weed Control, replacing the prior NPDES permit. DBW's aquatic weed control programs have been following the NPDES General Permit requirements since 2006. The State Water Resources Control Board (SWRCB) adopted the current NPDES General Permit for Aquatic Weed Control on March 5, 2013, effective December 2013 through November 2018. The current NPDES permit, as with the prior NPDES permits, does not require a fish passage protocol.

Since 2001, DBW has also received biological opinions (or letters of concurrence) for its programs. Conditions required by USFWS and NMFS promote fish passage in Delta waters. DBW environmental monitoring since 2001 has not found negative impacts to fish, or low dissolved oxygen levels that might impede fish passage. DBW is adding more reduced risk new herbicides (penoxsulam and imazamox), as evidence of their adaptive management program approach. Furthermore, herbicide labels for the two original WHCP herbicides (2,4-D and glyphosate) are now less restrictive in regards to measures to avoid dissolved oxygen impacts.

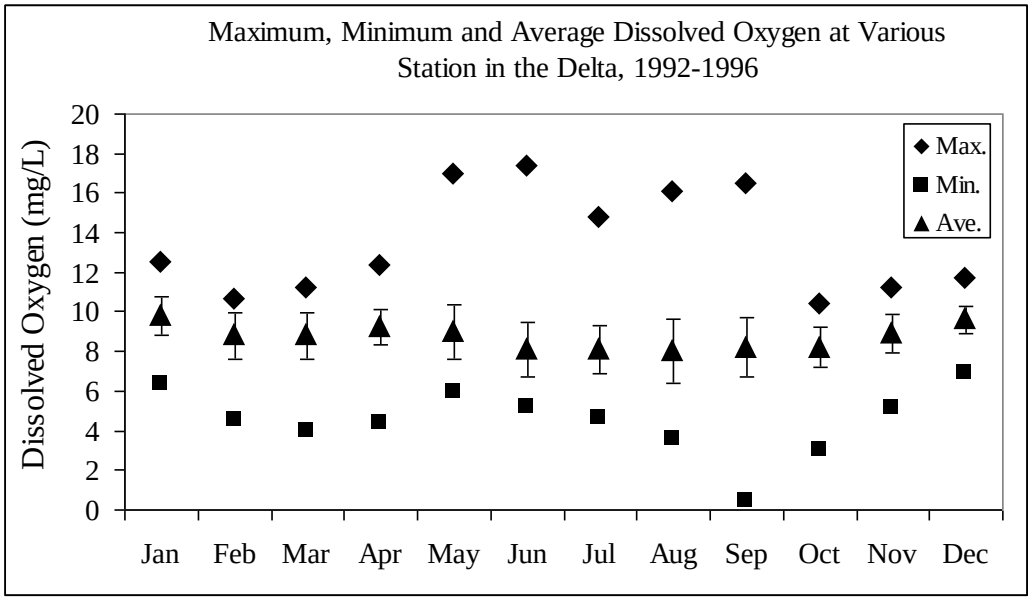
As a result of these significant changes, DBW and USDA-ARS have revised the fish passage protocol. A formal fish passage protocol is not required by the NPDES permit. However, DBW and USDA-ARS will implement this new fish passage protocol as a best practice to reduce the potential for negative effects on listed fish species movement near water hyacinth, *Egeria densa* and spongeplant treatment sites.

The impacts of aquatic weeds on dissolved oxygen can be complex. Water hyacinth mats tend to have lower dissolved oxygen (DO) levels than do open waters around the mats. Spongeplant is smaller than water hyacinth but has many similar characteristics. Thus, we can reasonably predict that findings for water hyacinth would apply to spongeplant. *Egeria densa*'s impact on DO levels are more complex, with higher DO levels during the day (oxygenation from photosynthesis), and lower DO levels at night and early morning (respiration). DO impacts tend to be notably significant with water hyacinth. There is also quantitative information and scientific literature more readily available for DO levels associated with water hyacinth. The following information is directly related to water hyacinth, though can broadly be applied to *Egeria densa* and spongeplant.

Dissolved Oxygen and Water Hyacinth

DO is the content of oxygen found in water. DO is determined by temperature, weather, water flow, nutrient levels, algae, and aquatic plants. Generally, a higher level of DO is beneficial to fish. Fish begin to experience oxygen stress or exhibit avoidance at levels below 5 mg/liter. Salmonids have been reported to actively avoid areas with low dissolved oxygen concentrations (Davis 1975 in Carter 2005). Fish will migrate to areas with higher DO levels. A 1990 study found that brookling trout moved away from water with DO concentrations of 1 to 1.9 mg/L within one hour, moved away from water with DO concentrations of 2 to 2.9 mg/L within one to two hours, and moved away more slowly from water with concentrations of 3 to 3.9 mg/L (Carter 2005). Juvenile Chinook salmon avoided DO concentrations of 1.5, 3.0, and 4.5 mg/L (Carter 2005). Salmonids are also likely to avoid water hyacinth mats in slow-moving waters and shorelines. In a fish migration study in Washington State, juvenile coho salmon, steelhead, and cutthroat trout were all found to use the faster-moving and deeper water sections of the waterway (Zydlewski et al. 2002).

Exhibit 1.



