Spongeplant Control Program

FINAL

Programmatic Environmental Impact Report

July 23, 2014

A program for effective control of Spongeplant in the Sacramento-San Joaquin Delta and its tributaries.

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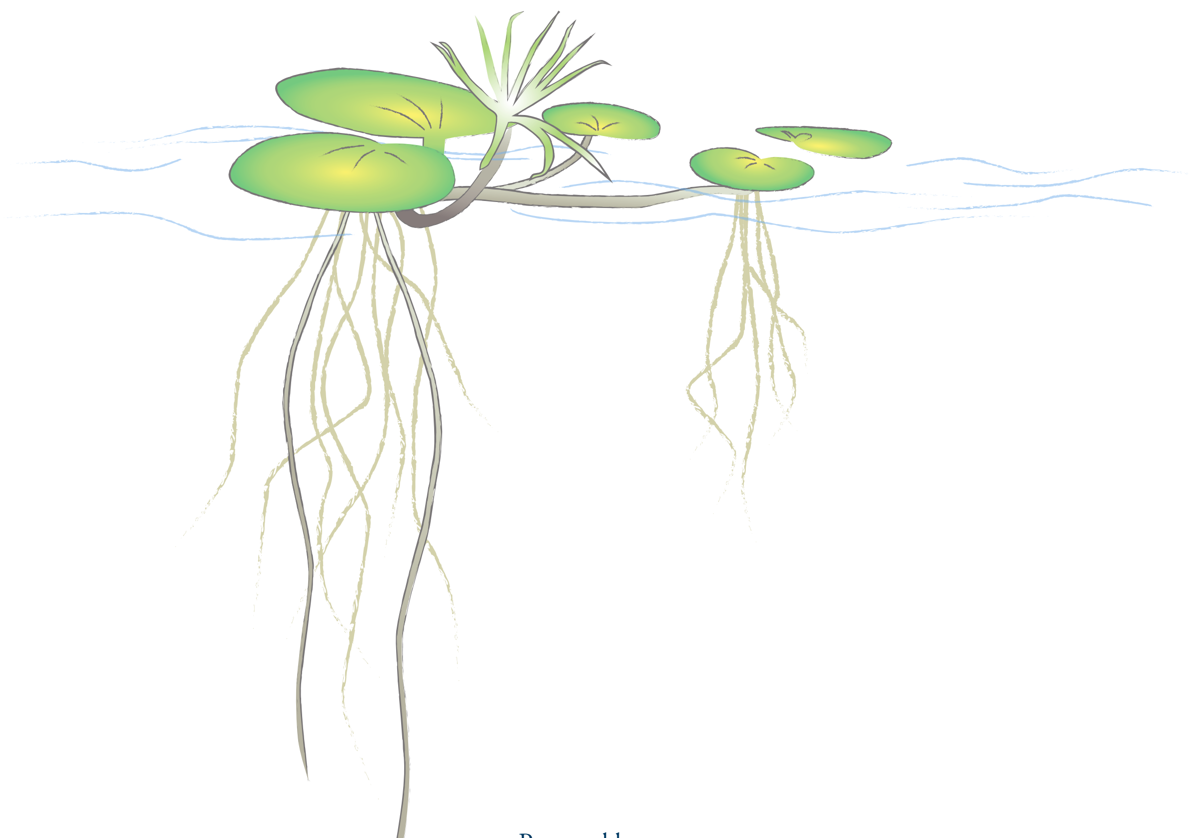

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Spongeplant

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Acronyms and Abbreviations

Acronyms and Abbreviations

1. **2,4-D** – 2,4-dichlorophenoxyacetic acid
2. **2,4,5-T** – 2,4,5-trichlorophenoxyacetic acid
3. **ADI** – Acceptable Daily Intake
4. **a.i.** – Active Ingredient
5. **AGR** – Agricultural Supply (Basin Plan beneficial use)
6. **AHS** – Agricultural Health Study
7. **ALS** – Amyotrophic Lateral Sclerosis or Acetolactate Synthase
8. **AMPA** – Aminomethylphosphonic Acid
9. **APMP** – Aquatic Pesticide Monitoring Program
10. **Bay-Delta Estuary** – San Francisco Bay and Sacramento-San Joaquin Delta
11. **BA** – Biological Assessment
12. **BCF** – Bioconcentration Factor
13. **BDCP** – Bay Delta Conservation Plan
14. **BMP** – Best Management Practices
15. **BO or BiOp** – Biological Opinion
16. **BSMT** – Bay Study Midwater Trawl
17. **BSOT** – Bay Study Otter Trawl
18. **C** – Centigrade/Celsius
19. **CAC** – County Agricultural Commissioner
20. **CALFED** – California-Federal Bay Delta Program
21. **CCF** – Clifton Court Forebay
22. **CCWD** – Contra Costa Water District
23. **CDFA** – California Department of Food and Agriculture
24. **CDFG** – California Department of Fish and Game
25. **CDFW** – California Department of Fish and Wildlife (formerly CDFG)
26. **CE** – California Endangered
27. **CEC** – Contaminants of Emerging Concern
28. **CEQA** – California Environmental Quality Act
29. **CESA** – California Endangered Species Act
30. **cfs** – Cubic Feet Per Second
31. **CI** – Confidence Interval
32. **COA** – Coordinated Operations Agreement
33. **COMM** – Commercial Sport Fishing (Basin Plan beneficial use)
34. **COLD** – Cold Freshwater Habitat (Basin Plan beneficial use)
35. **CNDDB** – California Natural Diversity Database

Acronyms and Abbreviations *(continued)*

36. **CNPS** – California Native Plant Society
37. **CR** – California Rare
38. **CRR** – Cohort Replacement Rate
39. **CSC** – California Species of Special Concern
40. **CT** – California Threatened
41. **CVP** – Central Valley Project
42. **CVRWQB** – Central Valley Regional Water Quality Control Board
43. **CVTRT** – Central Valley Technical Review Team
44. **CWA** – Clean Water Act
45. **CWT** – Coded-Wire Tag
46. **dBA** – Decibels
47. **DBW** – Division of Boating and Waterways (formerly Department of Boating and Waterways)
48. **DCC** – Delta Cross Channel
49. **Delta** – Sacramento-San Joaquin Delta
50. **DMA** – Dimethylamine Salt
51. **DO** – Dissolved Oxygen (measured in mg/L or ppm)
52. **DOC** – California Department of Conservation
53. **DPR** – California Department of Pesticide Regulation (also CDPR)
54. **DPS** – Distinct Population Segment
55. **DRERIP** – Delta Regional Ecosystem Restoration Implementation Plan
56. **DWSP** – Delta Water Supply Project
57. **DWR** – California Department of Water Resources
58. **E:I** – Export to Import
59. **EA** – Environmental Assessment
60. **EC** – Effective Concentration
61. **EC50** – Effective Concentration for 50 Percent of Target
62. **EDCP** – *Egeria densa* Control Program
63. **EEC** – Exposure Estimate Concentration
64. **EFH** – Essential Fish Habitat
65. **EIR** – Environmental Impact Report
66. **EIS** – Environmental Impact Statement
67. **ERP** – Ecosystem Restoration Program
68. **ESA** – Endangered Species Act (federal)
69. **EST** – Estuarine habitat (Basin Plan beneficial use)
70. **ESU** – Evolutionary Significant Unit
71. **EWA** – Environmental Water Account
72. **FC** – Federal Candidate (for consideration of endangered or threatened status)

Acronyms and Abbreviations *(continued)*

73. **FCH** – Federal Critical Habitat
74. **FCHP** – Federal Critical Habitat for this Species Proposed
75. **FE** – Federal Endangered
76. **FETAX** – Frog Embryo Teratogenesis Assay – *Xenopus*
77. **FIFRA** – Federal Insecticide, Fungicide, and Rodenticide Act
78. **FMWT** – Fall Midwater Trawl
79. **FONSI** – Finding of No Significant Impact
80. **FRH** – Feather River Hatchery
81. **FT** – Federal Threatened
82. **GCID** – Glenn Colusa Irrigation District
83. **GGS** – Giant Garter Snake
84. **GI** – Gastrointestinal
85. **GWR** – Groundwater Recharge (Basin Plan beneficial use)
86. **HAPC** – Habitat Areas of Particular Concern
87. **HCP** – Habitat Conservation Plan
88. **HQ** – Hazard Quotient
89. **IARC** – International Agency for Registration of Carcinogens
90. **IEP** – Interagency Ecology Program
91. **IND** – Industrial Service Supply (Basin Plan beneficial use)
92. **IPM** – Integrated Pest Management
93. **JPE** – Juvenile Production Estimate
94. **JPI** – Juvenile Production Index
95. **K_{OC}** – Soil Adsorption Coefficient (normalized by organic matter)
96. **LC5** – Lethal Concentration for 5 Percent of Subjects
97. **LC10** – Lethal Concentration for 10 Percent of Subjects
98. **LC50** – Lethal Concentration for 50 Percent of Subjects
99. **LD50** – Lethal Dose or Lethal Dietary Dose for 50 Percent of Subjects
100. **LH** – Luteinizing hormone
101. **LOC** – Level of Concern
102. **LOD** – Limit of Detection
103. **LOAEC** – Lowest Observable Adverse Effect Concentration
104. **LOEC** – Lowest Observable Effect Concentration
105. **LOEL** – Lowest Observable Effect Level
106. **LSNFH** – Livingston Stone National Fish Hatchery
107. **LSZ** – Low Salinity Zone
108. **MAF** – Million Acre Feet
109. **MATC** – Maximum Acceptable Toxicant Concentration

Acronyms and Abbreviations *(continued)*

110. **MCL** – Maximum Contaminant Level
111. **MCP** – Maintenance Control Practices
112. **MCPA** – 4-chloro-2-methylphenoxyacetic acid
113. **MIGR** – Migration of Aquatic Organisms (Basin Plan beneficial use)
114. **mM** – Millimolar (a concentration of one thousandth of a mole per liter)
115. **MOE** – Margin of Error or Margin of Safety
116. **MOU** – Memorandum of Understanding
117. **MRDL** – Maximum Residual Disinfectant Level
118. **MRA** – Montane Riverine Aquatic
119. **MRDL** – Maximum Residual Disinfectant Level
120. **MSA** – Magnuson-Stevens Fishery Conservation and Management Act
121. **MSDS** – Material Safety Data Sheet
122. **MUN** – Municipal and Domestic Supply
123. **NAV** – Navigation (Basin Plan beneficial use)
124. **NBA** – North Bay Aqueduct
125. **NCCP** – Natural Community Conservation Plan
126. **ND** – Non-detectable
127. **NFPE** – Nontidal Freshwater Permanent Emergent
128. **NHL** – Non-Hodgkin Lymphoma
129. **NIH** – National Institute of Health
130. **NMFS** – National Marine Fisheries Service
131. **NOAA-Fisheries** – National Oceanic and Atmospheric Administration-Fisheries (also referred to as NMFS, National Marine Fisheries Service)
132. **NOAEC** – Non-observable Adverse Effect Concentration
133. **NOEC** – Non-observable Effect Concentration
134. **NOEL** – Non-observable Effect Level
135. **NOI** – Notice of Intent
136. **NOP** – Notice of Preparation
137. **NPDES** – National Pollution Discharge Elimination System
138. **NPE** – Nonylphenol Ethoxylates
139. **NRDC** – Natural Resources Defense Council
140. **NTU** – Nephelometric Turbidity Units
141. **OCAP** – Operations Criteria and Plan
142. **OMP** – Operations Management Plan
143. **OMR** – Old and Middle River
144. **OR** – Odds Ratio
145. **OSHA** – Occupational Safety and Health Administration

Acronyms and Abbreviations *(continued)*

146. **PAHs** – Poly aromatic Hydrocarbons
147. **PCA** – Pest Control Advisor
148. **PCE** – Primary Constituent Elements (of critical habitat)
149. **PEIR** – Program Environmental Impact Report
150. **PFMC** – Pacific Fisheries Management Council
151. **PG&E** – Pacific Gas and Electric
152. **POD** – Pelagic Organism Decline
153. **POEA** – Polyethoxylated tallowamine
154. **ppb** – Parts per Billion (µg/L or µg/kg)
155. **ppm** – Parts per Million (mg/L or mg/kg)
156. **ppt** – Parts per Thousand (g/L)
157. **PPE** – Personal Protective Equipment
158. **PRO** – Industrial Process Supply (Basin Plan beneficial use)
159. **psu** – Practical Salinity Units
160. **PUR** – Pesticide Use Report
161. **PVA** – Population Viability Analysis
162. **QAC** – Qualified Applicator Certificate
163. **QAPP** – Quality Assurance Project Plan
164. **RARE** – Rare, Threatened, or Endangered Species (Basin Plan beneficial use)
165. **RBDD** – Red Bluff Diversion Dam
166. **RCRA** – Resource Conservation and Recovery Act
167. **REC-1** – Water Contact Recreation (Basin Plan beneficial use)
168. **REC-2** – Non-water Contact Recreation (Basin Plan beneficial use)
169. **RfD** – Reference Dose
170. **RM** – River Mile
171. **ROD** – Record of Decision
172. **RPA** – Reasonable and Prudent Alternative
173. **RQ** – Risk Quotient
174. **RR** – Risk Ratio
175. **RTS** – Rotary Screw Traps
176. **RUP** – Restricted Use Permit
177. **SCP** – Spongeplant Control Program
178. **SDIP** – South Delta Improvement Program
179. **SF** – San Francisco
180. **SFA** – Seasonally Flooded Agricultural
181. **SFEI** – San Francisco Estuary Institute
182. **SHELL** – Shellfish harvesting (Basin Plan beneficial use)

Acronyms and Abbreviations *(continued)*

183. **SJ** – San Joaquin
184. **SJRRP** – San Joaquin River Restoration Program
185. **SL** – Standard Length
186. **SMR** – Standard Mortality Ratio
187. **SMUD** – Sacramento Municipal Utility District
188. **SOD** – Superoxide dismutase
189. **SPWN** – Spawning, Reproduction, and/or Early Development (Basin Plan beneficial use)
190. **STS** – Soft Tissue Sarcoma
191. **SVWMA** – Sacramento Valley Water Management Agreement
192. **SWB** – State Water Board (Water Resources Control Board)
193. **SWP** – State Water Project
194. **SWRCB** – State Water Resources Control Board
195. **TDF** – Through-Delta Facility
196. **TFE** – Tidal Freshwater Emergent
197. **THM** – Trihalomethane
198. **TL** – Total Body Length
199. **TNS** – Townet Survey
200. **TPA** – Tidal Perennial Aquatic
201. **UC** – Upland Cropland
202. **USBR** – United States Bureau of Reclamation
203. **USDA-ARS** – United States Department of Agriculture – Agricultural Research Service
204. **USFS** – United States Forest Service
205. **USFWS** – United States Fish and Wildlife Service
206. **VAMP** – Vernalis Adaptive Management Plan
207. **VFR** – Valley Foothill Riparian
208. **VRA** – Valley Riverine Aquatic
209. **WARM** – Warm Freshwater Habitat (Basin Plan beneficial use)
210. **WHCP** – Water Hyacinth Control Program
211. **WHO** – World Health Organization
212. **WILD** – Wildlife Habitat (Basin Plan beneficial use)
213. **WOE** – Weight-of-evidence
214. **WY** – Water Year
215. **X2** – The Line at which 2ppt (parts per thousand) Saline Occurs
216. **YOY** – Young of the Year.

Executive Summary

Executive Summary

A. Introduction to the PEIR

This document presents a final programmatic environmental impact report (PEIR) analyzing the potential environmental effects of the California Department of Parks and Recreation, Division of Boating and Waterways[1] (DBW), Spongeplant Control Program (SCP). This document was prepared in compliance with the California Environmental Quality Act of 1970 (CEQA) (Public Resource Code 21000 *et seq.*).

The basic purpose of CEQA is to: (1) inform governmental decision-makers and the public about the potential, significant environmental effects of proposed activities; (2) identify ways that environmental damages can be avoided or significantly reduced; (3) prevent significant avoidable damages through alternatives and mitigation measures; and (4) disclose why a project is approved if significant environmental effects are involved. The Environmental Impact Report (EIR) is a State of California public document used by governmental agencies to analyze significant environmental effects of a proposed project, to identify project alternatives, and to disclose possible ways to reduce, or avoid, possible environmental damages.

A programmatic EIR is an EIR which may be prepared on a series of actions that can be characterized as one large project, such as this SCP. DBW is the Lead Agency for purposes of this PEIR.

South American spongeplant (*Limnobium laevigatum* (Hub & Bonpl. Ex Willd.Heine)) is native to South America, Central America, and Central Mexico. Spongeplant is a floating aquatic plant that grows in dense floating mats or rooted in mud or wetland edges (Akers 2010b). It occurs from sea level to 2,800 meters (Cook and Urmi-König 1983). Spongeplant was first seen in California in a pond system in the East Bay in 1996 (Akers 2010a). This infestation was eradicated. The next identified infestations of spongeplant were found in 2003 in ponds near Arcata and Redding.

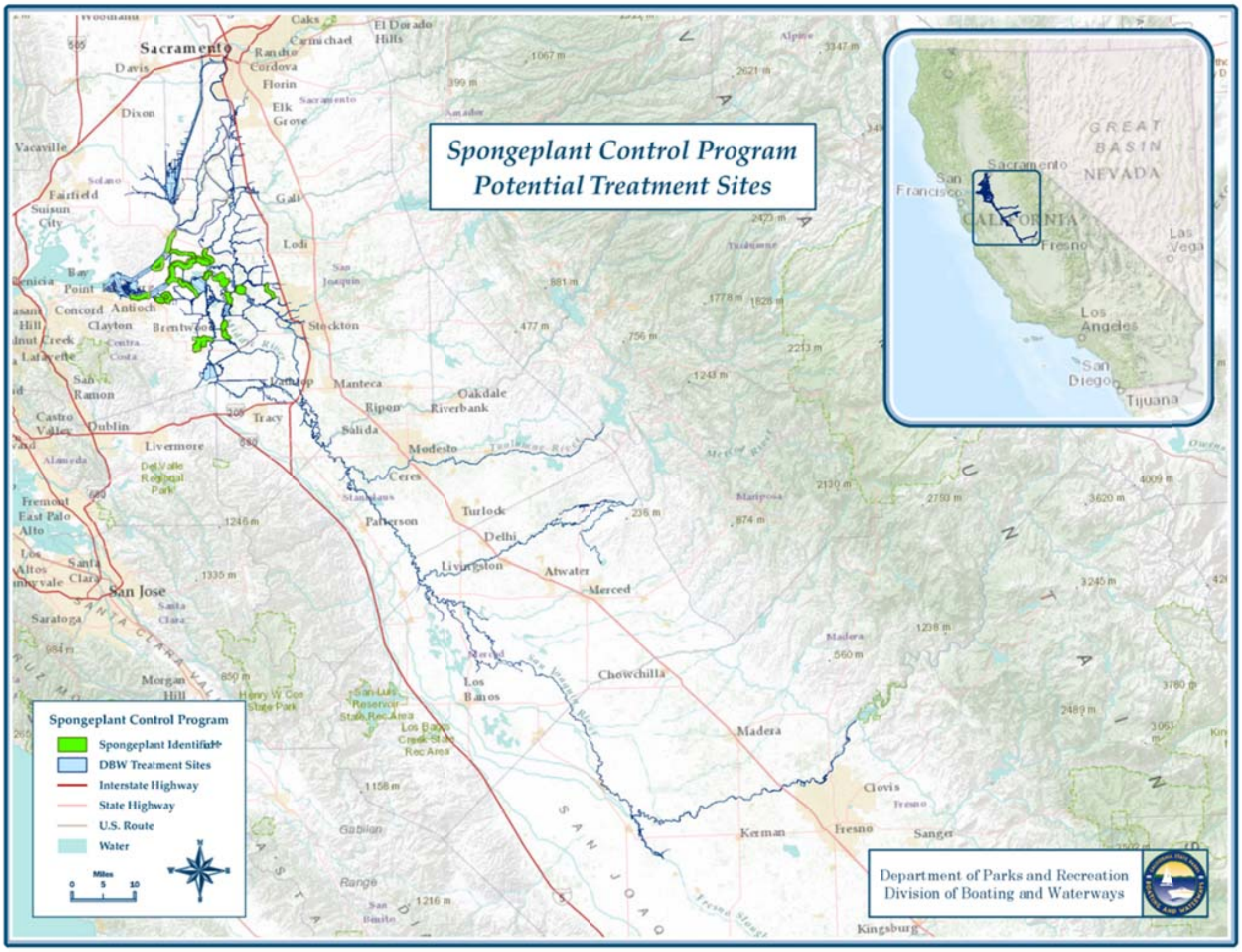
In 2007, spongeplant was identified in the Sacramento-San Joaquin Delta near Antioch. The Antioch infestation apparently was washed out of the Delta after a storm. In 2008, spongeplant was identified in irrigation canals near Fresno. In 2009 and 2010, spongeplant was found again in the Delta. In 2013, spongeplant was identified in twenty locations within the Delta. Most mats were small (no more than 30 square feet), and many were inter-mixed with other aquatic plants (native and non-native). Spongeplant is found mixed in, and under, other plants at many of the current spongeplant locations in the Delta. Spongeplant has also been seen in Riverside and Monterey counties.

In 2010, California Department of Food and Agriculture (CDFA) classified spongeplant as "A-rated (control action required), but more information needed" (Calflora 2013). In 2011, the California Invasive Plant Council (Cal-IPC) classified spongeplant as a high-alert invasive plant. The Cal-IPC assessment identified the threat from spongeplant as "severe" due to potential impacts on abiotic ecosystem processes, plant communities, higher tropic levels, and the role of anthropogenic and natural disturbance in establishment (Cal-IPC 2011). CDFA has been treating and removing spongeplant in various locations since 2005. **Figure ES-1,** on the next page, illustrates the SCP project area.

The invasion of spongeplant in California, and the Delta specifically, is relatively new. By comparison, water hyacinth was first found in the Delta in 1904. In 2012, the California Legislature passed Assembly Bill 1540 (Buchanan, Chapter 188, Statutes of 2012) to add spongeplant to the two aquatic invasive weeds (water hyacinth and *Egeria densa*) that DBW controls. DBW is designated as the lead agency to control all three species, in cooperation with federal, other state, local agencies, and districts.

[1] As of July 1, 2013, the California Department of Boating and Waterways became the Division of Boating and Waterways within the California Department of Parks and Recreation.

Figure ES-1
SCP Project Area Map



(Spongeplant locations as reported by DBW.)

The objective of the SCP is to keep waterways safe and navigable by controlling the growth and spread of spongeplant *(Limnobium laevigatum)* (referred to as spongeplant) in the Sacramento-San Joaquin Delta (Delta), its surrounding tributaries, and Suisun Marsh. Spongeplant is not yet well established in the Delta. Thus, the goals of the SCP will be to keep the spongeplant infestation at a low level and limit the spread of spongeplant in the Delta. The SCP balances potential impacts of spongeplant management while (1) minimizing non-target species impacts and (2) preventing environmental degradation in Delta waterways and tributaries.

The SCP will operate under the following three permits/guiding documents:

- National Pollution Discharge Elimination System (NPDES) Statewide General Permit (CAG990005)
- A United States Fish and Wildlife Service (USFWS) Biological Opinion (currently in the consultation process)
- A National Oceanic and Atmospheric Administration- National Marine Fisheries Service (NMFS) Letter of Concurrence (currently in the consultation process).

B. Purpose of this PEIR

With preparation of this SCP Final PEIR, DBW is seeking to complete environmental documentation for the SCP. DBW also wants to provide parity with its other aquatic weed programs, the *Egeria densa* Control Program (EDCP) and Water Hyacinth Control Program (WHCP). For the EDCP, DBW prepared an EIR in 2001, and has prepared EIR Addendums as follow-up documents. For the WHCP, DBW prepared a PEIR in 2009 and a PEIR Addendum in 2013. This programmatic Final EIR for the SCP will provide DBW with the opportunity to carefully evaluate the program within the current context of the Delta environment and its current treatment practices.

C. Project Alternatives Considered in this PEIR

CEQA requires that an EIR discuss a reasonable range of alternatives that could avoid, or substantially lessen, the significant environmental impacts of the proposed program, even if the alternatives might impede to some degree attainment of program objectives, or the alternatives would be more costly. An EIR must also evaluate the impacts of the “No Program Alternative” to allow decision makers to compare impacts of approving the proposed program with impacts of not approving the proposed program.

DBW considered six program alternatives: (1) Integrated Management (the selected alternative); (2) Chemical Control Only; (3) Hand Removal with Nets Only; (4) Herding Only; (5) Mechanical Removal Only; and (6) No Program Alternative. In over thirty years of operating the WHCP, which is similar to the SCP, DBW has examined and tested a broad range of potential control methods. Based on an adaptive management approach, the SCP will continuously evolve to incorporate new information and experience. The selected SCP alternative reflects DBW’s aquatic weed control program experience, and provides flexibility to continue to adapt the SCP over time, as DBW gains more experience with this new aquatic invasive species.

D. SCP Overview

DBW utilizes treatment protocols that balance the need to control spongeplant with the need to minimize resulting environmental impacts to Delta waterways. The selected program alternative consists of an integrated approach.

The SCP is a new aquatic weed control program for a new invasive species. As of May 2014, the extent of the spongeplant invasion is small. In any given treatment season, the scope of the treatment approaches, and resulting impacts, will be scaled to the level of invasion. At the current low levels of spongeplant invasion, the SCP approach consists of spot treatments with herbicides and hand removal with pool-skimmer nets. Only if spongeplant spreads extensively in the future will DBW utilize herding and/or mechanical removal methods. DBW is incorporating all potential treatment approaches into the proposed action because this PEIR covers future program years, and there is the potential for the extent of spongeplant in the Delta to increase significantly over time.

DBW is seeking approval for the use of five different herbicides for the SCP. Approval of five herbicides will provide flexibility in targeting this new invasive species and allow DBW to identify herbicide(s) that will effectively treat the plant while minimizing the potential for negative environmental effects. All of the five herbicide active ingredients have been approved for the WHCP and/or EDCP: 2,4-D, glyphosate, imazamox, penoxsulam, and diquat. All five herbicides have been proven effective in treatment spongeplant, or the closely related species, American frogbit *(Limnobium spongia).* All herbicides will be used with an adjuvant surfactant, Agridex® or Competitor®, to increase adhesion to spongeplant leaves.

DBW will utilize the same two-person crews that conduct WHCP and EDCP treatments to treat spongeplant. Treatment start dates will follow a similar survey-based approach as the WHCP. Treatment crews will begin surveying for growing spongeplant in the Spring, focusing on those areas where spongeplant was seen in the prior year. When crews identify locations with greening spongeplant, they will report these areas to DBW Environmental Scientists.

DBW will report these locations to USFWS and NMFS, and consult fish surveys to determine whether listed fish species are present. If listed fish species are not present, and USFWS and NMFS concur, treatments will immediately start in these specific approved treatment sites. Based on this approach, spongeplant treatments will begin in the Spring, and continue through November 30th of each year.

DBW has divided the SCP region into approximately 418 treatment sites that average between one and two miles in length. Sites may be treated multiple times during a treatment season. Treatment sites will be prioritized so that nursery areas, and areas with public, agricultural, or industrial impacts are treated first. Logistical factors such as wind, travel time, and weather will be taken into account when selecting treatment times and locations.

The SCP will follow DBW's combined WHCP/SCP Operations Management Plan procedures that specify a pre-application planning protocol; an application/monitoring coordination protocol; "Best Management Practices" for handling herbicides; spray equipment maintenance and calibration; and an herbicide spill contingency plan. The Operations Management Plan also specifies requirements related to: (1) avoiding threatened or endangered species; (2) conducting habitat evaluations; (3) dissolved oxygen measurement; (4) fish passage protocols; and (5) other requirements.

In addition to chemical treatments, the SCP will utilize hand removal with nets (pool skimmer nets), herding, and mechanical harvesting. Use of small nets will be a primary removal method for spongeplant, particularly infestations growing under and within native plants. Use of mechanical harvesting and herding will only take place if, and when, spongeplant infestations reach a level that would warrant these approaches. In this case, DBW 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, DBW, and their partners will evaluate the use of biological controls to reduce the spread of spongeplant in the future.

Based on NPDES permit requirements, DBW follows an Annual Environmental Monitoring Protocol specified in the Aquatic Pesticide Application Plan (APAP). DBW recently updated the WHCP APAP, and incorporated spongeplant monitoring procedures into the new document. This protocol fulfills the monitoring requirements of the Regional Water Quality Control Board, NMFS, and USFWS. At each monitoring site, water samples are taken immediately pre-application (adjacent to the spongeplant). DBW also takes follow-up water samples at least two times following treatment.

E. SCP Environmental Impacts and Mitigation Measures

Exhibit ES-1, starting on page ES-6, provides the SCP Environmental Checklist for the 18 (I to XVIII) broad EIR impact categories. This table follows the general format provided in CEQA Guidelines, Appendix G. There are five (5) resource areas with avoidable, potentially avoidable, or unavoidable significant impacts. Exhibit ES-1 also identifies eight (8) resource areas for which the SCP has beneficial impacts. Finally, Exhibit ES-1 identifies Mandatory Findings of Significance. In two areas, the SCP has unavoidable, or potentially unavoidable significant impacts: (1) potential to degrade the environment, and (2) cumulative impacts.

Within this PEIR, the DBW has identified 21 mitigation measures to reduce environmental impacts of the SCP. Many of these mitigation measures apply to more than one impact. **Exhibit ES-2,** on starting page ES-14, provides each mitigation measure, and identifies the associated SCP potential impact areas the measures seek to reduce.

Exhibit ES-3, starting on page ES-20, provides a summary of proposed SCP impacts, significance levels before mitigation, associated mitigation measures, and significance levels after mitigation. Exhibit ES-3 identifies two specific agricultural resource impacts; eight specific biological resource impacts; three specific hazards and hazardous materials impacts; six specific hydrology and water quality impacts; and one specific utilities and service systems impact.

The CEQA Guidelines, Section 15142, state that EIR's shall focus on the significant effects on the environment. Section 15128 states that the EIR shall briefly indicate reasons that various possible effects of a project were determined not to be significant.

Furthermore, Section 15150 discusses incorporation by reference from another public document in cases where descriptions and/or analyses are duplicative. The SCP Final PEIR makes use of these guidelines to address eleven environmental factor categories. These eleven resource categories are addressed in detail in the *Egeria densa* Control Program Final EIR, prepared by the DBW in 2001. Exhibit ES-4 also summarizes the reasons for DBW's determination that greenhouse gas emission impacts will be less than significant, or have no impact.

Exhibit ES-1 summarizes 18 environmental factor areas, plus mandatory findings of significance. Exhibit ES-3 summarizes potential impacts in the five environmental factor areas with any potential for significant impacts. **Exhibit ES-4,** starting on page ES-25, summarizes 12 environmental factor areas that DBW determined will not be significantly affected by the SCP. Exhibit ES-4 also summarizes growth inducing impacts, stating that the SCP will not result in any growth inducing impacts.

Exhibit ES-1
SCP Environmental Checklist

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ENVIRONMENTAL FACTORS POTENTIALLY AFFECTED BY THE SCP

The environmental factors checked below would be potentially affected by this project, involving at least one impact that is a "Significant Impact" (either "unavoidable", "potentially unavoidable", or "avoidable") as indicated by the checklist on the following pages.

[ ] Aesthetics I	[X] Agricultural Resources II	[ ] Air Quality III
[X] Biological Resources IV	[ ] Cultural Resources V	[ ] Geology/Soils VI
[ ] Greenhouse Gas Emissions VII	[ ] Hazards & Hazardous Materials VIII	[X] Hydrology/Water Quality IX
[ ] Land Use/Planning X	[ ] Mineral Resources XI	[ ] Noise XII
[ ] Population/Housing XIII	[ ] Public Services XIV	[ ] Recreation XV
[ ] Transportation/Traffic XVI	[X] Utilities/Service Systems XVII	[X] Mandatory Findings of Significance XVIII

Environmental Factors	Mitigation Measures	Unavoidable or Potentially Unavoidable Significant Impact	Avoidable Significant Impact	Less than Significant Impact	No Impact	Beneficial Impact
I. AESTHETICS — Would the project:						
a) Have a substantial adverse effect on a scenic vista?		[ ]	[ ]	[ ]	[X]	[ ]
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?		[ ]	[ ]	[ ]	[X]	[ ]
c) Substantially degrade the existing visual character or quality of the site and its surroundings?		[ ]	[ ]	[ ]	[X]	[X]
d) Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area?		[ ]	[ ]	[ ]	[X]	[ ]
II. AGRICULTURAL RESOURCES — In determining whether impacts to agricultural resources are significant environmental effects, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model (1997) prepared by the California Department of Conservation as an optional model to use in assessing impacts on agriculture and farmland. In determining whether impacts to forest resources, including timberland, are significant environmental effects, lead agencies may refer to information compiled by the California Department of Forestry and Fire Protection regarding the state's inventory of forest land, including the Forest and Range Assessment Project and the Forest Legacy Assessment project; and forest carbon measurement methodology provided in Forest Protocols adopted by the California Air Resources Board. Would the project:						
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?		[ ]	[ ]	[ ]	[X]	[ ]
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?		[ ]	[ ]	[ ]	[X]	[ ]
c) Conflict with existing zoning for, or cause rezoning of, forest land (as defined in Public Resources Code section 12220(g)), timberland (as defined by Public Resources Code section 4526), or timberland zoned Timberland Production (as defined by Government Code section 51104(g))?		[]	[]	[]	[X]	[]
d) Result in the loss of forest land or conversion of forest land to non-forest use?		[]	[]	[]	[X]	[]
e) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use or conversion of forest land to non-forest use?		[ ]	[ ]	[ ]	[X]	[ ]
f) Adversely impact agricultural crops or agricultural operations, such as irrigation?						
Impact A1: Agricultural crops	3, 21	[ ]	[X]	[ ]	[ ]	[ ]
Impact A2: Irrigation pumps	13, 21	[ ]	[X]	[ ]	[ ]	[X]

Exhibit ES-1
SCP Environmental Checklist *(continued)*

Environmental Factors	Mitigation Measures	Unavoidable or Potentially Unavoidable Significant Impact	Avoidable Significant Impact	Less than Significant Impact	No Impact	Beneficial Impact
III. AIR QUALITY — Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:						
a) Conflict with or obstruct implementation of the applicable air quality plan?		[ ]	[ ]	[ ]	[X]	[ ]
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?		[ ]	[ ]	[ ]	[X]	[ ]
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors)?		[ ]	[ ]	[ ]	[X]	[ ]
d) Expose sensitive receptors to substantial pollutant concentrations?		[ ]	[ ]	[X]	[ ]	[ ]
e) Create objectionable odors affecting a substantial number of people?		[ ]	[ ]	[X]	[ ]	[ ]
IV. BIOLOGICAL RESOURCES — Would the project:						
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the CDFG or USFWS?						
Impact B1: Herbicide overspray	1, 2, 3, 4, 5	[X]				[X]
Impact B2: Herbicide toxicity	1, 3, 4, 6, 7, 8, 9	[X]				
Impact B3: Herbicide bioaccumulation				[X]		
Impact B4: Food web effects	1, 3, 4, 7, 8	[X]				[X]
Impact B5: Dissolved oxygen levels	10, 11		[X]			[X]
Impact B6: Treatment disturbances	1, 5, 12		[X]			
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the CDFG or USFWS?						
Impact B1: Herbicide overspray	1, 2, 3, 4, 5	[X]				[X]
Impact B5: Dissolved oxygen levels	10, 11		[X]			[X]
Impact B6: Treatment disturbances	1, 5, 12		[X]			
Impact B7: Plant fragmentation	12, 13		[X]			
Impact B8: Disposal of harvested spongeplant	12, 14, 15			[X]		
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?						
Impact B1: Herbicide toxicity	1, 3, 4, 6, 7, 8, 9	[X]				[X]
Impact B5: Dissolved oxygen levels	10, 11		[X]			[X]
Impact B6: Treatment disturbances	1, 5, 12		[X]			[X]
Impact B7: Plant fragmentation	12, 13		[X]			
Impact B8: Disposal of harvested spongeplant	12, 14, 15			[X]		

Exhibit ES-1
SCP Environmental Checklist *(continued)*

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Environmental Factors	Mitigation Measures	Unavoidable or Potentially Unavoidable Significant Impact	Avoidable Significant Impact	Less than Significant Impact	No Impact	Beneficial Impact
IV. BIOLOGICAL RESOURCES *(continued)* — Would the project:						
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?						
Impact B2: Herbicide toxicity	1, 3, 4, 6, 7, 8, 9	[X]				
Impact B4: Food web effects	1, 3, 4, 7, 8	[X]				[X]
Impact B5: Dissolved oxygen levels	10, 11		[X]			[X]
Impact B6: Treatment disturbances	1, 5, 12		[X]			
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?		[ ]	[ ]	[X]	[ ]	[X]
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?		[ ]	[ ]	[ ]	[X]	[X]
V. CULTURAL RESOURCES — Would the project:						
a) Cause a substantial adverse change in the significance of a historical resource as defined in §15064.5?		[ ]	[ ]	[ ]	[X]	[ ]
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to §15064.5?		[ ]	[ ]	[ ]	[X]	[ ]
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?		[ ]	[ ]	[ ]	[X]	[ ]
d) Disturb any human remains, including those interred outside of formal cemeteries?		[ ]	[ ]	[ ]	[X]	[ ]
VI. GEOLOGY AND SOILS — Would the project:						
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:						
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.		[ ]	[ ]	[ ]	[X]	[ ]
ii) Strong seismic ground shaking?		[ ]	[ ]	[ ]	[X]	[ ]
iii) Seismic-related ground failure, including liquefaction?		[ ]	[ ]	[ ]	[X]	[ ]
iv) Landslides?		[ ]	[ ]	[ ]	[X]	[ ]
b) Result in substantial soil erosion or the loss of topsoil?		[ ]	[ ]	[ ]	[X]	[ ]
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?		[ ]	[ ]	[ ]	[X]	[ ]
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?		[ ]	[ ]	[ ]	[X]	[ ]
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?		[ ]	[ ]	[ ]	[X]	[ ]

Exhibit ES-1
SCP Environmental Checklist *(continued)*

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Environmental Factors	Mitigation Measures	Unavoidable or Potentially Unavoidable Significant Impact	Avoidable Significant Impact	Less than Significant Impact	No Impact	Beneficial Impact
VII. GREENHOUSE GAS EMISSIONS — Would the project:						
a) Generate greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment?				[X]		
b) Conflict with an applicable plan, policy or regulation adopted for the purpose of reducing the emissions of greenhouse gases?					[X]	
VIII. HAZARDS AND HAZARDOUS MATERIALS — Would the project:						
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?						
Impact H1: General public exposure	16			[X]		
Impact H2: Treatment crew exposure	3, 8, 17, 18, 19		[X]			
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?						
Impact H3: Accidental spills	18		[X]			
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?		[ ]	[ ]	[ ]	[X]	[ ]
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?		[ ]	[ ]	[ ]	[X]	[ ]
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?		[ ]	[ ]	[ ]	[X]	[ ]
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?		[ ]	[ ]	[ ]	[X]	[ ]
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?		[ ]	[ ]	[ ]	[X]	[X]
h) Expose people or structures to a significant risk of loss, injury or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?		[ ]	[ ]	[ ]	[X]	[ ]
IX. HYDROLOGY AND WATER QUALITY — Would the project:						
a) Violate any water quality standards or waste discharge requirements?						
Impact W1: Chemical constituents	3, 4, 7, 8, 20	[X]				
Impact W2: Pesticides	1, 3, 4, 5, 6, 7, 8, 20	[X]				
Impact W3: Toxicity	1, 3, 4, 5, 6, 7, 8, 20	[X]				
Impact W4: Dissolved oxygen levels	10, 11	[X]				[X]
Impact W5: Floating material	12, 13, 14, 15, 20, 21		[X]			[X]
Impact W6: Turbidity	5			[X]		

Exhibit ES-1
SCP Environmental Checklist *(continued)*

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Environmental Factors	Mitigation Measures	Unavoidable or Potentially Unavoidable Significant Impact	Avoidable Significant Impact	Less than Significant Impact	No Impact	Beneficial Impact
IX. HYDROLOGY AND WATER QUALITY *(continued)* — Would the project:						
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?		[ ]	[ ]	[ ]	[X]	[ ]
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?		[ ]	[ ]	[ ]	[X]	[ ]
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?		[ ]	[ ]	[ ]	[X]	[ ]
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?		[ ]	[ ]	[ ]	[X]	[ ]
f) Otherwise substantially degrade water quality?						
Impact W1: Chemical constituents	3, 4, 7, 8, 20	[X]				
Impact W2: Pesticides	1, 3, 4, 5, 6, 7, 8, 20	[X]				
Impact W3: Toxicity	1, 3, 4, 5, 6, 7, 8, 20	[X]				
Impact W4: Dissolved oxygen levels	10, 11	[X]				[X]
Impact W5: Floating material	12, 13, 14, 15, 20, 21		[X]			[X]
Impact W6: Turbidity	5			[X]		
g) Otherwise substantially degrade drinking water quality?						
Impact W1: Chemical constituents	3, 4, 7, 8, 20	[X]				
Impact W2: Pesticides	1, 3, 4, 5, 6, 7, 8, 20	[X]				
Impact W3: Toxicity	1, 3, 4, 5, 6, 7, 8, 20	[X]				
h) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?		[ ]	[ ]	[ ]	[X]	[ ]
i) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?		[ ]	[ ]	[ ]	[X]	[ ]
j) Expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam?		[ ]	[ ]	[ ]	[X]	[ ]
k) Inundation by seiche, tsunami, or mudflow?		[ ]	[ ]	[ ]	[X]	[ ]

Exhibit ES-1
SCP Environmental Checklist *(continued)* *Page 6 of 8*

Environmental Factors	Mitigation Measures	Unavoidable or Potentially Unavoidable Significant Impact	Avoidable Significant Impact	Less than Significant Impact	No Impact	Beneficial Impact
X. LAND USE AND PLANNING — Would the project:						
a) Physically divide an established community?		[ ]	[ ]	[ ]	[X]	[ ]
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?		[ ]	[ ]	[ ]	[X]	[ ]
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?		[ ]	[ ]	[ ]	[X]	[ ]
XI. MINERAL RESOURCES — Would the project:						
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?		[ ]	[ ]	[ ]	[X]	[X]
b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?		[ ]	[ ]	[ ]	[X]	[ ]
XII. NOISE — Would the project result in:						
a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?		[ ]	[ ]	[ ]	[X]	[ ]
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels?		[ ]	[ ]	[ ]	[X]	[ ]
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?		[ ]	[ ]	[ ]	[X]	[ ]
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?		[ ]	[ ]	[X]	[ ]	[ ]
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?		[ ]	[ ]	[ ]	[X]	[ ]
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?		[ ]	[ ]	[ ]	[X]	[ ]
XIII. POPULATION AND HOUSING — Would the project:						
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?		[ ]	[ ]	[ ]	[X]	[ ]
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?		[ ]	[ ]	[ ]	[X]	[ ]
c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?		[ ]	[ ]	[ ]	[X]	[ ]

Exhibit ES-1
SCP Environmental Checklist *(continued)*

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Environmental Factors	Mitigation Measures	Unavoidable or Potentially Unavoidable Significant Impact	Avoidable Significant Impact	Less than Significant Impact	No Impact	Beneficial Impact
XIV. PUBLIC SERVICES — Would the project:						
a) Result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services:						
Fire protection?		[ ]	[ ]	[ ]	[X]	[ ]
Police protection?		[ ]	[ ]	[ ]	[X]	[ ]
Schools?		[ ]	[ ]	[ ]	[X]	[ ]
Parks?		[ ]	[ ]	[ ]	[X]	[ ]
Other public facilities?		[ ]	[ ]	[ ]	[X]	[ ]
XV. RECREATION — Would the project:						
a) Increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?		[ ]	[ ]	[ ]	[X]	[X]
b) Include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?		[ ]	[ ]	[ ]	[X]	[ ]
c) Would the project adversely impact existing recreational opportunities?		[ ]	[ ]	[X]	[ ]	[X]
XVI. TRANSPORTATION/TRAFFIC — Would the project:						
a) Cause an increase in traffic which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections)?		[ ]	[ ]	[ ]	[X]	[ ]
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?		[ ]	[ ]	[ ]	[X]	[ ]
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?		[ ]	[ ]	[ ]	[X]	[ ]
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?		[ ]	[ ]	[ ]	[X]	[ ]
e) Result in inadequate emergency access?		[ ]	[ ]	[ ]	[X]	[ ]
f) Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?		[ ]	[ ]	[ ]	[X]	[ ]

Exhibit ES-1
SCP Environmental Checklist *(continued)*

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Environmental Factors	Mitigation Measures	Unavoidable or Potentially Unavoidable Significant Impact	Avoidable Significant Impact	Less than Significant Impact	No Impact	Beneficial Impact
XVII. UTILITIES AND SERVICE SYSTEMS — Would the project:						
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?		[ ]	[ ]	[ ]	[X]	[ ]
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?		[ ]	[ ]	[ ]	[X]	[ ]
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?		[ ]	[ ]	[ ]	[X]	[ ]
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?		[ ]	[ ]	[ ]	[X]	[ ]
e) Result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?		[ ]	[ ]	[ ]	[X]	[ ]
f) Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?		[ ]	[ ]	[ ]	[X]	[ ]
g) Comply with federal, state, and local statutes and regulations related to solid waste?		[ ]	[ ]	[ ]	[X]	[ ]
h) Result in problems for local or regional water utility intake pumps?						
Impact U1: Water utility intake pumps	13, 21	[ ]	[X]	[ ]	[ ]	[X]
XVIII. MANDATORY FINDINGS OF SIGNIFICANCE — Does the project:						
a) Have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	1 to 15	[X]	[ ]	[ ]	[ ]	[ ]
b) Have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?	1 to 21	[X]	[ ]	[ ]	[ ]	[ ]
c) Have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?	3, 7, 8, 16, 17, 18, 19	[ ]	[X]	[ ]	[ ]	[ ]