DO levels drop in warmer temperatures, and increase with precipitation, wind, and water flow. Running water, such as the tidal water in the Delta, dissolves more oxygen than still water. Diurnal tidal movement also mixes lower DO water that might be present under a growing or decaying water hyacinth mat with incoming, higher DO, water. High levels of nutrients in water reduce DO levels, while algae and aquatic plants can increase DO through photosynthesis, but decrease DO through respiration and decomposition. DO levels fluctuate throughout the day, and are typically lowest in the morning and peak in the afternoon. In deep, still waters, DO levels are lower in the hypolimnion (bottom layer of water) because there is little opportunity for oxygen replenishment from the atmosphere. As illustrated in **Exhibit 1,** above, DO levels measured at various locations in the Delta averaged between 8 and 9.8 mg/L.

Treatment of aquatic weeds with certain herbicides can result in a faster than natural decaying of plant biomass that may create a large biological oxygen demand, resulting in decreases in dissolved oxygen. DBW recognizes that decaying water hyacinth has the potential to temporarily reduce DO levels. The problem of low DO following herbicide treatment of water hyacinth is a concern when the herbicide is relatively fast-acting, such as 2,4-D, imazapyr, and to a lesser extent glyphosate. The labels for these three herbicides include recommendations to reduce the potential for DO impacts. Diquat is also relatively fast-acting (which may be used for *Egeria densa* and spongeplant treatments), and its label also includes recommendations to reduce potential for DO impacts.

The low DO following herbicide treatment may be amplified by the fact that DO levels under large water hyacinth mats can already be low. DBW conducts DO monitoring, as described in this document, to evaluate DO impacts following treatment. A further uncertainty as to the extent of potential low DO impacts on fish is that few native fish are found in water hyacinth mats (Hanni 2005). **Table 1,** on the following page, summarizes the herbicide label requirements regarding dissolved oxygen effects and timing of follow-up treatments, should they be required. Note that the follow-up treatment timing refers to treating previously treated plants a second (or more) time, <u>not</u> treating previously untreated plants in the same site. These requirements help to avoid negative impacts to fish resulting from decaying weeds.

Table 1
Summary of Herbicide Label Requirements Related to Dissolved Oxygen and Repeat Treatments (Current as of April 2014)

Herbicide	Aquatic Weed Program	Dissolved Oxygen Requirements	Number of Treatments	Time Between Treatments
2,4-D	WHCP, SCP	It may be appropriate to treat only part of the infestation at one time. For example, apply the product in lanes separated by untreated strips that can be treated after the vegetation in treated lanes has disintegrated (2-3 weeks in growing season). Begin treatment along the shore and move outward in bands to allow fish to move into untreated areas.	Two applications per season	21 days between applications
Glyphosate	WHCP, SCP	When infestations require treatment of the total surface area of impounded water*, treating the area in strips may avoid oxygen depletion due to decaying vegetation.	May require retreatment	24 hours between applications
Penoxsulam	WHCP, EDCP, SCP	None	Not specified	Not specified
Imazamox	WHCP, EDCP, SCP	None	Up to 4 applications per season at 32 ounces per acre application rate	Not specified
Fluridone	EDCP	None	Not specified	Not specified
Diquat	EDCP, SCP	Treat no more than one-third to one-half of a water body at one time, waiting 14 days for follow-up treatment of the remaining area. Do not initiate treatment if measured DO levels are between 3.0 mg/L and 5.0 mg/L.	Not specified	14 days between treatments

* The WHCP, EDCP and SCP project areas encompass tidal and riverine waters, not impounded waters.

Existing DO levels in large water hyacinth mats are often already low, particularly in slower-moving waters and dead-end sloughs. Thus, with adequate avoidance measures, further decreases in dissolved oxygen that would impede fish passage can be avoided and/or minimized. Large patches of water hyacinth can cause low dissolved oxygen levels (Toft 2000). Data summarized below indicate that DO levels under water hyacinth mats are lower than DO levels elsewhere in the Delta. Toft found average spot DO measurements below 5 mg/L for water hyacinth and above 5 mg/L for pennywort (Toft 2000). In a similar study of DO in aquatic weeds in Texas, water hyacinth was found to have the lowest DO levels as compared to milfoil, hydrilla, pondweed, and a mix of native species, and was the only plant to have DO levels below 5 mg/L (Madsen 1997 in Toft).

Research in the Delta conducted by USDA-ARS measured DO levels every half-hour under a large mat of water hyacinth that completely covered a 15-meter wide slough on the Cosumnes River Nature Preserve. The slough was subject to tidal flows. Over a four-day period in June 1996, DO levels each day ranged from 0 mg/L to just over 5 mg/L. Only about 5 of 200 data points measured under the mat were above 5 mg/L, and the vast majority of the data points were between 2 mg/L to

4 mg/L (Spencer 2001). The results of the DO testing are shown in **Exhibit 2,** starting on the following page. These data indicate that large infestations of water hyacinth across waterways, such as those that have occurred on the Merced and San Joaquin Rivers prior to treatment, are likely to impede the passage of fish.

Results of WHCP Dissolved Oxygen Monitoring

DBW and USDA-ARS track two sets of DO monitoring. At every herbicide application, treatment crews take DO samples immediately prior to treating, and approximately one-hour post-treatment. These levels would be expected to be similar, as they occur a few hours apart and the potential for lowering DO due to decaying water hyacinth would not occur immediately post-treatment. Data from Daily Treatment Logs support that there is no significant impact on DO immediately post-treatment. Of 719 treatments occurring between 2007 and 2011, there were 13 cases with no change in DO, 404 cases with an increase in DO (average increase of 0.8 mg/L), and 302 cases with an average decrease in DO (average decrease of 0.6 mg/L). The average pre-treatment DO was 7.9 mg/L, and the average post-treatment DO was 8.1 mg/L. The minimum allowable DO in most of the WHCP program area is 5.0 mg/L. Both pre- and post-treatment levels are well above the 5.0 mg/L considered safe for fish.