Exhibit ES-2
SCP Mitigation Measures

Page 1 of 6

Mitigation Measures	Mitigated Impact Areas
1. Avoid herbicide application near special status species, and sensitive riparian and wetland habitat; and other biologically important resources Each year, prior to start of the treatment season, DBW will conduct field crew environmental awareness training. Under this training, crews will be informed about the presence and life histories of special status species; habitats associated with species; sensitive habitats and wetlands; the terms and conditions of the program's biological opinion and/or letter of concurrence; environmental survey procedures; incidental take procedures; and that unlawful take of an animal or destruction of its habitat is a violation of the Endangered Species Act. DBW will provide crews with a field guide (Species Identification Deck) for easy identification of special status species on-site. Prior to treating a site, crews will conduct a visual survey to determine whether special status plants, animals, or sensitive habitats are present. Crews will complete an Environmental Observations Checklist, following an established protocol, for each site to document the presence or absence of listed or special status species. If listed or special status species or sensitive habits are present at the site, the field crew will not perform treatments that could potentially affect the species or habitat. DBW Environmental Scientists will classify treatment sites as high, medium, or low potential for nesting birds. DBW also will examine CNDDB records to determine if special status bird species have been sited within SCP treatment locations, and prepare a map for field crews identifying such sites. For those treatment sites that have habitat characteristics that might support special status bird species, Environmental Scientists will survey the specific site. DBW will delay treatments at locations where nesting Swainson's hawks are present until after June 10th, the start of the post-fledging stage. At all treatment locations, crews will conduct a visual survey, following an established protocol, to determine whether special status plants, animals, or sensitive habitats are present, including bird nesting sites. Crews will complete an Environmental Observations Checklist for each site to document the presence or absence of bird nesting sites. If nesting yellow-headed blackbird, Swainson's hawk, or tricolored blackbird are known to be present at the site, the field crew will not perform any treatment within 200 yards of the nesting site until the post-fledging stage.	Biological Resources, Hydrology and Water Quality
2. Provide a 100 foot buffer between treatment sites and shoreline elderberry shrubs (*Sambucus* ssp.), host plant for the valley elderberry longhorn beetle *(Desmocerus californicus dimorphus)*(reduced to 50 feet in some instances) DBW will conduct a survey of treatment sites to prepare a map that identifies locations of elderberry shrubs, and provide this map to field crews. Exhibit 3-3 provides a map identifying locations of elderberry shrubs and giant garter snake sitings within the SCP treatment area. DBW crews will maintain the 100 buffer zone when elderberry shrubs are present. Crews will also conduct treatments downwind of elderberry shrubs. Where there are a large number of valley elderberry shrubs that may preclude treatments at the 100 foot buffer, DBW may provide a 50 foot buffer between treatment sites and shoreline elderberry shrubs if treatments occur when winds are less than 3 mph. In addition, DBW's Environmental Scientists will survey a sample of elderberry shrubs which could be potentially impacted by SCP application activities at the beginning of the treatment season, and at the end of the treatment season. The Environmental Scientists will compare the health of elderberry shrubs at control sites (i.e. not adjacent to treatments) with elderberry shrubs located adjacent to treated sites. If elderberry shrubs located near treated sites show signs of adverse effects from treatment, DBW will develop additional mitigation measures to protect elderberry shrubs (for example, increasing the size of the buffer zone).	Biological Resources

Exhibit ES-2
SCP Mitigation Measures *(continued)*

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Mitigation Measures	Mitigated Impact Areas
3. Conduct herbicide treatments in order to minimize potential for drift In addition to complying with the label application requirements, DBW will, to the degree possible, schedule herbicide applications to occur at high tide, or at a point in the tidal cycle determined by the field supervisor to provide the least non-target impact at a particular site. In general, treatment at high tide will allow for better spray accuracy and access, and will provide for greater dilution volume of herbicides. DBW crews will change nozzle type and spray pressures whenever conditions warrant, limiting the amount of herbicide which may inadvertently contact non-target species or enter the water.	Biological Resources, Agricultural Resources, Hydrology and Water Quality
4. Conduct herbicide treatments using diquat only in emergency situations and for no more than 50 acres in total among DBW aquatic weed control programs To minimize the potential for negative impacts to covered species from exposure to diquat dibromide, DBW will only utilize diquat in emergency situations. Diquat will only be utilized from August 1st through November 30th of each year, and will be limited to a total of 50 treatment acres in the Delta per year, as a sum of the combined diquat acres treated in the SCP and EDCP. Emergency conditions are such that spongeplant growth completely impedes navigation of Delta waters, such as a completely blocked slough that would impair the movement of emergency response vessels. DBW will consult with USFWS and NMFS prior to utilizing diquat to help ensure that covered fish species are not likely to be present at the time of treatment.	Biological Resources, Hydrology and Water Quality
5. Operate program vessels in a manner that causes the least amount of disturbance to the habitat Operational procedures for DBW vessels will minimize boat wakes and propeller wash. These procedures will be particularly important in shallow water, or other sensitive habitats.	Biological Resources, Hydrology and Water Quality

Exhibit ES-2
SCP Mitigation Measures *(continued)*

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Mitigation Measures	Mitigated Impact Areas
6. Implement temporal and spatial limitations and restrictions on herbicide treatments to minimize treatments during times, and at locations, where larval and/or migratory fish are likely to be present The SCP will seek to adjust the timing of treatments to avoid periods when juvenile steelhead and salmon, delta smelt, or longfin smelt may be present. The SCP will base treatment dates, in part, on fish survey monitoring data showing that listed fish species are not likely to be present at a particular treatment site. DBW will review fish survey data between March 1st and July 1st to determine whether listed fish species are likely to be present, following the procedures below. For USFWS Areas 2, 3, and 4 (see Exhibit 2-1): DBW's Environmental Scientist will obtain the potential treatment site list (based on field surveys of re-growing spongeplant and prioritization process) from Field Supervisor. Each week, the Environmental Scientist will check the following (or equivalent) State and federal fish survey data to determine whether listed fish species are likely to be near, or in, any of the potential treatment sites. The Environmental Scientist will compare the list of potential treatment sites and the locations of listed fish species and determine which, if any, potential sites should not be treated that week. Between March 1st and July 1st, the Environmental Scientist will prepare a weekly summary list for USFWS, NMFS, and CDFW that identifies treatment sites where listed fish species are not likely to be present. - USFWS "DatCall" data (juvenile fish monitoring program through the Interagency Ecology Program (IEP)) - California Department of Fish and Wildlife (CDFW) surveys and studies - Department of Water Resources (DWR) and United States Bureau of Reclamation (USBR) fish salvage data - FishBio San Joaquin Basin Update reports - CDFW Knights Landing Rotary Screw Trap data For USFWS Area 1 (see Exhibit 2-1), DBW will implement this same fish survey procedure during the month of June. To further minimize potential to impact delta smelt, SCP will not begin treatments in treatment sites likely to be used as spawning and rearing habitat for delta smelt until after June 1st. DBW will not conduct herbicide treatments in USFWS Area 1, covering much of the northern and central Delta, until after June 1st.	Biological Resources
7. Monitor herbicide and adjuvant levels to ensure that the SCP does not result in potentially toxic concentrations of chemicals in Delta waters DBW will conduct comprehensive monitoring. This monitoring is in compliance with the general NPDES permit, and NMFS and USFWS Biological Opinions and/or Letters of Concurrence. DBW will collect samples prior to treatment, immediately after treatment, and post-treatment within one week of spraying. DBW will conduct water quality monitoring for visual parameters, physical parameters, and chemical parameters at one site per water body type for glyphosate and six sites per water body type for all other herbicides. Water samples will be submitted to a certified analytical laboratory to measure 2,4-D, glyphosate, penoxsulam, imazamox, diquat, and adjuvant levels. Should these levels exceed allowable limits, DBW will take immediate measures to reduce chemical levels at future treatment sites.	Biological Resources, Hydrology and Water Quality

Exhibit ES-2
SCP Mitigation Measures *(continued)*

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Mitigation Measures	Mitigated Impact Areas
8. Implement an adaptive management approach to minimize the use of herbicides Under an adaptive management approach, DBW will seek to improve efficacy and reduce environmental impacts over time as new and better information is available. Specifically, DBW will evaluate the need for control measures on a site by site, month-to-month, basis; select appropriate indicators for pre-treatment monitoring; monitor indicators following treatment and evaluate data to determine program efficacy and environmental impacts; support ongoing research to explore impacts of the SCP and alternative control methodologies; report findings to regulatory agencies; and adjust program actions, as necessary, in response to recommendations and evaluations by DBW staff, regulatory agencies and stakeholders. In addition to this adaptive management approach, DBW will follow maintenance control practices that seek to limit the growth and further spread of spongeplant to be treated each year. This will reduce the volume of herbicide utilized by the SCP.	Biological Resources, Hydrology and Water Quality
9. Provide treatment crews with electronic mapping that identifies previously surveyed areas for giant garter snake habitat, valley elderberry shrub locations (see hard copy example in Exhibit 3-3), and nesting special status birds. Application crews will use these maps as tools for performing pre-application visual inspections for the presence of giant garter snakes, valley elderberry longhorn beetle, or nesting special status birds. If giant garter snakes are present, treatment crews will not treat at that location. If valley elderberry shrubs are within 100 feet of the potential spray area (or 50 feet with low wind conditions), crews will not treat at that location. If nesting special status birds are present, treatment crews will not perform any treatment within 200 yards of the nesting site until the post-fledging stage.	Biological Resources
10. Monitor dissolved oxygen levels pre- and post-treatment for all SCP treatments Based on the pre-treatment DO levels, the application crew will determine whether to conduct treatment at that site. No treatment will be performed when dissolved oxygen levels are between 3 ppm (the level below which DO is considered to be detrimental to fish species) and the basin plan limits established by the CVRWQCB. The basin plan limits depend on location and time of year, and range from 5 ppm to 8 ppm. DBW will maintain written and map summaries of specific DO numeric limits. When pre-treatment levels are below 3 ppm, fish species are not likely to be present due to the extremely low oxygen levels. When pre-treatment levels are above the basin plan limit, SCP treatments, following label guidelines and mitigation measures, are not expected to adversely affect special status fish, resident native or migratory fish, or sensitive riparian or wetland habitats.	Biological Resources, Hydrology and Water Quality
11. Implement the Fish Passage Protocol to provide a zone of passage through areas of low dissolved oxygen In slow-moving and back-end sloughs infested with spongeplant, treat up to 30 percent of spongeplant mats at one time. Treat mats in up to 3 acre strips, leaving at least 100 foot buffer strips between treated areas. Treat the untreated buffer strips and remaining 70 percent of the spongeplant mat at least three more times following the initial treatment (in 30 percent increments). Conduct follow-up treatments in three week intervals In Delta tidal waters, treat up to 50 percent of the spongeplant mat at one time. Treat mats in up to 3 acre strips, leaving at least 100 foot buffer strips between treated areas. Treat the untreated buffer strips and remaining 50 percent of the mat three weeks following the initial treatment for 2,4-D, and one week following the initial treatment for other herbicides In treatment sites where DO levels are below 3 mg/l prior to SCP treatments, treat the entire area, without the 3 acre strips or buffer strips.	Biological Resources, Hydrology and Water Quality

Exhibit ES-2
SCP Mitigation Measures *(continued)*

Mitigation Measures	Mitigated Impact Areas
12. Follow environmental compliance measures for species avoidance, equipment operation, and disposal when conducting mechanical harvesting operations DBW will implement a protocol similar to that for chemical treatment prior to conducting mechanical removal. Environmental scientists will check fish survey data to verify that listed fish species are not likely to be present at the removal site. The equipment operator will utilize the Environmental Checklist to evaluate presence of listed species or sensitive habitat prior to removal. If listed species or sensitive habitats are present, the operator will not conduct mechanical removal at that site. DBW will conduct mechanical removal of spongeplant in sensitive giant garter snake habitat or areas where giant garter snakes have been sighted in the past, only between October 1st and May 1st. The mechanical harvester will maintain a speed of 2 to 2.5 knots in areas outside of sensitive giant garter snake habitat, or areas where giant garter snake has been sighted in the past, during the active season, so that if giant garter snake were in the area, they could move out of the way. The operator will stop and reverse the mechanical harvester if a snake is seen within spongeplant during removal. DBW will dispose of all spongeplant collected by mechanical removal outside of the May 1st to October 1st giant garter snake active season at an approved disposal facility to ensure no hibernating giant garter snakes are buried under piles of collected spongeplant.	Biological Resources, Hydrology and Water Quality
13. Collect plant fragments during and immediately following treatment To maximize containment of plant fragments, crews will collect spongeplant fragments. Crews will also be trained on the importance of minimizing fragment escape.	Biological Resources, Agricultural Resources, Hydrology and Water Quality
14. Identify and utilize disposal areas that have no and/or low habitat value for the federal and State listed giant garter snake *(Thamnophis gigas)* DBW will provide crews electronic mapping that identifies previously surveyed areas for giant garter snake habitat. Crews also will conduct surveys to ensure that there are no other special status plant or animal species located within 100 feet of disposal sites.	Biological Resources
15. Identify and utilize disposal areas that are at least 100 feet away from elderberry shrubs (*Sambucus* ssp.) Elderberry shrubs are potential habitat for the federally threatened valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*).	Biological Resources
16. Minimize public exposure to herbicide treated water Prior to treatments, DBW will notify marina and dock owners regarding timing of treatments. SCP treatments generally take place in heavily infested waterways, which are usually unsuitable for water recreation. If recreationists are present when treatment occurs, treatments crews will inform recreationists about the treatment, asking them to move to a different location, or move treatments to a different location.	Hazards and Hazardous Materials
17. Require treatment crews to participate in training on herbicide and heat hazards DBW will provide training to ensure that treatment crews have the knowledge and tools necessary to conduct the program in a safe manner. Training will include reading, understanding, and following herbicide label requirements; purpose and proper use of PPE; symptoms of herbicide poisoning and minimization of exposure; avoidance, symptoms, and treatment of heat exposure; and emergency medical procedures.	Hazards and Hazardous Materials

Exhibit ES-2
SCP Mitigation Measures *(continued)* *Page 6 of 6*

Mitigation Measures	Mitigated Impact Areas
18. Follow best management practices to minimize the risk of spill and to minimize the impact of a spill, should one occur The best management practices includes several provisions to reduce the potential for spill, such as: fastening herbicide containers securely in boats in original, watertight containers; carrying a marker buoy and anchor line to mark any spills in water; reporting spills immediately to appropriate State and local agencies; immediately stopping movement of land spills using absorbing materials; marking and monitoring spills in water for herbicide residues and environmental impacts, if appropriate. Treatment crews will include at least one person with a Qualified Applicators Certificate (QAC), and all crew members will participate in annual training on herbicide handling procedures.	Hazards and Hazardous Materials
19. Implement safety precautions on hot days to prevent heat illness In addition to annual training on heat illness prevention, and compliance with CalOSHA's California Heat Illness Prevention Standard, DBW Field Supervisors will conduct special training sessions on days when weather is expected to be hot. This training will cover the symptoms of heat illness, and immediate actions to take should any symptoms occur. Field Supervisors will cancel treatments if the weather is exceptionally hot. DBW will also provide bimini tops (shade covers) for SCP treatment boats.	Hazards and Hazardous Materials
20. Follow the protocol for herbicide applications within one mile of drinking water intake facilities. In order to treat within one mile of a drinking water intake, DBW must notify the appropriate jurisdiction at least two weeks in advance, and make every reasonable attempt to schedule applications during periods when intakes are shut down for environmental or maintenance reasons, allowing at least two complete tidal cycles between application and restart. This measure is primarily aimed at reducing the potential for drinking water contamination from the SCP. DBW has a formal Memorandum of Understanding (MOU) regarding applications near drinking water intakes with the Contra Costa Water District (CCWD), but also follows the same protocol with other jurisdictions, such as the City of Stockton and the City of Antioch. In Contra Costa County, generally, no applications shall occur within Rock Slough, or within one mile of the confluence of Rock Slough and Old River, or within one mile of CCWD's Old River or Mallard Slough intake pumps without consensual agreement between CCWD and DBW. Herbicide applications within one mile of CCWD's water intakes may only occur with prior consent of CCWD.	Hydrology and Water Quality, Utilities/Service Systems
21. Notify County Agricultural Commissioners about SCP activities Before an application may occur, DBW shall file Pesticide Use Recommendations (PUR) and a Notice of Intent (NOI) with the appropriate County Agricultural Commissioner (CAC) office. Each NOI will include the site number, spray dates, locations, and herbicides and adjuvants to be used. NOIs will be submitted before the upcoming treatment week. Based on information in the NOIs, CAC's could inform land owners of particular periods of time during which irrigation should not occur. If necessary, DBW shall also obtain a Restricted Use Permit (RUP) from all appropriate CACs.	Agricultural Resources, Hydrology and Water Quality

Exhibit ES-3
Summary of Proposed SCP Impacts, Mitigation Measures, and Significance Levels Before and After Mitigation

Resource Areas	Potential Impacts	Significance Level Before Mitigation: Unavoidable or Potentially Unavoidable Significant Impact	Significance Level Before Mitigation: Avoidable Significant Impact	Significance Level Before Mitigation: Less than Significant Impact	Mitigation	Significance Level After Mitigation: Reduced, but still Potentially Unavoidable Significant Impact	Significance Level After Mitigation: Less than Significant Impact
II. Agricultural Resources	**A1 – Agricultural crops:** effects of SCP herbicide treatments on agricultural crops		[X]		**3** – Conduct herbicide treatments in order to minimize drift **21** – Notify County Agricultural Commissioners about SCP activities		[X]
	A2 – Irrigation pumps: effects of SCP treatments on agricultural irrigation		[X]		**13** – Collect plant fragments during and immediately following treatment **21** – Notify County Agricultural Commissioners about SCP activities		[X]
IV. Biological Resources	**B1 – Herbicide overspray:** effects of herbicide overspray on special status species, riparian or other sensitive habitats, and wetlands	[X]			**1** – Avoid herbicide application near special status species, and sensitive riparian and wetland habitat; and other biologically important resources **2** – Provide a 100 foot buffer between treatment sites and shoreline elderberry shrubs, host plant for the valley elderberry longhorn beetle **3** – Conduct herbicide treatments in order to minimize potential for drift **4** – Conduct herbicide treatments using diquat only in emergency situations and for no more than 50 acres in total among DBW aquatic weed control programs **5** – Operate program vessels in a manner that causes the least amount of disturbance to the habitat	[X]	
	B2 – Herbicide toxicity: toxic effects of herbicides on special status species, native resident fish, and migratory fish	[X]			**1** – Avoid herbicide application near special status species, and sensitive riparian and wetland habitat; and other biologically important resources **3** – Conduct herbicide treatments in order to minimize potential for drift **4** – Conduct herbicide treatments using diquat only in emergency situations and for no more than 50 acres in total among DBW aquatic weed control programs **6** – Implement temporal and spatial limitations and restrictions on herbicide treatments to minimize treatments during times, and at locations, where larval and/or migratory fish are likely to be present **7** – Monitor herbicide and adjuvant levels to ensure that the SCP does not result in potentially toxic concentrations of chemicals in Delta waters **8** – Implement an adaptive management approach to minimize the use of herbicides **9** – Provide treatment crews with electronic mapping that identifies previously surveyed areas for giant garter snake habitat, valley elderberry shrubs, and nesting special status birds	[X]	
	B3 – Herbicide bioaccumulation: effects of herbicide bioaccumulation on special status species			[X]	NA		NA

Exhibit ES-3
Summary of Proposed SCP Impacts, Mitigation Measures, and Significance Levels Before and After Mitigation *(continued)*

Page 2 of 5

Resource Areas	Potential Impacts	Significance Level Before Mitigation: Unavoidable or Potentially Unavoidable Significant Impact	Significance Level Before Mitigation: Avoidable Significant Impact	Significance Level Before Mitigation: Less than Significant Impact	Mitigation	Significance Level After Mitigation: Reduced, but still Potentially Unavoidable Significant Impact	Significance Level After Mitigation: Less than Significant Impact
IV. Biological Resources *(continued)*	**B4 – Food web effects:** effect of treatment on food webs, and resulting impact on special status species, sensitive habitats, and migration of species	[X]			**1** – Avoid herbicide application near special status species, and sensitive riparian and wetland habitat; and other biologically important resources **3** – Conduct herbicide treatments in order to minimize potential for drift **4** – Conduct herbicide treatments using diquat only in emergency situations and for no more than 50 acres in total among DBW aquatic weed control programs **7** – Monitor herbicide and adjuvant levels to ensure that the SCP does not result in potentially toxic concentrations of chemicals in Delta waters **8** – Implement an adaptive management approach to minimize the use of herbicides	[X]	
	B5 – Dissolved oxygen levels: effects of treatment on local dissolved oxygen (DO) levels, and resulting impact on special status species, resident native or migratory fish, sensitive habitat, and wetlands		[X]		**10** – Monitor dissolved oxygen levels pre- and post-treatment for all SCP treatments **11** – Implement the Fish Passage Protocol to provide a zone of passage through areas of low dissolved oxygen		[X]
	B6 – Treatment disturbances: effects of treatment disturbances on special status species, resident native or migratory fish, sensitive habitat, and wetlands		[X]		**1** – Avoid herbicide application near special status species, and sensitive riparian and wetland habitat; and other biologically important resources **5** – Operate program vessels in a manner that causes the least amount of disturbance to the habitat **12** – Follow environmental compliance measures for species avoidance, equipment operation, and disposal when conducting mechanical harvesting operations		[X]
	B7 – Plant fragmentation: effects of plant fragmentation on sensitive habitat and wetlands		[X]		**12** – Follow environmental compliance measures for species avoidance, equipment operation, and disposal when conducting mechanical harvesting operations **13** – Collect plant fragments during and immediately following treatment		[X]
	B8 – Disposal of harvested spongeplant: effects of disposal following hand removal with nets or mechanical harvesting on sensitive habitat and wetlands			[X]	**12** – Follow environmental compliance measures for species avoidance, equipment operation, and disposal when conducting mechanical harvesting operations **14** – Identify and utilize disposal areas that have no and/or low habitat value for federal and State listed giant garter snake **15** – Identify and utilize disposal areas that are at least 100 feet away from elderberry shrubs		[X]

Exhibit ES-3
Summary of Proposed SCP Impacts, Mitigation Measures, and Significance Levels Before and After Mitigation *(continued)*

Resource Areas	Potential Impacts	Significance Level Before Mitigation: Unavoidable or Potentially Unavoidable Significant Impact	Significance Level Before Mitigation: Avoidable Significant Impact	Significance Level Before Mitigation: Less than Significant Impact	Mitigation	Significance Level After Mitigation: Reduced, but still Potentially Unavoidable Significant Impact	Significance Level After Mitigation: Less than Significant Impact
VIII. Hazards and Hazardous Materials	**H1 – General public exposure:** there is potential for the SCP to create a significant hazard to the public through the routine transport, use, or disposal of SCP herbicides			[X]	Not required; however, DWB will implement the following mitigation measure: **16** – Minimize public exposure to herbicide treated water		[X]
	H2 – Treatment crew exposure: there is potential for the SCP to create a significant hazard to treatment crews through the routine transport, use, or disposal of SCP herbicides; and/or through heat exposure		[X]		**3** – Conduct herbicide treatments in order to minimize potential for drift **8** – Implement an adaptive management approach to minimize the use of herbicides **17** – Require treatment crews to participate in training on herbicide and heat hazards **18** – Follow best management practices to minimize the risk of spill, and to minimize the impact of spill, should one occur **19** – Implement safety precautions on hot days to prevent heat illness		[X]
	H3 – Accidental spill: there is potential for the SCP to create a significant hazard to the public or the environment through reasonably foreseeable upset and accidental conditions involving the release of hazardous materials into the environment		[X]		**18** – Follow best management practices to minimize the risk of spill, and to minimize the impact of spill, should one occur		[X]
IX. Hydrology and Water Quality	**W1 – Chemical constituents:** following SCP herbicide treatment, waters may potentially contain chemical constituents that adversely affect beneficial uses, violating water quality standards or otherwise substantially degrading water quality or drinking water quality	[X]			**3** – Conduct herbicide treatments in order to minimize potential for drift **4** – Conduct herbicide treatments using diquat only in emergency situations and for no more than 50 acres in total among DBW aquatic weed control programs **7** – Monitor herbicide and adjuvant levels to ensure that the SCP does not result in potentially toxic concentrations of chemicals in Delta waters **8** – Implement an adaptive management approach to minimize the use of herbicides **20** – Follow the protocol for herbicide applications within one mile of drinking water intake facilities	[X]	

Exhibit ES-3
Summary of Proposed SCP Impacts, Mitigation Measures,
and Significance Levels Before and After Mitigation *(continued)*

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Resource Areas	Potential Impacts	Significance Level Before Mitigation			Mitigation	Significance Level After Mitigation	
		Unavoidable or Potentially Unavoidable Significant Impact	Avoidable Significant Impact	Less than Significant Impact		Reduced, but still Potentially Unavoidable Significant Impact	Less than Significant Impact
IX. Hydrology and Water Quality *(continued)*	**W2 – Pesticides:** following SCP herbicide treatment pesticides may potentially be present in concentrations that adversely affect beneficial uses, violating water quality standards or otherwise substantially degrading water or drinking water quality	[X]			**1** – Avoid herbicide applications near special status species, and sensitive riparian and wetland habitat; and other biologically important resources **3** – Conduct herbicide treatments in order to minimize potential for drift **4** – Conduct herbicide treatments using diquat only in emergency situations and for no more than 50 acres in total among DBW aquatic weed control programs **5** – Operate program vessels in a manner that causes the least amount of disturbance to the habitat **7** – Monitor herbicide and adjuvant levels to ensure that the SCP does not result in potentially toxic concentrations of chemicals in Delta waters **8**– Implement an adaptive management approach to minimize the use of herbicides **20** – Follow the protocol for herbicide applications within one mile of drinking water intake facilities	[X]	
	W3 – Toxicity: following SCP herbicide treatment toxic substances may potentially be found in waters in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life, violating water quality standards or otherwise substantially degrading water or drinking water quality	[X]			**1** – Avoid herbicide applications near special status species, and sensitive riparian and wetland habitat; and other biologically important resources **3** – Conduct herbicide treatments in order to minimize potential for drift **4** – Conduct herbicide treatments using diquat only in emergency situations and for no more than 50 acres in total among DBW aquatic weed control programs **5** – Operate program vessels in a manner that causes the least amount of disturbance to the habitat **6** – Implement temporal and spatial limitations and restrictions on herbicide treatments to minimize treatments during times, and at locations, where larval and/or migratory fish are likely to be present **7** – Monitor herbicide and adjuvant levels to ensure that the SCP does not result in potentially toxic concentrations of chemicals in Delta waters **8** – Implement an adaptive management approach to minimize the use of herbicides **20** – Follow the protocol for herbicide applications within one mile of drinking water intake facilities	[X]	

Exhibit ES-3
Summary of Proposed SCP Impacts, Mitigation Measures, and Significance Levels Before and After Mitigation *(continued)*

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Resource Areas	Potential Impacts	Significance Level Before Mitigation			Mitigation	Significance Level After Mitigation	
		Unavoidable or Potentially Unavoidable Significant Impact	Avoidable Significant Impact	Less than Significant Impact		Reduced, but still Potentially Unavoidable Significant Impact	Less than Significant Impact
IX. Hydrology and Water Quality *(continued)*	**W4 – Dissolved oxygen:** following SCP herbicide treatment, dissolved oxygen may potentially be reduced below Basin Plan and Bay-Delta Plan objectives, violating water quality standards or otherwise substantially degrading water quality	[X]			**10** – Monitor dissolved oxygen (DO) levels pre- and post- treatment for all SCP treatments **11** – Implement the Fish Passage Protocol to provide a zone of passage through areas of low dissolved oxygen	[X]	
	W5 – Floating material: following SCP treatments, waters may potentially contain floating spongeplant fragments in amounts that cause nuisance or adversely affect beneficial uses, violating water quality standards or otherwise substantially degrading water quality		[X]		**12** – Follow environmental compliance measures for species avoidance, equipment operation, and disposal when conducting mechanical harvesting operations **13** – Collect plant fragments during and immediately following treatment **20** – Follow the protocol for herbicide applications within one mile of drinking water intake facilities **21** – Notify County Agricultural Commissioners about SCP activities		[X]
	W6 – Turbidity: SCP treatment may potentially result in changes to turbidity that cause nuisance or adversely affect beneficial uses, violating water quality standards or otherwise substantially degrading water quality			[X]	Not required, however, the following measure will be followed: **5** – Operate program vessels in a manner that causes the least amount of disturbance to the habitat		[X]
XVII. Utilities and Service Systems	**U1 – Water utility intake pumps:** effects of SCP treatments on water utility intake pumps		[X]		**13** – Collect plant fragments during and immediately following treatment **20** – Follow the protocol for herbicide applications within one mile of drinking water intake facilities		[X]

Exhibit ES-4
SCP Environmental Factors with "Less Than Significant Impact" or "No Impact"

Page 1 of 5

Environmental Factors	Impact Level: Less Than Significant	Impact Level: No Impact	Discussion *The SCP will not:*	Incorporation by Reference
I. AESTHETICS — Would the project:				
a) Have a substantial adverse effect on a scenic vista?	[ ]	[X]	Impact scenic vistas. The SCP will improve scenic vistas by controlling large monoculture expanses of spongeplant.	*EDCP Final EIR* (2001), DBW, Pages 2-48 to 2-49; 3-99
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?	[ ]	[X]	Damage scenic resources. The SCP will improve scenic resources by controlling large monoculture expanses of spongeplant.	
c) Substantially degrade the existing visual character or quality of the site and its surroundings?	[ ]	[X]	Degrade the existing visual character or quality of the Delta. The SCP will improve the visual character of the Delta by controlling large monoculture expanses of spongeplant.	
d) Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area?	[ ]	[X]	Create a new source of light or glare.	
III. AIR QUALITY — Would the project:				
a) Conflict with or obstruct implementation of the applicable air quality plan?	[ ]	[X]	Conflict with or obstruct implementation of the applicable air quality plan.	*EDCP Final EIR* (2001), DBW, Pages 2-42; 3-84 to 3-85
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?	[ ]	[X]	Violate any air quality standard or contribute to an existing or projected air quality violation.	
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors)?	[ ]	[X]	Result in net increases of any criteria pollutants for which the project region is under an applicable federal or state ambient air quality standard.	
d) Expose sensitive receptors to substantial pollutant concentrations?	[X]	[ ]	Result in significant exposure of sensitive receptors to substantial pollutant concentrations. There may be short-term less than significant impacts on sensitive receptors due to drift of SCP herbicides during spraying operations.	
e) Create objectionable odors affecting a substantial number of people?	[X]	[ ]	Result in significant objectionable odors. There may be short-term, less than significant, objectionable odors in the immediate vicinity of treatments due to drift of SCP herbicides during spraying operations.	
V. CULTURAL RESOURCES — Would the project:				
a) Cause a substantial adverse change in the significance of a historical resource as defined in §15064.5?	[ ]	[X]	Cause a substantial adverse change in a historical resource.	*EDCP Final EIR* (2001), DBW, Pages 2-47; 3-98
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to §15064.5?	[ ]	[X]	Cause a substantial adverse change in an archeological resource.	
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	[ ]	[X]	Destroy a unique paleontological resource or site or a geologic feature.	
d) Disturb any human remains, including those interred outside of formal cemeteries?	[ ]	[X]	Disturb any human remains.	

Exhibit ES-4
SCP Environmental Factors with “Less Than Significant Impact” or “No Impact” *(continued)* *Page 2 of 5*

Environmental Factors	Impact Level		Discussion *The SCP will not:*	Incorporation by Reference
	Less Than Significant	No Impact		
VI. GEOLOGY AND SOILS — Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				*EDCP Final EIR* (2001), DBW, Pages 2-44; EC-4
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.	[ ]	[X]	Expose people or structures to adverse effects due to a known earthquake fault.	
ii) Strong seismic ground shaking?	[ ]	[X]	Expose people or structures to adverse effects due to seismic ground shaking.	
iii) Seismic-related ground failure, including liquefaction?	[ ]	[X]	Expose people or structures to adverse effects due to seismic related ground failure, including liquefaction.	
iv) Landslides?	[ ]	[X]	Expose people or structures to adverse effects due to landslides.	
b) Result in substantial soil erosion or the loss of topsoil?	[ ]	[X]	Result in substantial erosion or loss of topsoil.	
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?	[ ]	[X]	Be located on a geological unit or soil that is or could become unstable and result in landslide, lateral spreading, subsidence, liquefaction, or collapse.	
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?	[ ]	[X]	Be located on expansive soil	
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?	[ ]	[X]	Have soils incapable of supporting septic tanks or alternative waste disposal systems.	
VII. GREENHOUSE GAS EMISSIONS — Would the project:				
Generate greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment?	[X]	[ ]	The SCP will result in minimal additional greenhouse gas emissions, as compared to existing DBW programs, other state and federal activities in the Delta, recreation in the Delta, and commercial boating operations. The SCP will operate motorized boats in the Delta, in coordination with WHCP and EDCP boating operations. The potential greenhouse gas emission impact of DBW’s six treatment boats and two monitoring boats during treatment is less than significant.	
Conflict with an applicable plan, policy or regulation adopted for the purpose of reducing the emissions of greenhouse gases?	[ ]	[X]	The SCP will not conflict with existing plans, policies, or regulations adopted for the purpose of reducing emissions of greenhouse gases.	

Exhibit ES-4
SCP Environmental Factors with "Less Than Significant Impact" or "No Impact" *(continued)* *Page 3 of 5*

Environmental Factors	Impact Level: Less Than Significant	Impact Level: No Impact	Discussion *The SCP will not:*	Incorporation by Reference
X. LAND USE AND PLANNING — Would the project:				
a) Physically divide an established community?	[ ]	[X]	Physically divide a community.	*EDCP Final EIR* (2001), DBW, Pages 2-45 to 2-46; 3-95
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?	[ ]	[X]	Conflict with applicable land use plans, policies, or regulations.	
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?	[ ]	[X]	Conflict with any applicable habitat conservation plan or natural community conservation plan. SCP has no known conflicts with various conservation plans, programs, or other initiatives in the Delta (see Chapter 7). SCP's control of spongeplant is consistent with, and supportive of, conservation planning efforts to reduce invasive species in the Delta.	
XI. MINERAL RESOURCES — Would the project:				
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	[ ]	[X]	Result in loss of availability of a known mineral resource.	*EDCP Final EIR* (2001), DBW, Pages 2-43; EC-7
b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?	[ ]	[X]	Result in loss of availability of a locally-important mineral resource recovery site.	
XII. NOISE — Would the project result in:				
a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?	[ ]	[X]	Result in exposure to, or generation of, noise levels in excess of standards.	*EDCP Final EIR* (2001), DBW, Pages 2-43; EC-7; 3-91
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels?	[ ]	[X]	Result in exposure of persons, or generation of, excessive groundborne vibration or groundborne noise levels.	
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?	[ ]	[X]	Result in a permanent increase in ambient noise levels.	
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?	[X]	[ ]	Result in a substantial temporary or period increase in ambient noise levels. There may be a less than significant increase in localized ambient noise levels due to operation of SCP boats during treatment.	
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?	[ ]	[X]	Be located within an airport land use plan, or within two miles of a public airport, or expose people within the area to excessive noise levels.	
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?	[ ]	[X]	Be located within the vicinity of a private airstrip, or expose people within the area to excessive noise levels.	

Exhibit ES-4
SCP Environmental Factors with "Less Than Significant Impact" or "No Impact" *(continued)* *Page 4 of 5*

Environmental Factors	Impact Level: Less Than Significant	Impact Level: No Impact	Discussion *The SCP will not:*	Incorporation by Reference
XIII. POPULATION AND HOUSING — Would the project:				
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?	[ ]	[X]	Induce population growth in the area.	*EDCP Final EIR* (2001), DBW, Pages 2-47; 3-97
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?	[ ]	[X]	Displace existing housing.	
c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?	[ ]	[X]	Displace people.	
XIV. PUBLIC SERVICES — Would the project:				
a) Result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services:				*EDCP Final EIR* (2001), DBW, Pages 2-47; 3-96
Fire protection?	[ ]	[X]	Impact fire protection.	
Police protection?	[ ]	[X]	Impact police protection.	
Schools?	[ ]	[X]	Impact schools.	
Parks?	[ ]	[X]	Impact parks.	
Other public facilities?	[ ]	[X]	Impact other public facilities.	
XV. RECREATION — Would the project:				
a) Increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	[ ]	[X]	Result in substantial physical deterioration of neighborhood or regional parks due to increased use.	*EDCP Final EIR* (2001), DBW, Pages 2-40 to 2-41; 3-82 to 3-83
b) Include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?	[ ]	[X]	Include or require expansion of recreational facilities that would have an adverse physical effect on the environment.	
c) Would the project adversely impact existing recreational opportunities?	[X]	[ ]	Adversely impact existing recreational opportunities. The SCP would temporarily impact recreational boating at treatment sites, during treatment, however this impact would be less than significant. The SCP would have a beneficial impact on recreational boating in the Delta by controlling the growth of spongeplant.	

Exhibit ES-4
SCP Environmental Factors with "Less Than Significant Impact" or "No Impact" *(continued)* *Page 5 of 5*

Environmental Factors	Impact Level: Less Than Significant	Impact Level: No Impact	Discussion *The SCP will not:*	Incorporation by Reference
XVI. TRANSPORTATION/TRAFFIC — Would the project:				
a) Cause an increase in traffic which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections)?	[ ]	[X]	Cause an increase in traffic.	*EDCP Final EIR* (2001), DBW, Pages 2-38 to 2-39; EC-9
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?	[ ]	[X]	Exceed a level of service standard for designated roads or highways.	
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?	[ ]	[X]	Result in a change in air traffic patterns.	
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?	[ ]	[X]	Substantially increase hazards due to a design feature or incompatible uses.	
e) Result in inadequate emergency access?	[ ]	[X]	Result in inadequate emergency access.	
f) Result in inadequate parking capacity?	[ ]	[X]	Result in inadequate parking capacity.	
g) Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?	[ ]	[X]	Conflict with adopted policies, plans, or programs supporting alternative transportation.	

GROWTH-INDUCING IMPACTS[a] — Would the project:				
a) Foster economic or population growth?	[ ]	[X]	Foster economic or population growth.	*EDCP Final EIR* (2001), DBW, Page 7-1
b) Foster construction of additional housing, either directly or indirectly, in the surrounding environment? (Including removing obstacles to population growth).	[ ]	[X]	Foster construction of housing, either directly or indirectly.	
c) Encourage or facilitate other activities that could significantly affect the environment, either individually or cumulatively?	[ ]	[X]	Encourage or facilitate other activities that could affect the environment.	

[a] Growth-inducing impacts are not included within the environmental factors checklist, however, CEQA Guidelines, Section 15126.2(d) require a discussion of the growth-inducing impacts of the proposed project or program. Because the SCP will not result in growth-inducing impacts, the topic is included in this table of "Less Than Significant Impact" and "No Impact" factors.

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Section 1

Introduction

1. Introduction

The California Department of Parks and Recreation, Division of Boating and Waterways (DBW) operates the Spongeplant Control Program (SCP). The objective of the SCP is to keep waterways safe and navigable by controlling the growth and spread of spongeplant *(Limnobium laevigatum)* (referred to as spongeplant) in the Sacramento-San Joaquin Delta (Delta), its surrounding tributaries, and Suisun Marsh. Spongeplant is not yet well established in the Delta. Thus, the goals of the SCP will be to keep the spongeplant infestation at a low level and limit the spread of spongeplant in the Delta. The SCP balances potential impacts of spongeplant management by working to minimize non-target species impacts and to prevent environmental degradation in Delta waterways and tributaries.

In 2012, the California Legislature passed Assembly Bill 1540 (Buchanan, Chapter 188, Statutes of 2012) to add spongeplant to the two aquatic invasive weeds (water hyacinth and *Egeria densa*) that the Department of Parks and Recreation, Division of Boating and Waterways (DBW)[1] controls. DBW is designated as the lead agency to control these three species, in cooperation with federal, other state, local agencies, and districts. Section 64 of the Harbors and Navigation Code currently reads as follows:

> *"(a) The Legislature hereby finds and declares that the growth of water hyacinth (Eichhornia crassipes), Brazilian elodea (Egeria densa), and South American spongeplant (Limnobium laevigatum) in the Sacramento-San Joaquin Delta, its tributaries, and the Suisun Marsh has occurred at an unprecedented level and that the resulting accumulations of water hyacinth (Eichhornia crassipes), Brazilian elodea (Egeria densa), and South American spongeplant (Limnobium laevigatum) obstruct navigation, impair other recreational uses of waterways, have the potential for damaging manmade facilities, and may threaten the health and stability of fisheries and other ecosystems within the delta and marsh. Accordingly, it is necessary that the state, in cooperation with agencies of the United States, undertake an aggressive program for the effective control of water hyacinth (Eichhornia crassipes), Brazilian elodea (Egeria densa), and South American spongeplant (Limnobium laevigatum) in the delta, its tributaries, and the marsh.*
>
> *(b) The department 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 (Eichhornia crassipes), Brazilian elodea (Egeria densa), and South American spongeplant (Limnobium laevigatum) in the delta, its tributaries, and the marsh."*

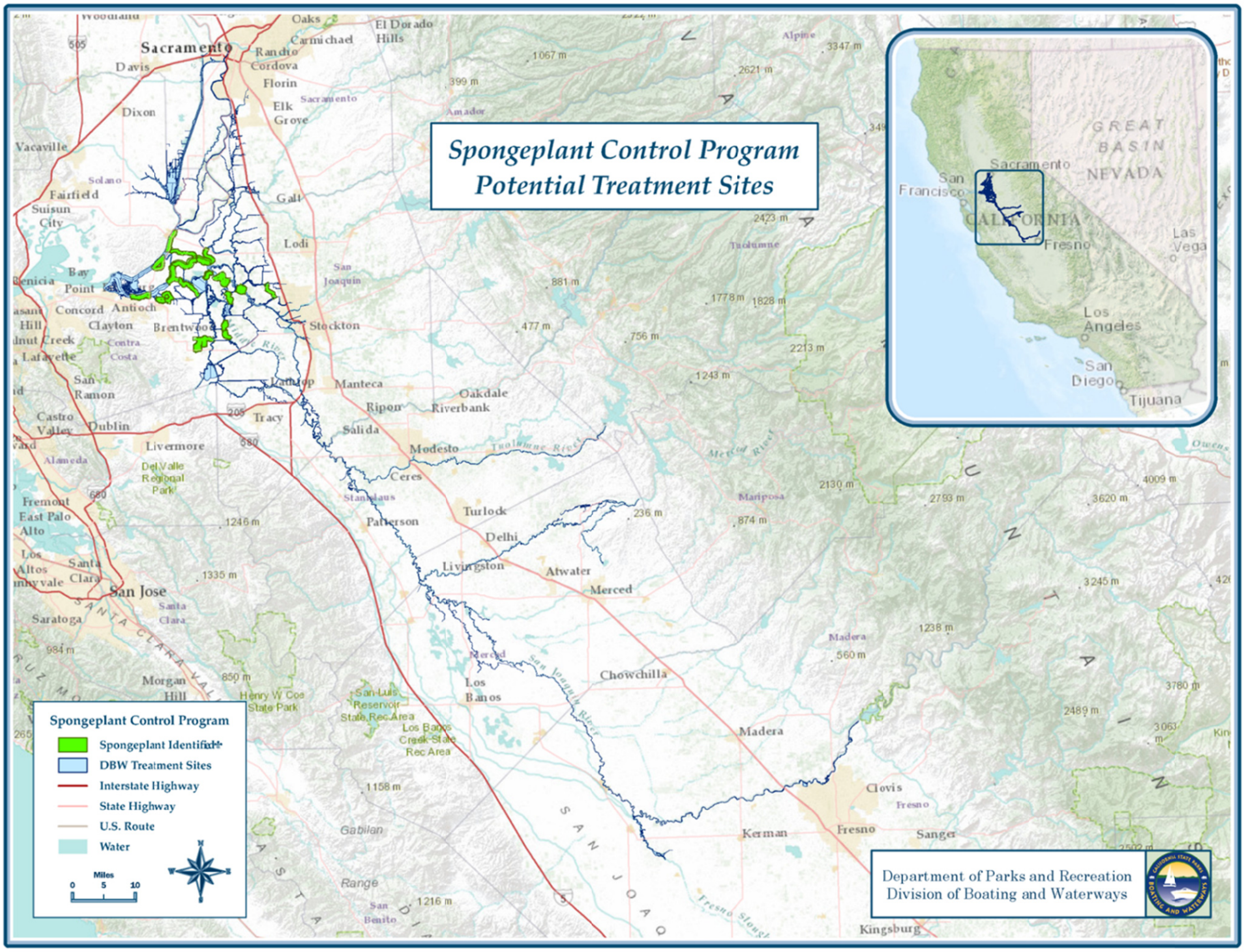
Exhibit 1-1, on the next page, illustrates the location of the SCP. The SCP will operate within the Delta, and three major tributaries: the San Joaquin, Merced, and Tuolumne Rivers. The location of the SCP is identical to the locations of the Water Hyacinth Control Program (WHCP) and *Egeria densa* Control Program (EDCP). **Exhibit 1-2,** on page 1-4, provides an illustration of the legal boundaries of the Sacramento-San Joaquin Delta, as defined by Section 12220 of the California Water Code.[i]

This chapter of the Final Program Environmental Impact Report (PEIR) describes the approach, describes the purpose, and provides background on spongeplant. This chapter is organized as follows:

A. *Organization of the SCP Final PEIR*
B. *Purpose of the SCP Final PEIR*
C. *Background of Spongeplant.*

[1] As of July 1, 2013, the California Department of Boating and Waterways became the Division of Boating and Waterways within the California Department of Parks and Recreation.

Exhibit 1-1
The SCP Project Area



(Spongeplant locations as reported by DBW.)

A. Organization of the SCP Final PEIR

The DBW, as the lead agency under the California Environmental Quality Act (CEQA), has prepared this Final PEIR. This Final PEIR satisfies the procedural, analytical, and public disclosure requirements of CEQA. DBW has prepared this document pursuant to CEQA Guidelines (Title 14. California Code of Regulations, Section 15000 et. seq.). This Final PEIR is a programmatic EIR, as defined in CEQA Guidelines, Section 15168.

This Final PEIR is organized as follows:

Volume I – Chapters 1 to 7

- **Executive Summary** – provides overview of the Final PEIR and SCP, the SCP Environmental Checklist of environmental factors potentially affected by the SCP, and summary of mitigation measures.

- **Chapter 1: Introduction** – describes the organization and purpose of the Final PEIR. This chapter also provides background on spongeplant.
- **Chapter 2: Program Description and Program Alternatives** – provides a description of SCP locations, operations, permits, compliance, and monitoring. This chapter also describes project alternatives, including those that are not considered for further analysis.
- **Chapter 3: Biological Resources Impacts Assessment** – provides descriptions of the environmental setting, potentially significant impacts, and mitigation measures related to SCP potential impacts on biological resources. This chapter includes discussions of potentially impacted special status species and critical habitats.
- **Chapter 4: Hazards and Hazardous Materials Impacts Assessment** – provides descriptions of the environmental setting, potentially significant impacts, and mitigation measures related to SCP potential impacts on worker safety and hazardous materials in the environment.
- **Chapter 5: Hydrology and Water Quality Impacts Assessment** – provides descriptions of the environmental setting, potentially significant impacts, and mitigation measures related to SCP potential impacts on water quality.
- **Chapter 6: Utilities and Service Systems and Agricultural Resources Impacts Assessments** – provides descriptions of the environmental setting, potentially significant impacts, and mitigation measures related to SCP potential impacts on water utility intake pumps, agricultural crops, and agricultural irrigation pumps.
- **Chapter 7: Cumulative Impacts Assessment** – discusses the potential cumulative impacts of the SCP when considered in combination with other projects and programs in the Delta.
- **References** – contains references used in the preparation of the Final EIR.

Appendices – the following appendices provide additional information on the environmental review process, technical information that was used in the EIR analysis, and SCP procedures.

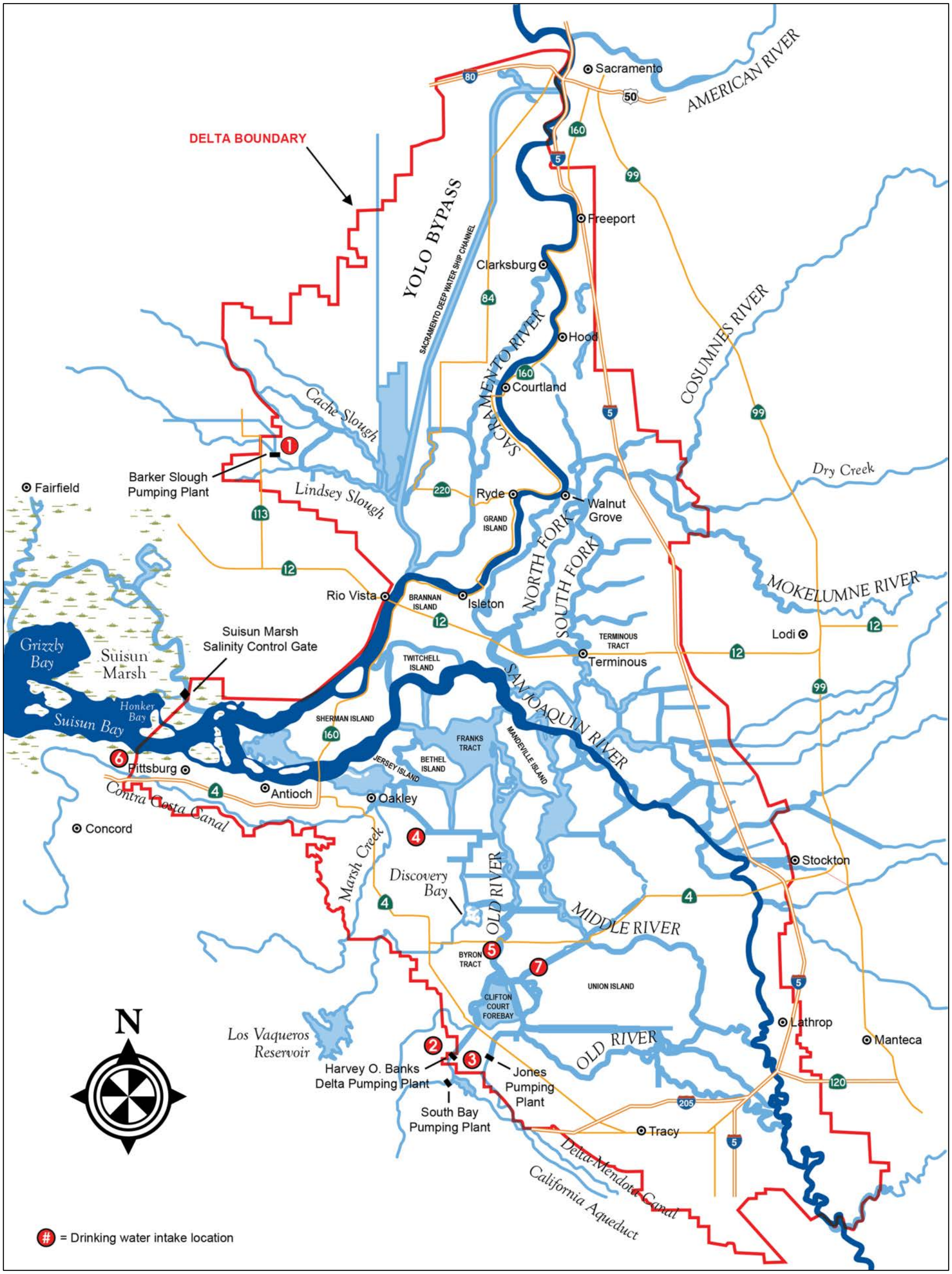
Volume II – Appendices

- **Appendix A: SCP Permits** – provides copies of the current SCP National Pollutant Discharge Elimination System (NPDES) permit; and the most recent versions of USFWS and NMFS Biological Opinion or Letter of Concurrence (when available).
- **Appendix B: SCP Herbicide Labels and Material Safety Data Sheets** – provides copies of labels and material safety data sheets for SCP herbicides and adjuvants.
- **Appendix C: WHCP/SCP Operations Management Plan** – provides a detailed description of SCP operations.
- **Appendix D: Fish Passage Protocol** – provides procedures to allow for fish passage during treatment.
- **Appendix E: SCP Environmental Checklist** – provides a checklist reference that can be used by SCP field crews to help implement the mitigation measures in this PEIR.
- **Appendix F: SCP Maps** – provides 11” x 17” versions of map exhibits in Volume I.

B. Purpose of the SCP Final PEIR

With preparation of this SCP Final PEIR, the DBW is seeking to complete environmental documentation for the SCP. This Final PEIR for the SCP provides the DBW with the opportunity to carefully evaluate this new program within the current context of the Delta environment and its current treatment practices for the WHCP and EDCP. Much has changed in the Delta since DBW began controlling aquatic weeds in 1983. The list of threatened and endangered species has expanded, new (potentially less toxic) aquatic herbicides and adjuvants have been added to the program, and there are significant new water quality and environmental concerns in the Delta.

Exhibit 1-2
The Sacramento-San Joaquin Delta Legal Area



This SCP Final PEIR provides environmental documentation parity with other aquatic invasive weed programs. Over the last several years, agencies implementing new aquatic invasive weed control programs in California have prepared EIRs:

- In 2001, the DBW prepared an EIR for the *Egeria densa* Control Program
- In 2003, the State Coastal Commission and U.S. Fish and Wildlife Service prepared an EIR/EIS for the Spartina Control Program
- In 2005, Lake County prepared a PEIR for their Clear Lake Integrated Aquatic Plant Management Plan
- In 2009, DBW prepared a PEIR for the Water Hyacinth Control Program.

There are two important characteristics of the SCP which make it somewhat different from many projects or programs that require EIRs. First, like the four aquatic invasive weed programs identified above, the SCP has long-term beneficial impacts. These beneficial impacts are in contrast to potential short-term detrimental impacts resulting from spongeplant control alternatives. Discussions of the overall environmental impact of the SCP must take into account trade-offs between potential short-term negative impacts and long-term positive impacts.

Second, as noted previously, the SCP is a legislatively mandated State of California program. The SCP is being implemented in order to address potential environmental, navigational, and economic problems created by spongeplant in the Delta.

C. Background of Spongeplant

1. History of Spongeplant Invasion

South American spongeplant (*Limnobium laevigatum* (Hub & Bonpl. Ex Willd.Heine)) is native to South America, Central America, and Central Mexico. It occurs from sea level to 2,800 meters (Cook and Urmi-König 1983). Spongeplant was first seen in California in a pond system in the East Bay in 1996 (Akers 2010a). This infestation was eradicated. The next identified infestations of spongeplant were found in 2003 in ponds near Arcata and Redding. By 2005, when the Redding pond was first treated, spongeplant had grown into a dense mat that out-competed native water primrose and parrotsfeather. The mat was dense enough that grass was growing on top of the spongeplant (Akers 2010a). (See picture, below).

Photo: Spongeplant in a Redding pond (courtesy of CDFA).

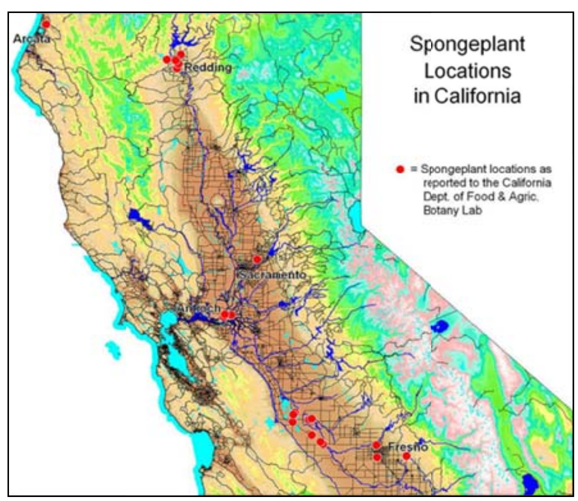


Photo: Spongeplant locations as of 2010 (courtesy of CDFA).

In 2007, spongeplant was identified in the Sacramento-San Joaquin Delta near Antioch. The Antioch infestation apparently was washed out of the Delta after a storm. In 2008, spongeplant was identified in irrigation canals near Fresno. In 2009 and 2010, spongeplant was found again in the Delta. In 2013, spongeplant was identified in twenty locations within the Delta. Most mats were small (no more than 30 square feet), and many were inter-mixed with other aquatic plants (native and non-native). Spongeplant is found mixed in, and under, other plants at many of the current spongeplant locations in the Delta. Spongeplant has also been seen in Riverside and Monterey counties.

In 2010, CDFA classified spongeplant as “A-rated (control action required), but more information needed” (Calflora 2013). In 2011, the California Invasive Plant Council (Cal-IPC) classified spongeplant as a high-alert invasive plant. The Cal-IPC assessment identified the threat from spongeplant as “severe” due to potential impacts on abiotic ecosystem processes, plant communities, higher tropic levels, and the role of anthropogenic and natural disturbance in establishment (Cal-IPC 2011). CDFA has been treating and removing spongeplant in various locations since 2005.

The invasion of spongeplant in California, and the Delta specifically, is relatively new. By comparison, water hyacinth was first found in the Delta in1904. Scientific literature identifies four general stages of invasion: 1) transport, 2) colonization, 3) establishment and 4) spread (Theoharides and Dukes 2007). The stages are defined as follows:

- Transport – intercontinental movement of a species into a new region
- Colonization – survival in the new region and achievement of positive growth rates at low densities
- Establishment – colonization of a site and development of self-sustaining, expanding populations
- Spread – dispersal within a region over significantly longer time periods, with the region containing groups of populations.

The movement of an invasive plant along this spectrum occurs when the plant overcomes a series of barriers or filters characteristic to each stage. For example, barriers during the colonization phase include propagule pressure, genetic variation, reasons for introduction and spatial distribution of the introduction (Theoharides and Dukes 2007).

In 2014, spongeplant in the Delta falls into the colonization and/or establishment phase. Spongeplant can be further classified as being in a lag phase. The lag phase is a well-documented time period between establishment and spread of an invasive species (Theoharides and Dukes 2007; Sakai et al. 2001; Pysek and Hulme 2005; Barney 2006). Many studies have found a slow initial spread in which the species occurs in a few isolated locales (lag phase), followed by a rapid expansion phase (exponential phase), and a phase with little or no expansion (Pysek and Hulme 2005).

The lag phase can vary widely in time. For example, Barney (2006) studied the invasion of two plants into a similar ecosystem. Mugwort had a lag phase of 400 years; Japanese knotweed had a lag phase of 50 years. The extent of the lag phase is thought to reflect a combination of spatial and temporal factors. The spread of invasive species is highly variable, with average rates of local spread reported in the literature of 2 meters per year to 370 meters per year (Pysek and Hulme 2005). Pysek and Hulme note that non-native species have considerable potential to spread over large areas in a relatively short time. The lag phase may represent the time necessary for the population to reach a threshold size that allows it to spread (Sakai et al. 2001; Barney 2006).

Spongeplant has characteristics that promote its further establishment and spread, such as multiple reproductive strategies, fast growth, short juvenile period, and seeds that germinate without pretreatment (Theoharides and Dukes 2007; Sakai et al. 2001). These factors could reduce the lag phase. However, aggressive management of spongeplant, through the SCP, could increase the lag phase, and reduce the further spread of spongeplant. The SCP should seek to keep spongeplant from reaching the exponential growth phase, or to prolong the transition to the exponential phase as long as possible.

2. Characteristics of Spongeplant

Spongeplant is a floating aquatic plant that grows in dense floating mats or rooted in mud or wetland edges (Akers 2010b). Spongeplant consists of leafy rosettes in a complex branching system (Cook and Urmi-König 1983). The root system is usually branched. Flowers are unisexual; however, male and female flowers exist on the same plant.

Spongeplant leaves have pads of aerenchyma (spongy air spaces) on the undersides that provide buoyancy. When plants are less dense, the leaves lay horizontally on the water. Under optimal conditions, and when plants are more dense, the leaves become vertical. Vertical leaves are typically associated with flowering (Cook and Urmi-König 1983). 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, with abundant seed pods and seedlings. Flowering and seed production appear to be heaviest when temperatures warm in May and June, although flowering continues into the fall (Akers 2010b). Spongeplant pollination is thought to occur by wind (Cook and Urmi-König 1983). Spongeplant fruits develop under water. Seeds are released and germinate underwater when the fruit ruptures; seedlings float to the surface (Cook and Urmi-König 1983). Seedlings are extremely small, and may be mistaken for duckweed (Anderson 2011a). Seedlings disperse easily by wind, currents, and tidal action. They may also be dispersed by waterfowl, boats, and other mobile plants such as water hyacinth (Anderson 2011b). Spongeplant seeds survive over multiple seasons, as evidenced by a pond in Redding where spongeplant seedlings have appeared over three seasons, even though mature plants have not been evident since 2007 (Akers 2010b).

In its native region, spongeplant is found in bogs, swamp, lakes, pools, ponds, and along margins of rivers (Cook and Urmi-König 1983). Spongeplant appears to prefer slow or still waters, sheltered from the wind. In California, spongeplant has also been found along the edges of fast-moving rivers (Akers 2010b). The spongeplant growing near Antioch in 2007 was in a location where salt water intrusion and tides could be a factor. Spongeplant is found in fresh water; the plant's ability to tolerate low salinity levels is unknown.

Spongeplant is found in wet climates with winter temperatures above 0°C (Cook and Urmi-König 1983). In the Delta, spongeplant seedlings from 0.2 cm to 2 cm in diameter have survived frost and mild freezes (Anderson 2011). Spongeplant stays protected under taller-statured plants such as water hyacinth, cattails and tules. Spongeplant begins to grow as temperatures and day length increase. USDA-ARS has identified green seedlings in February.

Spongeplant grows in extremely dense mono-specific mats, similar to water hyacinth. It has the capacity to cover large areas of open water, and can cause significant reductions in dissolved oxygen (Cal-IPC 2011). Dense spongeplant mats have the potential to block open water needed by waterfowl and other wildlife, as well as negatively impact pumps in the Delta.

Characteristics of spongeplant that make the plant challenging to manage and increase the potential of spread include spongeplant's:

- Growth in and amongst other aquatic plants
- Abundant seed production throughout the growing season
- Reproductive strategies (vegetative and seed production)
- Survival of seeds over multiple years
- Dispersement by waves, tides, wind and waterfowl
- Relative growth rate, nearly twice as fast as water hyacinth
- High density, with 2,000 to 2,500 plants per square meter
- Small size and vertical orientation of leaves (making herbicide application difficult).

[i] The legal definition of the Sacramento-San Joaquin Delta is as follows. These boundaries are reflected in Exhibit 1-2. 12220. The Sacramento-San Joaquin Delta shall include all the lands within the area bounded as follows, and as shown on the attached map prepared by the Department of Water Resources titled "Sacramento-San Joaquin Delta," dated May 26, 1959:

Beginning at the Sacramento River at the I Street bridge proceeding westerly along the Southern Pacific Railroad to its intersection with the west levee of the Yolo By-Pass; southerly along the west levee to an intersection with Putah Creek, then westerly along the left bank of Putah Creek to an intersection with the north-south section line dividing sections 29 and 28, T8N, R6E; south along this section line to the northeast corner of section 5, T7N, R3E; west to the northwest corner of said section; south along west boundary of said section to intersection of Reclamation District No. 2068 boundary at northeast corner of SE 1/4 of section 7, T7N, R3E; southwesterly along Reclamation District No. 2068 boundary to southeast corner of SW 1/4 of section 8, T6N, R2E; west to intersection of Maine Prairie Water Association boundary at southeast corner of SW 1/4 of section 7, T6N, R2E; along the Maine Prairie Water Association boundary around the northern and western sides to an intersection with the southeast corner of section 6, T5N, R2E; west to the southwest corner of the SE 1/4 of said section; south to the southwest corner of the NE 1/4 of section 7, T5N, R2E; east to the southeast corner of the NE 1/4 of said section; south to the southeast corner of said section; west to the northeast corner of section 13, T5N, R1E; south to the southeast corner of said section; west to the northwest corner of the NE 1/4 of section 23, T5N, R1E; south to the southwest corner of the NE 1/4 of said section; west to the northwest corner of the SW 1/4 of said section; south to the southwest corner of the NW 1/4 of section 26, T5N, R1E; east to the northeast corner of the SE 1/4 of section 25, T5N, R1E; south to the southeast corner of said section; east to the northeast corner of section 31, T5N, R2E; south to the southeast corner of the NE 1/4 of said section; east to the northeast corner of the SE 1/4 of section 32, T5N, R2E; south to the northwest corner of section 4, T4N, R2E; east to the northeast corner of said section; south to the southwest corner of the NW 1/4 of section 3, T4N, R2E; east to the northeast corner of the SE1/4 of said section; south to the southwest corner of the NW 1/4 of the NW 1/4 of section 11, T4N, R2E; east to the southeast corner of the NE 1/4 of the NE 1/4 of said section; south along the east line of section 11, T4N, R2E to a road intersection approximately 1000 feet south of the southeast corner of said section; southeasterly along an unnamed road to its intersection with the right bank of the Sacramento River about 0.7 mile upstream from the Rio Vista bridge; southwesterly along the right bank of the Sacramento River to the northern boundary of section 28, T3N, R2E; westerly along the northern boundary of sections 28, 29, and 30, T3N, R2E and sections 25 and extended 26, T3N, R1E to the northwest corner of extended section 26, T3N, R1E; northerly along the west boundary of section 23, T3N, R1E to the northwest corner of said section; westerly along the northern boundary of sections 22 and 21, T3N, R1E to the Sacramento Northern Railroad; southerly along the Sacramento Northern Railroad; southerly along the Sacramento Northern Railroad to the ferry slip on Chipps Island; across the Sacramento River to the Mallard Slough pumping plant intake channel of the California Water Service Company; southward along the west bank of the intake channel and along an unnamed creek flowing from Lawler Ravine to the southern boundary of the Contra Costa County Water District; easterly along the southern boundary of the Contra Costa County Water District to the East Contra Costa Irrigation District boundary; southeasterly along the southwestern boundaries of the East Contra Costa Irrigation District, Byron-Bethany Irrigation District, West Side Irrigation District and Banta-Carbona Irrigation District to the northeast corner of the NW 1/4 of section 9, T3S, R6E; east along Linne Road to Kasson Road; southeasterly along Kasson Road to Durham Ferry Road; easterly along Durham Ferry Road to its intersection with the right bank of the San Joaquin River at Reclamation District No. 2064; southeasterly along Reclamation District No. 2064 boundary, around its eastern side to Reclamation District No. 2075 and along the eastern and northern sides of Reclamation District No. 2075 to its intersection with the Durham Ferry Road; north along the Durham Ferry Road to its intersection with Reclamation District No. 17; along the eastern side of Reclamation District No. 17 to French Camp Slough; northerly along French Camp Turnpike to Center Street; north along Center Street to Weber Avenue; east along Weber Avenue to El Dorado Street; north along El Dorado Street to Harding Way; west along Harding Way to Pacific Avenue; north along Pacific Avenue to the Calaveras River; easterly along the left bank of the Calaveras River to a point approximately 1,600 feet west of the intersection of the Western Pacific Railroad and the left bank of said river; across the Calaveras River and then north 18* 26' 36 west a distance of approximately 2,870 feet; south 72* 50' west a distance of approximately 4,500 feet to Pacific Avenue (Thornton Road); north along Pacific Avenue continuing onto Thornton Road to its intersection with the boundary line dividing Woodbridge Irrigation District and Reclamation District No. 348; east along this boundary line to its intersection with the Mokelumne River; continuing easterly along the right bank of the Mokelumne River to an intersection with the range line dividing R5E and R6E; north along this range line to the Sacramento-San Joaquin County line; west along the county line to an intersection with Reclamation District No. 1609; northerly along the eastern boundary of Reclamation District No. 1609 to the Cosumnes River, upstream along the right bank of the Cosumnes River to an intersection with the eastern boundary of extended section 23, T5N, R5E; north along the eastern boundary of said extended section to the southeast corner of the NE 1/4 of the NE 1/4 of said extended section; west to the southeast corner of the NE 1/4 of the NW 1/4 of extended section 14, T5N, R5E; west to an intersection with Desmond Road; north along Desmond Road to Wilder-Ferguson Road; west along Wilder-Ferguson Road to the Western Pacific Railroad; north along the Western Pacific Railroad to the boundary of the Elk Grove Irrigation District on the southerly boundary of the N 1/2 of section 4, T5N, R5E; northerly along the western boundary of the Elk Grove Irrigation District to Florin Road; west on Florin Road to the eastern boundary of Reclamation District No. 673; northerly around Reclamation District No. 673 to an intersection with the Sacramento River and then north along the left bank of the Sacramento River to I Street bridge. Section, range, and township locations are referenced to the Mount Diablo Base Line and Meridian. Road names and locations are as shown on the following United States Geological Survey Quadrangles, 7.5 minute series: Rio Vista, 1953; Clayton, 1953; Vernalis, 1952; Ripon, 1952; Bruceville, 1953; Florin, 1953; and Stockton West, 1952.

Section 2

Program Description and Program Alternatives

2. Program Description and Program Alternatives

This chapter of the Final PEIR describes SCP objectives, program alternatives, and the selected control alternative. This chapter is organized as follows:

A. Program Overview and Objectives

B. Program Area

C. Program Alternatives

D. Selected Program Alternative.

A. Program Overview and Objectives

The objective of the SCP is to keep waterways safe and navigable by controlling the growth and spread of spongeplant in the Delta, its surrounding tributaries, and Suisun Marsh. Because of the difficulty of controlling aquatic weeds in the Delta, the SCP legislative mandate is for control, rather than eradication of spongeplant. Spongeplant is not yet well established in the Delta. Thus, the goals of the SCP will be to keep the spongeplant infestation at a low level and limit the spread of spongeplant in the Delta. DBW seeks to manage spongeplant growth while minimizing non-target plant and species impacts and preventing environmental degradation in Delta waterways and tributaries.

Through the SCP, DBW clears spongeplant and maintains adequate navigation channels for Delta users; and clears spongeplant areas surrounding marinas, launch ramps, pumping facilities, and intake pipes. Another important SCP objective is to improve habitat for native species by reducing the negative impacts of spongeplant on surrounding ecosystems. This objective links directly to the Bay Delta Conservation Plan (BDCP) Conservation Measure (CM) 13 for invasive aquatic vegetation control. By clearing Delta spongeplant, DBW contributes to the creation of shallow-water habitat suitable for native species.

DBW utilizes treatment protocols that balance the need to control spongeplant with the need to minimize resulting environmental impacts to Delta waterways. **Table 2-1,** on the next page, identifies a total of ten specific objectives for the SCP. Table 2-1 also identifies performance measures (i.e. expected outcomes) that DBW uses to evaluate success of the SCP in meeting these project objectives.

The SCP will operate under the following three permits/guiding documents:

- NPDES Statewide General Permit (CAG990005)
- A USFWS Biological Opinion (currently in the consultation process)
- A National Oceanic and Atmospheric Administration- National Marine Fisheries Service (NMFS) Letter of Concurrence or Biological Opinion (currently in the consultation process).

These documents will substantially guide program operations, and are described in Subsection D.

B. Program Area

The SCP includes portions of eleven counties that encompass much of the Sacramento-San Joaquin Delta and its upland tributaries. The eleven counties include: Alameda, Contra Costa, Fresno, Madera, Merced, Sacramento, San Joaquin, Solano, Stanislaus, Tuolumne, and Yolo. The general boundaries for the treatment area in the Delta and its tributaries 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.

Within the SCP project area, there are approximately 418 possible treatment sites that average between one and two miles in length. **Exhibit 2-1a,** on the following page, provides a map of the Northern Sites of the SCP project area. **Exhibit 2-1b,** on page 2-4, provides a map of the Southern Sites.

Table 2-2, on page 2-5, provides a listing of the nineteen numbered treatment sites where spongeplant had been seen by DBW as of December 2013. The list of spongeplant locations within the Delta will continue to expand as the plant moves and spreads to new sites.

Table 2-1
SCP Objectives and Performance Measures

Objectives	Performance Measures
1. Limit future growth and spread of spongeplant in the Delta. Seek to maintain the spongeplant invasion at a low level. 2. Reduce potential for reinfestation by extensively monitoring spongeplant occurrence at sites following treatment. 3. Maintain boat and vessel navigation in the Delta. 4. Utilize the most efficacious treatment methods available with the least environmental impacts. 5. Prioritize sites as necessary so that SCP activities are focused on sites with a high degree of infestation and potential to spread. To the extent necessary, prioritize sites with navigational, agricultural, environmental, recreational, or public safety importance. 6. Employ a combination of control methods to allow maximum program flexibility. 7. Improve SCP as more information is available on appropriate control methods for the Delta. 8. Monitor results of SCP to fully understand its impacts on the environment. 9. Improve shallow-water habitat for native species by controlling spongeplant. 10. Minimize use of control methods that could cause adverse environmental impacts.	■ Minimize total acres infested with spongeplant ■ Reduce spongeplant biomass, including at high priority navigation sites currently infested with spongeplant ■ Reduce spongeplant biomass at nursery sites ■ Number of monitoring events and spongeplant occurrence at follow-up monitoring ■ Prevent spongeplant infestation of new sites ■ Prevent incidents of boat navigation, agricultural, recreation, and public safety incidents related to spongeplant ■ Prepare reports for regulatory agencies and the public summarizing SCP monitoring results ■ Minimize SCP environmental impacts, as measured by compliance with program permits ■ Increase efficacy of SCP, and of each control method over time ■ Increase the number of shallow-water sites suitable for native species ■ Limit the number of, and significance of, environmental impacts resulting from SCP ■ Limit the number of SCP acres treated with methods that have the potential for adverse environmental impacts.

Exhibit 2-1a
SCP Project Area Map – Northern Sites

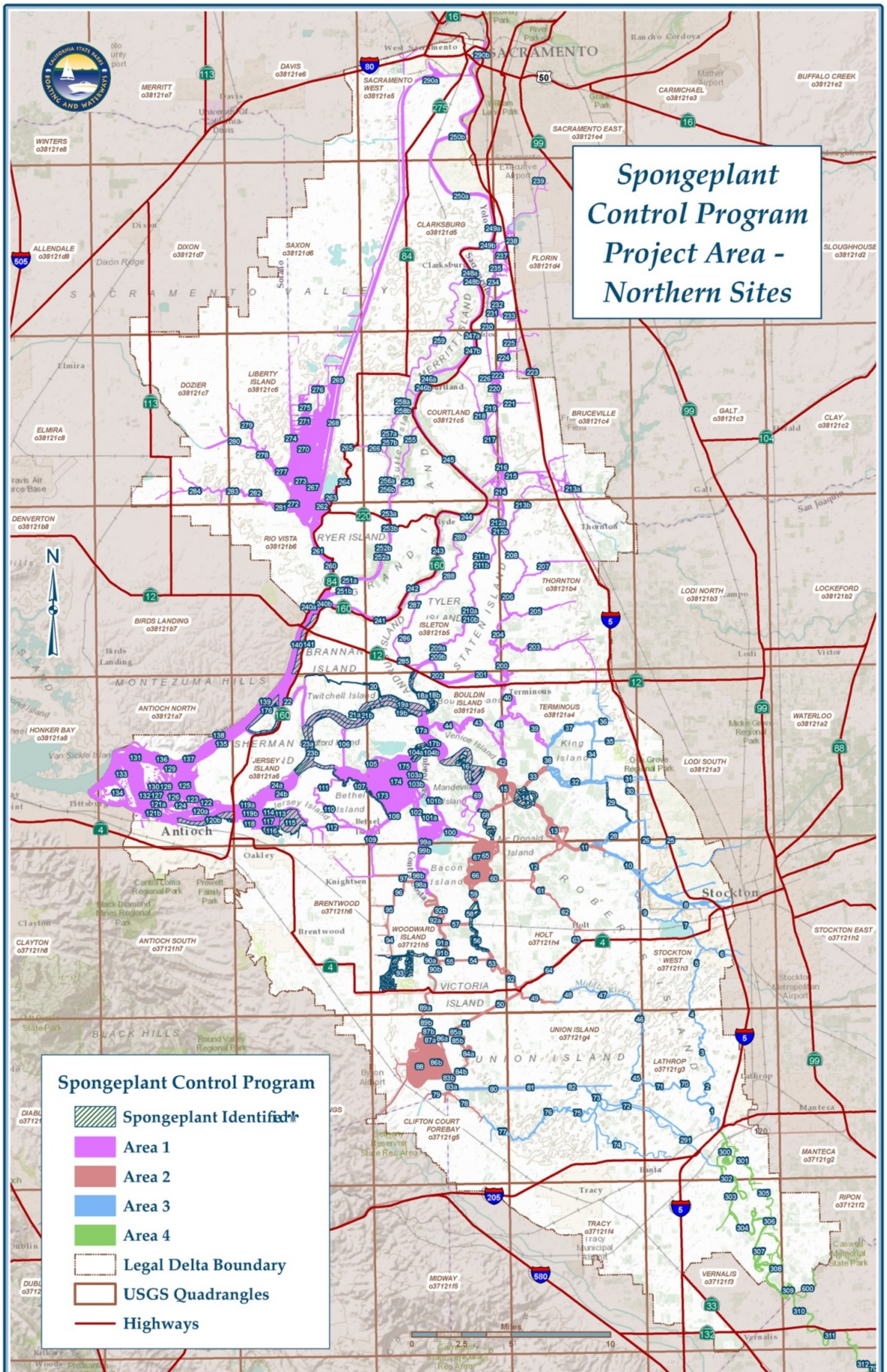


Exhibit 2-1b
SCP Project Area Map – Southern Sites

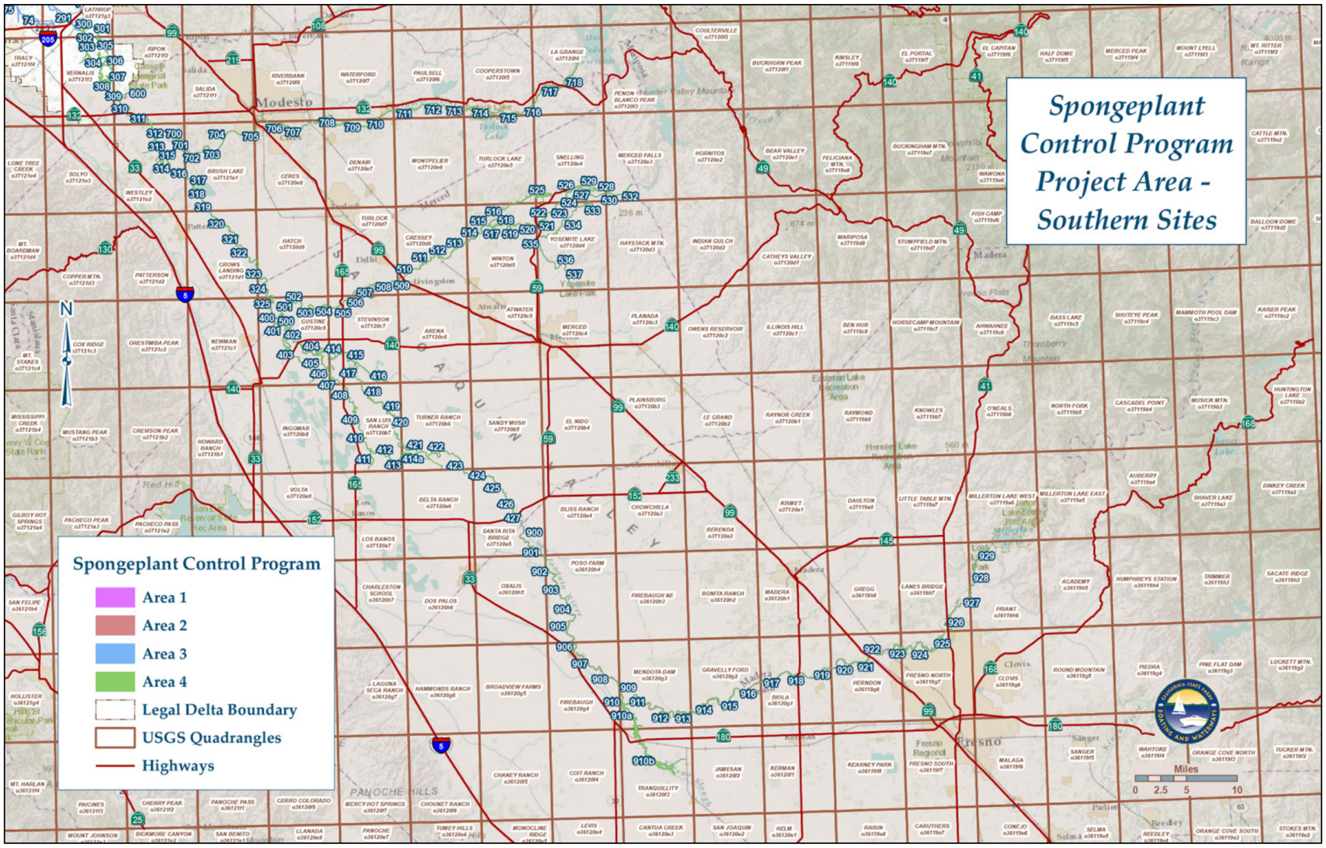


Table 2-2
SCP Treatment Sites as Reported by DBW

Site Number(s)	County	Location	Water-Type(s)
14	San Joaquin	▪ Fern Island ▪ Headreach Island ▪ Tule Island	▪ Tidal
16	San Joaquin	▪ Three River Reach ▪ Venice Cut	▪ Tidal
18a 18b	Sacramento San Joaquin	▪ Mokelumne River	▪ Tidal
19a 19b	Contra Costa San Joaquin	▪ San Joaquin River	▪ Tidal
20	Sacramento	▪ Three Mile Slough ▪ Seven Mile Cut	▪ Tidal
21a 21b	Contra Costa Sacramento	▪ San Joaquin River	▪ Tidal
23a 23b	Contra Costa Sacramento	▪ False River ▪ San Joaquin River	▪ Tidal
29	San Joaquin	▪ Fourteen Mile Slough	▪ Tidal
56	San Joaquin	▪ Middle River	▪ Tidal
58	San Joaquin	▪ Middle River	▪ Tidal
93	Contra Costa	▪ Discovery Bay	▪ Tidal
104	San Joaquin	▪ Piper Slough	▪ Tidal
107	Contra Costa	▪ Sugar Barge	▪ Tidal
115	San Joaquin	▪ Big Break	▪ Tidal
116	San Joaquin	▪ Big Break	▪ Tidal
120b	Contra Costa	▪ San Joaquin River, Sportsman Yacht Club	▪ Tidal
141	Solano	▪ Brannan Island	▪ Tidal
176	Solano	▪ Decker Island	▪ Tidal

C. Program Alternatives

CEQA requires that an EIR (or PEIR) discuss a reasonable range of alternatives that could avoid, or substantially lessen, the significant environmental impacts of the proposed program, even if the alternative might impede to some degree attainment of program objectives, or the alternative would be more costly. The discussion of each program alternative should provide sufficient information about each alternative to allow meaningful evaluation, analysis, and comparison with the proposed program. An EIR must also evaluate the impacts of the "No Program Alternative" to allow decision makers to compare the impacts of approving the proposed program with the impacts of not approving the proposed program.

This subsection identifies, discusses, and compares program alternatives for controlling spongeplant in the Delta and surrounding tributaries, including the selected alternative and a No Program Alternative. This subsection also briefly discusses alternatives that the DBW considered, but rejected as infeasible. **Exhibit 2-2,** starting on the next page, provides a summary of the expected impacts of program alternatives 2 through 6 on the five resource areas for which the SCP has potentially significant impacts.

In over thirty years of operating aquatic weed control programs in the Delta, the DBW has examined and tested a broad range of potential control methods. Reflecting an adaptive management approach, the SCP is designed to incorporate new information and experience. The selected SCP alternative reflects DBW's prior experience, and provides flexibility to continue to adapt the program over time.

Program Alternative 1 (Selected Alternative) – Integrated Management

The selected program alternative consists of an integrated management approach, emphasizing chemical treatment, with hand removal with nets, herding, and mechanical removal. Use of mechanical harvesting and herding will only take place if, and when, spongeplant infestations reach a level that would warrant these approaches. DBW will also work with their partners to evaluate biological controls for spongeplant. Selected herbicides are 2,4-D, glyphosate, penoxsulam, imazamox, and diquat. All herbicides will be applied with an adjuvant, Agridex or Competitor. DBW will continue to research and evaluate other less toxic herbicides and adjuvants.

In addition to herbicide treatments, the SCP proposes to utilize hand removal with nets, herding, and mechanical removal. These approaches can help reduce the need for herbicides.

Hand removal with nets will be a primary removal method for SCP. Spongeplant often grows in very small patches under water hyacinth or native plants. Hand removal with pool-skimmer type nets allows treatment crews to selectively extract young plants from among other plants.

Herding will be used if, and when, spongeplant mats reach a large enough size to be warranted, approximately 0.5 to 1 acre. Herding may be used to push spongeplant mats into: (1) main channels where it flows naturally out of the Delta and dies in the more saline water of San Francisco Bay; or, (2) toward mechanical removal sites.

The SCP 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. These mechanical removal methods will be utilized if spongeplant mats reach a large enough size to be warranted, e.g. similar in extent to water hyacinth (1,000+ acres in total).

The DBW is also working with the United States Department of Agriculture – Agricultural Research Service (USDA-ARS) to research viable biological control methods for spongeplant. Because spongeplant is a new invasive species, there are currently no known biological control agents. Thus, it could be five to ten years, at a minimum, before these research efforts provide viable control agents.

For each particular season and treatment site, DBW will evaluate characteristics of the site, and select the most appropriate treatment option(s).

The selected program alternative will be guided by the general NDPES permit and future USFWS and NMFS biological opinions and/or letters of concurrence issued for the program. Subsection D of this chapter describes the approach, permits, operations, and environmental monitoring for program alternative 1 in more detail.

Program Alternative 2 – Chemical Control Only

The chemical control only alternative would include only the chemical control aspects of the selected program alternative. DBW would utilize 2,4-D, glyphosate, penoxsulam, imazamox, and diquat to treat spongeplant, following program operational requirements. This alternative would not include hand removal with nets, herding, or mechanical removal.

Exhibit 2-2
Comparison of SCP Alternatives

Page 1 of 2

Resource	Program Alternative 2 – Chemical Control Only	Program Alternative 3 – Hand Removal with Nets Only	Program Alternative 4 – Herding Only	Program Alternative 5 – Mechanical Removal Only	Program Alternative 6 – No Program Alternative
1. Biological Resources	Under alternative 2, there would be the same potential impacts to biological resources due to herbicide use as discussed in Chapter 3, for the selected program alternative.	Under alternative 3 there would be no biological impacts due to herbicide use. Hand removal with nets would not result in impacts to biological resources; however, the increased growth in spongeplant due to the inability of hand removal with nets to effectively control the plant could result in direct and indirect negative impacts to biological resources.	Under alternative 4 there would be no biological impacts due to herbicide use. Herding would not result in impacts to biological resources; however, the increased growth in spongeplant due to the inability of herding to effectively manage the plant could result in direct and indirect negative impacts to biological resources.	Under alternative 5 there would be no biological impacts due to herbicide use; however, there is the potential for mechanical removal to kill, injure, or disturb mammals, birds, reptiles, amphibians, fish, and insects, and to damage or kill plants if not mitigated appropriately. This would result in potentially significant impacts to biological resources.	Under the no program alternative, uncontrolled growth of spongeplant would result in direct and indirect negative impacts to Delta ecosystems, fish habitat, and special status fish and plant species. To the extent that local landowners would conduct ad hoc chemical treatments, there would be additional potentially significant impacts to biological resources.
2. Hazards and Hazardous Materials	Under alternative 2, there would be the same potential impacts related to hazards and hazardous materials due to herbicide use as discussed in Chapter 4, for the selected program alternative.	Alternative 3 would result in no impacts related to hazards and hazardous materials.	Alternative 4 would result in no impacts related to hazards and hazardous materials.	Alternative 5 would result in no impacts related to hazards and hazardous materials.	Under the no program alternative, there would be no impacts related to hazards and hazardous materials, except to the extent that landowners conducted ad hoc chemical treatments.
3. Hydrology and Water Quality	Under alternative 2, there would be the same potential impacts to hydrology and water quality due to herbicide use as discussed in Chapter 5, for the selected program alternative.	Alternative 3 would result in no impacts to hydrology and water quality.	Alternative 4 would result in no significant impacts to hydrology and water quality.	Alternative 5 would not have a significant impact on Delta water quality or nutrient loading. There would be temporary impacts on turbidity.	Under the no program alternative, uncontrolled growth of spongeplant could result in reduced DO levels under spongeplant mats, however there would be no impacts to water quality due to herbicide treatments.

Exhibit 2-2
Comparison of SCP Alternatives *(continued)*

Page 2 of 2

Resource	Program Alternative 2 – Chemical Control Only	Program Alternative 3 – Hand Removal with Nets Only	Program Alternative 4 – Herding Only	Program Alternative 5 – Mechanical Removal Only	Program Alternative 6 – No Program Alternative
4. Utilities and Service Systems	Under alternative 2, there would be the same potential impacts to utilities and service systems due to herbicide use as discussed in Chapter 6, for the selected program alternative.	Under alternative 3, there would be less control of spongeplant than under the selected program alternative. This would potentially result in significant impacts to utility pump systems due to clogging by spongeplant.	Under alternative 4, there would be less control of spongeplant than under the selected program alternative. This would potentially result in significant impacts to utility pump systems due to clogging by spongeplant.	Under alternative 4, there would be less control of spongeplant than under the selected program alternative. Harvested spongeplant would increase solid waste generation, with potentially significant impacts.	Under the no program alternative, uncontrolled growth of spongeplant would result in potentially significant impacts to utility pump systems due to clogging by spongeplant.
5. Agricultural Resources	Under alternative 2, there would be the same potential impacts to agricultural resources due to herbicide use as discussed in Chapter 6 for the selected program alternative.	Under alternative 3, there would be less control of spongeplant than under the selected program alternative. This would potentially result in significant impacts to agricultural irrigation systems due to clogging by spongeplant. There would be no potential for negative impacts to crops due to herbicide treatments.	Under alternative 4, there would be less control of spongeplant than under the selected program alternative. This would potentially result in significant impacts to agricultural irrigation systems due to clogging by spongeplant. There would be no potential for negative impacts to crops due to herbicide treatments.	Under alternative 4, there would be less control of spongeplant than under the selected program alternative. This would potentially result in significant impacts to agricultural irrigation systems due to clogging by spongeplant. There would be no potential for negative impacts to crops due to herbicide treatments.	Under the no program alternative, uncontrolled growth of spongeplant would result in potentially significant impacts to agricultural irrigation systems due to clogging by spongeplant. There would be no potential for negative impacts to crops due to herbicide treatments.