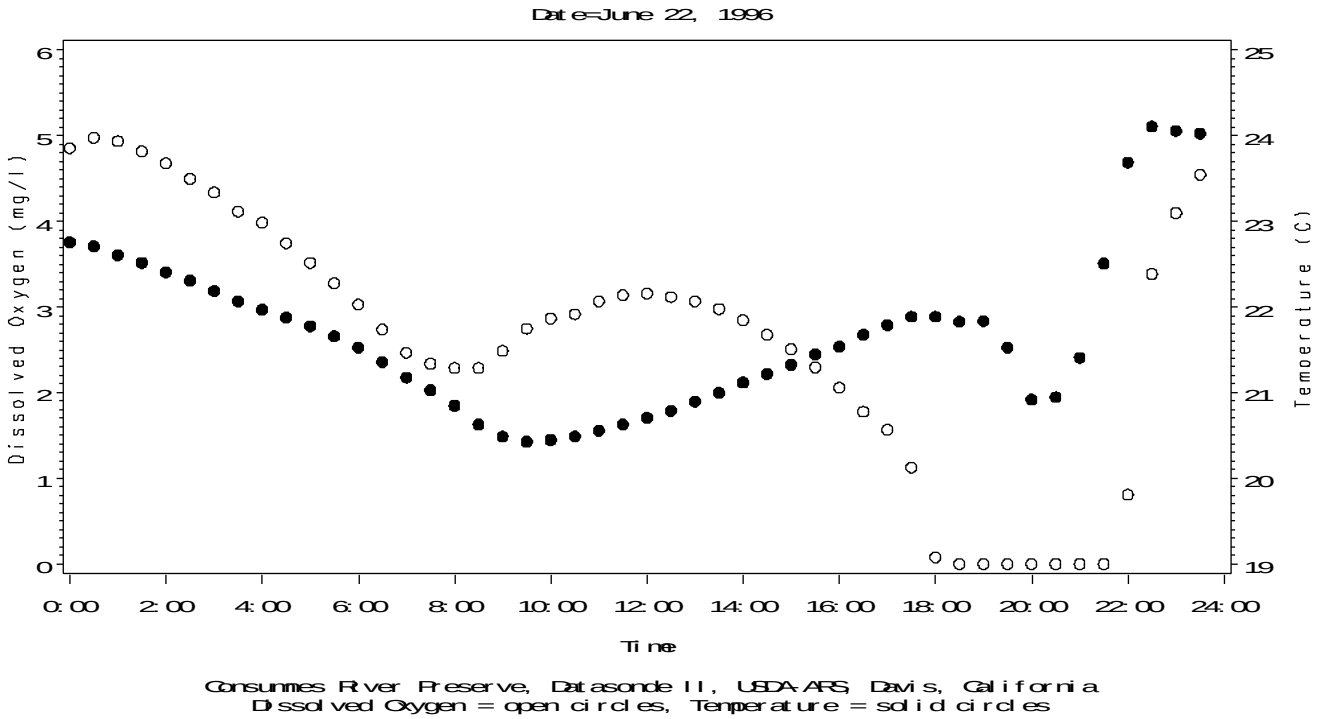
The DO monitoring that occurs with follow-up water quality sampling would be more likely to show potential decreases in DO, as post-treatment sampling occurs several days after treatment, when plant death symptoms are starting to occur. However, representative DO monitoring data from 2011 shows that herbicide treatments do not significantly impact DO. The data in **Table 2**, on page 9, provide 2011 treatment and post-treatment DO levels taken at the time of water quality sampling, on the day of treatment, and between four and seven days post-treatment. In five cases, DO levels increased. Note that the most significant increase occurred at Site 16, where existing DO was at an extremely low 2.06 mg/L prior to treatment (a level resulting in stress and avoidance for fish), and DO increased by six days post-treatment to 7.03 mg/L, a level safe for fish. In the other instance of extremely low DO prior to treatment at site 301, DO increased from 1.07 mg/L to 2.71 mg/L by five days post-treatment. In these two critical cases where DO levels prior to treatment were below levels safe for fish, DO levels improved following WHCP treatments. The average decrease in DO among the six 2011 monitoring sites with decreased DO was 0.79 mg/L, and in all cases where DO decreased, it was still well above the Basin Plan minimum of 5.0 mg/L. DBW and USDA-ARS will continue to monitor pre- and post-treatment DO levels in each of its aquatic weed programs (i.e., WHCP, EDCP and SCP).

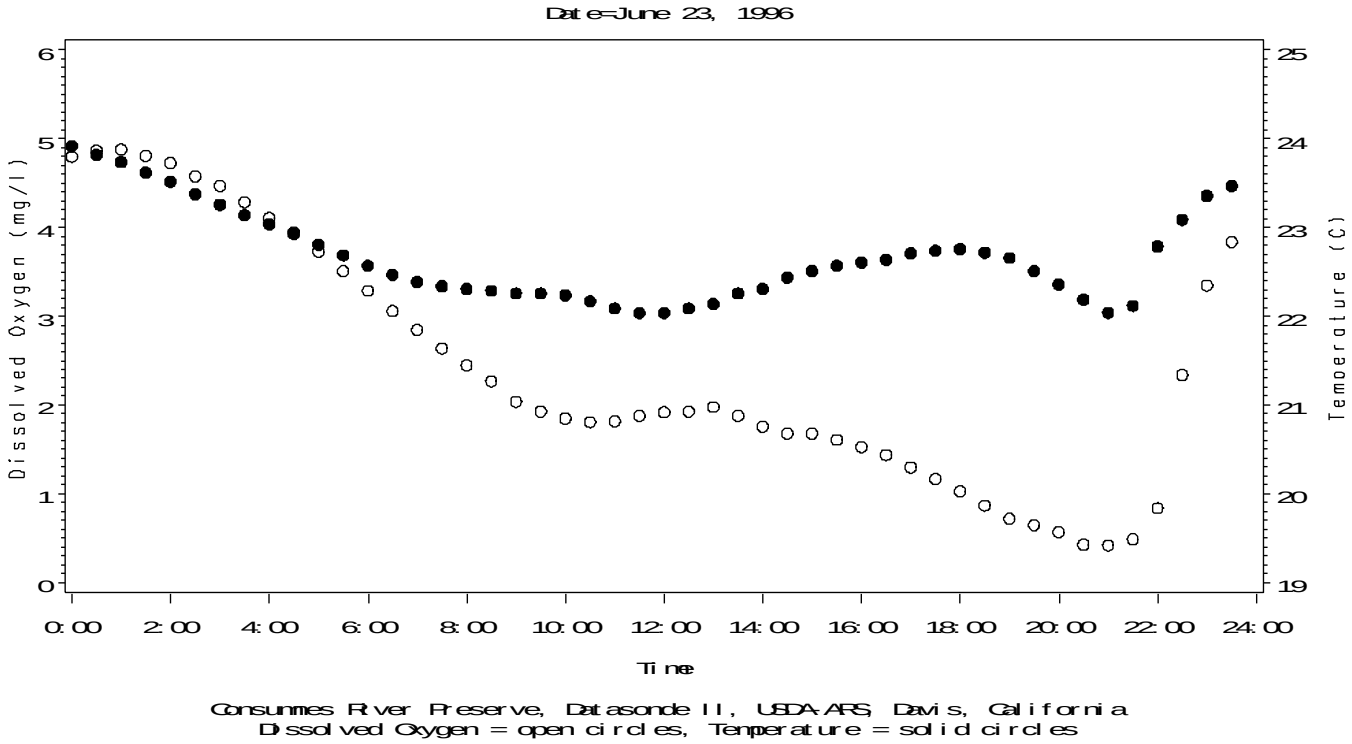
In 2013, DBW conducted a pilot study for DO monitoring to assess impacts of water hyacinth and herbicide treatments on DO. DO levels were measured continuously under a water hyacinth mat located along Middle River at Union Point. Data revealed greater fluctuations of DO underneath water hyacinth compared to adjacent open water. Within the water hyacinth, the lowest and highest DO concentrations were 1.43 mg/L and 11.76 mg/L, respectively. Whereas, DO ranged from 6.12 mg/L to 9.79 mg/L in open water. Diel changes in DO were observed, with low DO levels occurring at night or early morning and highest concentration occurring in the afternoon.