The chemical control only alternative would result in all of the alternative 1 potential impacts related to use of herbicides, without the additional flexibility that an integrated management approach would provide. This chemical only approach would not allow for adaptive adjustment of treatment methods to site-specific and season-specific needs and requirements. In addition, the chemical only approach would not provide any treatment alternatives during the portions of the year when chemical treatments are limited or prohibited, or in areas where spongeplant is growing within native plants that might be harmed by herbicide treatments.

Program Alternative 3 – Hand Removal with Nets Only

The hand removal with nets only alternative would include expanded, year-round, hand removal with nets of spongeplant. Hand removal with nets program is generally conducted by two-person field crews utilizing boats, 30-gallon barrels, and pool skimmer nets. Each crew consists of one person driving the boat and one person removing spongeplant. The crew member would use the pool skimmer net to collect spongeplant and place it in 30-gallon barrels.

Once the 30-gallon barrels are filled, field crews would locate a dispersal area. Dispersal areas are defined as levees or other previously surveyed areas with no- habitat values to the federal and state listed threatened giant garter snake (*Thamnophis gigas*). Dispersal would also be located at least 100 feet away from elderberry shrubs (*Sambucus* ssp.) that are potential habitat for the federally threatened valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*).

DBW would leave spongeplant in these dispersal areas to desiccate naturally, and DBW would periodically monitor the dispersal areas to observe and record the fate of the spongeplant and any effects of dispersal activities.

Hand removal with nets avoids all impacts resulting from application of herbicides. Hand removal with nets is likely to result in impacts to utilities and agricultural irrigation due to the release of small plants that are not captured by the nets.

While hand removal-only volumes would be relatively low, a hand removal-only alternative would potentially result in solid waste impacts, as more spongeplant would be deposited on shorelines.

Hand removal with nets only would result in fewer recreational and ecosystem benefits, as compared to the selected program alternative, because significantly less spongeplant would be controlled in any given year.

While hand removal with nets provides a viable option to control spongeplant during the winter months, and in areas when chemicals cannot be used, hand removal with nets alone is not a feasible program alternative. Problems with this alternative include: high cost and labor requirements, potential solid waste impacts, and relatively low acres managed.

Program Alternative 4 – Herding Only

Herding refers to the moving of spongeplant mats by pushing or pulling mats from one location to another. Mats would be moved to removal locations or to the main channel. Once in a main channel, the spongeplant could flow out of the Delta, into saline waters and may die. The ability of spongeplant to survive in waters of greater than 2 ppt to 2.5 ppt saline water (brackish water) is not documented.

For herding spongeplant out of the Delta, field supervisors would take into account tides, storm events, and dam releases to select appropriate days and times for herding to take place. Crews would not herd in areas where physical damage to emergent, native vegetation was 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 spongeplant herded in one area would be limited to avoid impeding navigation. Due to the current limited extent of the spongeplant invasion, timing, and logistical limitations of herding activities, this method could not be used as frequently as hand removal with nets.

A herding only alternative would not result in the impacts related to herbicide treatments, or to the solid waste disposal impacts, as spongeplant would flow out of the Delta.

A herding only alternative would result in fewer recreational and ecosystem benefits, as compared to the selected program alternative, because significantly less spongeplant would be controlled in any given year.

While herding might provide a viable option to control spongeplant during the winter months when there is adequate flow, herding alone is not a feasible program alternative. Problems with this alternative include: limited time and areas where herding is appropriate, limitations due to low flows in much of the Delta, and relatively low acres managed.

Program Alternative 5 – Mechanical Removal Only

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

The second mechanical removal approach would 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 would collect and unload vegetation using a conveyor system on a boom, adjustable to the appropriate cutting height for spongeplant. Cutter bars would collect material and bring it aboard the vessel using the conveyor; when the vessel reached capacity (between 2,000 and 15,000 pounds of plant material), the cut plant material would be offloaded to a dump truck parked at a nearby boat ramp to offload spongeplant. Spongeplant would be disposed of at an authorized location, typically utilizing nearby farm fields.

Mechanical removal can be costly. Mechanical control would result in fewer recreational and ecosystem benefits, as compared to the selected program alternative, because significantly less spongeplant would be controlled in any given year.

Mechanical control may be an important alternative for large mats of spongeplant; however, many of the current infestation sites are too small to warrant this approach. Furthermore, it would be unwise to knowingly allow spongeplant to grow to infestation levels where mechanical harvesting was appropriate, as would be necessary under a mechanical removal-only alternative.

Photo: Mechanical removal with excavator in irrigation canal (courtesy of CDFA).

Photo: Mechanical cutter and conveyor equipment being used on water hyacinth

Table 2-3
Potential SCP Methods Rejected as Infeasible

Control Method	Description	Reason Rejected
1. Triploid Grass Carp	Sterilized, herbivorous fish that provide control by consuming aquatic weeds and other plants in waterways.	The extent that spongeplant is a preferred food for triploid grass carp is unknown. In addition, the California Department of Fish and Wildlife prohibits the use of triploid grass carp in non-enclosed water bodies.
2. Physical Barriers	Physical barriers (such as booms) to limit the ability of spongeplant to spread.	Barriers are not effective in the winter high-flow period. Barriers require extensive maintenance, and are not effective in controlling spongeplant.
3. Shade Barriers	Use of shade fabrics placed over aquatic weeds to limit the amount of photosynthetically available light.	Utilizing shade fabrics in the Delta would be technically challenging, difficult to maintain, and expensive.
4. Water Level Manipulation	Pumping or releasing water via a dam or weir to dewater an area.	Delta channels do not have structures available to control water levels. In addition, spongeplant seeds can germinate after years of exposure to air.
5. Flow Rate Manipulation	Increasing or decreasing water flow through a channel for weed control.	Flow rates in the Delta could not be artificially increased to create enough force to flush spongeplant fully out of the Delta.
6. Biological Controls	Use of biological control agents (such as insects and/or pathogens) to control spongeplant.	Spongeplant is a new invasive species in the United States, and biological control agents have not yet been identified. Once identified, it takes several years to determine whether biological controls are viable, and to determine whether they can be imported and released in the United States.

Problems with this alternative include: large scale of infestation required to make mechanical removal viable, potential for solid waste impacts due to disposal, high cost per acre, and likely low acres that could be managed.

Program Alternative 6 – No Program Alternative

The No Program Alternative would be in conflict with existing state law. In 2012, Assembly Bill 1540 (Buchanan, Chapter 188, Statutes of 2012) amended the California Harbors and Navigation Code to designate DBW as the lead agency for controlling spongeplant in the Delta. The Harbors and Navigation Code, Section 64, specifies that it is "necessary that the state, in cooperation with agencies of the United States, undertake an aggressive program for the effective control of water hyacinth, *Egeria densa*, and South American spongeplant *(Limnobium laevigatum)* in the Delta, its tributaries, and the marsh [Suisun Marsh]." Thus, DBW is mandated to conduct spongeplant control efforts.

In addition, the uncontrolled growth of spongeplant which would result from the No Program Alternative would lead to negative impacts to navigation, recreation, agriculture, and Delta ecosystems. While it would avoid potential impacts due to herbicides, the No Program Alternative would not achieve any goals of the SCP.

Alternatives Rejected as Infeasible

In addition to the six program alternatives described in this chapter, the DBW considered a number of other alternatives for controlling spongeplant in the Delta. The DBW determined that these alternatives were legally, technically, or operationally infeasible; would fail to meet most of the basic project objectives; or would result in significant environmental impacts. **Table 2-3,** above, briefly summarizes six alternatives that were not considered for further analysis.

D. Selected Program Alternative

The selected program alternative is based on Integrated Pest Management (IPM) and Maintenance Control Practices (MCP). The State defines IPM as: a pest management strategy that focuses on long-term prevention or suppression of pest problems through a combination of techniques such as monitoring for pest presence and establishing treatment threshold levels, using non-chemical practices to make the habitat less conducive to pest development, improving sanitation, and employing mechanical and physical controls. Pesticides that pose the least possible hazard and are effective in a manner that minimizes risks to people, property, and the environment, are used only after careful monitoring indicates they are needed according to pre-established guidelines and treatment thresholds.

IPM denotes the coordinated use of available control methods for a particular pest. MCP refers to practices that minimize plant biomass through regular, low-level, control treatments applied at times during a plant's life cycle when treatments are most effective. Ideally, under a maintenance control program, the acres of spongeplant required to be treated will remain low.

DBW balances IPM and MCP in order to simultaneously reduce impacts and increase effectiveness. For example, in order to avoid impacts to migrating special status fish, treatments occur as early in the growing season as possible, but later in a plant's lifecycle than would be ideal.

To minimize potential environmental impacts, DBW selects the most appropriate control methods for a given site in the Delta based on the season and that site's conditions. DBW conducts hand removal with nets to supplement chemical treatment. As necessary, the SCP will include herding and mechanical removal. DBW will also monitor results of the SCP, and base future control methods on these results. This selected alternative is chosen to provide the greatest reduction in spongeplant biomass while avoiding or minimizing environmental impacts.

The SCP follows an adaptive management approach in which DBW seeks to improve efficacy and reduce environmental impacts over time as new and better information is available about the program. Within their adaptive management approach, DBW will:

- Evaluate the need for control measures on a site-by-site basis
- Follow NPDES general permit pre- and post-treatment monitoring protocols and evaluate data to determine environmental impacts
- Support ongoing research to explore impacts of the SCP and alternative control methodologies, including biological controls, and herbicides and adjuvants with reduced environmental impacts
- Report findings from monitoring evaluations and research to regulatory agencies and stakeholders
- Adjust program actions, as necessary, in response to recommendations and evaluations by regulatory agencies and stakeholders.

1. SCP Permits, Consultations, and Reporting

The SCP must comply with National Pollution Discharge Elimination System (NPDES) permit requirements and the Endangered Species Act (ESA). This subsection provides an overview of these requirements.

NPDES General Permit

The DBW obtained an individual National Pollutant Discharge Elimination System (NPDES) permit in 2001 (CA0084654) from the Central Valley Regional Water Quality Control Board (CVRWQCB) for their aquatic weed control programs. The individual NPDES permit expired in March 2006. In April 2006, the CVRWQCB replaced the individual NPDES permit with a general NPDES permit (CAG990005). The State Water Resources Control Board (SWB) issued a new NPDES General Permit on March 5, 2013. This permit went into effect on December 1, 2013, and will guide DBW water quality monitoring for the SCP.

The NPDES permit includes specific receiving water limits for herbicide concentrations, dissolved oxygen (DO), pH, and turbidity. Key NPDES requirements for the SCP are as follows:

- **Dissolved oxygen (DO)** – specific DO limits depend on the location and season, but range from 5.0 mg/l (ppm) to 9.0 mg/l (ppm). DO levels are not to drop below these levels as a result of SCP treatments
- **Turbidity** – specific turbidity standards are not to increase above a specified number or percent of Nephelometric Turbidity Units (NTUs), depending on the initial level of natural turbidity. Generally, the SCP shall not increase turbidity more than 10 to 20 percent
- **pH** – SCP discharges shall not cause pH to fall below 6.5, or exceed 8.5, or change by more than 0.5 units
- **2,4-D residues** – maximum 2,4-D levels are based on EPA municipal drinking water standards, and shall not exceed 70 µg/l, or 70 ppb
- **Glyphosate residues** – maximum glyphosate levels are based on EPA municipal drinking water standards, and shall not exceed 700 µg/l, or 700 ppb
- **Penoxsulam residues** – there are no specified limits for penoxsulam; however, the DBW is required to monitor penoxsulam levels
- **Imazamox residues** – there are no specified limits for imazamox; however, the DBW is required to monitor imazamox levels
- **Diquat residues** - maximum diquat levels are based on EPA municipal drinking water standards, and shall not exceed 20 µg/l, or 20 ppb
- **Adjuvant residues** – there are no specified limits for adjuvants; however, the DBW is required to monitor adjuvant levels
- **Monitoring** – requires a monitoring protocol. Monitoring is required at six treatment sites, for each chemical and waterbody type, with the exception of glyphosate, which only requires monitoring at one treatment site for each waterbody type. Sampling stations are identified as : “A” (where treatment occurred), “B” (downstream of the treatment area), and “C” (control, typically upstream). Sampling times are identified as: “1” (pre-treatment), “2” (immediately post-treatment), and “3” (within seven days after treatment). Thus, sample 2B is taken immediately post-treatment, downstream of the treatment location
- **Reporting** – The DBW is required to submit an annual report by March 1st of each year.

USFWS ESA Consultation

At the time this SCP PEIR is being prepared, the United States Department of Agriculture, Agricultural Research Service (USDA-ARS) and DBW are in consultation with the United States Fish and Wildlife Service (USFWS). This consultation is part of the Endangered Species Act (ESA) compliance for the SCP. The three listed USFWS species that could potentially be affected by the SCP are: delta smelt *(Hypomesus transpacificus)*, giant garter snake *(Thamnophis gigas)*, and valley elderberry longhorn beetle *(Desmocerus californicus dimporphus)*. Critical habitat for delta smelt falls within the SCP project area.

USDA-ARS and DBW submitted a SCP Biological Assessment (BA) to USFWS on February 11, 2014. The BA covers the 2014 to 2017 treatment seasons. USFWS will likely issue a biological opinion (BO) for the SCP in early summer, 2014. The BO will likely contain conservation measures similar to the WHCP BO, dated March 13, 2013, and the EDCP BO, dated May 3, 2013.

During the 2013 treatment season, DBW conducted limited spongeplant treatments under an amended WHCP BO. These spongeplant treatments followed all provisions of the WHCP BO.

Figure 2-1
SCP Treatment Sites[a], Herbicides, and Timing

Delta smelt (DS) Habitat Level	USFWS Area	Delta Boundary Area	Treatment Site Numbers	Fish Survey Reporting Required[b,c]	Glyphosate	2,4-D[d]	Penoxsulam[e]	Imazamox[e]	Diquat[f]
Primary DS Habitat	1	Legal Delta North of Hwy 12	200- 290	June 1 to June 30	June 1 to Nov. 30	No	No	No	August 1 to Nov. 30
		Legal Delta South of Hwy 12	16-24b, 39-44, 69, 98a-176	June 1 to June 30	June 1 to Nov. 30	June 15 to Sept. 15	No	No	August 1 to Nov. 30
Secondary DS Habitat	2	Legal Delta South of Hwy 12	11-15, 33, 49-68, 78, 79, 83a-97	March 1 to June 30	March 1 to Nov. 30	June 15 to Sept. 15	No	No	August 1 to Nov. 30
Tertiary DS Habitat	3	Legal Delta South of Hwy 12	1-10, 25-38, 45-48, 70-77, 80-82, 291	March 1 to June 30	March 1 to Nov. 30	June 15 to Sept. 15	March 1 to Nov. 30	March 1 to Nov. 30	August 1 to Nov. 30
Non-DS Habitat	4	Legal Delta South of Hwy 12	300-309	March 1 to June 30	March 1 to Nov. 30	June 15 to Sept. 15	March 1 to Nov. 30	March 1 to Nov. 30	August 1 to Nov. 30
		Non-Legal Delta	310 and above	March 1 to June 30	March 1 to Nov. 30	July 15 to Aug. 15	March 1 to Nov. 30	March 1 to Nov. 30	August 1 to Nov. 30

[a] DBW may not treat in any site if DO is between 3 ppm and Basin Plan limits (5 ppm to 8 ppm, by location). DBW may not treat if winds are >10 mph (or >7 mph in Contra Costa County).

[b] DBW will implement a survey-based approach to conducting treatments that allows for treatments from March through June in areas with re-growing spongeplant when listed fish species are not present, as reported to NMFS, USFWS, and CDFW.

[c] DBW environmental scientists will continue to monitor fish surveys and avoid treating in sites where listed fish species are present; however, formal weekly reporting to NMFS and USFWS is not required after July 1.

[d] The 2,4-D time and location restrictions are specified in the NMFS BO for the Environmental Protection Agency registration of pesticides in order to protect listed salmonid species.

[e] DBW will monitor the efficacy of the new herbicides penoxsulam and imazamox (time to symptoms, plant death, and regrowth). Depending on results of toxicity testing, and upon approval by USFWS, penoxsulam and imazamox may be utilized in Areas 1 and 2.

[f] Diquat will only be used from August 1st through November 30th of each year, and will be limited to a total of 50 treatment acres in the Delta per year, as a sum of the combined diquat acres treated in the SCP and EDCP. Diquat will be utilized as part of the SCP under emergency conditions only. Emergency conditions are such that spongeplant growth completely impedes navigation of Delta waters, such as a completely blocked slough that would impair the movement of emergency response vessels.

DBW has incorporated conservation measures specified in the WHCP BO and EDCP BO into the SCP project description. USFWS may include additional conservation measures in the SCP BO. If so, DBW will incorporate these measures into SCP operations. Specific conservation and avoidance measures incorporated into the SCP are as follows:

- **Avoidance** – the SCP has incorporated a number of measures to avoid the potential for impacts on USFWS listed species:
  - Consulting fish surveys prior to conducting herbicide treatments in order to determine whether delta smelt are likely to be in potential treatment sites, and avoiding treatment when delta smelt are likely present (DBW will also consult surveys to determine if longfin smelt are present)
  - Following the treatment start dates and herbicides, by USFWS Areas (**Figure 2-1,** above, and **Figure 2-2,** on the next page, provide specific dates, chemicals, and fish survey requirements by USFWS Area and DBW treatment site number)
  - Following the Fish Passage Protocol to provide a zone of passage through areas of low DO (the Fish Passage Protocol is provided in Volume II of this Final PEIR)
  - Conducting environmental observation surveys and avoiding treatments if listed species are present in a site

- Conducting surveys of valley elderberry shrubs, applying herbicides downwind of valley elderberry, maintaining a 100 feet buffer from valley elderberry shrubs for chemical treatments (50 feet in some instances), and disposing of spongeplant at least 100 feet away from elderberry shrubs
- Evaluating habitat for giant garter snake, avoiding disturbance of giant garter snake, disposing of spongeplant outside of the May 1st to October 1st giant garter snake active season in approved disposal areas

- **Environmental training** – personnel involved with the SCP are required to receive USFWS approved environmental awareness training related to delta smelt, valley elderberry longhorn beetles, and giant garter snakes.
- **Monitoring** – requires that DBW comply with the NPDES permit monitoring requirements
- **Reporting** – requires DBW to report results and impacts (including take) by January 31st of each year
- **Toxicity Testing** – requires DBW to fund toxicity testing of penoxsulam, imazamox, and the adjuvant Competitor on delta smelt prior to utilizing these chemicals in USFWS designated Areas 1 and 2.

NMFS ESA Consultation

After consultation, USDA-ARS and DBW received a letter of concurrence from the National Marine Fisheries Service (NMFS). This consultation is part of the ESA compliance for the SCP. The four listed NMFS species that could potentially be affected by the SCP are: Sacramento River winter-run Chinook salmon *(Oncorhynchus tshawytscha)*, Central Valley spring-run Chinook salmon *(Oncorhynchus tshawytscha)*, Central Valley steelhead *(Oncorhynchus mykiss)*, and Southern Distinct Population Segment (DPS) of North American green sturgeon *(Acipenser medirostris)*. The SCP project area is within critical habitat for each of these four species.

Figure 2-2
SCP Treatment Sites[a], Additives, and Timing

Delta smelt (DS) Habitat Level	USFWS Area	Delta Boundary Area	Treatment Site Numbers	Fish Survey Reporting Required[b,c]	Agridex	Competitor[d]
Primary DS Habitat	1	Legal Delta North of Hwy 12	200- 290	June 1 to June 30	March 1 to Nov. 30	No
		Legal Delta South of Hwy 12	16-24b, 39-44, 69, 98a-176	June 1 to June 30	March 1 to Nov. 30	No
Secondary DS Habitat	2	Legal Delta South of Hwy 12	11-15, 33, 49-68, 78, 79, 83a-97	March 1 to June 30	March 1 to Nov. 30	No
Tertiary DS Habitat	3	Legal Delta South of Hwy 12	1-10, 25-38, 45-48, 70-77, 80-82, 291	March 1 to June 30	March 1 to Nov. 30	March 1 to Nov. 30
Non-DS Habitat	4	Legal Delta South of Hwy 12	300-309	March 1 to June 30	March 1 to Nov. 30	March 1 to Nov. 30
		Non-Legal Delta	310 and above	March 1 to June 30	March 1 to Nov. 30	March 1 to Nov. 30

[a] DBW may not treat in any site if DO is between 3 ppm and Basin Plan limits (5 ppm to 8 ppm, by location). DBW may not treat if winds are >10 mph (or >7 mph in Contra Costa County).

[b] DBW will implement a survey-based approach to conducting treatments that allows for treatments from March through June in areas with re-growing spongeplant when listed fish species are not present, as reported to NMFS, USFWS, and CDFW.

[c] DBW environmental scientists will continue to monitor fish surveys and avoid treating in sites where listed fish species are present; however, formal weekly reporting to NMFS and USFWS is not required after July 1.

[d] Depending results of toxicity testing, and upon approval by USFWS, Competitor may be utilized in Areas 1 and 2.

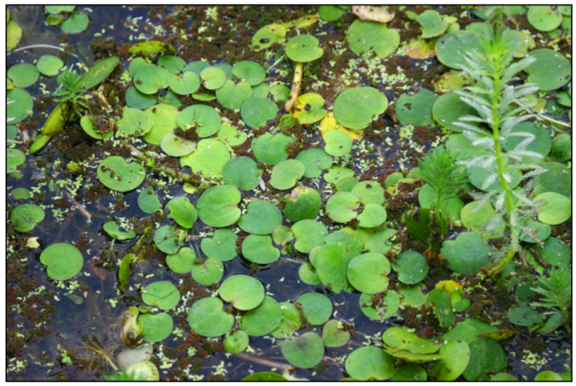


Photo: Spongeplant (courtesy of CDFA).

USDA-ARS and DBW submitted a SCP BA to NMFS on February 11, 2014. The BA covers the 2014 to 2017 treatment seasons. NMFS issued a letter of concurrence for the SCP on May 28, 2014. The letter of concurrence contains conservation measures similar to the WHCP letter of concurrence, dated February 27, 2013, the EDCP letter of concurrence, dated March 26, 2014, and the clarification letter dated April 18, 2014.

During the 2013 treatment season, DBW conducted limited spongeplant treatments under a second WHCP letter of concurrence. These spongeplant treatments followed all provisions of the WHCP letter of concurrence.

DBW has incorporated conservation measures specified in by NMFS for the WHCP and EDCP into the SCP project description. NMFS may include additional conservation measures in the SCP letter of concurrence. If so, DBW will incorporate these measures into SCP operations. Specific conservation and avoidance measures incorporated into the SCP are as follows:

- **Avoidance** – the SCP has incorporated a number of measures to avoid the potential for impacts on NMFS listed fish species and critical habitats:
  - Consulting fish surveys prior to conducting herbicide treatments in order to determine whether listed salmonids or green sturgeon are likely to be in potential treatment sites
  - Following the allowable locations and treatment dates for 2,4-D applications (provided in Figure 2-1)
  - Following the Fish Passage Protocol to provide a zone of passage through areas of low DO
  - Conducting environmental observation surveys and avoiding treatments if listed species are present in a site.
- **Environmental training** – providing training on the life history, importance of migratory routes, and terms and conditions of the biological opinion for Chinook salmon, steelhead, and green sturgeon
- **Dissolved oxygen** – DO levels of above 5.0 ppm and below 3.0 ppm are required for treatment (in addition to the NPDES DO requirements). DBW may treat if DO is below 3.0 ppm
- **Monitoring** – following NPDES monitoring requirements
- **Reporting** – requires DBW to report results and impacts (including take) by January 31st of each year.

Each year, DBW will prepare a SCP Annual Report that fulfills reporting requirements of NPDES, USFWS, and NMFS. The annual report will describe the treatment program, herbicide use, permit requirements, monitoring protocols, monitoring results, and compliance with permit requirements. Because the programs are very similar, DBW may combine the WHCP and SCP reports into one document.

Since 2001, the DBW has commissioned or conducted a number of special studies to better understand the impacts and efficacy of their aquatic weed control programs. These studies include the following:

- *Acute Oral and Dermal Toxicity of Aquatic Herbicides and a Surfactant to Garter Snakes,* Robert C. Hosea, California Department of Fish and Game (2004)
- *Chronic Toxicities of Herbicides Used to Control Water Hyacinth and Brazilian Elodea on Neonate Cladoceran and Larval Fathead Minnow,* Frank Riley and Sandra Finlayson, California Department of Fish and Game (2004)
- *Acute Toxicities of Herbicides Used to Control Water Hyacinth and Brazilian Elodea on Larval Delta Smelt and Sacramento Splittail,* Frank Riley and Sandra Finlayson, California Department of Fish and Game (2004)
- *Ceriodaphnia dubia (water flea) Static Definitive Chronic Toxicity Test Data (7-day) for Exposure to Various Aquatic Herbicides,* California Department of Fish and Game, Aquatic Toxicology Laboratory (2003)
- *Pogonichthys macrolepitdotus (Sacramento Splittail) Static Definitive Acute Toxicity Test Data (96-hour) for Exposure to Various Aquatic Herbicides,* California Department of Fish and Game, Aquatic Toxicology Laboratory (2003)
- *Biological Control of Water Hyacinth in the Sacramento-San Joaquin Delta,* Lars W.J. Anderson, Ph.D, and Jason Brennan, USDA-ARS Exotic and Invasive Weed Research (2003)
- *Biological Control of Water Hyacinth: Second Year Progress Report,* Lars W.J. Anderson and Jason Brennan, USDA-ARS Exotic and Invasive Weed Research (2005)
- *Biological Control of Water Hyacinth in the Sacramento-San Joaquin Delta: Year 3 – Final Report*, R. Patrick Akers and Michael J. Pitcairn, California Department of Food and Agriculture (2006)
- *Mapping Invasive Plant Species in the Sacramento-San Joaquin Delta Region Using Hyperspectral Imagery,* Susan L. Ustin, Ph.D., et al, Center for Spatial Technologies and Remote Sensing (CSTARS), California Space Institute Center of Excellence (CalSpace), UC Davis (2004)
- *Monitoring Valley Longhorn Elderberry Beetle Elderberry Shrub Habitat,* Paul Ryan, et al., California Department of Boating and Waterways (multiple years).

2. SCP Methods

General SCP Activities

There will be a number of management activities within SCP that support the program. USDA-ARS staffing for the SCP, WHCP and EDCP will include a managing supervisor, administrative support, and scientific staff. Within DBW, employees that work directly on the SCP, WHCP and EDCP will include a program manager, senior environmental scientist, field environmental scientists, field supervisor, GIS mapping specialist, and field crew members. DBW may add or reduce staff to support program needs over time. The SCP also receives management and administrative support from within DBW and the California Department of Parks and Recreation.

Prior to the start of each treatment season, DBW will conduct environmental awareness training for all field crew members. Training will be conducted by a USFWS and NMFS-approved biologist. 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. In addition, field crew members also will be trained on use and calibration of spray equipment and the WHCP/SCP Operations Management Plan.

The SCP will implement pre- and post-season surveys to identify locations and coverage of spongeplant, and supplement these formal surveys with mid-season evaluations of spongeplant locations and 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 spongeplant coverage (square feet/acres and percent coverage), and status of spongeplant at the site.

In the early season 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. 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, when necessary, and to measure efficacy of spongeplant treatments at the end of the season.

At the current low spongeplant infestation levels, DBW and USDA-ARS will classify all spongeplant locations as high priority sites. A key to minimizing the spread of spongeplant through the Delta will be to chemically treat, or remove by nets, spongeplant early in the growth cycle, before plants flower and produce seeds.

Should the spongeplant invasion reach a point that DBW cannot treat all infestations, DBW and USDA-ARS will prioritize treatment sites and methods prior to the start of each treatment season. The prioritization process will be based on results of pre-season field surveys combined with the experience and knowledge of spongeplant growth patterns of the treatment crews and program environmental scientists.

During pre-season field surveys, treatment crews will survey each treatment site and identify total acres infested. This pre-season infestation figure is only one indicator, as spongeplant may be dormant during the winter, and typically dies back in cold weather. When infestations are small, treatment crews will hand remove spongeplant with nets during the course of the field survey, or soon after.

When prioritizing sites, experienced treatment crew members, the field supervisor and environmental scientists will review each site and rank sites on several factors, including: (1) whether or not the site is a nursery area; (2) current infestation levels; (3) prior infestation levels at that site; (4) potential for infestation; and, (5) whether the site is important for navigation, public safety, recreation, and/or commercial use. Sites will be scored on each of these factors, the team will calculate a total priority score for each site, and prepare an initial priority ranking.

DBW may employ aerial surveys or other appropriate remote sensing methods to assist in site prioritization as well as follow-up evaluation. Staff will present the priority ranking to DBW management and USDA-ARS, who will then evaluate and approve a treatment plan for the season. DBW may also take into account resource allocation between the SCP, WHCP and EDCP when prioritizing treatment sites.

When applicable, this initial plan will indicate the general priority for site treatment. The plan may shift during the treatment season, as spongeplant appears in new locations and moves throughout the Delta, and may grow more rapidly in certain areas. Treatment crews will continue to monitor and record total acres infested, by site, throughout the treatment season, in order to provide management with information they need to focus treatments to high priority sites. Wind and weather conditions may also dictate when a particular site will be treated. In addition, treatment crews will return to sites to evaluate the need for, and conduct, additional treatments during the season when field surveys indicate presence of persistent or new infestations.

Using the initial prioritization and management plan as a starting point, each field crew will prioritize their assigned sites weekly via a field survey of their area. Based on the management plan, the field supervisor will determine weekly and daily spraying needs and assign crews to sites based on wind, weather, tides, travel times, available personnel, and equipment resources. The field supervisor will ensure that Notice of Intent requirements are met.

Prior to each treatment week, the field supervisor will report the treatment sites to the respective County Agricultural Commissioner. Prioritized sites are likely to change rapidly depending on the constant growth and movement of spongeplant, as well as wind and weather conditions.

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

Photo: Spongeplant in Discovery Bay, June 2012.

Photo: Spongeplant in Discovery Bay, January 2014.

Aquatic Herbicide Use

The SCP proposes to utilize five different herbicide active ingredients: 2,4-D; glyphosate; penoxsulam; imazamox; and, diquat. **Exhibit 2-3**, on the next page, summarizes characteristics of the five proposed SCP herbicides. All five of these herbicides have been approved for use in the WHCP and/or EDCP. Penoxsulam and imazamox have low toxicity profiles, and thus their use could reduce the potential for negative impacts.

There are several reasons why SCP is proposing five herbicides for the program. First, new lower-toxicity profile herbicides have the potential to minimize the environmental impact of SCP. Second, new herbicides may minimize the amount of herbicide applied to Delta waterways to treat spongeplant. Third, timing and crop restrictions currently limit the application of 2,4-D. Thus, including a number of herbicides expands treatment options. Fourth, utilizing herbicides with varying modes of action reduces the potential for target species to develop resistance. While there are no indications of spongeplant 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), and the aquatic weed hydrilla may develop resistance to fluridone (Richardson 2008).

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 SCP will be 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, SCP environmental scientists, and Pest Control Advisors will evaluate spongeplant response to program herbicides over time to identify potential resistance problems.

Two SCP herbicides (penoxsulam and imazamox) are part of the USEPA's Office of Pesticide Program's Conventional Reduced Risk Program. This program expedites the review and regulatory decision-making process of conventional pesticides that pose less risk to human health and the environment than existing conventional alternatives (Washington DOE 2012). Pesticides are typically included in the reduced risk program because they have advantages over existing pesticides such as low impact on human health, lower toxicity to non-target organisms, low potential for groundwater contamination, lower use rates, low pest resistance potential, and/or compatibility with integrated pest management practices.

Exhibit 2-3
Summary Comparison of SCP Treatment Herbicides

	2,4-D	Glyphosate	Penoxsulam	Imazamox	Diquat
Status	CDPR approved	CDPR approved	CDPR approved	CPDR approved	CDPR approved
Application Rate	64 to 128 ounces/acre 2.29 to 4.58 lb. a.i./acre	120 ounces/acre 5.06 lb. a.i./acre	2 to 5.6 ounces/acre 0.03125 to 0.0875 lb. a.i./acre	32 to 64 ounces/acre 0.265 to 0.53 lb. a.i./acre	16 to 64 ounces/acre 0.25 to 1.0 lb. cation/acre
Calculated Concentration in 1 Meter Deep Water with 20% Overspray	103 ppb	113 ppb	2 ppb	11.9 ppb	44.8 ppb
NPDES Maximum Limitation in Receiving Waters	70 ppb	700 ppb	Users to collect data to determine need for monitoring trigger	Users to collect data to determine need for monitoring trigger	20 ppb
USEPA Fish Toxicity Classification	Practically non-toxic	Slightly toxic to practically non-toxic	Practically non-toxic	Practically non-toxic	Slightly toxic
USEPA Macroinvertebrate Toxicity Classification	Moderately toxic to practically non-toxic	Slightly toxic to practically non-toxic	Slightly toxic	Practically non-toxic	Very highly toxic to highly toxic
Pros	Proven effective; lower cost; selective broadleaf herbicide	Use allowed in all areas and treatment times; proven effective	Requires less herbicide; lower toxicity; less DO impact; low cost per acre	Requires less herbicide; lower toxicity; less DO impact; relatively fast	Fast acting contact herbicide, supplements slower acting herbicide treatments in areas with acute spongeplant problems; effective on spongeplant in California (CDFA use)
Cons	Limited application period; can't be used near grapes, tomatoes; higher concentrations required than new herbicides	Slower acting than 2,4-D; binds to sediment; higher concentrations required than new herbicides; non-selective; increased cases of terrestrial weed resistance	Potential for groundwater pollution, although low potential at application rates; 1ppb irrigation water restriction; uncertain efficacy; limited use until toxicity studies complete	Uncertain efficacy; limited use until toxicity studies complete	Toxicity to macroinvertebrates; not all plant exposed to herbicide, resulting in more rapid re-growth, need to retreat; toxicity concerns for delta smelt; limited application periods and total acres

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. Treatment crews will determine the appropriate spray nozzle size to ensure that herbicide is deposited on small and/or vertically oriented spongeplant leaves. The pump will mix calibrated amounts of herbicide, adjuvant, and water. The SCP will apply the chemicals at the herbicide label-specified rates. Treatment crews will follow specific requirements, as described, to account for wind, dissolved oxygen, drinking water intakes, agricultural intakes, and total acres treated. Treatment crews will follow all label requirements, and implement the fish passage protocol developed for the WHCP when spongeplant mats are greater than 3 acres in size to ensure that migratory fish are not impacted by the SCP.

The amount of herbicide used and number of acres treated in a given year can reflect the magnitude of infestation. However, there are several other factors that will affect the amount of treatment that SCP conducts (regulatory limits, local water conditions, weather, staff levels, etc.).

Herbicide use in future years may be impacted by weather conditions. Because spongeplant is a relatively new invasive species in California, there is limited understanding of the effects of weather conditions on spongeplant growth in current, or following, years. However, it is known that spongeplant seeds are highly resilient, and can germinate several years after they were produced. Thus, DBW will closely monitor spongeplant locations and growth to increase understanding about the factors that influence spread of this highly invasive weed.

Similar to most weed species, the ideal herbicide treatment time for spongeplant is likely when the plant is in the early growth phases, between 5 percent and 25 percent of maximum size (Spencer and Ksander 2005). A key issue for spongeplant will be treating individual plants before they flower. Spongeplant can flower during the majority of the primary growing season (May to October). Thus, treating individual patches during the early growth phase will not only increase herbicide efficacy and reduce the total amount of herbicide required, but will also reduce the potential for spread of spongeplant. In addition, early treatments will reduce program resource needs. The proposed SCP timing approach will help optimize the balance between improved herbicide efficacy and presence of listed species.

SCP will only treat those sites that have spongeplant infestations, treating only the spongeplant plants within those sites. SCP may also be limited by time and resource constraints. Within a given treatment location, SCP will treat according to current herbicide label requirements to limit potential for decaying plants to result in low dissolved oxygen 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 spongeplant infestations spread out within a site that require treatment. In these cases, SCP will treat all spongeplant mats in the site as time and resources allow. Repeat treatments may utilize a different herbicide, depending on conditions at the site.

Hand Removal with Nets

Hand removal of spongeplant with nets (referred to as “hand removal”) will utilize pool-skimmer type nets, and will occur throughout the year when, or where, chemical treatment cannot be made. As treatment crews survey for spongeplant, they will conduct hand removal in selected areas. The goals of the hand removal aspect of the program are to aid in the control of spongeplant, reduce spongeplant growth among native plants, 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.

Photo: Spongeplant (smaller), among water hyacinth (courtesy CDFA).

Photo: Hand removal of spongeplant with net.

Herding

Herding refers to the moving of spongeplant 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 spongeplant will flow out of the Delta, into saline waters and may die. The ability of spongeplant to survive in waters of greater than 2 ppt to 2.5 ppt saline water (brackish water) is not documented.

For herding spongeplant 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 spongeplant herded in one area will be limited to avoid impeding navigation. Due to the current limited extent of the spongeplant invasion, timing, and logistical limitations of herding activities, this method will not be used as frequently as hand removal with nets.

The SCP will also utilize herding in conjunction with mechanical removal should it be warranted, based on the extent of infestation. Crews will push mats or sections of mats toward an excavator located on a boat ramp. This will maximize the amount of spongeplant that can be removed by the stationary excavator.

Mechanical Removal

The SCP will utilize two different mechanical removal approaches. The extent that SCP will utilize mechanical removal approaches depends on the size of the spongeplant infestation. At current (2014) levels, mechanical removal will likely not be necessary. However, should the extent of the spongeplant invasion increase substantially over the next few years, mechanical removal could become an important tool in controlling the further spread of spongeplant.

The first mechanical removal approach will be to park a small excavator and dump truck on a concrete boat ramp and mechanically lift spongeplant from the waterway surrounding the ramp. Crews will support the excavation by herding spongeplant that is outside of the excavator's reach closer to the equipment. This mechanical removal approach will be used only in limited locations when spongeplant growth is concentrated near a boat ramp. There may be relatively few locations within the Delta that are appropriate for excavation. CDFA has successfully utilized this approach to clear irrigation canals of spongeplant.

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The second mechanical removal 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 for spongeplant. 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 spongeplant. Spongeplant 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 spongeplant in locations where chemical treatment must be avoided, such as sites with many valley elderberry shrubs along the shoreline. SCP environmental scientists will consult the Interagency Ecology Program (IEP) database and survey mechanical removal sites immediately prior to weed removal to ensure that no listed species are present. If listed species are thought to be present, mechanical removal operations at that site will be postponed. DBW recently utilized mechanical equipment to remove water hyacinth from selected locations in the Delta.

The SCP will implement an operation protocol similar to the protocol for chemical treatment prior to conducting mechanical removal. SCP environmental scientists will check IEP monitoring data to help ensure that listed 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.

3. SCP Environmental Monitoring

The SCP will conduct extensive monitoring for the program. The SCP will be responsible for collecting water quality monitoring data, as well as collecting water samples for chemical residue testing.

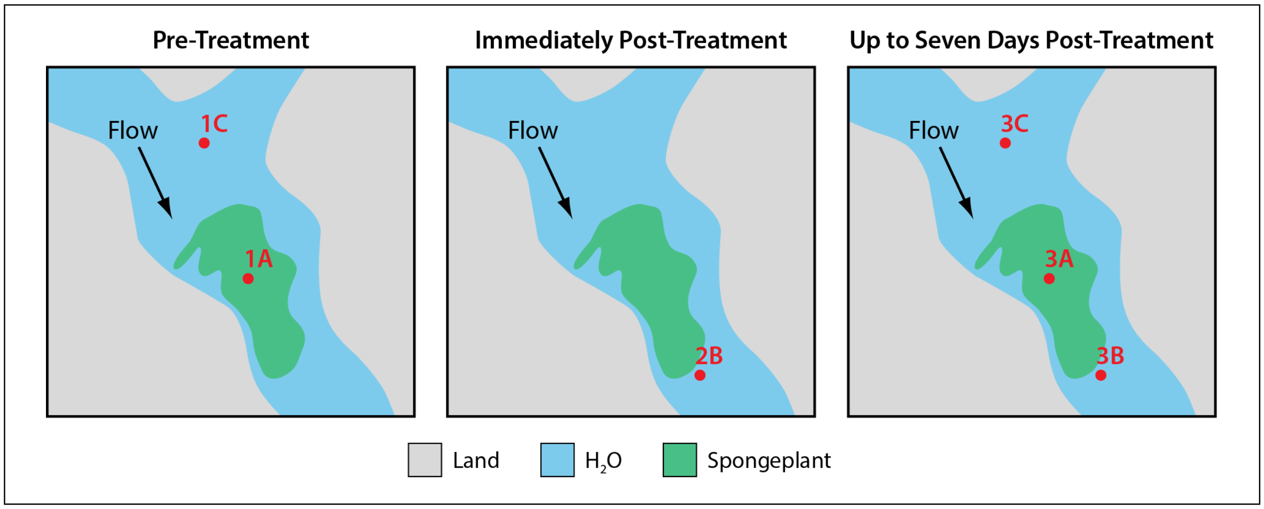
Based on NPDES permit requirements, SCP will follow a monitoring protocol. This protocol has historically fulfilled requirements of the Regional Water Quality Control Board, NMFS, and USFWS. At each monitoring site, SCP's environmental scientists will take samples immediately pre-application (upstream and adjacent to the spongeplant mat), and immediately post-application (downstream of the treatment area). SCP 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, illustrated in **Figure 2-4,** on the next page:

- 1A – Pre-treatment, in site
- 1C – Pre-treatment, control
- 2B – Immediately post-treatment, downstream
- 3A – Within 7 days, in site
- 3B – Within 7 days, downstream
- 3C – Within 7 days, control.

The SCP will select monitoring sites that reflect a mix of water types (tidal, riverine, and tidal dead-end), herbicides, and different habitat types.

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

Figure 2-4
SCP Monitor Sites



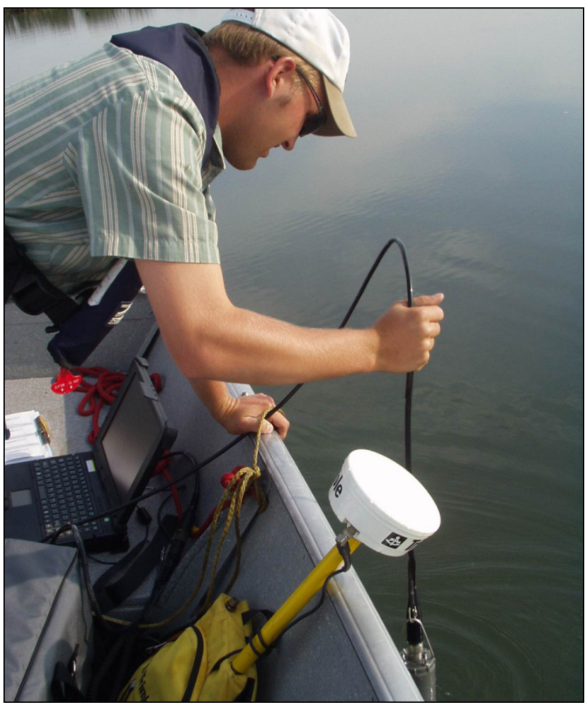


Photo: Example monitoring (WHCP).

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.

SCP treatment crews will conduct daily monitoring, in addition to the extensive monitoring to be conducted by SCP environmental scientists. Treatment crews will monitor and report pre- and post-treatment dissolved oxygen, wind speed, temperature, acres treated, quantity of herbicide and adjuvant, presence of elderberry shrubs or other species of concern, and coordinates of treatment location. **Table 2-4,** on the next page, lists monitoring requirements for SCP environmental scientists and SCP treatment crews.

Table 2-4
SCP 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 adjuvants	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)

Table 2-5
General Permit Receiving Water Limits or Monitoring Triggers for SCP Herbicides

Herbicide Active Ingredient	Maximum Limitation
2,4-D	70 ppb
Glyphosate	700 ppb
Penoxsulam	None*
Imazamox	None*
Diquat	20 ppb

* There are currently no maximum limitations; users will collect data to determine the need for monitoring triggers.

The State Water Quality Control Board updated the NPDES General Permit, effective December 2013, revising the monitoring approach. A copy of the NPDES General Permit is provided in Volume II of this Final PEIR. The updated permit maintains a similar monitoring protocol as described in Figure 2-3. However, 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 the SCP 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, SCP sampling may be reduced to a minimum of one application event per year for that active ingredient in that environmental setting. **Table 2-5,** above, provides the receiving water limits, where appropriate, for the five SCP herbicides. In November 2013, DBW updated the Aquatic Pesticide Application Plan for the WHCP and SCP to reflect the new monitoring requirements.