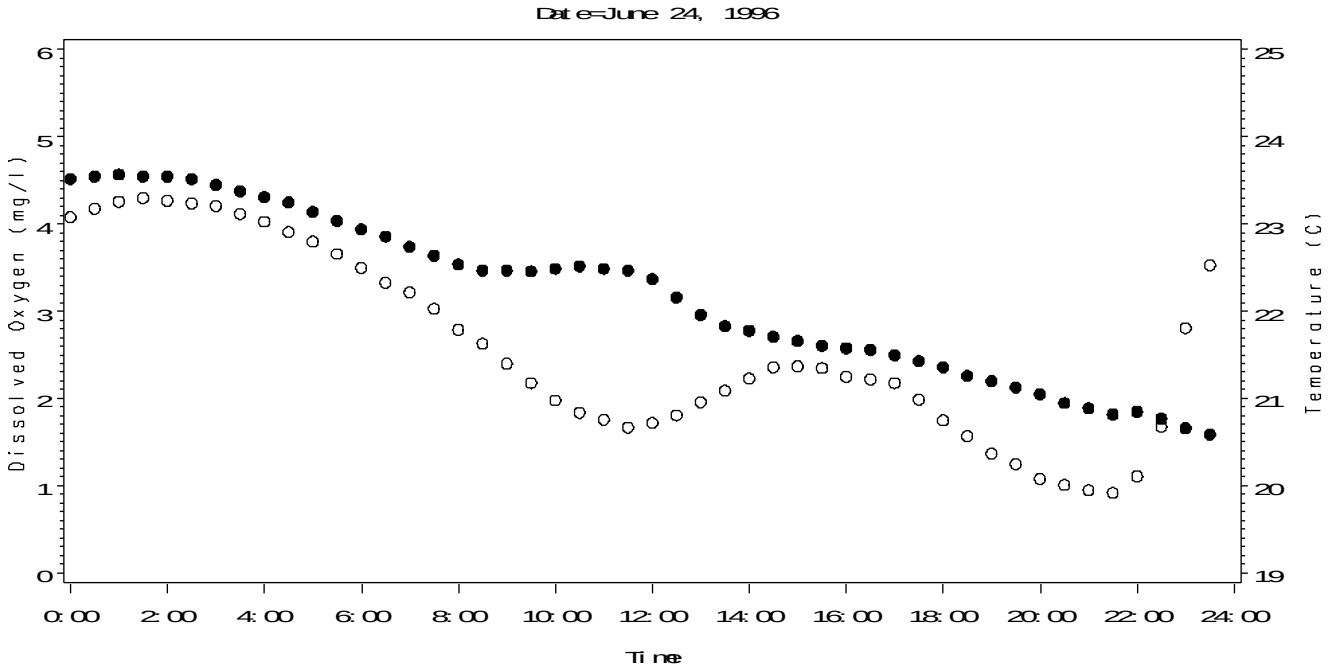
* * * * *

If reductions in dissolved oxygen do occur, these decreases in DO resulting from treatment of aquatic weeds are likely to be short-term since the Delta is a flowing, rather than a standing, water system. One of the long-term benefits of treating with herbicides is a reduction in the volume of invasive aquatic weeds in the Delta. Removing large patches of aquatic weeds will allow DO levels to increase, thus enhancing the ability of fish to move unimpeded in Delta waters. It can be argued that such a benefit outweighs the impact of potential short-term localized decreases in dissolved oxygen following treatment.

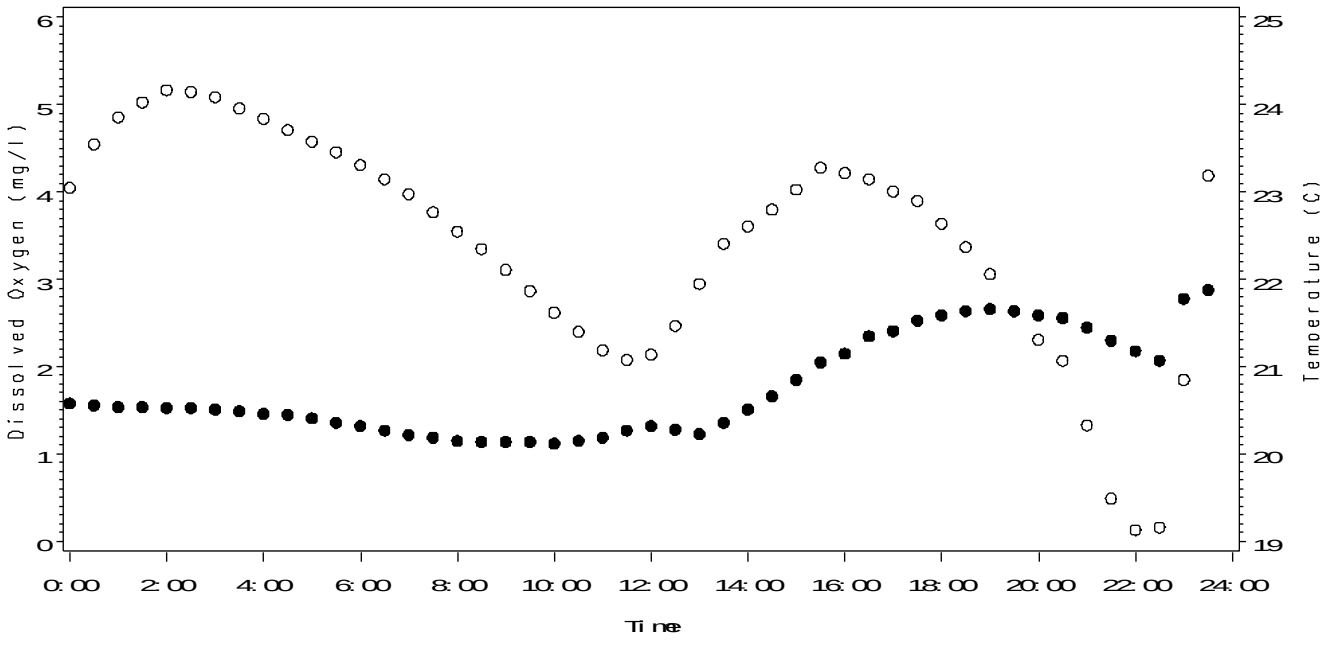
Exhibit 2. Four graphs depicting datasonde results under a dense mat of water hyacinth plants in a slough on the Cosumnes River Nature Preserve.







Consumnes River Preserve, Datasonde II, USDA-ARS, Davis, California
Dissolved Oxygen = open circles, Temperature = solid circles



Consumnes River Preserve, Datasonde II, USDA-ARS, Davis, California
Dissolved Oxygen = open circles, Temperature = solid circles

Table 2
Comparison of Treatment and Post-Treatment Dissolved Oxygen Levels (in mg/L) (2011)

Site	Days Post Treatment	Treatment DO	Post-Treat DO	Difference (Post-Treatment)
2,4-D Treatments				
13	6	7.18	7.09	(0.09)
14	5	8.46	7.23	(1.23)
15	6	7.74	7.73	(0.01)
16*	6	2.06	7.03	4.97
58	6	7.06	7.15	0.09
59	4	6.92	6.98	0.06
68	6	7.86	7.97	0.11
Glyphosate Treatments				
216	7	9.80	8.40	(1.40)
217	7	7.70	6.18	(1.52)
300	5	8.50	8.00	(0.50)
301*	5	1.07	2.71	1.64
			Average increase for five increased DO sites:	1.37
			Average decrease for six decreased DO sites:	(0.79)

* Highlighted rows had DO levels harmful to fish prior to WHCP treatments.