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Section 3

Biological Resources Impacts Assessment

3. Biological Resources Impacts Assessment

This chapter analyzes effects of the SCP on biological resources. The chapter is organized as follows:

A. *Environmental Setting*

B. *Impact Analysis and Mitigation Measures.*

The environmental setting describes the biological status of the Sacramento-San Joaquin Delta. This discussion includes identification of habitat types, and special status plants, invertebrates, fish, amphibians, reptiles, birds, and mammals. This chapter does not provide a detailed discussion of the regulatory context in the Delta. Such a discussion is included in Chapter 7 – Cumulative Impacts Assessment, in which we provide a description of relevant regulations, programs, projects, and planning efforts that shape the current Delta.

The impact analysis provides an assessment of the specific environmental impacts potentially resulting from program operations. The discussion of impacts utilizes findings from DBW environmental monitoring and research projects, technical information from scientific literature, government reports, and relevant information on public policies. The impact assessment is based on technical and scientific information.

The mitigation measures are specific actions that DBW will undertake to avoid, or minimize, potential environmental impacts. DBW is undergoing, and will continue to undergo, consultation with various State and federal agencies, including USFWS, CDFW, NMFS, and CVRWQCB regarding impacts and mitigation measures. Many of the mitigation measures result from the biological consultation process with USFWS and NMFS. Proposed mitigation measures may be revised, and/or additional mitigation measures incorporated, as a result of this ongoing consultation process with environmental regulatory agencies.

The SCP is a new aquatic weed control program for a new invasive species. At the time this PEIR is being prepared, the extent of the spongeplant invasion is small. In any given treatment season, the scope of the treatment approaches, and resulting impacts, will be scaled to the level of invasion. At the current low levels of spongeplant invasion, SCP approaches will consist of spot treatments with herbicides and hand removal with pool-skimmer nets. Only if spongeplant spreads extensively in the future will SCP utilize herding and/or mechanical removal methods. DBW and USDA-ARS are incorporating all potential treatment approaches into the proposed action because this PEIR covers future program years, and there is the potential for the extent of spongeplant in the Delta to increase significantly over time. Similarly, the potential impacts of the SCP will depend on the scale of the program.

A. Environmental Setting

Exhibit 2-1, in Section 2, illustrates the SCP program area. The SCP occurs primarily in the Delta, with additional treatments occurring on lower stretches of the San Joaquin, Tuolumne, and Merced Rivers.

The Delta is arguably the most environmentally sensitive region in California today. The Delta also has been described as "heavily modified" (Sommer et al. 2007). Starting in the mid-1800's, the Delta has been subject to hydraulic gold mining, channelization and wetland reclamation, fish and other non-native species introductions, dams controlling water inflows, and water exports (Sommer et al. 2007).

Concerns about the Delta environment gained momentum in the early 1990s. In establishing the Delta Protection Commission in 1992, the California legislature recognized that the Delta is "a natural resource of statewide, national, and international significance, containing irreplaceable resources." In the seventeen years since the Delta Protection Commission was established, and particularly over the last few years, concerns about water quality, water quantity, increasing land subsidence, flooding, climate change, increased salinity, invasive species, risk of catastrophic earthquake, and declining fish populations have only increased.

In 2006, Governor Schwarzenegger established the Delta Vision Blue Ribbon Task Force to identify a sustainable strategy for managing the Delta. The Governor's Executive Order recognized that "failure to act to address identified Delta challenges and threats will result in potentially devastating environmental and economic consequences of statewide and national significance" (Executive Order S-17-06).

The Delta Vision Blue Ribbon Task Force established a strategic plan to meet twelve objectives, the first objective being: "The Delta ecosystem and a reliable water supply for California are the primary co-equal goals of a sustainable Delta" (Delta Vision Blue Ribbon Task Force 2008).

In early 2008, Governor Schwarzenegger initiated another major collaborative planning effort, the Bay Delta Conservation Plan (BDCP). This initiative is led by the California Department of Water Resources (DWR), California Department of Fish and Wildlife (CDFW), U.S. Bureau of Reclamation (UBR), U.S. Fish and Wildlife Service (USFWS), and National Marine Fisheries Service (NMFS). The "purpose of the BDCP is to help recover endangered and sensitive species and their habitats in the Delta in a way that will also provide for sufficient and reliable water supplies" (DWR 2008). The BDCP will examine four water conveyance and physical habitat restoration alternatives for the Delta, including a peripheral aqueduct (or tunnel) from the Sacramento River to south Delta.

The effort was initiated by Governor Schwarzenegger when he requested that the DWR evaluate at least four alternative Delta conveyance strategies in coordination with BDCP efforts to better protect at-risk fish species. The BDCP effort will meet ESA and Natural Community Conservation Planning requirements, and will also include development of an EIR/EIS.

As outlined in the Notice of Preparation, the BCDP is ultimately intended to "secure authorizations that would allow the conservation of covered species, the restoration and protection of water supply reliability, protection of certain drinking water quality parameters, and the restoration of ecosystem health to proceed within a stable regulatory framework." Activities under the BDCP will include habitat development, water supply and power generation, facility maintenance, and improvements.

One of the goals of the project is to reexamine the conveyance alternatives that were analyzed in the CALFED August 2000 documents, based on recent declines in pelagic organisms, particularly delta smelt, increased concern about higher risks from Delta levees due to earthquakes, and potential impacts of climate change. The BDCP stems in part from the Delta Vision's recommendation that the State should consider different approaches to conveying water through the Delta than the current through-Delta alternative that was approved by the CALFED Record of Decision. In developing the Draft EIR/EIS, the BDCP steering committee considered four conservation strategy options:

- Existing through Delta conveyance with physical habitat restoration
- Improved through Delta conveyance with physical habitat restoration
- Dual conveyance, including improved through Delta conveyance and isolated conveyance from the Sacramento River to the south Delta, with physical habitat restoration
- Isolated conveyance from the Sacramento River to south Delta, with physical habitat restoration.

A series of deliberations has led to the creation of 15 action alternatives which are considered in the EIR/EIS. Among these 15 alternatives, one adopts an improved through Delta conveyance strategy, 11 adopt the dual conveyance strategy, and three adopt the isolated conveyance strategy. The CEQA (or state) preferred approach, known as Alternative 4, recommends four new on-bank intake facilities on the Sacramento River, two or four 16-foot diameter conduits used as conveyance pipelines, and three tunnels. The system is estimated to have a North Delta diversion capacity of 9,000 cfs (Bay Delta Conservation Plan, Draft Environmental Impact Report, 2013).

The Delta Vision and Bay Delta Conservation Plan are just two of dozens of initiatives in the Delta directed toward improving water quality, managing water diversion, controlling floods, restoring ecosystems, reducing fish decline, and reducing invasive species. Many of these initiatives are described in Chapter 7.

The SCP is a minor element of this complex dynamic Delta environment. The SCP seeks to control only one of the hundreds of invasive species in the Delta. The SCP operates within the context of an environment that has been managed and manipulated since the mid-1800s.

The challenge in today's Delta is to support gradual restoration of natural Delta ecosystems, where possible, while preventing further environmental deterioration. The specific challenge of the SCP is to control the growth of spongeplant within this highly modified Delta environment. Spongeplant, left to grow unchecked, has the potential to significantly negatively impact the environment. At the same time, the SCP also must minimize potential negative impacts of spongeplant treatment.

1. Regulatory Settings

There are several Federal and State laws relevant to biological resources that are applicable in the SCP project area. Below, we describe five such regulatory programs.

Endangered Species Act

The Endangered Species Act (ESA) was signed into law in 1973 to conserve and protect species that are endangered or threatened, and the ecosystems on which they depend (NMFS 2008). The law is implemented by USFWS and NMFS. Major activities within the law include identification of listed species, identification of critical habitat, development of recovery plans, cooperation with states, interagency consultation (Section 7), international cooperation, enforcement, permits, and habitat conservation plans. When a federal project may result in "take" of an endangered or threatened species, the federal agency must obtain a biological opinion and Section 7 Incidental Take permit. The SCP has obtained ESA Section 7 Biological Opinions from USFWS and NMFS through the consultation process. The federal nexus for this process is USDA-ARS. The biological opinions specify requirements that DBW must follow to minimize the potential for take of endangered or threatened species.

California Endangered Species Act

The California Endangered Species Act (CESA) states that all native species of fishes, amphibians, reptiles, birds, mammals, invertebrates, and plants, and their habitats, threatened with extinction and those experiencing a significant decline which, if not halted, would lead to a threatened or endangered designation, will be protected or preserved. CDFW works with all interested persons, agencies and organizations to protect and preserve such sensitive resources and their habitats. CESA, which is administered by the CDFW Habitat Conservation Planning Branch, protects wildlife and plants listed as threatened or endangered by the California Fish and Game Commission (CDFW 2008).

The law restricts "take" of listed species, and agencies must apply for an incidental take permit under CESA, similar to the process under ESA. As part of the permit process, the applicant must indicate that the measures to minimize or fully mitigate the impacts of the authorized take are a) roughly proportional in extent to the impact of the taking on the species; 2) maintain the applicant's objectives to the greatest extent possible; and 3) capable of implementation.

CESA includes additional species that are not covered by the federal ESA, however implementation of CESA and ESA is typically closely coordinated between USFWS, NMFS, and CDFW.

Magnuson-Stevens Fishery Conservation and Management Act (MSA) – Essential Fish Habitat (EFH)

The Magnuson-Stevens Fishery Conservation and Management Act was originally passed in 1976, and amended most recently in 2006. The MSA governs marine fisheries in the United States (Pacific Fisheries Management Council 2008). The MSA regulates fishing to waters 200 nautical miles off the U.S. coast, established fishery management councils, and includes provision to create fishery management plans, conserve and manage fishery resources, and prevent overfishing. The Pacific Fishery Management Council implements the MSA for Washington, Oregon, and California. The MSA defines essential fish habitat as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." The MSA requires fishery management councils to describe EFH within fishery management plans, and to minimize impacts on EFH. A habitat area of particular concern (HAPC) is a subset of EFH, and consists of sensitive areas that are particularly important in the fish life cycle. Estuaries, such as the Delta, are classified as HAPCs. The SCP could potentially impact EFH for salmon, as well as EFH for certain groundfish species that are regulated under the MSA.

Natural Community Conservation Plans (NCCP) and Habitat Conservation Plans (HCP)

The NCCP is a California planning program, while the HCP is a federal planning program (DFG 2008; USFWS 2005). Both programs are related to their respective endangered species laws. Within California, most entities prepare a joint NCCP/HCP. Both laws focus on broader ecosystem planning and protection of special status species, within the context of development of a particular project or region. The NCCP is intended to “conserve natural communities at the ecosystem scale while accommodating compatible land use.” The HCP provides planning and conservation measures, including mitigation, when a project or development could result in incidental take of a threatened or endangered species. The HCP process has evolved into a broad-based planning effort to incorporate conservation into development efforts. There are several NCCP/HCP planning efforts within the Sacramento/San Joaquin Delta, including those summarized below. To the extent that SCP activities are mitigated, and will result in long-term benefits to ecosystems, they are compatible with these planning efforts.

Migratory Bird Treaty Act

The Migratory Bird Treaty Act authorizes the U.S. Secretary of the Interior to protect and regulate migratory birds (USFWS 2008). The law is implemented by the USFWS, and protects migratory birds, occupied nests, and eggs. The Migratory Bird Treaty Act was first passed in 1918, and has been amended several times since. The act implements conventions between the United States and Canada, Mexico, Japan, and the former Soviet Union to protect migratory birds. There are 836 bird species protected by the Act.

Lake and Streambed Alteration Agreement

Section 1602 of the California Fish and Game Code requires notification to the CDFW for any proposed activity that will 1) substantially divert or obstruct the natural flow of any river, stream, or lake; 2) substantially change or use any material from the bed, channel, or bank of any river, stream, or lake; or 3) deposit or dispose of debris, waste, or other material containing crumbled, flaked, or ground pavement where it may pass into any river, stream, or lake (Fish and Game Code, Section 1602). Upon receiving such a notification, the CDFW assesses whether the activity could substantially adversely affect an existing fish or wildlife resource, and if so, provides a draft agreement that includes measures to mitigate the potential effects on fish and wildlife while performing the activity. If a party receiving the draft agreement disagrees with any of the proposed measures and is unable to informally resolve the disagreement with CDFW, a panel of arbitrators may decide on the terms of the agreement.

2. The Delta

The Sacramento-San Joaquin Delta includes approximately 1,100 square miles and was originally a tidal marsh and an overland area of the Sacramento and San Joaquin Rivers. The area was developed primarily for agriculture beginning in the mid-1800s and has approximately 60 major land tracts and islands protected from flooding by 1,100 miles of levees.

There are approximately 700 miles of rivers, sloughs, and connecting channels with a surface area of approximately 62,000 acres of water.[1] Delta river depths typically range between five and ten feet, with inland navigation channels for the ports of Sacramento and Stockton dredged to 30 feet.

Over 40 percent of the State’s runoff drains into the Delta. The Sacramento River contributes approximately 80 percent of Delta inflow, the San Joaquin River contributes approximately 15 percent, with the remaining five percent of flows contributed from the Cosumnes, Mokelumne, and Calaveras Rivers. Most of the Delta is subject to tidal action with mean fluctuations of approximately two to three feet.

The Delta climate is hot and dry in summer, and cool and moist in winter. Temperatures in the summer may reach over 100ºF, and drop to below freezing in the winter. Annual rainfall varies from approximately

1 There are 61,619 water acres in the legal Delta, and another 6,180 water acres in southern sites within DBW’s aquatic weed control program treatment sites, for a total of 67,799 water acres.

10 to 18 inches and prevailing winds are from the west. Winds frequently range up to approximately 25 miles per hour.

The primary land use in the Delta is agricultural, with only about five percent urban use. The Delta supports a wide variety of field crops, vegetables, fruits, nuts, livestock, and poultry.

Delta waterways also support a large variety of recreational uses. There are many public and private recreational areas including marinas and camping, primarily along waterfronts. Fishing and boating account for 70 percent of Delta recreation use.

The California State Water Project (SWP) and federal Central Valley Project (CVP) export approximately five million acre-feet of water annually from the Delta for agricultural, municipal, and industrial purposes in central and southern California. An almost equal amount of water is withdrawn from the Sacramento and San Joaquin Rivers for agricultural and municipal uses before it reaches the Delta. Approximately 25 percent of California's drinking water comes from the Delta, and two-thirds of California households receive some drinking water from the Delta (URS Corporation 2007).

The remainder of this Environmental Setting subsection describes habitat types within the Delta, and identifies special status species potentially impacted by the SCP. In developing this subsection, we relied on the CALFED Bay-Delta Program Multi-Species Conservation Strategy and the Bay Delta Conservation Plan (BDCP) EIR/EIS (BDCP, 2013).

3. Natural Community Conservation Planning (NCCP) Program Habitats

The Delta consists of a wide variety of different habitat types. In order to provide a background framework from which to discuss the biological resource impacts of the SCP, we first describe the habitat types within the SCP area. The NCCP's planning agreement (Section 2800 of the NCCPA) notes that natural communities are "those species and their habitat identified by the department that are necessary to maintain the continued viability of those biological communities." The CALFED Multispecies Conservation Strategy (MSCS) developed a classification system for eighteen habitats and two ecologically-based fish groups (CALFED July 2000). These categories include several habitat or vegetation types found in frequently used classification systems, such as the CDFW's California Wildlife Habitat Relationships System.

The BDCP identifies natural habitats more specific to the Delta region. In particular, there are 13 natural habitats identified in the Plan area, in addition to a separate community referred to as Cultivated Lands. Of these 14 habitats, eight fall within the SCP area, and are described below.

Additionally, two fish groups also fall within the plan area. The fish groups were developed because typical habitat classifications, based on vegetation, land-use, and geography, do not adequately address these groups, which move between habitats. Fish species included within the two fish groups were defined as those that are most affected by CALFED water projects, depend on the Bay-Delta ecosystem, and are subject to established USFWS, NMFS, and CDFW recovery goals (USBR 2003, 5-20).

Tidal Perennial Aquatic

Tidal Perennial Aquatic (TPA) habitat is defined as deep water aquatic (greater than three meters deep from mean low tide), shallow aquatic (less than or equal to three meters from mean low tide), and un-vegetated intertidal (i.e., tidalflats) zones of estuarine bays, river channels, and sloughs (CALFED July 2000). This habitat can be found throughout the Delta, including sloughs, channels, and flooded islands. Spongeplant is typically found in this habitat.

Additional TPA habitat aquatic plant species include water hyacinth, water primrose, *Egeria densa*, hornwort, parrot's feather, and western milfoil. Colonies of these aquatic plants are generally infrequent, but mats of noxious weeds, such as spongeplant, water hyacinth, or *Egeria densa*, can clog waterways, shade habitat for native aquatic vegetation, and smother low-growing intertidal vegetation when washed onto channel banks (DWR 2006, 6.2-6). There are no special status plants associated with tidal perennial aquatic habitats (CALFED July 2000, C-2-1 to C-2-12). However, many animal species rely on tidal perennial aquatic habitat during some portion of their life cycle.

There has been a substantial loss of historic shallow tidal waters, mainly as a result of reclamation and channel dredging and scouring. Many leveed lands in the Delta have subsided and are too low to support shallow tidal perennial aquatic habitat. Mid-channel islands and shoals have been shrinking or disappearing from progressive erosion of the remaining habitat.

Major factors contributing to the loss of mid-channel islands and shoals are gradual erosion from channels conveying water across the Delta to South Delta pumping plants, boat wakes, and dredging within the Delta or adjacent waters. The BDCP's goal is to restore 10,000 acres of TPA habitat.

Tidal Freshwater Emergent Wetland

Tidal freshwater emergent wetland (TFEW) habitat often occurs in the shallow, slow-moving, or stagnant edges of freshwater waterways in the intertidal zone and is subject to frequent long-duration flooding. It includes portions of the intertidal zones of the Delta that support emergent wetland plant species that are not tolerant of saline or brackish conditions (CALFED July 2000). Tidal freshwater emergent wetland occurs within the Delta along island levees, channel islands, and shorelines (USBR 2003, 5-11), including potential sites with spongeplant.

The dominant vegetation for tidal freshwater emergent wetland habitat includes bulrush, tules, cattails, and common reed. Several special status plant species potentially affected by the SCP are found within this habitat, including Suisun Marsh aster, wooly rose-mallow, Delta tule pea, Mason's lilaeopsis, and Delta mudwort (CALFED July 2000, C-2-1 to C-2-12). Freshwater emergent wetlands are among the most productive wildlife habitats in California, providing food, cover, and water for more than 160 species of birds, as well as many mammals, reptiles, and amphibians (USBR 2003, 5-10).

Historically, freshwater marshes were widespread throughout the Delta and backwaters of the upper Sacramento River. Many types of wetlands and their inhabitants have disappeared. Between 30 and 50 percent of the original wetlands of the United States have been lost, mostly to urban development, water diversions, conversion of land to agriculture, or contamination. Until the 1950s the rate of wetland loss in the United States was more than 800,000 acres per year, dropping to less than 80,000 acres per year in the 1980s and early 1990s (Heimlich 1998). The Clean Water Act has a policy of "no net loss of wetland" that has reduced wetland loss in the United States, estimated to be less than 60,000 acres per year in the late 1990s. The BDCP's goal is to restore 13,900 acres of TFEW.

In California, 90 percent of the original five million acres of wetlands has been lost, much of it within the Delta. Levees and other land uses led to loss of fresh emergent wetland in the Delta, reducing habitat for wetland wildlife species as well. Fresh emergent wetland losses have also substantially reduced the area available for biological conversion of nutrients in the Delta. The Delta now contains insufficient wetland area to provide adequate levels of nutrient transformation, which results in lower water quality in San Francisco Bay (USBR 2003, 5-10).

Valley/Foothill Riparian

Valley/foothill riparian (VFR) habitat includes all successional stages of woody vegetation, within active and historical floodplains of low-gradient reaches of streams and rivers generally below an elevation of 300 feet (CALFED July 2000). VFR habitat encompasses the approximately 0.1 to 1 mile width of woody vegetation along riverine habitats, including Delta waterways such as the Sacramento, San Joaquin, Cosumnes, Mokelumne, and Calaveras rivers and other sloughs, streams, and ephemeral creeks (USBR 2003, 5-16). Spongeplant may occur adjacent to, but not within, VFR.

Valley/foothill riparian habitat is dominated by cottonwood, sycamore, alder, ash, and valley oak tree overstory; and a blackberry, poison oak, and wild grape understory (USBR 2003, 5-15). None of the special status plants impacted by the SCP fall within this habitat. However, valley elderberry shrub, protected for the valley elderberry longhorn beetle, exist in this habitat. Over 225 species of birds, mammals, reptiles, and amphibians depend on riparian habitats and cottonwood-willow riparian areas support more breeding avian species than any other broad California habitat type (USBR 2003, 5-15).

The condition of riverine aquatic and nearshore habitats in the Delta has not been well documented, however, these habitats have been degraded by channel straightening; channel incising; channel dredging and clearing; instream gravel mining; riparian zone grazing; flow modifications; removal and fragmentation of shoreline riparian vegetation; and the loss of sediment, bedload, and woody debris from upstream watershed sources (USBR 2003, 5-15). The BDCP establishes a goal to protect 750 acres of VFR and restore an additional 5,000 acres.

Nontidal Perennial Aquatic

The nontidal perennial aquatic (NPA) natural community is found in association with any terrestrial habitat and often transitions into nontidal freshwater perennial emergent wetland and valley/foothill riparian. It is distributed throughout the BDCP area in all conservation zones and occurs mostly in small isolated patches along drainage and irrigation ditches in a cultivated landscape. This community can range in size from small ponds in upland areas to small lakes, such as the North and South Stone Lakes.

Nonplant primary producers such as diatoms, desmids, and filamentous green algae often form the base of the foodweb where they dominate open water habitat. Plant species found in this community vary with inundation depth and distance from shore, from submerged aquatics (e.g., pondweed and *Egeria*) to floating aquatic vegetation (e.g., duckweed and water hyacinth) that are found closer to shore and which may increase the rates of sediment and organic matter accumulation. The BDCP establishes a goal to protect 50 acres of NPA and nontidal freshwater perennial emergent wetland (discussed below) and restore an additional 1,200 acres.

Nontidal Freshwater Perennial Emergent Wetland

Nontidal freshwater perennial emergent wetland (NFPEW) habitat includes permanent (natural and managed) wetlands, including meadows, dominated by wetland plant species that are not tolerant of saline or brackish conditions (CALFED July 2000). NFPE habitat occurs throughout the Delta in areas where soils are inundated or saturated for all or most of the growing season, such as landward sides of levees, constructed waterways, ponds, and on Delta islands in low-lying areas among crop and pasture land (USBR 2003, 5-12). Portions of the SCP treatment area are within this classification.

Vegetation and wildlife for nontidal freshwater permanent emergent habitats are similar to tidal freshwater emergent wetland habitats (USBR 2003, 5-11). Special status plant species potentially affected by the project and within this habitat include: wooly rose-mallow, Sanford's arrowhead, marsh skullcap, and side-flowering skullcap. The decline of nontidal freshwater perennial emergent wetland habitats is similar to that described for tidal freshwater emergent wetland habitats. The BDCP establishes a goal to protect 50 acres of NPA and NFPEW and restore an additional 1,200 acres.

Managed Wetland

Managed seasonal wetland habitat includes wetlands dominated by native or non-native herbaceous plants, excluding croplands farmed for profit (e.g., rice), that land managers flood and drain during specific periods to enhance habitat values for specific wildlife species. Ditches and drains associated with managed seasonal wetlands are included in this habitat type (CALFED July 2000). Managed seasonal wetlands occur throughout the Delta, and are within the SCP project area, including private lands managed primarily for waterfowl or state and federal wildlife areas/refuges (USBR 2003, 5-14). SCP treatment sites may occur adjacent to managed seasonal wetland habitat.

Vegetation and wildlife species associated with managed seasonal wetland habitats are similar to those associated with natural seasonal wetland habitats, with the exception of vernal pool species (USBR 2003, 5-14). There are no plant species of concern potentially affected by the project within this habitat classification.

The extent and quality of managed seasonal wetlands vary, based on the practices that create and maintain this type of habitat. There are ongoing efforts to convert agricultural lands to managed seasonal wetlands in the Delta, and CALFED has a goal of restoring almost 30,000 acres of MSW (USBR 2003, 5-15). The BDCP establishes a goal to protect 6,500 acres of managed wetland.

Other Natural Seasonal Wetland

Natural seasonal wetland habitat includes vernal pools and other nonmanaged seasonal wetlands with natural hydrologic conditions that are dominated by herbaceous vegetation. These habitats also annually collect surface water or maintain saturated soils at the ground surface for enough of the year to support a variety of wetland plant species. Alkaline and saline seasonal wetlands that were not historically part of a tidal regime are included in natural seasonal wetlands (CALFED July 2000). Vernal pools, including those recently protected in the Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (USFWS 2005a) are found within the broader SCP control area, but are not adjacent to waterways, and thus will not be impacted by the program. The three vernal pool regions that are within the Delta are the Solano-Colusa region, Southeastern Sacramento Valley region, and San Joaquin region (USFWS 2005a).

Cultivated Lands

Cultivated Lands habitat includes agricultural lands farmed for small grains, field crops, truck crops, forage crops, pastures, orchards, and vineyards (USBR 2003, 5-15). Of the total BDCP area, 66 percent is cultivated. Of the total acreage of irrigated land in the Delta, which encompasses both seasonally flooded and upland cropland, corn is currently the predominant cover type (28 percent), followed by alfalfa (21 percent), pasture (12 percent), and tomatoes (8 percent). Orchards cover 4 percent of the total irrigated land acreage in the Delta, and asparagus covers 3 percent. Spongeplant may be situated in waterways adjacent to upland cropland habitat. The BDCP expects to protect 45,505 acres of cultivated lands.

Anadromous Fish Group

The anadromous fish group includes tidal perennial aquatic, valley riverine aquatic, montane river aquatic, saline emergent, and tidal freshwater emergent aquatic habitats. Fish species of concern associated with these habitats include Sacramento river winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead evolutionary significant units (ESUs), and green sturgeon (USBR 2003, 5-22). All of these species are potentially impacted by the SCP, and are discussed in this chapter.

Estuarine Fish Group

The estuarine fish group includes tidal perennial aquatic, valley riverine aquatic, saline emergent, and tidal freshwater aquatic habitats. Fish species of concern associated with these habitats include tidewater goby, delta smelt, longfin smelt, Sacramento splittail, and Sacramento perch (USBR 2003, 5-22). Three of these species, delta smelt, longfin smelt, and Sacramento splittail, may potentially be impacted by the SCP, and are discussed in this chapter.

4. Special Status Species

The SCP occurs on waterways within portions of 11 counties: Alameda, Contra Costa, Fresno, Madera, Merced, Sacramento, San Joaquin, Solano, Stanislaus, Tuolumne, and Yolo. DBW obtained lists of State and federal special status species occurring within these 11 counties from the USFWS, and the California Natural Diversity Database (CNDDB). Federal endangered and threatened species are regulated by USFWS and NMFS, through the Endangered Species Act (ESA). California threatened and endangered species are regulated by CDFW, through the California Endangered Species Act (CESA).

The 30 special status species that may occur in, or utilize, habitats potentially impacted by the SCP are identified in **Exhibit 3-1,** on the next page. There are eleven special status plants, one invertebrate, eleven fish, one amphibian, two reptiles, four birds, and six critical habitats potentially impacted by SCP activities.

Exhibit 3-1
Special Status Species Potentially Impacted by the SCP

Page 1 of 2

Invertebrates		
Scientific Name	**Common Name**	**Status***
1. *Desmocerus californicus dimorphus*	valley elderberry longhorn beetle	FT

Fish		
Scientific Name	**Common Name**	**Status**
1. *Acipenser medirostris*	green sturgeon	FT, FCH, CSC
2. *Acipenser transmontanus*	white sturgeon	CSC
3. Entosphenus tridentatus	Pacific lamprey	CSC
4. *Hypomesus transpacificus*	delta smelt	FT (approved FE)[1], FCH, CE
5. *Lampetra ayresi*	river lamprey	CSC
6. *Oncorhynchus mykiss*	Central Valley steelhead	FT, FCH
7. *Oncorhynchus tshawytscha*	Central Valley spring-run Chinook salmon	FT, FCH, CT
8. *Oncorhynchus tshawytscha*	Central Valley fall and late-fall Chinook salmon	CSC
9. *Oncorhynchus tshawytscha*	Sacramento River winter-run Chinook salmon	FE, FCH, CE
10. *Pogonichthys macrolepidotus*	Sacramento splittail	CSC
11. *Spirinchus thaleichthys*	longfin smelt	CT, under consideration for federal listing

Amphibians		
Scientific Name	**Common Name**	**Status**
1. *Rana aurora draytonii*	California red-legged frog	FT, FCH, CSC

Reptiles		
Scientific Name	**Common Name**	**Status**
1. *Clemmys marmorata*	western pond turtle	CSC
2. *Thamnophis gigas*	giant garter snake	FT, CT

Birds		
Scientific Name	**Common Name**	**Status**
1. *Agelaius tricolor*	tricolored blackbird	CSC
2. *Laterallus jamaicensis coturniculus*	California black rail	CT
3. *Xanthocephalus xanthocephalus*	yellow-headed blackbird	CSC
4. *Buteo Swainsoni*	Swainson's hawk	CT

[1] USFWS initiated a five-year review to assess endangered species classification on March 25, 2009.

Exhibit 3-1
Special Status Species Potentially Impacted by the SCP *(continued)*

Page 2 of 2

Plants		
Scientific Name	**Common Name**	**Status***
1. *Carex comosa*	bristly sedge	CNPS 2.1
2. *Hibiscus lasiocarpus*	wooly rose-mallow	CNPS 2.2
3. *Lathyrus jepsonii var. jepsonii*	Delta tule pea	CNPS 1B.2
4. *Lilaeopsis masonii*	Mason's lilaeopsis	CR, CNPS 1B.1
5. *Limonsella subulata*	Delta mudwort	CNPS 2.1
6. *Potamogeton zosteriformis*	Eel-grass pondweed	CNPS 2.2
7. *Sagittaria sanfordii*	Sanford's arrowhead	CNPS 1B.2
8. *Scutellaria galericulata*	marsh skullcap	CNPS 2.2
9. *Scutellaria lateriflora*	side-flowering skullcap	CNPS 2.2
10. *Symphyotrichum lentum*	Suisun Marsh aster	CNPS 1B.2
11. *Trichocoronis wrightii var. wrightii*	Wright's trichocoronis	CNPS 2.1

* Status Key

FE – federal endangered
FT – federal threatened
FCH – federal critical habitat specified for this species (of the six critical habitats identified in Exhibit 3-1, five include areas within the SCP, and could potentially be impacted by the SCP. Critical habitat for the California red-legged frog does not occur within the SCP area.)
FC – federal candidate for consideration of endangered or threatened
FCHP – federal critical habitat for this species is proposed
CE – California endangered
CT – California threatened
CR – California rare
CSC – California species of special concern
CNPS – California Native Plant Society listings:
1B.1: plants rare, threatened, or endangered in California and elsewhere; seriously threatened in California
1B.2: plants rare, threatened, or endangered in California and elsewhere; fairly threatened in California
2.1: plants rare, threatened, or endangered in California, but more common elsewhere; seriously threatened in California
2.2: plants rare, threatened, or endangered in California, but more common elsewhere; fairly threatened in California

Bolds above indicate plant has been found in the DBW surveys.

Under the ESA, the federal government may identify critical habitats for specific listed species. Critical habitats are defined as: (1) specific areas within the geographical area occupied by the species at the time of listing, if they contain physical or biological features essential to conservation or protection; and (2) specific areas outside the geographical area occupied by the species if the agency determines that the area itself is essential for conservation. The six species that are potentially impacted by the SCP, and for which critical habitat has been designated, are: (1) delta smelt, (2) Central Valley steelhead, (3) North American green sturgeon, Southern Distinct Population Segment, (4) Central Valley spring-run Chinook salmon, (5) Sacramento River winter-run Chinook salmon, and (6) California red-legged frog. Parts of the critical habitat for the first five of these species occur within the SCP, however none of the designated critical habitat for the California red-legged frog occurs within the SCP area. We describe the current status of each of these species below, and potential impacts of the SCP on these species in the impacts analysis section.

The majority of the special status species identified for these 11 relevant counties do not occur in, or utilize, waterways, channels, and channel banks of the Delta or its tributaries. For example, many of the identified species occur in mountainous or coastal habitats within the 11 counties, not within the Delta region. Other species may occur within the Delta, but are not at all likely to be impacted by SCP activities. This programmatic EIR does not consider these majority special status species.

Exhibit 3-5, located on page 3-108 at the end of Chapter 3, identifies more than 250 species that we do not expect to be impacted by the SCP, but that may occur within the 11 SCP counties. Less than ten percent of all the special status species identified for the 11 SCP counties could be potentially impacted by the SCP.

No new primary data surveys were conducted specifically for this final PEIR. However, data from previous DBW and prior relevant plant or wildlife surveys were included in this PEIR. DBW has monitored and reviewed environmental impacts of their aquatic weed control programs each year since 1983.

5. Invertebrates

Only one special status invertebrate, valley elderberry longhorn beetle, could potentially be affected by SCP operations. It is described below.

Valley Elderberry Longhorn Beetle

Valley elderberry longhorn beetle is classified as federally threatened. The most recent 5-year review of valley elderberry longhorn beetle, completed in September 2006, recommended delisting the beetle, primarily due to the fact that conservation actions have resulted in protection of 50,000 acres of riparian habitat and the restoration of 1,500 acres of beetle habitat. In addition, the number of occurrences increased from 10 locations in 1980, to 190 known locations in 2006 (USFWS 2009).


Source: www.fws.gov.

Photo: Valley Elderberry Longhorn Beetle.

On September 10, 2010, USFWS received a petition from the Pacific Legal Foundation requesting that USFWS delist the valley elderberry longhorn beetle. USFWS initiated a 12-month status review on August 19, 2011, to determine if delisting is warranted (Federal Register, August 19, 2012). The USFWS published its proposed rule in the Federal Register on October 2, 2012, recommending the delisting of the valley elderberry longhorn beetle and the removal of designated critical habitat. As of the end of 2013, the USFWS had not release a final rule. USFWS's Spotlight Species 5-Year Action Plan (2010 to 2014) for the valley elderberry longhorn beetle has recommended post-delisting monitoring of status, patch occupancy, and local turnover, should the species be delisted (USFWS 2009).

Valley elderberry longhorn beetle is a dimorphic species strictly tied to its host plant, the elderberry (*Sambucus* ssp.) during its entire life cycle. Adults emerge from pupation inside the wood of the elderberry in the spring as the trees begin to flower. The exit holes made by the emerging adults are distinctive small oval openings. Often these holes are the only clue that beetles occur in an area. Adults eat elderberry foliage until approximately June when they mate. Females lay eggs in crevices in the bark. Upon hatching, larvae begin to tunnel into the shrub, where they will spend one to two years eating interior wood, which is their sole food source.

Valley elderberry longhorn beetle historically occurred throughout the Sacramento and San Joaquin valleys and into the foothills of the Coast Ranges and the Sierra Nevada to 2,200-foot in elevation. Elderberry shrub is a common component of riparian forests and savannah areas (USFWS 2004). Recent surveys have found beetles in only scattered localities along the Sacramento, American, San Joaquin, Kings, Kaweah, and Tuolumne rivers and their tributaries. Valley elderberry shrubs with evidence of beetles have been spotted in SCP treatment sites along the Sacramento and Cosumnes Rivers (CNDDB 2006).

Over the last 150 years, agricultural and urban development has destroyed 90 percent of Central Valley riparian vegetation, which included the elderberry host plant, resulting in extreme fragmentation of the beetle's habitat.

The valley elderberry longhorn beetle is threatened by habitat loss and fragmentation, invasion by Argentine ants, agricultural conversion, levee construction, removal of riparian vegetation, riprapping of shoreline, and possibly other factors such as pesticide drift, exotic plant invasion, and grazing (USFWS 2004).

6. Fish

Fish dependent on the Delta as a migration corridor, nursery, or permanent residence include striped bass, American shad, sturgeon, Chinook salmon, steelhead, catfish, largemouth bass, and numerous less known marine and freshwater species. Since 1993, 87 species of fish have been identified in the Delta during the CDFW/ Interagency Ecology Program (IEP) fall midwater trawl (FMWT) survey, and salvage at the SWP pumping plant. In these two surveys, introduced species accounted for over 40 percent of the total number reported (Sommer et al. 2007).

Table 3-1, on the next page, identifies 13 native and 28 non-native fish species identified in sampling surveys during 1992 to 1999, and 2001 and 2003 (Feyrer and Healey 2003; Nobriga et al. 2005). Non-native fish species dominated surveys in both time periods, with non-native fish accounting for 96 percent of the total fish captured.

The most commonly captured fish in the 1992 to 1999 time period were bluegill, redear sunfish, white catfish, largemouth bass, and golden shiner. The most commonly captured fish in the 2001 and 2003 surveys were inland silverside, threadfin shad, striped bass, and yellowfin goby. In the later survey, inland silversides, thought to prey on and compete with delta smelt (Bennett 2005), accounted for over 50 percent of the fish captured.

Of more than 80 fish species in the Delta, important game fish include American shad, Chinook salmon, steelhead, and striped bass. Although all these fish spend most of their adult lives in the lower bays or in the ocean, the Delta is an important habitat for most of them.

Two Natural Community Conservation Plan (NCCP) habitat types for fish are present in the Delta: the Anadromous Fish Group, and the Estuarine Fish Group. Special status fish from each of these groups are potentially impacted by the SCP, and are described below. Delta fish habitat types include estuary, fresh water, and marine water. Transition from one zone to the next is gradual, and the zones move up or downstream depending on the amount of fresh water entering the estuary, outflow regime and water year hydrology.

Table 3-1
Numbers and Species of Fish Collected in Two Delta Fish Survey Studies (1992 to 1999, and 2001/2003)

#	Common Name	Scientific Name	Status*	1992 to 1999 Count	1992 to 1999 Percent	2001 and 2003 Count	2001 and 2003 Percent	Total Count
1	Inland silverside	*Menidia beryllina*	I	4,262	6%	42,994	53%	47,256
2	Threadfin shad	*Dorosoma petenense*	I	3,589	5%	18,267	23%	21,856
3	Bluegill	*Leposmis macrochirus*	I	19,820	28%	999	1%	20,819
4	Striped bass	*Morone saxatilis*	I	5,043	7%	5,886	7%	10,929
5	Redear sunfish	*Lepomis microlophus*	I	9,521	13%	1,294	2%	10,815
6	White catfish	*Ameiurus catus*	I	9,088	13%	501	1%	9,589
7	Largemouth bass	*Micropterus salmoides*	I	7,950	11%	1,248	2%	9,198
8	Golden shiner	*Notemigonus crysoleucas*	I	5,393	8%	352	0.4%	5,745
9	Yellowfin goby	*Acanthogobius flavimanus*	I	497	1%	2,366	3%	2,863
10	Common carp	*Cyprinus carpio*	I	1,726	2%	8	0.01%	1,734
11	American shad	*Alosa sapidissima*	I	63	0.1%	1,236	2%	1,299
12	Channel catfish	*Ictalurus punctatus*	I	712	1%	100	0.1%	812
13	Bigscale logperch	*Percina macrolepida*	I	180	0.3%	318	0.4%	498
14	Warmouth	*Lepomis gulosus*	I	313	0.4%	14	0.02%	327
15	Shimofuri goby	*Tridentiger bifasciatus*	I	192	0.3%	132	0.2%	324
16	Black crappie	*Pomoxis nigromaculatus*	I	226	0.3%	53	0.1%	279
17	Goldfish	*Carassius auratus*	I	256	0.4%	1	0.001%	257
18	Mosquitofish	*Gambusia affinis*	I	67	0.1%	153	0.2%	220
19	Brown bullhead	*Ameiurus nebulosus*	I	186	0.3%	7	0.01%	193
20	Green sunfish	*Lepomis cyanellus*	I	138	0.2%	–	–	138
21	Smallmouth bass	*Micropterus dolomieui*	I	138	0.2%	–	–	138
22	Rainwater killifish	*Lucania parva*	I	–	–	72	0.1%	72
23	Black bullhead	*Ameiurus melas*	I	43	0.1%	1	0.001%	44
24	Fathead minnow	*Ptychocheleius grandis*	I	18	0.03%	1	0.001%	19
25	Red shiner	*Cyprinella lutrensis*	I	13	0.02%	4	0.005%	17
26	White crappie	*Pomoxis annularis*	I	4	0.01%	–	–	4
27	Spotted bass	*Micropterus puntulatus*	I	–	–	2	0.002%	2
28	Shokihaze goby	*Tridentiger barbosus*	I	–	–	2	0.002%	2
1	Splittail	*Pogonichthys macrolepidotus*	N	94	0.1%	1,471	2%	1,565
2	Chinook salmon	*Oncorhynchus tshawytscha*	N	390	1%	825	1%	1,215
3	Tule perch	*Hysterocarpus traski*	N	384	1%	656	1%	1,040
4	Sacramento pikeminnow	*Ptychocheleius grandis*	N	55	0.1%	581	1%	636
5	Delta smelt	*Hypomesus transpacificus*	N	–	–	553	1%	553
6	Sacramento sucker	*Catostomus occidentalis*	N	278	0.4%	55	0.1%	333
7	Sacramento blackfish	*Orthodon microlepidotus*	N	238	0.3%	8	0.01%	246
8	Hitch	*Lavinia exilicauda*	N	–	–	174	0.2%	174
9	Prickly sculpin	*Cottus asper*	N	60	0.1%	104	0.1%	164
10	Starry flounder	*Platyichthys stellatus*	N	–	–	78	0.1%	78
11	Staghorn sculpin	*Leptocottus armatus*	N	–	–	64	0.1%	64
12	Three-spine stickleback	*Gasterosteus acculeatus*	N	–	–	9	0.0%	9
13	Steelhead	*Oncorhynchus mykiss*	N	2	0.003%	1	0.001%	3
	Total, All Species			70,939	–	80,590	–	151,529

Sources: Nobriga et al., 2005 (for 2001 and 2003 data), and Feyrer and Healey 2003 (for 1992-1999 data).

* "I" identifies invasive or non-native species, "N" identifies native species.

Delta aquatic habitat varies from dead-end sloughs to deep, open-water areas of the lower Sacramento and San Joaquin rivers and Suisun Bay. A scattering of flooded islands also offer submerged vegetative shelter. Channel banks are varied and include riprap, tules, emergent marshes, and native riparian habitat. The dominant channel banks are those that have been modified for flood control or navigation. There have also been substantial increases in the invasive aquatic weed, *Egeria densa*, over the past twenty years, further modifying natural waterways (Feyrer et al. 2007). Water temperatures generally reflect ambient air temperatures, but riverine shading may moderate summer temperatures in some areas.

Food supplies for Delta fish communities consist of phytoplankton, zooplankton, benthic invertebrates (living in the sediment), insects, and fish. General productivity is in constant flux. Monitoring of productivity is ongoing, including an evaluation of the interrelationships of the food web by the IEP for the Delta and Suisun Marsh. Recent evaluations of zooplankton in the Delta have found that all native zooplanktons have decreased in abundance since they were first monitored in the 1970s. At the same time, many introduced species are now more abundant (Mecum 2005). Monitoring data for zooplankton, phytoplankton, and benthic organisms indicate that overall productivity at lower food chain levels has decreased during the past 30 years.

The entrapment zone (at the X2 salinity line) concentrates sediments, nutrients, phytoplankton, some fish larvae, and fish food organisms. Biological standing crop (biomass) of phytoplankton and zooplankton in the estuary was historically highest in this zone. However, phytoplankton levels no longer show a peak in the entrapment zone, since introduced clams began cropping production in 1987. Keeping the entrapment zone in the upper reaches of Suisun Bay creates more desirable habitat for some species than could be maintained in narrower channels upstream in the Delta.

Flows caused, provided, or controlled by the CVP and SWP affect fish in numerous ways. Flows toward project pumps can draw both fish and fish food organisms into export facilities. Most large fish are screened out, and many do not survive screening and subsequent handling. Most fish less than about an inch long, and fish food, pass through the screens. In addition, the draw of the pumps may cause water in some channels to flow too fast for optimal fish food production, and reverse flows in some channels may confuse migrating fish. Delta flows may act as cues for anadromous fish outmigrating to the ocean.

Factors beside CVP and SWP operations that affect fish include water diversions within the Delta; upstream spawning conditions and diversions; municipal, industrial, and agricultural water pollution; habitat reduction; legal and illegal harvesting; competition from introduced species; natural predator/prey interactions; reduced food abundance; and drought. Cumulative effects of these and other factors have contributed to declining populations of many Delta fish.

Abundance of four important Delta fish species, native longfin smelt and delta smelt, and introduced striped bass and threadfin shad, have declined sharply since 2002. The decline was unexpected, given moderate winter-spring flows in the immediately preceding years. The Interagency Ecological Program (IEP) initiated a Pelagic Organism Decline (POD) working group in 2005 to evaluate causes of the decline.

The POD working group initially evaluated three general factors that appeared to be individually, or in concert, lowering pelagic productivity: invasive species (including the Asian clam, which consumes plankton); toxins; and water project operations (Armor et al. 2005). Increased water flows from the Delta through CVP and SWP operations have been targeted by many as a major cause of fish decline (Contra Costa Times 2006).

Analyses conducted in parallel with the POD working group examined other potential causes of pelagic organism decline. Engineers at the Contra Costa Water District hypothesized that salinity may be a threat to dwindling delta smelt (Traugher 2006). The engineers hypothesized that shifting the timing of State water project deliveries may have led to saltier water in the fall, and for same reason, may be leading to fewer delta smelt.

A presentation made by DWR environmental scientists at the 4th Biennial CALFED Science Conference on October 24, 2006 found declines in indices for habitat quality associated with salinity and turbidity variables. The scientists opined that turbidity indicators can be closely associated with submerged aquatic vegetation (including the invasive *Egeria densa*) (Feyrer et al. 2006). DWR scientists are also studying the effects of toxic algae in the Delta to determine whether it poses a serious threat to human health, and to determine if it plays a role in the Delta's ongoing ecosystem concerns (Taugher 2005). The algae, *Microsystis aeruginosa* (Microcystis toxins) was first discovered in the Delta circa 1999.

A San Francisco State University study is considering the impact of ammonia in wastewater released from the Sacramento Regional County Sanitation District facility in Freeport (Weiser 2008). Ammonia may disrupt the Delta food chain by reducing the availability of phytoplankton. This in turn reduces the amount of zooplankton available for fish species such as the delta smelt. Because the Sacramento region has grown significantly, the volume of wastewater has increased. In early 2009, a CalFed panel reported that ammonia is a likely contributor to environmental shifts in the Delta. The panel recommended further research (Weiser 2009).

In 2010, a study by the UC Davis Aquatic Toxicology Laboratory and the CDFW was published analyzing two years of toxicity monitoring data in the Delta (Werner 2010 et. al). The study results supported the claim that the water in the North Sacramento-San Joaquin estuary was at times acutely toxic to sensitive invertebrates. The authors found that sites in the Lower Sacramento River had the largest number of acutely toxic samples, high occurrence of piperonyl butoxide (PBO) effects on ampiphod growth, and the highest total ammonia/ammonium concentrations.

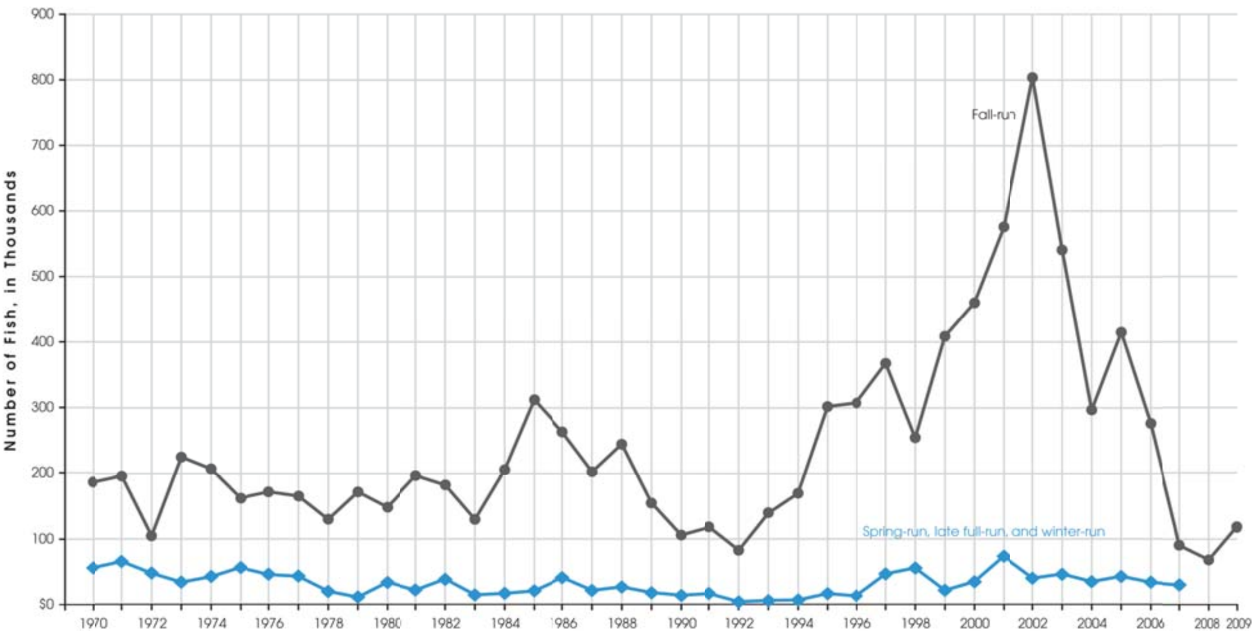
By 2010, the POD working group refined their analysis, developing three conceptual modeling approaches for identifying causes of pelagic organism decline. The "basic POD conceptual model" was introduced in 2006 and groups the effects of potential drivers into four categories: (1) previous abundance; (2) habitat; (3) top-down effects; and (4) bottom-up effects (Baxter et al. 2010). Previous abundance considers stock-recruitment levels and survival among different life stages. Habitat considers analyses of water clarity, salinity, temperature, and contaminants. Top-down effects evaluate predator relationships, including how invasive species such as *Egeria densa* improve habitats for invasive prey species (e.g. largemouth bass). Bottom-up effects consider the importance of food resources, particularly for delta smelt. The change in species composition of Delta zooplankton, with dominance of invasive plankton species, is of particular interest. The second conceptual model approach, introduced in 2008, is a "species-specific conceptual model" that shows how key population drivers affect each of the four POD species in each season. The most recent conceptual model, introduced in 2010 as a working hypothesis to be tested, suggests that the POD represents a rapid ecological regime shift that followed a longer-term erosion of ecological resilience (Baxter et al. 2010).

The POD working group continues to refine the conceptual models in order to further evaluate causes of POD. The 2010 workplan included 39 continuing study elements and 32 new elements. The work plan identifies three types of work: (1) continuation of expanded monitoring, (2) 31 ongoing studies, and (3) 19 new studies (Baxter et al. 2010). As the POD working group obtains new information, State and federal agencies are adapting Delta management practices, seeking to alleviate potential sources of decline (Broddrick 2007).

In other related actions, a federal court decision dated December 14, 2007, required the Bureau of Reclamation and CDWR to restrict water exports to specified levels in order to protect delta smelt larvae and juveniles. The decision also required the agencies to obtain a new biological opinion from the USFWS for the Operation Criteria and Plan (OCAP) for the SWP and CVP.

The USBR prepared a biological assessment for OCAP in August 2008. In June 2009, NMFS delivered its biological opinion and conference opinion on the proposed long-term operations on the CVP and SWP, concluding that the proposed action would likely jeopardize the continued existence of several threatened and endangered species. The biological opinion included a Reasonable and Prudent Alternative (RPA) that would allow the projects to continue operating without causing jeopardy or adverse modification. The RPA includes measures to improve habitat, reduce entrainment, and improve salvage, through both operational and physical changes in the system. Additionally, the RPA includes development of new monitoring and reporting groups to assist in water operations through the CVP and SWP systems and a requirement to study passage and other migratory conditions.

Figure 3-1
Central Valley Salmon Abundance, Hatchery, and Natural Escapements of Central Valley Adults (1970 to 2009)



Source: PFMC, February 2008, February 2009.

Salmon abundance has not followed the same pattern as pelagic species. Until 2007, salmon abundance appeared to be low, but relatively stable. However, low salmon abundance figures for 2007 were followed by even lower abundance estimates in the winter of 2008, particularly for the dominant fall-run. As a result, the Pacific Fishery Management Council (PFMC) and NMFS closed the commercial and recreational ocean salmon fisheries from Cape Falcon (in northern Oregon), south into California. The PFMC closed this fishery again in 2009.

The causes of this unprecedented decline are unknown, but likely factors include ocean temperature changes, in-stream water withdrawals, habitat alternations, dam operations, construction, pollution, and changes in hatchery operations (PFMC 2008). A multi-agency task force will review 46 possible causes of the decline.

Responding to these low salmon counts, CDFW closed Central Valley recreational salmon fishing for State waters in July 2008. This closure includes the Sacramento River and tributaries, and the ocean, out three miles. CDFW still allowed catch-and-release salmon fishing, and limited (one salmon catch) fishing on the Sacramento River between the Red Bluff Diversion Dam and Knights Landing from November 1st to December 31st, 2008. CDFW implemented similar closures in 2009.

The low abundance figures are for Sacramento River fall-run Chinook salmon, an ESU that is not listed as a threatened or endangered species. **Figure 3-1,** above, illustrates hatchery and natural escapement (i.e. fish that return to spawn) of Central Valley salmon (PFMC February 2008). Spring- and winter-run Chinook are endangered and threatened, respectively.

In November 2008, California Trout released two reports on the status of salmon, steelhead, and trout in California (Moyle et al. 2008a; Moyle et al. 2008b). The reports evaluated 31 living salmonid taxa, and identified 20 that are in danger of extinction in the next 100 years. While Moyle et al. (2008a, 2008b) identified significant threats to California salmonids, they also offered a number of recommendations to maintain these fisheries in the State.

Green Sturgeon

Photo: Green Sturgeon.

Green sturgeon (*Acipenser medirostris*) southern population (south of the Eel River), found in San Francisco Bay and the Delta, was designated as a federal threatened species by NMFS in July 2006. Critical habitat was designated in October 2009. Take prohibitions were established in June 2010. The Southern DPS is separate from green sturgeon found at the Eel River and north to British Columbia (NMFS February 2005). The green sturgeon is also listed as a California species of special concern by CDFW. There are many studies currently underway by a number of universities and state and federal agencies to better understand the distribution, migration, spawning habitat utilization, and population genetics of green sturgeon.

Green sturgeon is a large, olive green, bony-plated, prehistoric looking fish, with a shovel-like snout and vacuum cleaner-like mouth used to siphon food from the mud. Green sturgeon can reach over seven feet in length, weigh up to 350 pounds, and may live to be 60 to 70 years of age (CBD 2006). The Sacramento River contains the only known spawning population of southern DPS green sturgeon.

IEP fish monitoring in the San Francisco Bay, Delta, and river systems captured only 34 green sturgeons between April 2001 and September 2006, out of more than 100,000 fish sampled (IEP 2006a). Most captured sturgeon (17) were found at fish salvage facilities in the South Delta, indicating that they are found throughout the Delta. Another 14 sturgeon, most small, at less than 100mm, were found along the Sacramento River between Red Bluff and Colusa, and three were found during Chipps Island midwater trawls, west of SCP sites, near Suisun Marsh. Sturgeon captured at Chipps Island were generally larger, between 400 and 550mm in length, but still in juvenile stages. There is a significant need for additional information on abundance, distribution, population dynamics, mortality rates, and threats to green sturgeon. The CDFW Central Valley Bay-Delta Branch is conducting studies of both white and green sturgeon to increase understanding of these issues (CDFW 2006c).

The following information on green sturgeon is quoted from Moyle et al., (1995):

> “In California, green sturgeon have been collected in small numbers in marine waters from the Mexican border to the Oregon border. They have been noted in a number of rivers, but spawning populations are known only in the Sacramento and Klamath Rivers… The San Francisco Bay system, consisting of San Francisco Bay, San Pablo Bay, Suisun Bay and the Delta, is home to the southernmost reproducing population of green sturgeon...
>
> “The habitat requirements of green sturgeon are poorly known, but spawning and larval ecology probably are similar to that of white sturgeon. However, the comparatively large egg size, thin chorionic layer on the egg, and other characteristics indicate that green sturgeon probably require colder, cleaner water for spawning than white sturgeon (S. Doroshov, pers. comm.). In the Sacramento River, adult sturgeon are in the river, presumably spawning, when temperatures range between 8°C to 14°C. Preferred spawning substrate likely is large cobble, but can range from clean sand to bedrock. Eggs are broadcast-spawned and externally fertilized in relatively high water velocities and probably at depths >3 in (Emmett et al., 1991). The importance of water quality is uncertain, but silt is known to prevent the eggs from adhering to each other (C. Tracy, minutes to USFWS meeting)…
>
> “The ecology and life history of green sturgeon have received comparatively little study evidently because of their generally low abundance in most estuaries and their low commercial and sportfishing value in the past. Adults are more marine than white sturgeon, spending limited time in estuaries or fresh water…

> "Juveniles and adults are benthic feeders, and may also take small fish. Juveniles in the Sacramento-San Joaquin Delta feed on opossum shrimp (*Neomysis mercedis*) and amphipods (*Corophium* sp.) (Radtke 1966). Adult sturgeon caught in Washington had been feeding mainly on sand lances (Ammodyies hexapterus) and callianassid shrimp (P. Foley, unpublished). In the Columbia River estuary, green sturgeon are known to feed on anchovies, and they perhaps also feed on clams (C. Tracy, minutes to USFWS meeting)."

There has been substantial habitat loss in the Sacramento River above Keswick and Shasta dams (NMFS February 2005, 15). Threats to green sturgeon include concentration of spawning, small population size, lack of population data, potentially growth-limiting and lethal temperatures, harvest concerns, loss of spawning habitat, entrainment by water projects, influence of toxic material, and exotic species (NMFS February 2005, 13-14).

White Sturgeon

The white sturgeon is identified as a covered species in the BDCP. It is not listed under the federal Endangered Species Act (ESA) or the California Endangered Species Act (CESA).

Photo: White Sturgeon.

As a diadromous fish, white sturgeon inhabit riverine, estuarine, and occasionally marine habitats at various stages during their long life. Historically, white sturgeon ranged from Ensenada, Mexico to the Gulf of Alaska. Currently, spawning populations are found in the Sacramento–San Joaquin, Columbia, Snake, and Fraser River systems (Moyle 2002). In California, white sturgeon are most abundant in the San Francisco Bay/Sacramento–San Joaquin River Delta (Bay-Delta) and Sacramento River (Moyle 2002), but they have also been observed in the San Joaquin River system, particularly in wet years (California Department of Fish and Wildlife 2002; Beamesderfer et al. 2004).

The Delta and Suisun Bay serve as a migratory corridor, feeding area, and juvenile rearing area for white sturgeon. These corridors allow the upstream passage of adults and the downstream emigration of juveniles. Adult white sturgeon move from the waters of San Francisco Bay into the Delta and lower Sacramento River during the late fall and winter to spawn. They spawn preferentially in the Sacramento River between the Red Bluff Diversion Dam and Jelly's Ferry Bridge, at river mile 267, in areas characterized by swift currents and deep pools with gravel (U.S. Fish and Wildlife Service 1995; Schaffter 1997; California Department of Fish and Game 2002; Moyle 2002). Adult white sturgeon have been documented in the Yolo Bypass in the toe drain and at the base of Fremont Weir (Webber et al. 2007; Sommer et al. 2013) and in other bypasses in the Sacramento watershed (Healey and Vincik 2011). Larval and juvenile white sturgeon inhabit the lower reaches of the Sacramento and San Joaquin Rivers and the Delta (Stevens and Miller 1970).

The abundance and age structure of the population fluctuates substantially in response to highly variable annual reproductive success. In recent decades the population tends to be dominated by strong year classes produced in years with high spring flows. High spring flows were the norm prior to the major dam building effort on the rim of the Central Valley (Moyle 2002). Recent analyses of the abundance of white sturgeon 117 to 168 centimeters based on harvest data from 2007 to 2009 indicate current populations between about 43,000 and 57,000 fish (DuBois and Gingras 2011). From 2000 to 2009 the abundance of age 15 white sturgeon ranged from 3,252 to 6,539 (DuBois et al. 2011). The abundance of age-15 fish is the metric by which progress toward the Central Valley Project Improvement Act (CVPIA) recovery goal (11,000 fish) is assessed.

Pacific Lamprey

The Pacific lamprey is not listed under the California Endangered Species Act (CESA) or federal Endangered Species Acts (ESA). A broad group of west coast conservation organizations petitioned the U.S. Fish and Wildlife Service (USFWS) on January 27, 2003 to list Pacific lamprey, along with three other lamprey species on the West Coast, as threatened or endangered (Klamath-Siskiyou Wildlands Center et al. 2003). However, the petition was declined in a 90-day finding on December 27, 2004, citing insufficient evidence that listing was warranted (69 Federal Register [FR] 77158).

In the Central Valley, Pacific lamprey occurs in the Sacramento and San Joaquin Rivers (Moyle 2002) and many of their tributaries including the Stanislaus, Tuolumne, Merced, and King Rivers (Brown and Moyle 1993) (69 FR 77158). Individuals emigrating from Sacramento and San Joaquin River watersheds pass through the Plan Area during winter and spring on their way to the Pacific Ocean. Emigrating adults pass through the Plan Area on their way upstream towards spawning grounds between March and June. It is unknown to what extent Pacific lamprey use the Plan Area for purposes other than a migration corridor, but some studies (Brown and Michniuk 2007) have found ammocoetes within Sacramento–San Joaquin River Delta (Delta) sloughs, especially in the North Delta subregion.

Population trends are unknown in California, although anecdotal evidence indicates that populations have been in decline (Moyle 2002) (69 FR 77158). There are no monitoring programs that target Pacific lamprey in the Delta and those that catch Pacific lamprey do not catch them regularly enough to establish trends through time. In addition, Pacific lamprey are inconspicuous and often overlooked, and ammocoetes can be difficult to distinguish from ammocoetes of the co-occurring river lamprey (Webb pers. comm.).

The high density and limited mobility of lamprey ammocoetes in streams can potentially make them more vulnerable to channel alterations such as channelization, loss of riffle and side channels, and scouring (Streif 2007; Luzier et al. 2009). Loss or alteration of habitat can also limit spawning if it occurs in spawning reaches.

Delta Smelt

Source: www.fws.gov.

Photo: Delta Smelt.

The delta smelt (*Hypomesus transpacificus*) is State listed as endangered, and federally listed as threatened, with a recent decision to reclassify the federal listing from threatened to endangered. Delta smelt was first listed as threatened in 1993, with critical habitat designated in 1994.

Critical habitat for this species includes Suisun Bay (including contiguous Grizzly and Honker bays); the length of Goodyear, Suisun, Cutoff, First Mallard, and Montezuma sloughs; and existing continuous waters within the Sacramento-San Joaquin Delta. Delta smelt is native to the Sacramento-San Joaquin estuary. It is found primarily in the lower Sacramento and San Joaquin Rivers, in the Delta above their confluence, in Suisun Marsh water channels and in Suisun Bay. Delta smelt is endemic to low-salinity and freshwater habitats of the Delta (Bennett 2005).

Delta smelt spawn in fresh water from February to June, with peak spawning in April and May. Spawning has been reported to occur at about 45°F to 59°F in tidally influenced rivers and sloughs, including dead-end sloughs and shallow edgewaters of the upper Delta. Longer spawning seasons, based on this temperature range, are thought to result in more cohorts in a given season (Bennett 2005, 34). The spawning microhabitat for delta smelt is not known, and eggs have not been found in the field. Smelt are thought to spawn at night, broadcasting eggs just above the substratum, where the demersal (deposited near the bottom) and adhesive eggs mostly likely attach to submerged vegetation, rocks, or tree roots (Bennett 2005, 17).

Newly hatched larvae are planktonic and drift downstream near the surface in nearshore and channel areas to the freshwater/saltwater interface. Mager (1996) found that larvae hatched in 10 to 14 days under laboratory conditions and started feeding on phytoplankton at day four and on zooplankton at day six. Growth is rapid through summer, and juveniles reach 40 to 50 millimeters (fork length) by early August. Growth slows in fall and winter, presumably to allow for gonadal development. Adults range from 55 to 120 millimeters, but most do not grow larger than 80 millimeters.

The FWMT survey index, one measure of delta smelt abundance, declined in the mid-1980s, then generally increased through the late 1980s and early 1990s. In 1993, the FMWT index was the sixth highest of the 25 years of record. In 1990, the CDFW reviewed the status of delta smelt but could not determine factors causing the decline. In 1994, the index dropped to a 28-year low, but it rebounded again in 1995, only to drop again in 1996. Both the FMWT index and the summer tow net survey, conducted by CDFW, have shown extremely low levels of delta smelt starting in 2002, and continuing through 2008.

The 2008 FMWT index for delta smelt was the lowest on record, continuing a series of declining abundance indices (Smelt Working Group June 16, 2009). The total number of delta smelt caught in the CDFW's 2008 spring kodiak trawl survey was also low, as compared to previous years (Smelt Working Group June 16, 2008). There is significant concern regarding low fish counts over the last several years for delta smelt, as well as other species (see discussion of the POD working group, above). Delta smelt is of great concern, as the species is considered an indicator species of Delta health. There are a number of ongoing research efforts aimed at better understanding specific causes of the drastic decline in delta smelt (Baxter et al. 2010; Sommer et al. 2007).

Because delta smelt has only a one-year life-cycle, they are particularly sensitive to threats. In addition, delta smelt have a limited diet, produce low number of eggs, are poor swimmers, are easily stressed, and reside primarily in the moving interface between saltwater and freshwater. There are many potential reasons for delta smelt decline, including: high or low Delta water outflow, reduction in preferred food prey organisms, toxic substances, disease, competition, predation, and loss of genetic integrity (CDFW 2005, 73). In addition, delta smelt larvae, juveniles, and adults are entrained in diversions of the CVP and SWP. Although some species of fish can be salvaged at fish screening facilities, delta smelt suffer 100 percent mortality (USFWS March 2004, 11). In the USFWS 5-Year Review, fisheries biologist Peter Moyle indicated that Delta smelt will never be out of danger of extinction unless there are permanent and reliable changes made to the flow and temperature regimes that favor the smelt (USFWS March 2004, 27).

Relatively little is known about delta smelt compared to most other fish in the Delta, and even after a thorough review of delta smelt, three critical questions remain: (1) should the species continue to be listed as threatened, and what is the probability of extinction?, (2) What is the impact of human activities, particularly water export operations, on population abundance?, (3) Are there potential avenues for restoration and recovery (Bennett 2005)?

Bennett (2005) concluded that there is a 55 percent chance that the delta smelt population would become "quasi-extinct" (less than 8,000 fish) within 20 years. New analyses of threats to delta smelt are considering factors such as water quality and water flows on a regional, rather than a Delta-wide scale (Nobriga et al. 2008). Nobriga et al., (2008) found that at a regional level water clarity, salinity, and temperature were indicators of delta smelt habitat suitability.

River Lamprey

Source: www.hoatzin.de.

Photo: River Lamprey.

River lamprey (*Lampetra ayresi*) is a California species of special concern on the “watch list.” River lamprey has no federal listing. The USFWS evaluated Pacific lamprey, western brook lamprey, and river lamprey in 2004, and found no basis for listing these species (USFWS 2004c). No critical habitat has been designated for this species.

River lamprey are more widely distributed in British Columbia. Relatively little is known of the river lamprey’s distribution, abundance, life history, and habitat requirements in California (USFWS 2004c). The following is quoted from Moyle and others (1995):

> “The habitat requirements of spawning adults and ammocoetes [larvae] have not been studied in California. Presumably, the adults need clean, gravelly riffles in permanent streams for spawning, while the ammocoetes require sandy backwaters or stream edges in which to bury themselves, where water quality is continuously high and temperatures do not exceed 25°C.
>
> “River lampreys have been collected from large coastal streams from fifteen miles north of Juneau, Alaska, down to San Francisco Bay. In California, they have been recorded only from the lower Sacramento and San Joaquin rivers and from the Russian River (Lee and others 1980), but they have not really been looked for elsewhere. Wang (1980) indicates that a landlocked population may exist in upper Sonoma Creek (Sonoma County), a tributary to San Francisco Bay…
>
> “Trends in the populations of river lamprey are unknown in California, but it is likely that they have declined, along with the degradation of suitable spawning and rearing habitat in rivers and tributaries. River lamprey are abundant in British Columbia, the center of their range, but there are relatively few records from California, the southern end of their range.
>
> “The river lamprey has become uncommon in California, and it is likely that the populations are declining because the Sacramento, San Joaquin, and Russian Rivers and their tributaries have been severely altered by dams, diversions, pollution, and other factors. Two tributary streams where spawning has been recorded in the past (Sonoma and Cache creeks) are both severely altered by channelization, urbanization, and other problems.”

Central Valley Steelhead

Source: www.fs.fed.us.

Photo: Central Valley Steelhead.

Central Valley steelhead (*Oncorhynchus mykiss*), which are the anadromous form of rainbow trout, are federally listed threatened, a status that was confirmed in 2005 (NMFS 2005). NMFS is developing a recovery plan for Central Valley steelhead. Central Valley steelhead migrate to the ocean as juveniles and return to fresh water to spawn when they are 2 to 4 years old. Spawning migration (through the Delta) can be anytime from August through March.

Steelhead usually do not die after spawning. Survivors return to the ocean between April and June, and some make several more spawning migrations. Juvenile steelhead usually remain in fresh water for the first year, then migrate to the ocean between November and May. Steelhead are found in the Delta predominantly during migration.

Steelhead are primarily threatened by loss of the vast majority of historical spawning habitats above impassable dams, and mixing with hatchery fish (NMFS 2005, 290). California began implementing measures to protect steelhead in 1998, including 100 percent marking of all hatchery steelhead, zero bag limits for unmarked steelhead, gear restrictions, closures, and designation of size limits to protect smolts (NMFS 2007).

Chinook Salmon

There are four distinct runs of Chinook salmon (*Oncorhynchus tshawytscha*), distinguished by their timing of upstream migration and spawning season. The runs are named for the season during which the adults enter fresh water. Four of these runs are special status species and will be discussed below: winter-run, spring-run, and fall-run and late fall-run. NMFS is developing recovery plans for the winter- and spring-run species.

Source: www.fws.gov.

Photo: Chinook Salmon.

In 1989, the Sacramento River winter-run Chinook salmon was listed as threatened under the federal ESA by NMFS (54 FR 32085). NMFS reclassified the winter-run as endangered in 1994 (59 FR 440), and reaffirmed this classification in 2005 (NMFS 2005). Winter-run Chinook salmon were classified by the State as endangered in 1989. In 1993, NMFS designated critical habitat for the winter-run Chinook from Keswick Dam (Sacramento river mile 302) to the Golden Gate Bridge (58 FR 33212) (Federal Register 2004).

Central Valley spring-run salmon was listed as threatened by both the State and federal governments in 1999, and reaffirmed as threatened by the federal government in 2005. Critical habitat for Central Valley spring-run Chinook salmon was designated in September 2005. Critical habitat within the Delta includes portions of three hydrologic units: Sacramento Delta, Valley Putah-Cache, and Valley-American. Unlike winter-run Chinook, which utilize only the Sacramento River, spring-run Chinook utilize primarily the Feather and Yuba Rivers, with smaller populations likely in the Sacramento River and Big Chico Creek (NMFS 2005).

Central Valley fall-run and late fall-run Chinook salmon runs were listed as a species of special concern by NMFS in 2004. All four runs of Chinook salmon are found in the Delta only during migration to and from the Pacific Ocean. They do not spawn or rear in the Delta.

The life span of Chinook salmon ranges from two to seven years. Although Chinook salmon can spend 1½ to 5 years in the ocean before returning to natal streams to spawn, most return to fresh water 2½ years after entering the ocean.

Chinook salmon eggs are laid in nests (called "redds") excavated by the female in loose gravel. Juvenile salmon may migrate downstream to the estuary immediately after emerging from the redd, or they may spend a year or more in fresh water. The length of juvenile residence time in fresh water and estuaries varies between salmon runs and depends on a variety of factors, including season of emergence, streamflow, turbidity, water temperature, and interaction with other species.

There are two general types of Chinook salmon life history strategies, stream type and ocean type. Stream-type juveniles remain in the river for a year or more before migrating to the ocean. Ocean-type juveniles typically move to the ocean during their first few months. Although California races typically follow the ocean pattern, some juveniles of the fall, late-fall, and spring runs may emigrate as age-one smolts. Apparently all winter-run salmon migrate during the first few months after emergence.

Adult winter-run salmon immigrants enter the Sacramento River from December through June, peaking in March and April. Adults remain in the Sacramento River until spawning in May through August (CDFW 2005, 64). Juveniles spend five to nine months in the river and Delta before entering the ocean. Juveniles begin to move out of the upper river no earlier than fall, when water temperatures in lower reaches are suitable for migration (NMFS 2005, 145).

The entire historical spawning habitat of the Sacramento River winter-run Chinook salmon was blocked by construction of Shasta Dam. All spawning now occurs in the Sacramento River, below Keswick Dam (NMFS 2005, 145). The population size of winter-run Chinook salmon may have been as high as 200,000, dropped to 100,000 in the 1960s, and fell well below 5,000 between 1982 and 2001. Population estimates have increased to just under 10,000 since 2001 (NMFS 2005, 147).

Spring-run Chinook salmon traditionally spawned in upper reaches of Central Valley rivers and their tributaries, which are now blocked by dams. The spring run in the Sacramento River system generally enters fresh water between February and June, moving upstream and entering tributary rivers from February through July, peaking in May and June (CDFW 2005, 66). Fish migrate into headwaters and hold in pools through the summer, spawning from mid-August through mid-October. This is a distinguishing feature of this run, as adults hold over during the summer in colder pools in the upper river areas and do not spawn until fall, sometime between late August and October. Some juveniles emerge in early November, continuing through April, emigrating from the tributaries as fry from mid-November through June (CDFW 2005, 66). “Yearlings” remain in the stream until the following October, and emigrate starting in October through the following March (CDFW 2005, 66).

There are three independent populations of spring-run Chinook salmon, which utilize tributaries of the Sacramento River: Mill Creek, Deer Creek, and Butte Creek (NMFS 2007). There are also four dependent populations of spring-run Chinook salmon, utilizing Kings River, and Big Chico, Antelope, Clear, Thomes, Cottonwood, Beegum, and Stony Creeks (NMFS 2007).

Central Valley fall-run Chinook salmon fry (i.e., juveniles shorter than 2 inches long) generally emerge from December through March, with peak emergence occurring by the end of January. Most fall-run Chinook salmon fry rear in fresh water from December through June, with emigration as smolts occurring primarily from January through June. Central Valley late fall-run Chinook salmon fry generally emerge from April through June. Late fall-run fry rear in fresh water from April through the following April and emigrate as smolts from October through February (Snider and Titus 2000).

Adult Central Valley fall- and late fall-run Chinook salmon migrating into the Sacramento River and its tributaries primarily use the western and northern portions of the Delta, whereas adults entering the San Joaquin River system to spawn use the western, central, and southern Delta as a migration pathway. Fall- and late fall-run Chinook salmon must migrate through the Delta toward the Pacific Ocean and use the Delta, Suisun Marsh, and the Yolo Bypass for rearing to varying degrees, depending on their life stage (fry versus juvenile), size, river flows, and time of year.

Delta operations of the CVP and SWP affect adult and juvenile Chinook salmon as they pass through the Delta on their way to and from spawning and nursery areas in the Sacramento and San Joaquin River systems. Flow direction and velocity in Delta channels, operation of the Delta Cross Channel, and exposure of fish to the export pumps are major water project-related factors affecting salmon survival.

Adult salmon require presence of homestream water to guide them to their spawning grounds. Salmon from the Sacramento River system outmigrating through the Delta as juveniles in spring and early summer may be affected by altered flow patterns in the lower San Joaquin River. Some are also diverted to the interior Delta through Georgiana Slough and the Delta Cross Channel, where survival is lower than if they continued downstream in the Sacramento River. Exposure to water project fish screens results in losses due to predation by larger fish in front of screens, screen inefficiency, and attrition in the process of handling and hauling salvaged fish.

Other factors leading to declines in Chinook salmon include loss of most historical spawning habitat; degradation of remaining habitat, genetic threats from hatchery fish or other runs, predation by non-native species, and excessively high water temperatures (NMFS 2005, 153-155).

Sacramento Splittail

Photo: Sacramento Splittail.

Source: www.fws.gov.

Sacramento splittail (*Pogonichthys macrolepidotus*) was proposed threatened by the USFWS in January 1994, and officially listed as threatened in February 1999. Following a court challenge and mandated reevaluation in 2000, the USFWS delisted Sacramento splittail in 2003 (USFWS 2006). In August 2007, the Center for Biological Diversity submitted a notice of intent to sue the USFWS to require reconsideration of the splittail listing, and also to sue for political interference with the decision to delist the splittail (CBD 2008). Sacramento splittail is listed as a California species of special concern. No critical habitat is currently designated for this species.

Sacramento splittail is a large minnow endemic to the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta Estuary). Once found throughout low elevation lakes and rivers of the Central Valley from Redding to Fresno, this native species is now confined to lower reaches of the Sacramento and San Joaquin rivers, the Delta, Suisun and Napa marshes, and tributaries of north San Pablo Bay (CDFW 1994). Although Sacramento splittail is considered a freshwater species, adults and sub-adults have an unusually high tolerance for saline waters, up to 10-18 ppt (Meng 1993), for a member of the minnow family (CDFW 1994). Therefore, Sacramento splittail is often considered an estuarine species. When splittail were more abundant, they were commonly found in Suisun Bay and Suisun Marsh. Salt tolerance of splittail larvae is unknown (CDFW 1992).

Juveniles and adults use shallow edgewater areas lined by emergent aquatic vegetation. Submerged vegetation provides food sources and escape cover. Shallow, seasonally flooded vegetation is also apparently a preferred splittail spawning habitat. Year class strength appears to be primarily controlled by inundation of floodplain areas (high rainfall years), which provides spawning, rearing and foraging habitat. The splittail's life history pattern, featuring high fecundity, relatively long life span, and ability to migrate to spawning areas, shows an ability to adapt to a variable environment (Moyle et al. 2004).

Sacramento splittail is a relatively long-lived minnow, reaching ages of five and possibly up to seven years. Both males and females usually reach sexual maturity in their second year. Like most cyprinids, splittail has high fecundity, ranging from 5,000 to 100,000 eggs per female.

Timing and location of splittail reproduction have varied during separate investigations. From 1978 to 1983, samples of larvae indicate that splittail spawned in tidal freshwater and oligohaline (brackish, 0.5 to 5ppt saline) habitats such as Montezuma and Suisun sloughs and San Pablo Bay, from late January or early February through July. However, most spawning activity appears to occur in the Sacramento and San Joaquin Rivers and their tributaries. Splittail in the Delta are most abundant in the north and west portions when populations are low, but are more evenly distributed in years with higher reproductive success (Moyle et al. 2004).

Splittail eggs are adhesive or become adhesive soon after contacting water. Eggs appear to be demersal, are believed to be laid in clumps, and attach to vegetation or other submerged substrates. Larvae become free swimming five to seven days after hatching; feeding begins after five days post-hatch.

Young splittail appear to seek out shallow, vegetated areas protected from strong currents near spawning grounds and move downstream as they grow. They apparently move or are carried with higher spring flows downstream into the estuary and bays, where they are captured regularly by midwater trawl sampling in Suisun Bay near Montezuma Slough, in the vicinity of Pittsburgh Power Plant near New York Slough, near Antioch, and sometimes as far downstream as Carquinez Strait and San Pablo Bay.

Splittail recruitment decreased during 1987 to 1990 and apparently improved in 1991 and 1993. Juvenile splittail abundance is often highest in wet years. In 1994, the midwater trawl index once again showed a decline in young-of-the-year abundance, but the 1995 year class was exceptionally strong. In most surveys, the number of adult splittail has been variable since 1979, without a discernible trend, but Suisun Marsh surveys showed a major decline after 1981, with little or no resurgence since then. Again, 1995 abundance indices were the highest on record for CVP and SWP salvages, the San Francisco Bay Study otter trawl, and the (San Francisco) Bay Study midwater trawl (Sommer et al. 1997).

There are several different monitoring programs that measure splittail abundance, although none are focused on splittail. These surveys show that splittail have high natural variability (due to their life history), some successful reproduction takes place every year, and most successful reproduction years occur with relatively high outflow (Moyle et al. 2004, 13).

A major factor in species decline appears to be habitat constriction associated with the reduction of water flows and changed hydraulics in the Delta. There is a strong positive correlation between splittail year class success and outflows, with reduced survival during years of low outflow and high diversion (CDFW 2006a). A number of other factors may also influence splittail abundance, including loss of prey, effects of drought and climate change on habitat, non-native competitors and predators, and possible threats of disease and environmental contaminants (CDFW 2006a).

Longfin Smelt

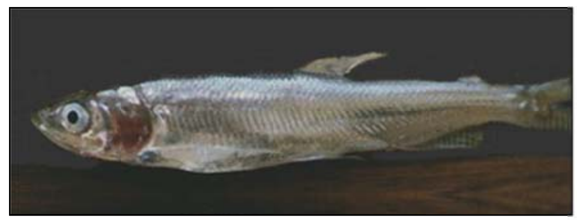

Source: swr.nmfs.noaa.gov.

Photo: Longfin Smelt.

Longfin smelt (*Spirinchus thaleichthys*) is designated as a California threatened species. The USFWS initiated a status assessment of the longfin smelt in April 2009. No critical habitat has been granted to this species.

The longfin smelt is a small, planktivorous fish that is found in several Pacific coast estuaries from San Francisco Bay to Prince William Sound, Alaska. Within California, longfin smelt have been reported from Humboldt Bay and the mouth of the Eel River. However, data are infrequently collected from Humboldt Bay, and there are no recent records from the Eel River (SFEP 1992a). In California, the largest longfin smelt reproductive population inhabits the Bay-Delta Estuary (CDFW 1992). This four to five inch long (adult), pelagic anadromous species spawns in fresh waters of the Delta and lower rivers, rears throughout the Estuary, and matures in brackish and marine waters (SFEP 1997).

Longfin smelt can tolerate salinities ranging from fresh water to sea water. Spawning occurs in fresh to brackish water or fresh water, over sandy-gravel substrates, rocks, or aquatic vegetation (Meng 1993; CUWA 1994).

In the Bay-Delta Estuary, the longfin smelt life cycle begins with spawning in the lower Sacramento and San Joaquin Rivers, the Delta, and freshwater portions of Suisun Bay (SFEP 1992a). Spawning may take place as early as November and extend into June, with peak spawning occurring from February to April (Meng 1993). Eggs are adhesive and, after hatching, larvae are carried downstream by freshwater outflow to nursery areas in the lower Delta and Suisun and San Pablo Bays (SFEP 1992a). The principal nursery habitat for larvae is productive waters of Suisun and San Pablo Bays. Adult longfin smelt are found mainly in Suisun, San Pablo, and San Francisco Bays, although their distribution is shifted upstream in years of low outflow (Meng 1993).

With the exceptions that both longfin smelt and Delta smelt spawn adhesive eggs in river channels of the eastern Estuary and have larvae that are carried to nursery areas by freshwater outflow, the two species differ substantially. Consistently, a measurable portion of the longfin smelt population survives into a second year (SFEP 1992a). During the second year of life, they inhabit San Francisco Bay and, occasionally, the Gulf of the Farallones; thus, longfin smelt are often considered anadromous. Longfin smelt are also more broadly distributed throughout the Estuary, and are found at higher salinities, than Delta smelt (Sommer et al. 2002).

Because longfin smelt seldom occur in fresh water except to spawn, but are widely dispersed in brackish waters of the Bay, it seems likely that their range formerly extended as far up into the Delta as salt water intruded. The easternmost catch of longfin smelt in the fall midwater trawl was at Medford Island in the Central Delta. They have been caught at all stations of the Bay Study. A pronounced difference between the two species in their region of overlap in Suisun Bay is by depth; longfin smelt are caught more abundantly at deep stations (10 meters), whereas Delta smelt are more abundant at shallow stations (<3 meters) (SFEP 1992a).

A strong relationship exists between freshwater outflow during spawning and larval periods and subsequent abundance of longfin smelt (SFEP 1997). Outflow disperses buoyant larvae, increasing likelihood that some will find food. By reducing salinities in Suisun and San Pablo Bays, outflow may also provide habitat with few marine or freshwater competitors and predators (marine species often do not tolerate lower salinities, and freshwater species have mechanisms to avoid being washed downstream (SFEP 1997)).

The factor most strongly associated with recent declines in abundance of longfin smelt has been the increase in water diverted by the SWP and the CVP during winter and spring months when longfin smelt are spawning (NHI 1992a; DWR 1992). Pumping changes the hydrology of the Delta and increases exposure of larval, juvenile, and adult longfin smelt to predation and entrainment (NHI 1992b). Salvage data indicate that longfin smelt have been more vulnerable to pumping operations since 1984. This increase in vulnerability may be due to concentration of longfin smelt populations in the upper Estuary, within the zone of influence of the pumps, as a result of reduced Delta outflow. Also, decreases in outflow fail to disperse larvae downstream to Suisun Bay nursery areas, away from effects of Delta pumping (Meng 1993).

Longfin smelt have declined significantly from historic levels. Prior to the drought years 1987 through 1994, the FMWT Survey recorded longfin smelt averages of approximately 17,000 fish (USFWS May 6, 2008). This figure dropped to less than 600 during the drought, and then increased to approximately 4,000 from 1995 to 2000. Since 2001, FMWT surveys have averaged less than 600 longfin smelt per year, although there have not been drought conditions. A study of FWMT, San Francisco Bay Study, and Suisun Marsh Survey data, found significant declines in longfin smelt abundance (Rosenfield and Baxter 2007).

7. Amphibians

California Red-Legged Frog

Source: www.fws.gov.

Photo: California Red-Legged Frog.

The California red-legged frog (*Rana aurora draytonii*) is listed as federal threatened, and a California species of special concern. The California red-legged frog is the largest frog native to California. Habitat of the California red-legged frog is characterized by dense, shrubby vegetation associated with deep, still, or slow-moving water. They are infrequent inhabitants where introduced aquatic predators (e.g., bullfrogs) are present. Red-legged frogs rely on dense cover to protect them while breeding and foraging. They were found historically throughout the Central Valley, along the Pacific Coast, and in the San Francisco Bay area. Today the frog occupies only about 30 percent of its original range and is found primarily along the coast between San Francisco and Ventura. The USFWS finalized critical habitat designation for the California red-legged frog in May 2006. There are thirty critical habitat units covering 4.1 million acres in 28 counties. None of the designated habitat overlaps with SCP treatment sites.

California red-legged frogs breed from late November to April. At breeding sites, males typically call in small mobile groups (three to seven individuals) to attract females. Females attach eggs to emergent vegetation where embryos hatch six to 14 days after fertilization. Larvae require four to five months to attain metamorphosis. Juvenile frogs seem to favor open, shallow aquatic habitats with dense submergent vegetation. They frequently are active during the day, spending daylight hours basking in the warm surface water layer associated with floating and submergent vegetation. Adult frogs are wary and highly nocturnal. Introduced predators (particularly bullfrogs), habitat modification and destruction, and drought have all contributed to the decline of the species.

8. Reptiles

Giant Garter Snake

Photo: Giant Garter Snake.

The giant garter snake (*Thamnophis gigas*) is listed as State and federal threatened. Giant garter snakes are the largest garter snake in North America and are endemic to the valley floor wetlands in the Sacramento and San Joaquin Valleys. They inhabit sloughs, ponds, small lakes, and other low-gradient waterways, including irrigation canals where water is present throughout the summer. Giant garter snakes are usually found close to water, forage in the water for food, and will retreat to water to escape predators and disturbance (USFWS May 2004). These snakes typically avoid larger waterways with predatory fish, and woodland streams with excessive cover.

Giant garter snakes may exceed five feet in length, are dull brown with a checkered pattern of black spots on the dorsal side, and have a dull yellow, mid-dorsal stripe. The head is elongated with a pointed snout (CDFW 2005, 128).

Giant garter snake diet consists of small fishes, tadpoles, and frogs. Components of essential giant garter snake habitat include: adequate water during the active season (early-spring through mid-fall) to provide food and cover; emergent, herbaceous wetland vegetation, such as cattails and bulrushes, for escape cover and foraging habitat during the active season; upland habitat with grassy banks and openings in waterside vegetation for basking; and higher elevation uplands for cover and refuge from flood waters during the snake's dormant season in the winter (CDFW 2005, 17).

Giant garter snakes are most active from early spring through mid-fall, with its activity dependent on local weather conditions. During the winter between November and April, they are generally inactive, although some may move short distances on warmer days. During the active season, giant garter snakes generally remain in close proximity to wetland habitats but can move over 800 feet from the water during the day (East Contra Costa County Habitat Conservation Plan Association, 2006).

Giant garter snakes are currently found in only a small number of populations. Loss of wetlands, development, levee construction, grazing, and agriculture have all fragmented and reduced giant garter snake habitat (CDFW 2005, 18).

Western Pond Turtle

Photo: Western Pond Turtle.

The western pond turtle (*Clemmys marmorata*) includes two subspecies, the northwestern pond turtle (*Clemmys marmorata marmorata*) and the southwestern pond turtle (*Clemmys marmorata palida*). Both subspecies are designated as California species of special concern by CDFW. No critical habitat has been designated for this species.

Western pond turtles occur in suitable aquatic habitats throughout California west of the Sierra-Cascade crest and in parts of Oregon and Washington (Stebbins 1985). The northwestern subspecies is found generally north of San Francisco Bay, while the southwestern subspecies is found south of San Francisco Bay. The two subspecies may intergrade throughout the Delta and San Joaquin Valley (Stebbins 1985), or intergrades may be restricted to the Delta region with San Joaquin Valley populations represented by the southwestern pond turtle (USFWS 1992).

Western pond turtles are omnivorous. In addition to aquatic vegetation, turtles feed on larval dragonflies, mayflies, stoneflies, caddisflies, beetles, and other aquatic invertebrates (DBW 2001). Carrion is reported to be a common food item. Western pond turtles are a common prey item for river otters, raccoons, minks, coyotes, and bears.