Fish Passage Protocol

There is very little quantitative information and/or scientific literature upon which to base treatment acreage limitations for a fish passage protocol, and even less information specific to the Delta environment. The previous 3 acre limitation was originally put forward by a member of the Water Hyacinth Task Force in the early 1980s as a precautionary limit to address potential for reductions in water quality beneficial uses. At the time the 3 acres was proposed, water hyacinth treatments started earlier in the season, before mats grew to the large acreage (sometimes over 50 acres) that can occur in today's Delta environment. Based on data summarized in this document, these large mats likely have a greater detrimental impact on dissolved oxygen than herbicide treatments.

The protocol below is based on combined recommendations of an aquatic weed expert, an herbicide company representative, the Pacific Northwest Weed Management Handbook, Washington State NPDES requirements, herbicide label requirements, Delta water conditions, prior dissolved oxygen monitoring data, the prior 3 acre limit, and literature on salmonid migration. The intent is to provide a fish passage protocol with numerical treatment limits that provide conservative fish protection, reflect actual Delta conditions, take into account the variability in treatment site size (6.5 acres to 1,707 acres) and consider field operation constraints. DBW will follow this protocol for all water hyacinth treatments, all spongeplant treatments, and only *Egeria densa* treatments using diquat.

1. In slow-moving and back-end sloughs with aquatic weed infestations, DBW will treat up to 30 percent of the mat at one time. Mats will be treated in up to 3 acre strips, leaving at least 100 foot buffer strips between treated areas. The untreated buffer strips and remaining

70 percent of the mat will be treated at least three more times following the initial treatment (in 30 percent increments). These follow-up treatments will take place at three week intervals.

2. In Delta tidal waters, DBW will treat up to 50 percent of the mat at one time. Mats will be treated in up to 3 acre strips, leaving at least 100 foot buffer strips between treated areas. The untreated buffer strips and remaining 50 percent of the mat will be treated three weeks following the initial treatment for 2,4-D treatments, 14 days for following initial treatment for diquat, and one week following initial treatment for other herbicides.
3. If DO levels in an area to be treated are at a level considered to be detrimental to fish species prior to treatment (below 3 mg/liter), DBW may treat the entire area (without the 3 acre strips or buffer strips), therefore allowing the DO levels to increase to beneficial use levels once the aquatic weed is controlled.
4. For each treatment site and herbicide application, DBW staff shall follow herbicide label requirements, as specified, to reduce the potential for low dissolved oxygen. Current requirements for DBW's aquatic weed program herbicides are provided in Table 1.
5. When follow-up herbicide applications of previously treated plants are required, DBW staff shall follow herbicide label requirements, as specified, regarding the number of treatments and time between treatments.

On the following page, and in **Exhibit 3,** starting on page 13, we provide examples of the fish passage protocol in regards to water hyacinth. The large numerals in Exhibit 3 refer to the treatment number.

20 acre water hyacinth mat in a dead end slough site:

Treatment 1: 30% = 6 acres
Protocol – spray two strips of 3 acres each with 100 feet between strips

Treatment 2: 30% = 6 acres
Protocol – spray two strips of just under 3 acres each with 100 feet between strips, plus the previously untreated strip

Treatment 3: 30% = 6 acres
Protocol – spray two strips of just under 3 acres each with 100 feet between strips, plus the previously untreated strip

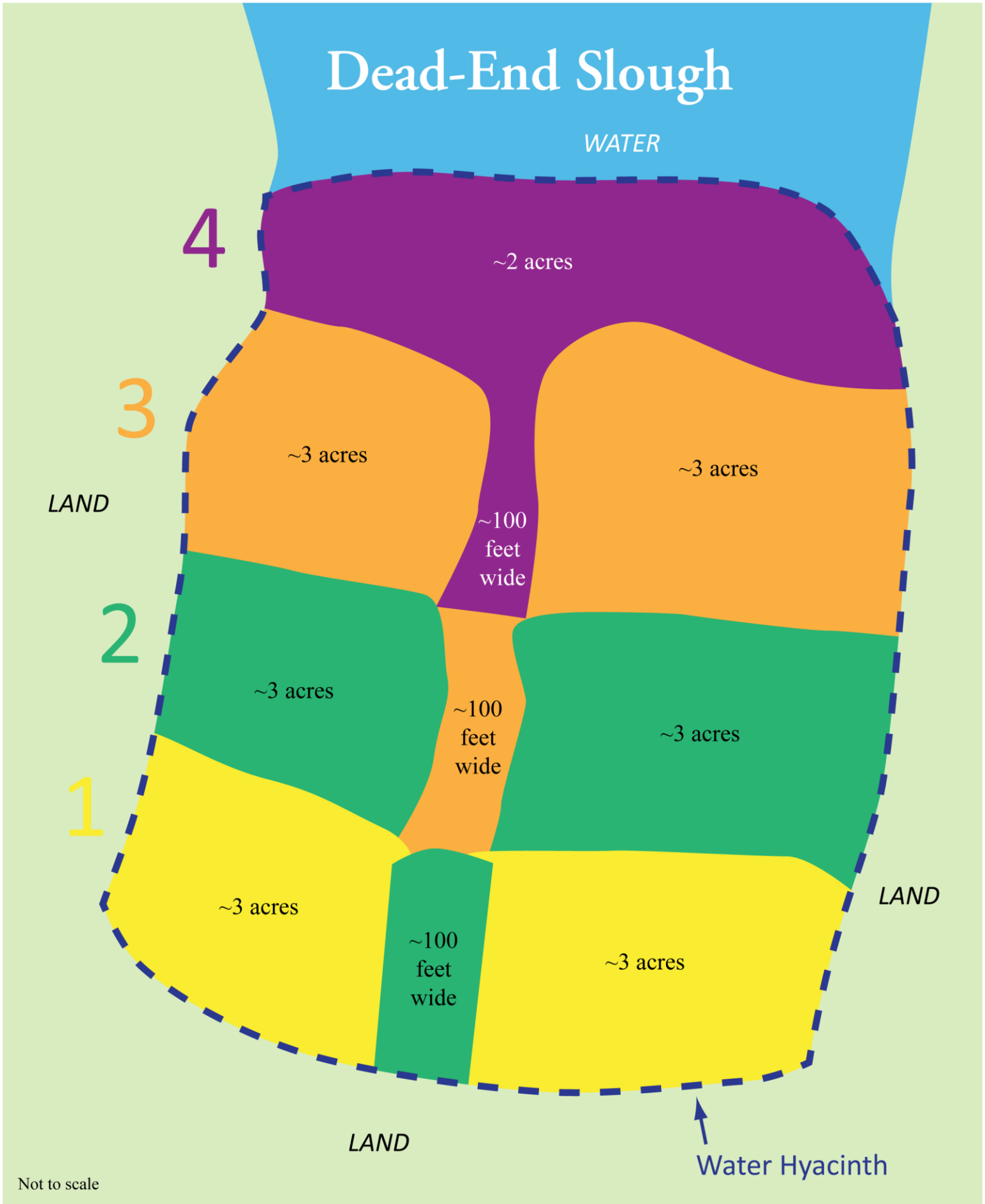
Treatment 4: 10% = 2+ acres
Protocol – spray the remaining 2+ acres, plus the previously untreated strip.