Western pond turtles are found in association with a wide variety of wetlands, including ponds, marshes, lakes, streams, and irrigation ditches (Stebbins 1985). Suitable habitat is typically well-vegetated and contains exposed logs, rocks, or other basking sites from which turtles can easily escape into the water when disturbed (Stebbins 1985). Egg-laying may occur along sandy wetland margins or at upland locations as far as 1,300 feet from water (DBW 2001). Hatchlings and juveniles apparently require a more specialized aquatic habitat than do adults (USFWS 1992). Western pond turtles may move overland for short distances: females to lay eggs; entire local populations to reach new water and escape drying bodies of water (Zeiner et al. 1988).

Historic populations of western pond turtles in California have declined extensively (possibly as much as 90 to 99 percent in the Central Valley since 1850) as riparian corridors have been stripped of vegetation, flood plains diminished, and natural waterways channelized, leveed, and riprapped. Young turtles are vulnerable to a wide variety of predators including many introduced species such as bullfrogs and game fish (DBW 2001). Pond turtles may be victims of bioaccumulation of heavy metals and other toxins, which have increased dramatically in California's waterways since the industrialization of the state (DBW 2001). In the San Joaquin Valley, western pond turtles declined between 1880 and 1990 from an estimated 10 million or more, to less than 5,000 (DBW 2001).

Commercial collecting, wetland and upland habitat loss, and introduced predators have all been implicated in the decline of western pond turtles (USFWS 1992). Less than 10 percent of wetlands historically found throughout the species' range in California persist today (USFWS 1992).

9. Birds

California Black Rail

The California black rail (*Laterallus jamaicensis coturniculus*) is listed as a threatened species in California. There is no critical habitat for this species.

The California black rail is believed to have occurred historically from Tomales Bay in Marin County, south along the coast into northern Baja California, and in inland marshes of San Francisco Bay, the Delta, the San Bernardino-Riverside area, and along the lower Colorado River and the Salton Sea (Steinhart 1990). Throughout its range, the species is known to inhabit tidal salt, brackish, and freshwater marshes.

Source: www.birdphotography.com.

Photo: California Black Rail.

Highest densities of breeding black rails occur in larger undiked tidal marshes associated with the Petaluma and Napa Rivers, and in some bayshore marshes of San Pablo Bay. Elsewhere in San Pablo Bay, Suisun Bay, Suisun Marsh, and the Delta, distribution of the species is patchy due to habitat loss and fragmentation.

California black rail is the most secretive of rails, moving through and hiding under dense marsh vegetation. Black rails utilize undiked tidal marshes that include a high marsh elevational zone. They are critically dependent on the narrow upper peripheral halophyte zone above the area of extreme and frequent tidal action where insect abundance is greatest. Marsh elevation, freshwater inflow, and tidal regime may be variables that control occurrence of black rails in wetlands (DWR 1994).

The population of California black rail subspecies has been reduced to just a few thousand, the bulk of which are now limited to the northern San Francisco Bay area. Suitable California black rail habitat is limited in the Delta. The few areas of marsh vegetation that form suitable habitat are either shrinking from inundated substrates or are dominated by willows.

Loss, conversion, and fragmentation of natural tidal marshes have reduced historic habitat of California black rails. Domestic animals such as cats and introduced exotics such as red fox continue to threaten the species' existence. Black rail mortality has been reported from collisions with power lines, transmission towers, and automobiles (Zeiner et al. 1990).

California black rails are rarely found in the project area (Herbold and Moyle 1989). The only documented locations of black rails in the Delta are on instream berm islands, and these islands are slowly disappearing (DWR 1996).

Yellow-Headed Blackbird

Source: www.fws.gov.

Photo: Yellow-Headed Blackbird.

The yellow-headed blackbird (*Xanthocephalus xanthocephalus*) is a California species of special concern, priority 3. There is no critical habitat designated for this species.

Yellow-headed blackbirds are primarily migrant and summer residents of California, with current ranges in the Central Valley, northeastern California, and southern deserts (information on this species from: Jaramillo 2008). Yellow-headed blackbirds are present from April to early October, breeding from mid-April to late July.

Yellow-headed blackbirds breed in marshes with tall emergent vegetation, such as tules or cattails. They generally prefer open areas and edges over relatively deep water, and nest in low vegetation. Most nests are attached to cattails, tules, or willows. Males choose territories with open water, and females choose waterway edges with moderately dense vegetation and extensive channels. The diet of yellow-headed blackbirds consists of seed, and to a minor extent, insects.

Yellow-headed blackbirds are threatened by habitat loss, specifically wetland drainage for irrigation, flood control, or water diversion. They are sensitive to water depth, and lowering water levels may adversely affect breeding. Loss of historic wetlands has reduced the number of breeding yellow-headed blackbirds in the Delta, however they have been identified in the Delta in Sacramento, Yolo, San Joaquin, and Contra Costa counties. The species may also be present along rivers in the San Joaquin Valley.

Tricolored Blackbird

Source: www.fws.gov.

Photo: Tricolored Blackbird.

The tricolored blackbird (*Agelaius tricolor*) is a California species of special concern, priority 1. There is no critical habitat designated for this species.

Tricolored blackbirds are most numerous in the Central Valley and vicinity, and are largely endemic to California (CNDDB 1997). Most breeding occurs in California's Central Valley from mid-March through early August (Beedy 2008). A first breeding effort occurs primarily from the San Joaquin Valley south to

Kern County, and separately in southern Sacramento County (DBW 2001). An itinerant breeding effort following this occurs in other portions of the Sacramento Valley, including north of the Delta in Glenn and Colusa counties. A large portion of the population is believed to overwinter in the Delta. Large numbers observed there indicate that the region may be especially important for overwintering adults and juveniles.

Tricolored blackbirds are highly colonial birds. These birds breed near fresh water, preferably in emergent wetlands with tall, dense cattails and tules, but also in thickets of willow, blackberry, wild rose, and tall herbs (Zeiner et al. 1990). Tricolored blackbirds create dense colonies of nests in cattail marshes, typically from a few centimeters to 1.5 meters above water or ground in freshwater marshes (Beedy 2008). They may also nest slightly higher, in willows and other riparian trees (Beedy 2008). Nesting sites are adjacent to open accessible water, provide protected nesting substrate, and suitable nearby foraging space with adequate insect prey (Beedy 2008).

The tricolored blackbird population has been declining, at least since the 1930s. Habitat loss is thought to be the primary reason for this decline. Recent conversion of pastures and grasslands to vineyards in Sacramento County has resulted in loss of several large colonies (Beedy 2008).

Swainson's Hawk

Source: CDFW.

Photo: Swainson's hawk.

The Swainson's hawk (*Buteo Swainsoni*) was listed as a threatened species in 1983 by the California Fish and Game Commission. This listing was based on loss of habitat and decreased numbers across the state. The information on Swainson's hawk is CDFW's Non-Game Wildlife Program website (CDFW 2014b).

The Swainson's hawk is a medium-sized buteo with relatively long, pointed wings which curve up somewhat in a slight dihedral while the bird is in flight. The most distinctive identifying feature of adults is dark head and breast band distinctive from the lighter colored belly, and the underside of the wing with the linings lighter than the dark gray flight feathers. Adult females weigh between 900 and 1100 grams (32 to 39 oz), and males from 800 to 1000 grams (28 to 35 oz).

The Swainson's Hawk breeds in the western United States and Canada and winters in South America as far south as Argentina. A raptor adapted to the open grasslands, it has become increasingly dependent on agriculture, especially alfalfa crops, as native communities are converted to agricultural lands. The diet of the Swainson's hawk in California is varied, but mainly consists of small rodents called voles; however other small mammals, birds, and insects are also taken.

Swainson's Hawks often nest peripheral to riparian systems. They will also use lone trees in agricultural fields or pastures and roadside trees when available and adjacent to suitable foraging habitat. Swainson's Hawks in the Great Basin occupy the Juniper/Sagebrush community typical to the area.

The most recognized threat to Swainson's hawks in the loss of their native foraging and breeding grounds. As important foraging areas are converted to urban landscapes or other unsuitable habitat, the aptitude for the landscape to support breeding pairs decreases. Other threats include climate change, infrastructure placement, disease, pesticide poisoning, and electrocution.

10. Plants

We identified eleven special status plant species potentially affected by the SCP as those that are located, or potentially located, in those habitat types that will be directly impacted by spongeplant treatments. Species on channel banks immediately adjacent to treatment sites may potentially be affected by herbicide drift, although DBW takes steps to minimize drift, as described in mitigation measures. The eleven plant species that are potentially impacted by the SCP are identified in Table 3-1, and are described below.

In botanical surveys conducted by DBW in 2002 and 2003 at SCP treatment sites, two emergent or submergent special status plants, and two additional special status plants were identified: Suisun Marsh aster (common on Sherman Island), wooly rose-mallow (common on Old River and Middle River), Delta tule pea (on Delta island interiors and the lower Sacramento River), and elderberry, protected for the valley elderberry longhorn beetle. **Table 3-2,** on the next page, identifies submergent and emergent plants found in DBW's botanical surveys.

Bristly Sedge

Bristly sedge (*Carex comosa*) has no federal or State status. It is included on California Native Plant Society (CNPS) List 2.1: plants are rare, threatened, or endangered in California, but more common elsewhere, and seriously threatened in California. No critical habitat has been designated for this species.

Source: calphotos.berkeley.edu.

Photo: Bristly sedge.

Bristly sedge is recognized by male and female flowers on separate spikes. It is a monocot perennial herb with slender rhizomes, the stem is erect and smooth, growing up to five feet tall (USGS 2006).

Bristly sedge is found in marshes and swamps, as well as coastal prairies, and valley and foothill grasslands. It has been found in three topographic quadrants that include SCP treatment sites: Holt, Bouldin Island, and Courtland (CNPS 2008). Bristly sedge is more common in wetlands in the Midwest and East. Bristly sedge is threatened by marsh drainage (CNPS 2008). Bristly sedge is associated with the nontidal freshwater permanent emergent habitat classification within the Delta (CALFED July 2000, C-2-3).

Wooly Rose-Mallow

Wooly rose-mallow (*Hibiscus lasiocarpus*) is on the CNPS List 2.2: plants are rare, threatened, or endangered in California, but more common elsewhere, and fairly threatened in California. The plant has no State or federal status. No critical habitat has been designated for this species.

Source: www.dbw.ca.gov.

Photo: Wooly Rose Mallow.

Wooly rose-mallow occurs along the Sacramento River and adjoining sloughs from Butte County to the Delta. Wooly rose-mallow has been found throughout the Delta, and has been identified in several topographic quads covering SCP treatment sites, including: Stockton West, Holt, Woodward Island, Clifton Court Forebay, Thornton, Terminous, Isleton, Rio Vista, Jersey Island, Bouldin Island, and Courtland (CNPS 2008). Outside of California, the species is widespread, but threatened. Wooly rose-mallow is primarily found in western North America, but occurs as far east as Missouri (CNDDB 1992).

Wooly rose-mallow is a rhizomatous perennial emergent herb. It grows three to seven feet, and has two to four-inch white and rose flowers (Jepson Flora Project 1993). Within the Delta, wooly rose-mallow is found in tidal freshwater emergent and nontidal freshwater permanent emergent habitats (CALFED July 2000, C-2-7). It is associated with tules, willows, buttonwillow, and other marsh and riparian species on heavy silt, clay, or peat soils (CNDDB 1992).

Wooly rose-mallow is seriously threatened by development, agriculture, recreation, and channelization of the Sacramento River and its tributaries (CNPS 2006). Preferred habitat has been altered or destroyed by levee construction and maintenance, agricultural development, and marsh reclamation (CALFED July 2000, 303).

Table 3-2
Common Submergent and Emergent Plants Identified in DBW Botanical Surveys (2002 and 2003)

Submergent

Common Name	Scientific Name	Native/Nonnative *(if specified)*
1. Coontail	*Ceratophyllum demersum*	Native
2. Brazilian elodea	*Egeria densa*	Nonnative
3. Eurasion water milfoil	*Myriophyllum spicatum*	Nonnative
4. curly leaf pondweed	*Potamogeton crispus*	Nonnative
5. fanwort	*Cabomba caroliniana*	Nonnative
6. long-leaved pondweed	*Potamogeton nodosus*	Native
7. southern naid	*Najas guadalupensis*	Native
8. sago pondweed	*Stuckenia pectinata*	Native

Emergent

Common Name	Scientific Name	Native/Nonnative *(if specified)*
1. pennywort	*Hydrocotyle ranunculoides*	Native
2. common tule	*Scirpus acutus*	Native
3. California bullrush	*Scirpus californicus*	Native
4. smartweed	*Polygonum*	Native
5. water hyacinth	*Eichhornia crassipes*	Nonnative
6. yellow water primrose	*Ludwigia peploides*	*
7. common reed	*Phragmites australis*	Native
8. cattail	*Typha latifolia*	Native
9. flatsedge	*Cyperus odoratus*	Native
10. rush	*Juncus*	Native
11. spike rush	*Eleocharis*	Native
12. bur marigold	*Bidens cernua*	Native

* There are both native and non-native species of *Ludwigia peploides* in the Delta.

Delta Tule Pea

Delta tule pea (*Lathyrus jepsonii Greene ssp. Jepsonii*) is on CNPS List 1B.2: plants are rare, threatened, or endangered in California and elsewhere, and fairly threatened in California. It has no State or federal status. No critical habitat has been designated for this species.

Delta tule pea occurs on the Delta islands of the lower Sacramento and San Joaquin Rivers and westward through Suisun Bay to the lower Napa River. The plant also has been reported in western Alameda and Santa Clara counties (Calflora 2006).

Source: www.dbw.ca.gov.

Photo: Delta Tule Pea.

Delta tule pea has been identified in a number of topographic quads covering SCP treatment sites, including: Stockton West, Holt, Woodward Island, Thornton, Terminous, Isleton, Rio Vista, Jersey Island, Bouldin Island, Antioch North, and Courtland (CNPS 2008). Delta tule pea is associated with saline emergent and tidal freshwater emergent habitats within the Delta (CALFED July 2000, C-2-7).

Delta tule pea is a sprawling perennial vine found in coastal and Valley freshwater marshes. It has been observed in association with a broad spectrum of other plants ranging from common tule to Valley oak to arrowgrass. It prefers sites above tidal influence, which are still within the area of soil saturation (CNDDB 1992). It is threatened by agriculture, water diversions, salinity, and erosion (CNPS 2006).

Mason's Lilaeopsis

Source: calphotos.berkeley.edu.

Photo: Mason's Lilaeopsis.

Mason's lilaeopsis *(Lilaeopsis masonii)* is State listed rare and is included on the CNPS List 1B.1: plants are rare, threatened, or endangered in California and elsewhere, and seriously threatened in California. It has no federal status. No critical habitat has been designated for this species.

Mason's lilaeopsis is found in the Delta from the margins of the Napa River in Napa County, east to the channels and sloughs of the Delta (CDFW 2005, 444). Mason's lilaeopsis is found in topographic quads throughout SCP treatment sites, including: Holt, Union Island, Woodward Island, Clifton Court Forebay, Thornton, Terminous, Lodi South, Isleton, Rio Vista, Jersey Island, Bouldin Island, and Antioch North (CNPS 2008). Mason's lilaeopsis is found in tidal freshwater emergent habitats within the Delta (CALFED July 2000, C-2-8). The DBW botanical surveys in 2002 and 2003 found Mason's lilaeopsis to be common at the tidal edge clay.

Mason's lilaeopsis is a minute, turf-forming, perennial herb in the carrot family. It is found in tidal zones, on mud-banks and flats along sloughs and rivers, in freshwater marshes, brackish marshes, and in riparian scrub, that are in some way, influenced by saline water. Mason's lilaeopsis is semi-aquatic, growing on saturated clay soils that are regularly inundated by water. It is often found with other rare plants such as Delta mudwort, Suisun Marsh aster, and Delta tule pea (CDFW 2005, 444).

This species is threatened by development, bank and channel-stabilization, flood control projects, widening of Delta channels for water transport, dredging and dumping of spoils, boat wake overwash, recreation (fishing trails), levee maintenance, erosion, agriculture, and in some areas, by water hyacinth (CDFW 2005, 444).

Delta Mudwort

Source: calphotos.berkeley.edu.

Photo: Delta Mudwort.

Delta mudwort (*Limosella subulata* Ives.) has no federal or State status. It is included on CNPS List 2.1: plants are rare, threatened, or endangered in California, but more common elsewhere, and seriously threatened in California. No critical habitat has been designated for this species. Delta mudwort is not native to California, it was introduced and naturalized in the wild (Calflora 2006).

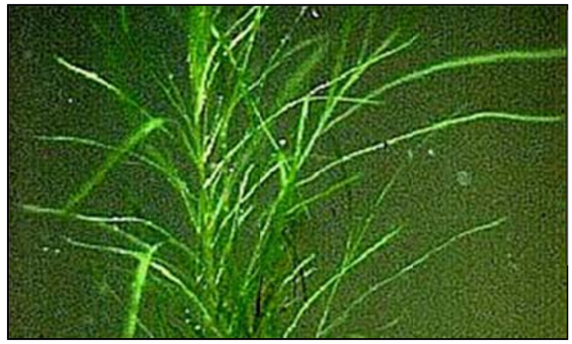
Delta mudwort is found in the Delta, along the Sacramento River near Bradford and Twitchell Islands, near Holland Tract, Victoria Island, and Mandeville Island (Calflora 2006). The plant also has been located in Marin County at Drakes Bay, and in Oregon, Washington, and on the Atlantic coast (CNPS 2006). Delta mudwort has been found in ten topographic quads that include SCP treatment sites, including: Stockton West, Holt, Woodward Island, Clifton Court Forebay, Thornton, Terminous, Rio Vista, Jersey Island, Bouldin Island, and Antioch North (CNPS 2008). The DBW botanical surveys in 2002 and 2003 found Delta mudwort to be common at the tidal edge clay.

Delta mudwort is a low-growing stoloniferous herb with white to lavender flowers (Jepson Flora Project 1993). Delta mudwort occurs in intertidal fresh- and brackish-water marshes. In the Delta, it is associated with the tidal freshwater emergent habitat classification (CALFED 2000, C-2-8). It grows on exposed mud often associated with Mason's lilaeopsis, aquatic pigmy-weed, or dwarf spike-rush (CNDDB 1992).

The intertidal habitats available to Delta mudwort are limited. Levee construction and maintenance, recreational boating, and trampling from fishing access are possible threats to Delta mudwort populations (CNDDB 1992).

Eel-Grass Pondweed

Eel-grass pondweed (*Potamogeton zosteriformis*) is included on CNPS List 2.2: plants are rare, threatened, or endangered in California, but more common elsewhere, and fairly threatened in California. It has no State or federal status. No critical habitat has been designated for this species.



Source: www.elacuarista.com.

Photo: Eel-Grass Pondweed.

Eel-grass pondweed is found in the Delta in two topographic quads, Jersey Island and Bouldin Island. It is also found in Lake County, northeastern California, Idaho, Oregon, Utah, and Washington (CNPS 2008).

Eel-grass pondweed is an annual aquatic herb of the pondweed family. It is a monocot, and generally found in fresh to alkaline water, and grows less than 60 centimeters tall. Eel-grass pondweed blooms in June and July. It is found in various freshwater marsh and swamp habitats including lake beds, ponds, and streams (CALFED 1999, 376). Eel-grass pondweed is associated with the valley riverine aquatic habitat classification category in the Delta (CALFED July 2000, C-2-10).

Eel-grass pondweed has very small populations and occupies only a small area, making it vulnerable to decline and extinction from genetic problems and events such as floods, insect attacks, disease, or extended droughts (CALFED 1999, 376).

Sanford's Arrowhead

Sanford's arrowhead (*Sagittaria sanfordii*) is on CNPS List 1B.2: plants are rare, threatened, or endangered in California and elsewhere, and fairly threatened in California. The plant has no State or federal status. No critical habitat has been designated for Sanford's arrowhead.

Source: calphotos.berkeley.edu.

Photo: Sanford's Arrowhead.

Sanford's arrowhead is distributed throughout the northern part of the north coast, Central Valley, and northern south coast of California (CALFED July 2000, 382). It has been recently observed at several locations within Sacramento County (Calflora 2006), and observed historically in seven topographic quads included in SCP treatment sites: Stockton West, Lathrop, Isleton, Fresno North, Turner Ranch, Mendota Dam, and Stevinson (CNPS 2008). Sanford's arrowhead is found within nontidal freshwater permanent emergent habitats within the Delta (CALFED July 2000, C-2-10).

Sanford's arrowhead is a rhizomatous perennial emergent herb. It is a monocot with blades 14 to 25 cm in length and small white flowers that bloom from May through October (Jepson Flora Project 1993). It grows in freshwater marshes, ponds, ditches, and various other freshwater habitats (CALFED 1999, 382).

Sanford's arrowhead is threatened by grazing, development, dumping, road maintenance, pond maintenance, herbicide spraying, clearing of channel vegetation, non-native plants, and channel alteration (CALFED 1999, 382).

Marsh Skullcap

Photo: Marsh Skullcap.

Source: cricket.biol.sc.edu.

Marsh skullcap (*Scutellaria galericulata*) is included on CNPS List 2.2: plants are rare, threatened, or endangered in California, but more common elsewhere, and fairly threatened in California. It has no State or federal status. No critical habitat has been designated for this species.

Marsh skullcap has been found in San Joaquin and Contra Costa Counties, within the Woodward Island and Bouldin Island topographic quadrants, although it is noted that these occurrences need further study. It is more commonly found in northeastern California, Oregon, and elsewhere (CNPS 2008). Marsh skullcap is typically found at elevations above 1,000 meters (Jepson Flora Project 1993).

Marsh skullcap is a shrub-like annual perennial herb in the mint family. It grows 20 cm to 80 cm in height, and has violet-blue flowers that bloom from June through September (Jepson Flora Project 1993). Marsh skullcap is found in meadows and seeps, marshes and swamps, and lower montane coniferous forests (CNPS 2006). It is found in the nontidal freshwater permanent emergent habitat classification within the Delta (CALFED July 2000, C-2-11). Known populations of marsh skullcap are threatened by erosion (CALFED 1999, 386).

Side-Flowering Skullcap

Photo: Side-Flowering Skullcap.

Source: www.globalherbalsupplies.com.

Side-flowering skullcap (Scutellaria lateriflora) has no federal or State status. It is included on CNPS List 2.2: plants are rare, threatened, or endangered in California, but more common elsewhere, and fairly threatened in California. No critical habitat has been designated for this species.

Side-flowering skullcap is found in Sacramento and San Joaquin counties on the Sacramento River near Locke (Calflora 2006). Within the SCP area, side-flowering skullcap has been found in the Bouldin Island topographic quadrant (CNPS 2008). It has also been found in Inyo county. Side-flowering skullcap is associated with non-tidal freshwater permanent emergent and natural seasonal wetlands within the Delta (CALFED July 2000).

Side-flowering skullcap is a rhizomatous perennial herb with blue flowers and loosely branching stems, 20 to 60 cm in height (Jepson Flora Project 1993). It blooms from July to September. This skullcap occurs in marshes and swamps, and meadows and seeps. Threats to the plant include altered water regimes (CALFED 1999).

Suisun Marsh Aster

Photo: Suisun Marsh Aster.

Source: calphotos.berkeley.edu.

Suisun Marsh aster (*Symphyotrichum lentum*) is on CNPS List 1B.2: plants are rare, threatened, or endangered in California and elsewhere. The plant has no State or federal status. No critical habitat has been designated for Suisun Marsh aster.

Suisun Marsh aster has a historical range that includes Suisun Bay and the Delta (CALFED 1999, 190). It has been observed in many topographic quads covered by SCP sites, including: Vernalis, Union Island, Lathrop, Woodward Island, Thornton, Terminous, Isleton, Rio Vista, Jersey Island, Bouldin Island, and Antioch North (CNPS 2008). Suisun Marsh aster is found within saline emergent and tidal freshwater emergent habitat classifications in the Delta (CALFED July 2000, C-2-2).

Suisun Marsh aster is a slightly succulent perennial rhizomatous herb of the sunflower family that grows over three feet tall (CALFED 1999, 190). It is a dicot, and has small violet flowers that bloom from May to November (Jepson Flora Project 1993). Suisun Marsh aster grows in brackish and freshwater marshes. It occurs along brackish sloughs, riverbanks, and levees affected by tidal fluctuations, usually around the mid- to high-tide mark (CALFED 1999, 190). Associated species include marsh plants such as bulrush, cattail, common reed, willow, and rose mallow. The plants are often found at, or near, the water's edge.

Factors leading to decline of this species include marsh alteration, trampling by livestock, recreational use, riprap, levee repair and maintenance, competition from non-native plants, and habitat loss (CALFED 1999, 190).

Wright's Trichocoronis

Source: www.nativeplantproject.com.

Photo: Wright's Trichocoronis.

Wright's trichocoronis (*Trichocoronis wrightii var. wrightii*) is on the CNPS List 2.1: plants are rare, threatened, or endangered in California, but more common elsewhere, and seriously threatened in California. The plant has no State or federal status. No critical habitat has been designated for this species.

Wright's trichocoronis is found in meadows and seeps, marshes and swamps, riparian forests, and vernal pools (CNPS 2008). It is found in the northern Central Valley (Colusa County), as well as Merced and San Joaquin Counties. Wright's trichocoronis has been found in two topographic quadrants covering SCP treatment sites: Turner Ranch and Lathrop (CNPS 2008). There are also plant populations in Riverside County, and Texas. There is confusion related to the origin of the plant. It may be native to California, or may have been introduced to California and naturalized into the wild (CNPS 2008; Calflora 2008).

Wright's trichocoronis is an annual herb. It grows to two feet in height, with white or bluish flowers. The plant grows in moist locations, and usually occurs in wetlands. Wright's trichocoronis is nearly extirpated in the Central Valley, due to habitat lost to agriculture and urbanization (CNPS 2008).

11. Essential Fish Habitat

Recognizing the importance of habitat to the viability of fish species, in 1996 Congress added new habitat provisions to the Magnuson-Stevens Fishery Conservation and Management Act (MSA). The MSA is the federal law that regulates marine fisheries management in the United States (PFMC 2005). The MSA is implemented through the activities of eight management councils. The Pacific Fisheries Management Council (PFMC) has jurisdiction over California, Oregon, and Washington.

Each management council is required to develop fishery management plans, which among other requirements, describe essential fish habitat (EFH) (PFMC 2006). Councils are to minimize impacts on EFH from fishery and other activities, and to coordinate and consult with NMFS and other federal agencies that undertake activities that could impact EFH. Because EFH and Endangered Species Act (ESA) consultations often overlap, agencies are encouraged to coordinate regulatory activities to the extent possible (NMFS 2004).

The primary focus of EFH is promoting long-term health of ocean fisheries through fishery management activities such as catch-limits. The intended purpose of the EFH guidance process is to avoid or minimize adverse impacts of activities on EFH by forward, informed planning (PFMC 1999, A-74).

Essential fish habitat includes habitats necessary to ensure healthy fisheries now, and in the future, and is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (PFMC 2006). EFH consists of both the water column and underlying surface (seafloor, vegetation, etc.) of a particular area. The PFMC has developed documents for four EFH: Coastal Pelagic Species, Groundfish, Salmon, and Highly Migratory Species. Two of these EFH are within the SCP area, Salmon and Groundfish. In addition, as a subset of EFH, the PFMC defines "habitat areas of particular concern" (HAPC). There are currently five HAPC types identified in the Fisheries Management Plan for groundfish, one of which (estuaries) potentially overlaps with SCP treatment locations. The other HAPC types are: canopy kelp, seagrass, rocky reefs, and specific "areas of interest" (PFMC 2006).

Chinook Salmon

Amendment 14 to the Pacific Coast Salmon Plan, *Identification and Description of Essential Fish Habitat, Adverse Impacts, and Recommended Conservation Measures for Salmon*, describes habitat and potential impacts for three salmon species: Chinook salmon, Coho salmon, and Puget Sound pink salmon. Only one of these species, Chinook salmon, is found within SCP treatment sites. EFH for Chinook salmon includes freshwater and marine habitat, encompassing "all currently viable waters and most of the habitat historically accessible to salmon…" (PFMC 1999, A-2). EFH is inclusive, and encompasses USGS hydrologic units (watersheds) from Washington to Central California, including the Sacramento-San Joaquin Delta unit. Critical habitat for winter-run and spring-run Chinook salmon also overlap with EFH, and SCP treatment sites, in the Delta.

Amendment 14 describes habitat requirements and habitat concerns for six life stages of salmon: (1) adult migration pathways, (2) spawning and incubation, (3) stream rearing habitat, (4) smolt migration pathways, (5) estuarine habitat, and (6)marine habitat. Three of these life stages move through, or temporarily reside in the Delta, potentially within or near SCP treatment locations: adult migration pathways, smolt migration pathways, and estuarine habitat. Characteristics of Chinook salmon, including migration patterns in the Delta, are described earlier in this Chapter.

Groundfish

The *Pacific Coast Groundfish Fishery Management Plan for the California, Oregon, and Washington Groundfish Fishery* provides a chapter addressing EFH for groundfish (PFMC September 2006). As with pacific salmon, the PFMC took an inclusive approach in identifying groundfish EFH for 80-plus species of groundfish included in the management plan. The groundfish fish management plan covers over 60 species of rockfish, 12 species of flatfish, six species of roundfish, as well as sharks, skates, and several other species. All of these species are managed for fishery values. Groundfish EFH is defined as:

- "Depths less than or equal to 3,500 m (1,914 fathoms) to mean higher water level (MHHW) or the upriver extent of saltwater intrusion, defined as upstream and landward to where ocean-derived salts measure less than 0.5ppt [i.e. freshwater] during the period of average annual low flow.
- Seamounts in depths greater than 3,500 m as mapped in the EFH assessment GIS.
- Areas designated as HAPCs not already identified by the above criteria" (PFMC September 2006).

Groundfish EFH includes areas within the SCP, as the Delta could fall within the first definition above, as well as the estuary HAPC. There are two groundfish species identified by NMFS as potentially impacted by the SCP: starry flounder (*Platichthys stellatus*) and English sole (*Parophrys vetulus*). We provide a description of these two species, and their habitats, below.

<u>Starry Flounder</u>

Source: www.afsc.noaa.gov.

Photo: Starry Flounder.

Starry flounder (*Platichythys stellatus*) is a flatfish found throughout the rim of the north Pacific Ocean. It is commonly found in nearshore waters and estuaries off the west coast of the United States (Ralston 2005). Starry flounder usually grows to 12 to 14 inches, and has distinctive light-dark bars on both the dorsal and anal fins. Starry flounder is tolerant to a wide range of salinities, and has been observed in the Sacramento and San Joaquin Rivers in freshwater, at salinities of 0.02 to 0.06ppt (Ralston 2005).

Adults move inshore in late winter or early spring to spawn (from November to February in California), and move offshore to deeper waters in summer and fall (Ralston 2005; PFMC November 2005). Eggs and larvae float at the surface (epipelagic), while juveniles and adults are demersal (bottom fish). Eggs are found in polyhaline (18 to 30ppt saline) and euhaline (30 to 40ppt saline, i.e. seawater), while juveniles are found in mesohaline (5 to 18ppt saline) to freshwater (<0.5ppt saline). Both adults and larvae are found in euhaline to freshwater. Larvae are thought to move into estuarine waters with the tide, with metamorphosis to juveniles occurring at 10 to 12mm in length. Juveniles remain in estuarine waters until age two, when most migrate into the ocean. Larvae are planktivorous, while juveniles and adults are carnivorous, feeding on a wide number of copepods, amphipods, annelid worms, mollusks, and crabs.

IEP fish monitoring in the Delta and San Francisco Bay captured 275 starry flounder (out of about 33,000 fish) between April, 2004 and September, 2006 (IEP 2006b). Given the size of the starry flounder captured (mostly from 50 to 200mm), the fish were predominantly juveniles between two-plus months and two-years of age. Most captured fish were either at Chipps Island and Suisun Slough, both west of the SCP project area, or salvaged at the Skinner or Tracy fish facilities in the South Delta, indicating that starry flounder are found throughout the Delta.

<u>English Sole</u>

Source: hmsc.oregonstate.edu.

Photo: English Sole.

English sole (*Parophrys vetulus*) is also a flatfish, found from the southeast Bering Sea to Baja California. English sole is an important commercial fish, particularly off the coasts of Washington, Oregon, and Northern and Central California (PFMC November 2005). English sole primarily inhabit estuaries and near-shore areas. English sole is a right-eyed flatfish, typically brown to olive brown in color, sometimes with white speckles. Adult females are over 35cm long, while males are somewhat smaller.

In California, English sole spawn in January and February in deeper water (PFMC November 2005; Stewart 2005). Larvae are thought to move to near-shore areas or estuaries with the tide. Larvae metamorphose into juveniles in spring and early summer. Near shore areas and estuaries are considered nurseries for this species, where juveniles rear until fall/winter, when most emigrate to somewhat deeper waters. Juveniles spend one or two years in coastal estuaries and/or the open coast, in part determined by water temperature (the upper lethal limit for English sole is 26.1C). Eggs are found in polyhaline waters, optimally at 25ppt to 28ppt, while adults are found in euhaline waters. Juveniles and larvae occur in polyhaline and euhaline waters. Juvenile English sole are also temperature sensitive, with 18C appearing to be the upper tolerance. Optimal conditions for larval survival were temperatures of 8 to 9C and 25 to 28ppt salinity – indicating that larval English sole are not likely to be found within the SCP. Like starry flounder, English sole larvae are planktivorous, while juveniles and adults are carnivorous.

IEP fish monitoring in the Delta and San Francisco Bay between April, 2001 and September, 2006 captured only thirteen English sole (IEP 2006c). All fish were in the juvenile size range (45mm to 89mm in length), and all were found within San Pablo or San Francisco Bays. Lower salinity levels and somewhat higher temperatures found within the Delta (and SCP treatment areas) are not consistent with English sole habitat, as described in the literature.

12. Wildlife

The complex interface between land and water in the Delta provides rich and varied habitat for wildlife, especially birds. Wildlife habitats include agricultural land, riparian forest, riparian scrub-shrub, emergent freshwater marsh, heavily shaded riverine aquatic, and grassland/rangeland.

Although much of the Delta is used for agriculture, the land also provides habitat for wildlife. Many agricultural fields are flooded in winter, providing foraging and roosting sites for migratory waterfowl. Aside from these seasonally used areas, tens of thousands of acres are managed specifically for wildlife. Major State, federal, and private wildlife areas in Delta areas are shown in **Table 3-3,** below. There has been a significant increase in protected habitat acreage in the Delta over the last ten years, including conversion of agricultural land to natural habitat (Arambura 2005).

Table 3-3
Major Wildlife and Habitat Areas in the Sacramento-San Joaquin Delta

Name	County	Owner/Manager	Acreage
1. Yolo Bypass Wildlife Area	Yolo County	CDFW	17,770
2. Lower Sherman Island Wildlife Area	Sacramento County	CDFW/Sacramento County	3,115
3. White Slough Wildlife Area	San Joaquin County	CDFW/DWR/ San Joaquin County	800
4. Rhode Island Wildlife Area	Contra Costa County	CDFW/Contra Costa County	67
5. Miner Slough and Decker Island Wildlife Areas	Solano County	Solano County	50
6. Woodbridge Ecological Reserve	San Joaquin	CDFW	360
7. Antioch Dunes National Wildlife Refuge	Contra Costa	USFWS	67
8. Stone Lakes National Wildlife Refuge	Sacramento	USFWS, Sacramento County, others	17,640
9. Jepson Prairie Reserve	Solano	Solano Land Trust	1,566
10. Cosumnes Preserve	Sacramento and San Joaquin Counties	The Nature Conservancy	11,085
11. Liberty Island	Solano and Yolo Counties	Trust for Public Land	4,760
12. Conservation easements	All Delta counties	Various	12,656
13. Decker Island	Solano	CDFW	648
14. Grizzly Island	Solano	CDFW	14,300
Total			84,884

The Delta is particularly important to waterfowl migrating via the Pacific Flyway. The principal attraction for waterfowl is winter-flooded fields, mainly cereal crops, which provide food and extensive seasonal wetlands. The Delta and other Central Valley wetlands provide winter habitat for 60 percent of waterfowl on the Pacific Flyway and 91 percent of waterfowl that winter in California. More than a million waterfowl are frequently in the Delta at one time, although this occurs during winter months when there are no SCP treatments. While there are a number of special status bird species that inhabit the eleven county SCP region (see Exhibit 3-5), only three of these species may be potentially impacted by the SCP.

Small mammals find suitable habitat in the Delta and upland areas. Vegetated levees, remnants of riparian forest, and undeveloped islands provide some of the best mammalian habitat in the region. Species include muskrat, mink, river otter, beaver, raccoon, gray fox, and skunks.

While there are a number of special status mammal species in the eleven county SCP region (see Exhibit 3-5), none of these species is likely to be impacted by the SCP. None of these mammal special status species are expected to frequent specific treatment locations during the treatment season. In the extremely unlikely event that a special status mammal species did occur within a treatment site, herbicide levels for the SCP are well below those likely to impact mammals (DBW 2001).

B. Impact Analysis and Mitigation Measures

This biological resources impact analysis provides an assessment of the specific environmental impacts potentially resulting from program operations. The discussion of impacts utilizes findings from DBW research projects, technical information from scientific literature, relevant information on public policies, and the Spongeplant Control Program Biological Assessment (USDA-ARS and DBW, 2014). Impact assessments are based on technical and scientific information.

In determining significance, where possible, we quantify the extent of the impacts (e.g. persistence of herbicides in the water column over time and herbicide toxicity levels compared to herbicide treatment levels). However, in many instances it was not possible to quantify the extent of a particular impact accurately. In such cases, the analysis is primarily qualitative.

For purposes of this analysis, we considered a Biological Resource impact (designated with the letter ‘B’) to be significant and require mitigation if it would result in any of the following:

- Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the CDFW, NMFS, or USFWS
- Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations, or by the CDFW, NMFS, or USFWS
- Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means
- Interfere substantially with the movement of any native resident or migratory fish, or wildlife species, or with established native resident or migratory wildlife corridors, or impede use of native wildlife nursery sites
- Conflict with any local policies or ordinances protecting biological resources, such as tree preservation policies or ordinances
- Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan.

Following each Biological Resource impact, we identify associated mitigation measures. These include specific actions that DBW will undertake to avoid or minimize potential impacts. DBW continues to undergo consultation with various State and federal agencies, including USFWS, NMFS, CDFW, and CVRWQCB regarding impacts and mitigation measures. Many of the discussed mitigation measures are specific conditions that result from the biological consultation process with USFWS and NMFS. Proposed mitigation measures may be revised and/or additional mitigation measures incorporated as a result of this ongoing consultation process with regulatory agencies.

Exhibit 3-2, on the next page, provides a summary of potential SCP impacts for each of the significance criteria areas. The remainder of this chapter analyzes eight specific impacts and associated mitigation measures.

For each of the eight potential SCP impacts, we provide a description of the impact, analyze the impact, classify the impact level, and when appropriate, identify mitigation measures to reduce the impact level. The impact levels are as follows:

1. Unavoidable or potentially unavoidable significant impact – an impact that may result in significant adverse effects, and cannot be mitigated with certainty. We identify mitigation measures for these impacts
2. Avoidable significant impact – an impact that may result in significant adverse effects that can be mitigated to a less than significant level. We identify mitigation measure for these impacts
3. Less than significant impact – an impact that is likely to result in less than significant adverse effects, without mitigation. We may not identify mitigation measures for less than significant impacts
4. No impact – no adverse effects resulting from the proposed action.

We have taken a conservative approach in our impact assessment for this PEIR. We have identified and incorporated 15 mitigation measures to reduce the potential for impacts to biological resources. We have classified impacts as “unavoidable or potentially unavoidable” even in situations where these impacts are possible, but likely to be insignificant or discountable.

The public review BDCP includes a series of conservation measures to reduce stressors in the Delta, including invasive aquatic vegetation. Conservation Measure 13 (CM13) “would control the growth of invasive aquatic vegetation, such as Brazilian waterweed (*Egeria densa*), water hyacinth, and other nonnative submerged and floating aquatic vegetation. CM 13 would rely on existing control methods by the California Division of Boating and Waterways *Egeria Densa* and Water Hyacinth Control Programs. The primary control method would be the application of herbicides as specific as possible to species and site conditions. Limited mechanical removal of invasive vegetation would also be used. Other removal methods could be implemented, depending on site-specific conditions, current research, and intended outcomes. An early detection and rapid response program would be implemented, and restoration sites would be designed to minimize the risk of invasive vegetation establishment and propagation.” (California Natural Resources Agency 2013). In comparison to DBW’s identification of potential for unavoidable or potentially unavoidable significant impacts due to the SCP, the BDCP Draft EIR/EIS (ICF November 2013) does not predict significant impacts, and concludes that control of invasive aquatic vegetation would provide a net benefit to covered fish species. While DBW agrees with the net benefit conclusion, we feel it is prudent to consider the potential for, and seek to mitigate, significant impacts, if they do occur.

<u>Impact B1 – Herbicide overspray: effects of herbicide overspray on special status species, riparian or other sensitive habitats, and wetlands</u>

A primary treatment of the SCP is chemical. The program will utilize five herbicides: 2,4-D, glyphosate, penoxsulam, imazamox, and diquat dibromide.

2,4-Dichlorophenoxyacetic acid, dimethylamine (DMA) salt, or 2,4-D is a systemic herbicide specific to broadleaf plants and is most effective in plants with a large enough leaf area to absorb sufficient quantities. 2,4-D is water soluble and chemically stable. The herbicide mimics the plant hormone auxin, causing rapid cell division and abnormal growth. 2,4-D can be absorbed by both foliage and roots.

Plant death from 2,4-D typically occurs within three to five weeks after treatment, although during periods of warm weather, plants may show signs of dying within hours of spraying. Any broadleaf vegetation subject to overspray will be vulnerable to 2,4-D activity. Most of the special status plants and several other native plants are broadleaf species. Sensitive riparian habitats and wetlands near SCP treatment sites also include other potentially impacted broadleaf plants.

Exhibit 3-2
Crosswalk of Biological Resources Significance Criteria, Impacts, and Benefits of the SCP *Page 1 of 2*

	Mitigation Measures	Unavoidable or Potentially Unavoidable Significant Impact	Avoidable Significant Impact	Less than Significant Impact	No Impact	Beneficial Impact
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the CDFW, NMFS, or USFWS?						Removal of spongeplant and prevention of further spread of spongeplant could improve habitat for sensitive species (through opening up shallow water habitat, regrowth of native plant species, improving navigation channels, and increased DO levels)
Impact B1: Herbicide overspray	1, 2, 3, 4, 5	X				X
Impact B2: Herbicide toxicity	1, 3, 4, 6, 7, 8, 9	X				
Impact B3: Herbicide bioaccumulation				X		
Impact B4: Food web effects	1, 3, 4, 7, 8	X				X
Impact B5: Dissolved oxygen levels	10, 11		X			X
Impact B6: Treatment disturbances	1, 5, 12		X			
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the CDFW, NMFS, or USFWS?						Removal of spongeplant and prevention of further spread of spongeplant could improve riparian and sensitive habitat
Impact B1: Herbicide overspray	1, 2, 3, 4, 5	X				X
Impact B5: Dissolved oxygen levels	10, 11		X			X
Impact B6: Treatment disturbances	1, 5, 12		X			
Impact B7: Plant fragmentation	12, 13		X			
Impact B8: Disposal of harvested spongeplant	12, 14, 15			X		
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?						Removal of spongeplant and prevention of further spread of spongeplant could improve wetland habitat
Impact B1: Herbicide overspray	1, 2, 3, 4, 5	X				X
Impact B5: Dissolved oxygen levels	10, 11		X			X
Impact B6: Treatment disturbances	1, 5, 12		X			
Impact B7: Plant fragmentation	12, 13		X			
Impact B8: Disposal following handpicking	14, 15			X		

Exhibit 3-2
Crosswalk of Biological Resources Significance Criteria, Impacts, and Benefits of the WHCP *(continued)* *Page 2 of 2*

	Mitigation Measures	Unavoidable or Potentially Unavoidable Significant Impact	Avoidable Significant Impact	Less than Significant Impact	No Impact	Beneficial Impact
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?						Removal of spongeplant and prevention of further spread of spongeplant could improve navigation channels for migrating species and movement of resident species
Impact B2: Herbicide toxicity	1, 3, 4, 6, 7, 8, 9	X				
Impact B4: Food web effects	1, 3, 4, 7, 8	X				X
Impact B5: Dissolved oxygen levels	10, 11		X			X
Impact B6: Treatment disturbances	1, 5, 12		X			
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?				SCP has no known significant conflicts with local policies or ordinances protecting biological resources		Removal of spongeplant and prevention of further spread of spongeplant could improve local habitat
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?					SCP has no known conflicts with various conservation plans, programs, or other initiatives in the Delta. SCP's reduction in an invasive species is supportive of these conservation efforts	Removal of spongeplant and prevention of further spread of spongeplant is consistent with conservation planning efforts to reduce invasive species in the Delta

Glyphosate is a broad spectrum, non-selective, systemic herbicide. Glyphosate is water soluble, and is absorbed across the plant surface and translocated throughout the plant. Glyphosate inhibits activity of the shikimic acid pathway enzymes, found only in plants and microorganisms. Glyphosate is not metabolized by plants (Schuette 1998).

Plants begin to show symptoms of glyphosate treatment (gradual wilting and yellowing) within two to seven days. Exposure of any non-target plants to glyphosate, including those in sensitive riparian and wetland habitats, could result in loss of individual plants and habitat impacts.