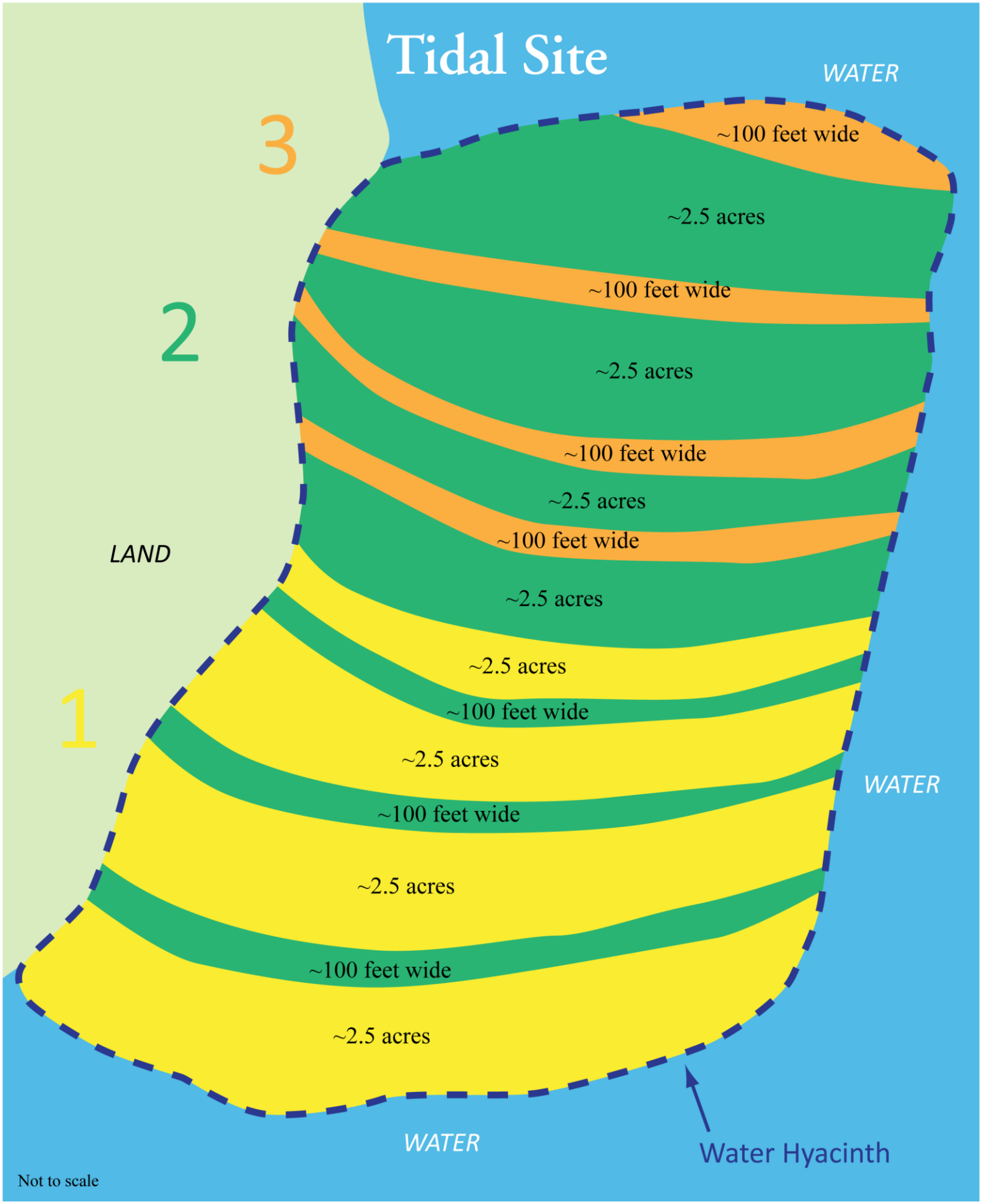
20 acre water hyacinth mat in a tidal site:

Treatment 1: 50% = 10 acres
Protocol – spray three strips of 3 acres plus one strip of 1 acre with 100 feet between strips, or treat four 4 strips of 2.5 acres with 100 feet between strips

Treatment 2: 50% = 10 acres
Protocol – spray three strips of just under 3 acres plus one strip of 1 acre with 100 feet between strips, or treat four 4 strips of just under 2.5 acres with 100 feet between strips, plus previously untreated strips

Treatment 3: untreated strips
Protocol – spray remaining untreated strips from Treatment 2.


Dead-End Slough
WATER
4
~2 acres
3
~3 acres
~3 acres
LAND
~100 feet wide
2
~3 acres
~100 feet wide
~3 acres
1
~3 acres
~100 feet wide
~3 acres
LAND
LAND
Water Hyacinth
Not to scale


Tidal Site
WATER
3
~100 feet wide
~2.5 acres
2
~100 feet wide
~2.5 acres
~100 feet wide
~2.5 acres
LAND
~100 feet wide
~2.5 acres
~2.5 acres
1
~100 feet wide
~2.5 acres
WATER
~100 feet wide
~2.5 acres
~100 feet wide
~2.5 acres
WATER
Water Hyacinth
Not to scale

References

Akers, Patrick. 2010. *"A New Invader: South American Spongeplant: Worse Than Water Hyacinth?"*

Akers, Patrick. 2010. *Pest Profile: South American spongeplant*. California Department of Food and Agriculture. Sacramento, Ca. 5pp.

Anderson, Lars. W.J.. 2012. United States Department of Agriculture, Agricultural Research Service and University of California Davis Exotic and Invasive Weed Research Unit (retired). Personal Communication, October 11, 2012.

Carter, Katherine. 2005. *The effects of dissolved oxygen on steelhead trout, coho salmon, and Chinook salmon biology and function by life stage*. California Regional Water Quality Control Board, North Coast Region

Cohen, A.N., and J.T. Carlton. 1995. *Nonindigenous aquatic species in a United States estuary: A case study of the biological invasions of the San Francisco Bay and Delta*. Prepared for the United States Fish and Wildlife Service, Washington D.C. and the National Sea Grant College Program Connecticut Sea Grant. 218pp.

Cook, Christopher D.K. and Katharina Urmi-König. 1983. *"A Revision of the Genus Limnobium including Hydromystria (Hydrocharitaceae)"*. Aquatic Botany. 17:1-27.

DBW. 2001. Egeria densa *Control Program Volume III: Response to Comments*. Sacramento: California Department of Boating and Waterways. 90pp.

DBW. 2001. *Water Hyacinth Control Program Biological Assessment*. Sacramento: California Department of Boating and Waterways. 125pp.

Hanni, Jason. 2005. *USFWS seasonal fishery catch and a follow up investigation of fish fauna assemblages in the Sacramento-San Joaquin River Delta and Bay*. IEP Newsletter 18, no. 3 (Fall 2005): 3-8.

Jennings, Jon. 2012. Washington Department of Ecology, Water Quality. Personal Communication, October 16, 2012.

Morgan, Vanessa Howard and Kim Patten. 2012. *Section J. Aquatic Weed Control, Pacific Northwest Weed Management Handbook*. Pacific Northwest Extension Publication, Oregon State University. Corvalis, OR.

Pennington, Toni Garrett. 2007. *Seasonal changes in allocation, growth, and photosynthetic responses of the submersed macrophyte* Egeria densa *Planch*. (Hydrocharitaceae) from Oregon and California. Dissertation. Portland State University. 153 pp.

Schuler, Scott. 2012. SePRO Corporation, Aquatics Program Manager. Personal Communication, October 9, 2012.

Spencer, David. 2001 Personal communication and unpublished data. United States Department of Agriculture, Agricultural Research Service. Davis, California.

Toft, J.D. 2000. *Community effects of the non-indigenous aquatic plant water hyacinth (*Eichhornia crassipes*) in the Sacramento/San Joaquin Delta, California*. University of Washington. 86pp.

United States Environmental Protection Agency. *Dissolved oxygen and biochemical oxygen demand, in Monitoring Water Quality*. Washington D.C.: EPA Office of Water. http://www.epa.gov/owowwtr1/monitoring/volunteer/stream/vms52.html. 11pp.

Washington Department of Ecology. 2011. *Aquatic plant and algae management general permit*. NPDES and State Waste Discharge General Permit. Olympia, Washington.

Yarrow, Matthew, Victor H. Marin, Max Finlayson, Antonio tironi, Luisa E. Delgado, and Fernanda Fischer. 2009. *The ecology of* Egeria densa *Plancon (Liliopsida: Alismatales): A wetland ecosystem engineer?* Revista Chilena de Historia Natural. 82:299-313

Zydlewski, Gayle, Christiane Winter, Dee McClanahan, Jeffrey Johnson, Joseph Zydlewski, Sean Casey. 2002. *Evaluation of fish movements, migration patterns, and population abundance with streamwidth PIT tag interrogation systems*. Project No. 2001-01200, 72 electronic pages, (Bonneville Power Administration Report DOE/BP-00005464-1.