Penoxsulam (2-(2,2-difluoroethoxy)-N-(5,8-dimethoxyl[1,2,4] triazolo[1,5-c]pyrimidin-2-yl)-6-trifluoromethyl) benzenesulfonamide), 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). Exposure of any non-target plants to penoxsulam, including those in sensitive riparian and wetland habitats, could result in loss of individual plants and habitat impacts.

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), is in the imidazolinone herbicide family. The mode of action is similar to penoxsulam, 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. Exposure of any non-target plants to imazamox, including those in sensitive riparian and wetland habitats, could result in loss of individual plants and habitat impacts.

Diquat dibromide (6,7-dihydrodipyrido(1,2-a:2’,1’-c) pyrazinediium dibromide) is a post-emergent, non-selective, fast-acting, contact herbicide. Diquat is a photosynthetic electron flow diverter. Diquat is rapidly absorbed by green plant tissues and results in rapid disruption of cell membranes and rapid kill (Washington DOE 2002), with effects visible within a few days. The bipyridyliums penetrate into the cytoplasm, causing the formation of peroxides and free electrons upon exposure to light, destroying the cell membranes. Because the herbicide is so fast-acting, diquat is not translocated to other portions of the plant, acting only on the portions that the herbicide contacted. Any portions of non-target plants exposed to diquat, including those in sensitive riparian and wetland habitats, could result in damage to plants, loss of individual plants, and habitat impacts.

DBW also utilizes adjuvants to increase absorption and translocation of the herbicide. Currently, DBW utilizes the paraffin-based non-ionic surfactant, Agridex. The DBW may also utilize the modified vegetable oil, Competitor. Relatively little is known about impacts of adjuvants on plants. However, use of these chemicals in concentrations specified on the labels is not expected to negatively impact special status species, sensitive habitats, or wetlands.

The potential for impacts resulting from herbicide overspray depend on the amount of exposure, concentration of herbicide, and proximity of sensitive habitats, wetlands, and special status plants. One study found that only three to four percent of 2,4-D droplets drift beyond the target zone, and no significant amount of material is collected as drift (HSDB 2001). Blankenship and Associates (2004) found that using conservative application rates, detectable adverse effects could result from less than one percent spray drift of glyphosate or 2,4-D. (Note that we would expect similar overspray percentages from any herbicide).

The amount of overspray potential also depends on the shape and size of the spongeplant mat. Overspray that could impact native plants is likely to occur only at the edge of the mat, where other plants may be present. It is also important to consider the extent of spongeplant treatments as compared to the project area. In the near term, spongeplant treatments are likely to range from 20 to 1,000 acres per year, with the potential to increase to 2,500 acres per year if the spongeplant invasion reached the level of water hyacinth. These low and high acreage figures represent 0.03 percent and 3.7 percent of the entire project area. Thus, the percent of the project area that might be subject to overspray is likely insignificant.

The concentration of herbicide active ingredient leaving the spray nozzle is high enough (ranging from 105 ppm to 6,066 ppm, depending on the herbicide) to cause adverse effects. There is the potential that uncontrolled herbicide overspray could affect nearby non-target vegetation. Treatment of spongeplant is not likely to result in loss of native submerged aquatic vegetation growing in and around treatment areas.

Depending on the herbicide and concentration in water, treatment of spongeplant could result in limited loss of native submerged aquatic vegetation growing in and around treatment areas. Such vegetation may be utilized by special status fish for rearing, coverage, and forage. In particular, shallow vegetated habitat is believed to be important to spawning success of delta smelt, although most spawning occurs before SCP treatments begin.

Loss of aquatic plants near spongeplant for cover, rearing, and forage area of special status species could constitute a significant impact under certain conditions. However, dense canopies of spongeplant reduce light levels for submerged plant photosynthesis and thus can effectively shade out native vegetation. The benefit to native submerged aquatic vegetation from removal of spongeplant is expected to outweigh losses due to herbicide toxicity overspray.

While there is a potential risk to sensitive habitats, wetlands, and special status plants due to herbicide overspray, the likelihood of such effects occurring is low, and likely to be insignificant if it does occur. Herbicide application will be focused directly on target plants to decrease the possibility that concentrated herbicides would come in contact with sensitive plants, or result in impacts to sensitive habitats or wetlands. When spongeplant is growing within or immediately under native plants, DBW will utilize hand removal with nets, rather than herbicide treatments.

DBW will follow herbicide label instructions that reduce herbicide drift. These steps include using the largest size spray droplets, and lowest spray pressure, that will provide sufficient coverage and control. Furthermore, DBW will not treat at a particular site if the wind is greater than 10 mph (or 7 mph in Contra Costa County).

Should any herbicide damage to special status plants, or sensitive riparian or wetland habitats occur, it would represent a significant impact. This impact would be an **unavoidable or potentially unavoidable significant impact.** This impact would potentially be reduced by implementing the following five mitigation measures.

- **Mitigation Measure 1** – Avoid herbicide application near special status species, and sensitive riparian and wetland habitat; and other biologically important resources.

  Each year, prior to start of the treatment season, DBW will conduct field crew environmental awareness training. Under this training, crews will be informed about the presence and life histories of special status species; habitats associated with species; sensitive habitats and wetlands; the terms and conditions of the program's biological opinion and/or letter of concurrence; environmental survey procedures; incidental take procedures; and that unlawful take of an animal or destruction of its habitat is a violation of the Endangered Species Act.

  DBW will provide crews with a field guide (Species Identification Deck) for easy identification of special status species on-site. Prior to treating a site, crews will conduct a visual survey to determine whether special status plants, animals, or sensitive habitats are present. Crews will complete an Environmental Observations Checklist, following an established protocol, for each site to document the presence or absence of listed or special status species. If listed or special status species or sensitive habits are present at the site, the field crew will not perform treatments that could potentially affect the species or habitat.

  DBW Environmental Scientists will classify treatment sites as high, medium, or low potential for nesting birds. DBW also will examine CNDDB records to determine if special status bird species have been sited within SCP treatment locations, and prepare a map for field crews identifying such sites. For those treatment sites that have habitat characteristics that might support special status bird species, Environmental Scientists will survey the specific site. DBW will delay treatments at locations where nesting Swainson's hawks are present until after June 10th, the start of the post-fledging stage.

At all treatment locations, crews will conduct a visual survey, following an established protocol, to determine whether special status plants, animals, or sensitive habitats are present, including bird nesting sites. Crews will complete an Environmental Observations Checklist for each site to document the presence or absence of bird nesting sites. If nesting yellow-headed blackbird, Swainson's hawk, or tricolored blackbird are known to be present at the site, the field crew will not perform any treatment within 200 yards of the nesting site until the post-fledging stage.

- **Mitigation Measure 2** – Provide a 100 foot buffer between treatment sites and shoreline elderberry shrubs (*Sambucus* ssp.), host plant for the valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*).

  DBW will conduct a survey of treatment sites to prepare a map that identifies locations of elderberry shrubs, and provide this map to field crews. **Exhibit 3-3,** on page 3-47, provides a map identifying locations of elderberry shrubs and giant garter snake sitings within the SCP treatment area.

  DBW crews will maintain the 100 buffer zone when elderberry shrubs are present. Crews will also conduct treatments downwind of elderberry shrubs. Where there are a large number of valley elderberry shrubs that may preclude treatments at the 100 foot buffer, DBW may provide a 50 foot buffer between treatment sites and shoreline elderberry shrubs if treatments occur when winds are less than 3 mph.

  In addition, DBW's Environmental Scientists will survey a sample of elderberry shrubs which could be potentially impacted by SCP application activities at the beginning of the treatment season, and at the end of the treatment season. The Environmental Scientists will compare the health of elderberry shrubs at control sites (i.e. not adjacent to treatments) with elderberry shrubs located adjacent to treated sites. If elderberry shrubs located near treated sites show signs of adverse effects from treatment, DBW will develop additional mitigation measures to protect elderberry shrubs (for example, increasing the size of the buffer zone).

- **Mitigation Measure 3** – Conduct herbicide treatments in order to minimize potential for drift.

  In addition to complying with the label application requirements, DBW will, to the degree possible, schedule herbicide applications to occur at high tide, or at a point in the tidal cycle determined by the field supervisor to provide the least non-target impact at a particular site. In general, treatment at high tide will allow for better spray accuracy and access, and will provide for greater dilution volume of herbicides. DBW crews will change nozzle type and spray pressures whenever conditions warrant, limiting the amount of herbicide which may inadvertently contact non-target species or enter the water.

- **Mitigation Measure 4** – Conduct herbicide treatments using diquat only in emergency situations and for no more than 50 acres in total among DBW aquatic weed control programs.

  To minimize the potential for negative impacts to covered species from exposure to diquat dibromide, DBW will only utilize diquat in emergency situations. Diquat will only be utilized from August 1st through November 30th of each year, and will be limited to a total of 50 treatment acres in the Delta per year, as a sum of the combined diquat acres treated in the SCP and EDCP. Emergency conditions are such that spongeplant growth completely impedes navigation of Delta waters, such as a completely blocked slough that would impair the movement of emergency response vessels. DBW will consult with USFWS and NMFS prior to utilizing diquat to help ensure that covered fish species are not likely to be present at the time of treatment.

- **Mitigation Measure 5** – Operate program vessels in a manner that causes the least amount of disturbance to the habitat.

  Operational procedures for DBW vessels will minimize boat wakes and propeller wash. These procedures will be particularly important in shallow water, or other sensitive habitats.

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Exhibit 3-3a
Valley Elderberry Shrub Locations and Giant Garter Snake Habitat Valuation – Northern Sites

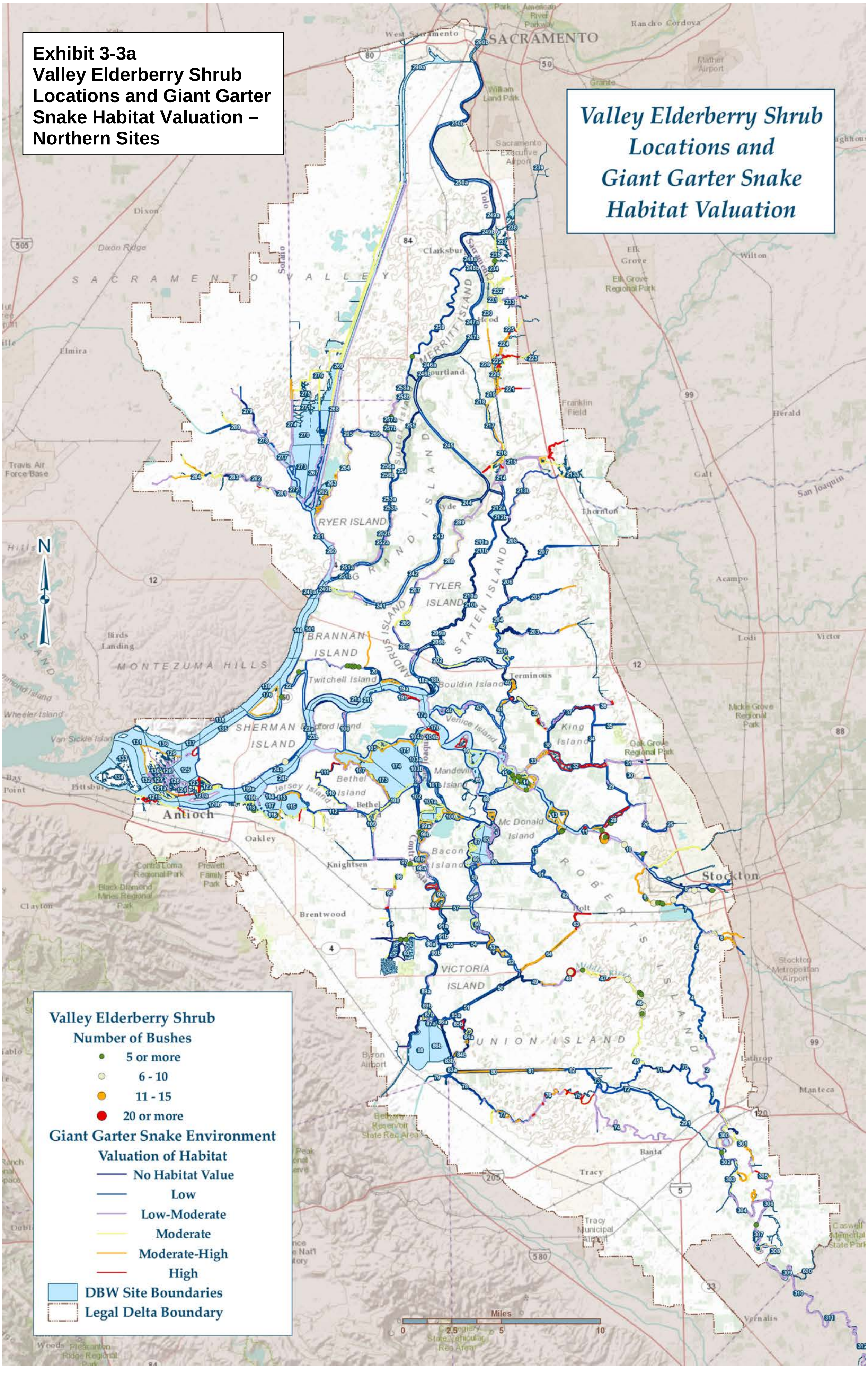
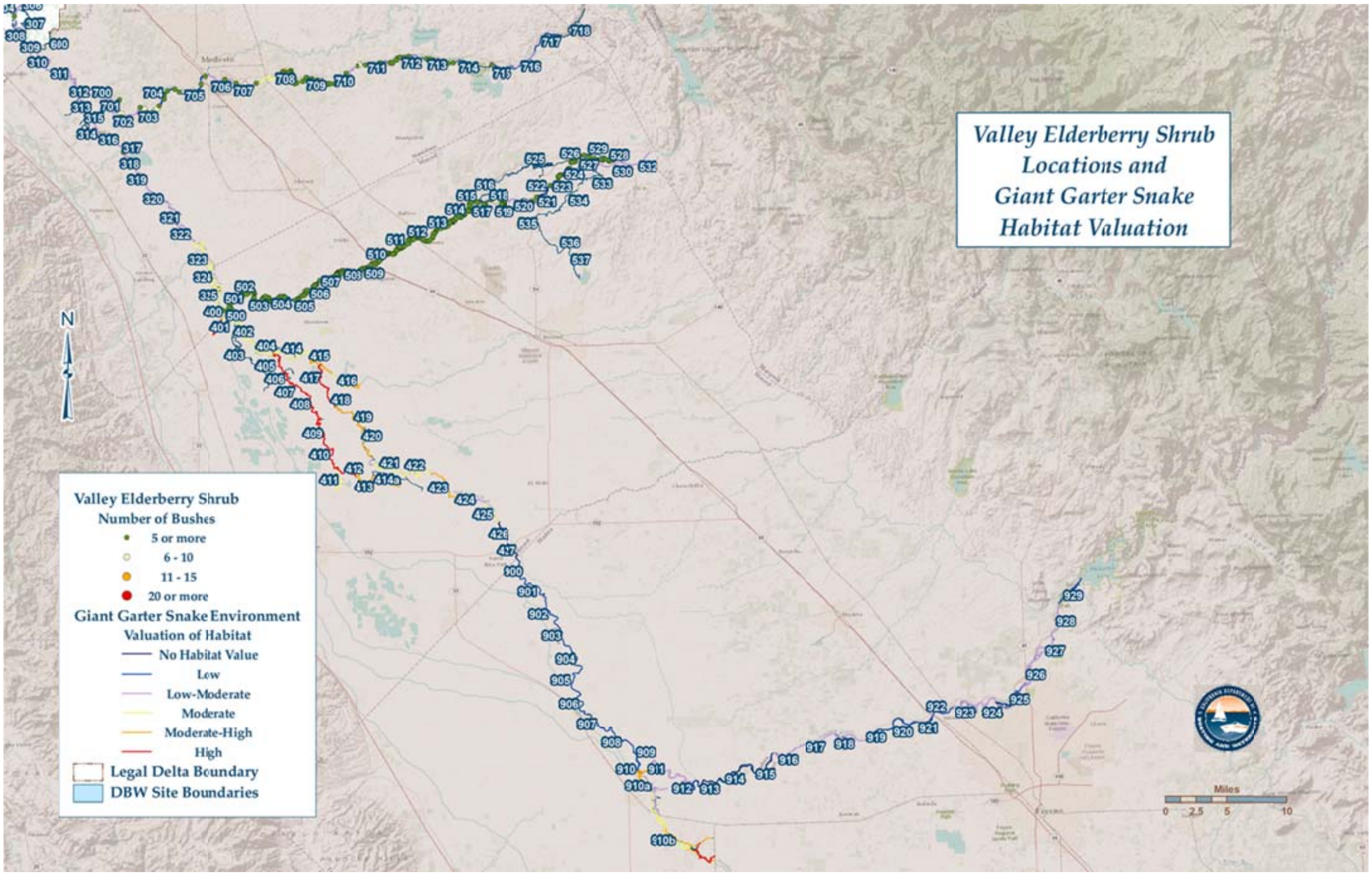


Exhibit 3-3b
Valley Elderberry Shrub Locations and Giant Garter Snake Habitat Valuation – Southern Sites



There also are potential positive impacts to special status plants, sensitive habitats, and wetlands from the SCP. Spongeplant has the potential to be more problematic in the Delta than water hyacinth, blocking waterways and reducing overall habitat for native plants (Anderson 2011b). In 2011, the California Invasive Plant Council (Cal-IPC) classified spongeplant as a high –alert invasive plant due to potential impacts on abiotic ecosystem processes, plant communities, and higher trophic levels (Calflora 2013).

Controlling and limiting the further spread of spongeplant in Delta waterways will help maintain habitat suitable for native species. Thus, long-term impacts of spongeplant control on special status plant species and sensitive habitats are likely to be beneficial.

There is uncertainty as to how habitats will respond to removal of spongeplant. For example, under the WHCP, some areas which had previously been heavily infested with water hyacinth, became heavily infested with native pennywort.

It may be that existing imbalances in Delta ecosystem functions may promote some monospecific growth, even of native species. While removing invasive species is a positive first step, there is need for additional research on Delta ecosystem restoration following removal of non-native species.

Impact B2 – Herbicide toxicity: toxic effects of herbicides on special status species, native resident fish, and migratory fish

There is the potential for direct toxic effects on special status or common fish, amphibian, reptile, and bird species, and resident native and migratory fish, due to the use of SCP herbicides and adjuvants. Toxic effects may be acute, chronic, or sublethal.

Acute toxic effects are typically measured in LC50 levels over 48 or 96 hours, the concentration at which there is 50 percent mortality (lethal concentration) among test organisms. Chronic effects are typically measured in 7-day, or longer, LC50 levels. Toxicity tests may also measure a no observed effect level (NOEL). LC50 values are usually expressed in parts per million (ppm or mg/l) or parts per billion (ppb or µg/l). Length of test time is also typically indicated. Sublethal effects are more difficult to measure, as they may be reflected in subtle responses such as reduced ability to avoid predators, or more identifiable effects such as reduced enzyme activity, lesions, or tissue damage.

There have been hundreds of toxicity tests of 2,4-D, glyphosate, and diquat on various animal species over the last 30 years. There are fewer toxicity tests available for penoxsulam and imazamox because these are new herbicides. However, both new herbicides were part of the USEPA's reduced risk program due to their low toxicity profiles. DBW has also conducted a number of toxicity tests using 2,4-D, glyphosate, and diquat on covered and surrogate species and in mid-2014 is conducting toxicity testing of penoxsulam, imazamox, Agridex, and Competitor on delta smelt.

For this herbicide toxicity impact assessment, we first discuss some general issues related to potential toxic effects, and then discuss toxic effects separately for fish, followed by a combined toxicity discussion for amphibians, reptiles, and birds. We discuss the toxicity of SCP herbicides to invertebrates under Impact B4 – Food web effects.

Estimated Herbicide Concentrations in Delta Waters Immediately Following Treatments

Toxic effects result from the combination of exposure and toxicity. Exposure refers to the degree of contact of an organism with a chemical. Exposure consists of a concentration component, and a temporal component. The concentration component of exposure depends on an initial concentration of the herbicide treatment, and dilution factors. The temporal component of exposure depends on dissipation of the herbicide, as well as water flow and movement of the organism. Toxicity depends on the specific interactions between the herbicide and organism in question.

The SCP utilizes pump-driven hand-held spray nozzles to treat spongeplant. The pump mixes calibrated amounts of herbicide, adjuvant, and water. DBW applies the chemicals at, or below, the herbicide label-specified rates.

Table 3-4
Calculated Maximum Concentrations of SCP Herbicide Active Ingredients[a] and Adjuvants Following Treatment

Concentration of:	2,4-D *(active ingredient)*	Glyphosate *(active ingredient)*	Penoxsulam *(active ingredient)*	Imazamox *(active ingredient)*	Diquat *(cation equivalent)*	Agridex or Competitor *(total adjuvant)*
1. Chemical directly out of spray nozzle	2,744 ppm	6,066 ppm	105 ppm	635 ppm	2,397 ppm	5,000 ppm
2. Chemical in 1 meter deep water, @ 100% water contact	0.51 ppm	0.57 ppm	9.8 ppb	59 ppb	0.22 ppm	0.47 ppm
3. Chemical in 2 meter deep water, @ 100% water contact	0.26 ppm	0.28 ppm	4.9 ppb	29.7 ppb	0.11 ppm	0.23 ppm
4. Chemical in 1 meter deep water, @ 20% water contact	103 ppb	113 ppb	2 ppb	11.9 ppb	44.8 ppb	0.09 ppm
5. Chemical in 2 meter deep water, @ 20% water contact	51 ppb	57 ppb	1 ppb	5.9 ppb	22.4 ppb	0.05 ppm

[a] The concentrations above are based on the pounds of active ingredient (2,4-D dimethylamine salt, glyphosate isopropylamine salt, penoxsulam, ammonium salt of imazamox, or diquat cation) 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.

Table 3-4, above, summarizes expected instantaneous concentrations of active ingredients at the spray nozzle, and in the water. Table 3-4 provides estimates based on the highest herbicide application rate, assuming 20 percent overspray, and one or two meter(s) deep water. These assumptions represent conservative and instantaneous concentrations. The overspray was determined in early WHCP tests by Anderson (1982), finding that only 10 to 20 percent of 2,4-D moved through the water hyacinth mat and into the water.

In reality, mixing of any herbicide that reaches the water occurs through the entire depth of water at the site, and tidal movement and through water Delta flow dilutes herbicides even further. The Delta is not a stationary water environment, thus, the concentration of herbicide immediately after treatment is not stable, but rather readily dilutes (in addition to degradation pathways). There are two tidal cycles in the Delta every day, with typical water fluctuations of three to five feet in each cycle. In addition, the Delta functions in a complex hydrological system consisting of inflows from rivers and reservoirs, Delta exports, and tidal fluctuations.

Approximately 30 km3 of freshwater enter the Delta (and then San Francisco Bay) annually, with peak flows in early March (Knowles 2000). Freshwater inflows and Delta exports are the major influences of salinity in the Delta. Illustrating the movement of water within the Delta, the X2 salinity line (distance of the near-bottom 2 psu isohaline line from the Golden Gate) varies by up to 30 km during the course of a year (Knowles 2000).

The calculated maximum concentrations in Table 3-4 reflect potential chemical concentrations immediately after (or during) spraying. DBW has utilized three of the proposed spongeplant herbicides for the WHCP or EDCP (2,4-D, glyphosate, and diquat). WHCP monitoring data for 2,4-D and glyphosate are directly applicable to the SCP, as herbicide applications will be similar. Prior DBW monitoring data for diquat give some indication of likely diquat concentrations following SCP treatments. We discuss prior DBW monitoring data for 2,4-D, glyphosate, and diquat, below.

Table 3-5
Results of Delta Coney Island Field Test, Concentrations of 2,4-D Following Water Hyacinth Treatment

Time and Location of Samples *(Number of Samples)*	Range	Average
1. Float samplers in spray plot (5)	51 ppb to 3,150 ppb	1,047 ppb
2. Water samples in spray plot @ 15 minutes post (6)	107 ppb to 8,420 ppb	2,262 ppb
3. Water samples in spray plot @ 60 minutes post (3)	593 ppb to 1,398 ppb	895 ppb
4. Water samples in spray plot @ 90 minutes post (3)	100 ppb to 157 ppb	119 ppb
5. Water samples upstream of spray plot @ 15 minutes post (3)	17 ppb to 59 ppb	32 ppb
6. Water samples downstream of spray plot @ 30 minutes post (3)	3 ppb to 5 ppb	4 ppb
7. Water samples downstream of spray plot @ 60 minutes post (3)	0 ppb to 50 ppb	17 ppb
8. Water samples downstream of spray plot @ 90 minutes post (3)	3 ppb to 23 ppb	10 ppb

Historical 2,4-D Concentrations

Historical water quality monitoring data for the WHCP demonstrates that actual 2,4-D concentrations decrease rapidly in the Delta following treatment. Water samples taken downstream of the treatment site at two to three feet depth one-hour post treatment show actual herbicide levels that are at least an order of magnitude below the calculated concentrations in 1 meter of water in Table 3-4. Note that Table 3-4 includes both ppm and ppb concentrations.

In 1982, prior to the start of WHCP, USDA-ARS (Anderson 1982) conducted field tests of 2,4-D levels following herbicide applications at Coney Island, in the Delta. Anderson collected samples in float samplers (open-top vessels on top of the water containing 500 mls Delta water), inside the spray plot, upstream of the spray plot, and downstream of the spray plot, at 15 to 30 minute intervals post-treatment. This simulated the actual concentration reaching the water hyacinth plant, and the instantaneous concentration on the surface of the water if the herbicide reached the water, rather than the plant, prior to the herbicide mixing and diluting with the water. In addition, Anderson (1982) utilized 2,4-D levels 25 percent higher than current herbicide application rates. Both of these factors resulted in a higher concentration than if the samples had been collected in the water, as illustrated by the lower historical 2,4-D levels taken in actual water samples. The data in **Table 3-5,** above, provides the range and average for test measurements, illustrating the above-maximum immediate 2,4-D concentrations and the drop in concentrations within the first 90 minutes post-treatment. Anderson also utilized this study to estimate herbicide overspray. The results of this study are applicable to utilizing 2,4-D for spongeplant.

WHCP environmental monitoring results since 2001 provide additional data on actual herbicide residue levels following treatments, which would be similar to levels following spongeplant treatment with 2,4-D. From 2001 to 2005, DBW obtained chemical residue tests on 110 water samples collected at two to three feet depth one hour after treatment, inside the treatment areas. Samples were obtained from 48 different sites, and throughout the treatment season (for both chemicals at some sites). The average concentration at each of the 2,4-D sites ranged from non-detectable (ND), to 390 ppb. The 390 ppb measure was an outlier, representing one of over 100 sampling events between 2001 and 2005. The highest measured 2,4-D level since 2005 was 30 ppb, and this measure was also an outlier, representing one of 62 sampling events. **Figure 3-2,** on the next page, summarizes herbicide concentrations of the in-treatment-site samples for 2001 to 2005.

Over seven years of environmental monitoring (2006 to 2012), DBW monitored receiving waters directly downstream of the treatment sites, one-hour after treatment. Environmental scientists also returned to each site two to seven days later to sample upstream, within, and downstream of the treatment site. All samples were taken at two to three feet depth. Over the seven year period, DBW conducted 68 sampling events for 2,4-D. DBW also monitored Agridex at all the 117 sampling events. In every case, Agridex concentrations were non-detectable.

Figure 3-2
Number of Sites at Various 2,4-D Concentrations (IN Treatment Site) (2001 to 2005)

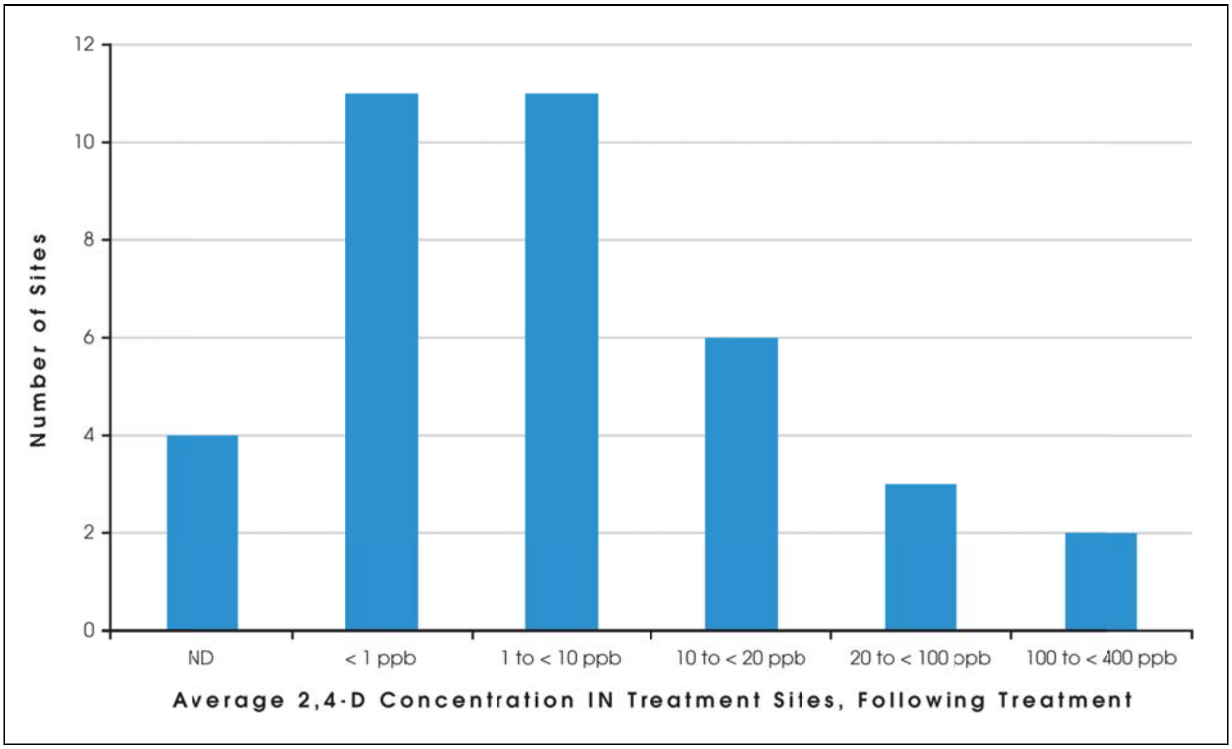


Figure 3-3, on the next page, illustrates the 2006 to 2012 sampling results from immediately downstream of treatment sites, in WHCP receiving waters, for 2,4-D. This is a slightly different location than the 2001 to 2005 results illustrated in Figure 3-2. While both sets of samples were taken one-hour post-treatment, we would expect the downstream location to have lower chemical concentrations than the in-treatment-site location, due to dilution as herbicide flows out of the treatment site.

Table 3-6, on the next page, provides a tabular summary of the sampling data presented in Figure 3-3. For 2,4-D, the maximum post-treatment concentration one hour after treatment was 30 ppb, and 68 percent of the samples over the 7 year period had levels of less than 1 ppb or non-detectable.

In the 2006 to 2012 follow-up sampling results (two to seven days after treatment), there were a few cases where 2,4-D levels were slightly higher in than immediately post treatment, although still low (a maximum of 16.3 ppb at one site). Typically, 2,4-D levels declined to very low or non-detectable levels in the follow-up sampling taken between two days and seven days after treatment showed very low herbicide levels in waters in and downstream of the treatment site. 2,4-D levels four to six days following treatment at seven 2,4-D samples taken in 2011 ranged from non-detectable to 0.2 ppb, and at six 2,4-D samples taken in 2012 ranged from non-detectable to 0.6 ppb. Between 2006 and 2010, the maximum 2,4-D level found between one and four days following treatment was 2.5 ppb.

The calculated, test plot, and actual WHCP herbicide levels indicate that 2,4-D concentrations in the Delta following herbicide treatment are likely to be low. Maximum 2,4-D levels immediately after spraying within a treatment site have reached levels as high as 390 ppb (0.4 ppm, rounded), although this occurred one time in monitoring conducted immediately after treatment, under a water hyacinth mat, out of over 100 similar samples taken between 2001 and 2005.

Figure 3-3
Concentrations of 2,4-D Downstream of Treatment (2006 to 2012)

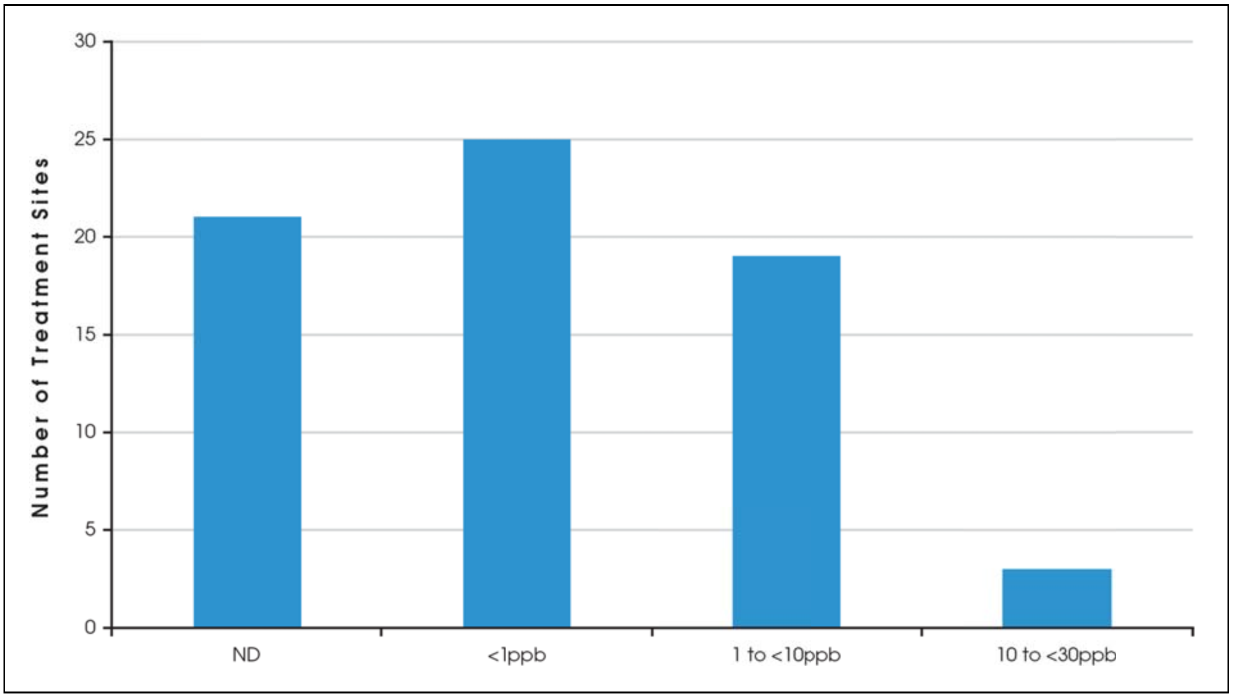


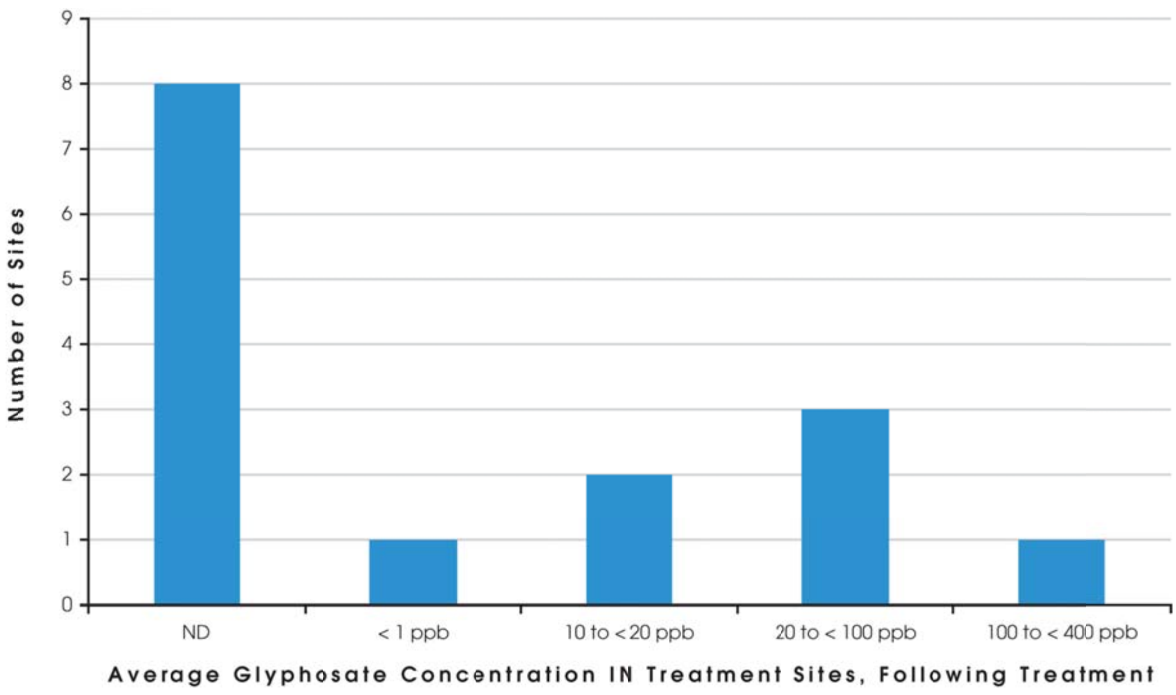
Table 3-6
Concentrations of 2,4-D Downstream of WHCP Treatments, 1 Hour Post-Treatment (2006 to 2012)

Concentration (ppb or ug/l)	Number of Sites
No Detect (ND)	21
<1 ppb	25
1 to <10 ppb	19
10 to ≤30 ppb	3
Total	68

Between 2006 and 2012, maximum 2,4-D levels immediately downstream of the site were less than 1 ppb in 68 percent of samples, between 1 ppb and 10 ppb in 31 percent of samples, and have never been measured at levels higher than 30 ppb (30 ppb was measured once out of 68 samples). Based on historical data, herbicides remain at these maximum levels for a short period of time (for example, the downstream sampling typically occurs within one hour of treatment).

Because both water hyacinth and spongeplant are floating aquatic weeds, concentrations of 2,4-D following spongeplant treatment are likely to be similar to those found following water hyacinth treatment.

Figure 3-4
Number of Sites at Various Glyphosate Concentrations (IN Treatment Site) (2001 to 2005)



Historical Glyphosate Concentrations

The historical WHCP environmental monitoring results provide additional data on actual herbicide residue levels following treatments. These data are applicable to the SCP, as glyphosate treatments will be similar to those of the WHCP. From 2001 to 2005, the DBW obtained chemical residue tests on 110 water samples collected one-hour after treatment, inside the treatment areas at two to three feet depth. Samples were obtained from 48 different sites, and throughout the treatment season. The concentration at each of the glyphosate sites ranged from non-detectable to 158 ppb. The 158 ppb measure was an outlier, accounting for one of over 100 sampling events between 2001 and 2005. **Figure 3-4,** above, summarizes glyphosate concentrations of the in-treatment-site samples for 2001 to 2005.

Over seven years of environmental monitoring (2006 to 2012), DBW has monitored receiving waters directly downstream of the treatment sites, one-hour after treatment. As in previous years, environmental scientists also returned to each site two to seven days later to sample upstream, within, and downstream of the treatment site. Over the seven year period, DBW conducted 63 sampling events for glyphosate. All samples were taken at a depth of two to three feet.

Figure 3-5, on the next page, illustrates the 2006 to 2012 sampling results from immediately downstream of treatment sites, in WHCP receiving waters. This is a slightly different location than the 2001 to 2005 results illustrated in Figure 3-4. While both sets of samples were taken immediately post- treatment, we would expect the downstream location to have lower chemical concentrations than the in-treatment-site location, due to dilution as herbicide flows out of the treatment site. **Table 3-7,** on the next page, provides a tabular summary of the sampling data presented in Figure 3-5. For glyphosate, the maximum post-treatment concentration one hour after treatment was 22 ppb, and 92% of the samples had levels of less than 1 ppb or non-detectable.

Figure 3-5
Concentrations of Glyphosate Downstream of Treatment (2006 to 2012)

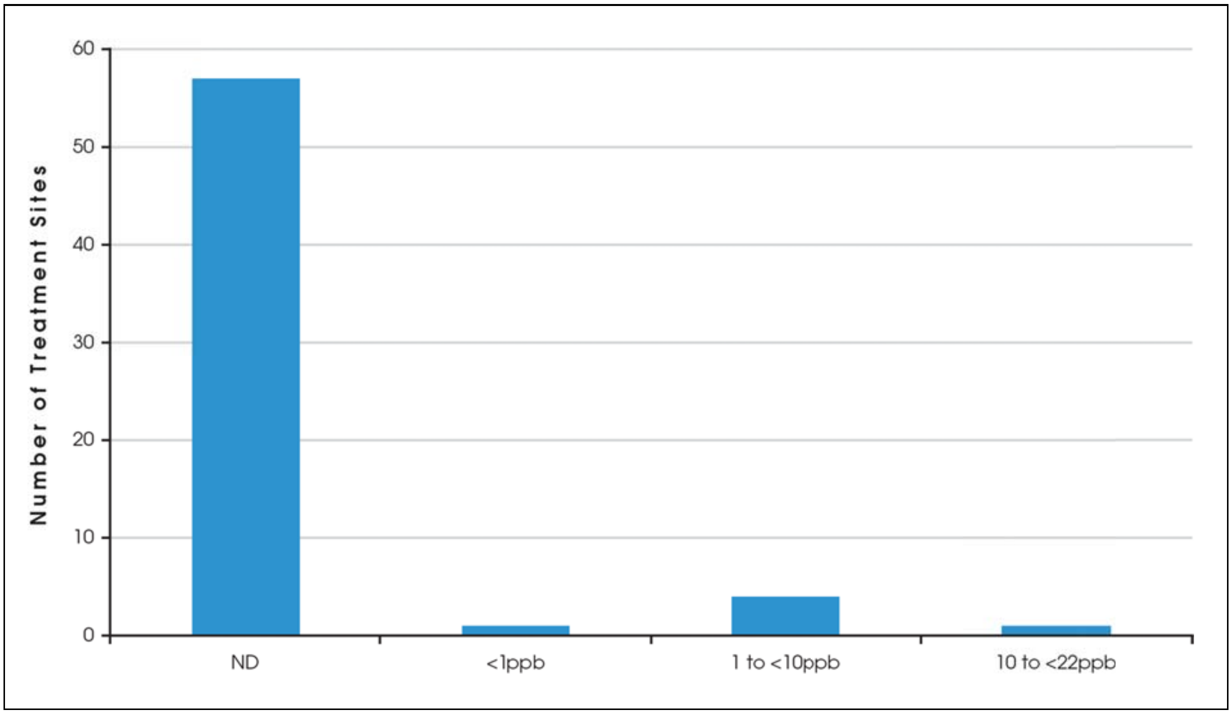


Table 3-7
Concentrations of Glyphosate Downstream of WHCP Treatments, 1 Hour Post-Treatment (2006 to 2012)

Concentration (ppb or ug/l)	Number of Sites
ND	57
<1 ppb	1
1 to <10 ppb	4
10 to ≤22 ppb	1
Total	63

Glyphosate levels in follow-up sampling taken between one day and seven days after treatment show even lower herbicide levels in waters in and downstream of the treatment site. Glyphosate was non-detectable in samples taken five to seven days after treatment. Between 2006 and 2012, all glyphosate samples taken one or more days post-treatment had non-detectable levels of the herbicide. Glyphosate levels decreased in the follow-up visits, however there were a few cases in which glyphosate levels were higher in the pre-treatment samples (up to 21 ppb), indicating the herbicide was present in Delta waters from other sources.

The calculated, test plot, and actual WHCP herbicide levels indicate that glyphosate levels in the Delta following herbicide treatment of spongeplant will be low. Maximum glyphosate levels within a treatment site, immediately after spraying, may reach as high as 158 ppb (0.158 ppm), but are likely to be less than 30 ppb. Maximum glyphosate levels immediately downstream are likely to be less than 2 ppb. Herbicides may remain at these maximum levels for a relatively short period of time (for example, the downstream sampling typically occurs within one hour of treatment). Glyphosate was non-detectable in all monitoring samples taken in 2012.

Historical Diquat Concentrations

Diquat that reaches the water will rapidly dissipate due to water flow and binding to sediment. Most assessments of diquat persistence have focused on lentic (i.e. standing) water systems, such as ponds or lakes. In such systems, an instantaneous concentration of 0.37 ppm can fall to approximately 0.10 ppm after 24 hours and 0.01 ppm after four days (DBW 2001). Field trials have shown that dissipation and dilution of diquat (as Reward) in flowing, tidally influenced and highly turbid waters such as the Delta are much more rapid. In 1988, a study in conducted at three one-acre plots in the Delta (White Slough, Owl Harbor, and Sandmound Slough) examined the persistence of diquat under different environmental and tidal conditions (DBW 2001). Persistence at these sites varied, depending on conditions. Where there was less water movement, diquat concentrations in the sites remained at 30 to 75 percent of initial levels after three hours. At faster moving sites, diquat dissipated within one hour of application. Overall, in four of the five test applications, an instantaneous concentration of 0.50 ppm decreased to 0.01 ppm within twelve to twenty-four hours, indicating that the persistence of diquat in a tidal environment is shorter than that observed for closed ponds (DBW 2001). These studies were applying diquat directly into the water for *Egeria densa* treatment; application of diquat to floating weeds such as spongeplant would result in lower diquat levels, as less diquat reaches the water.

As part of early evaluations of the WHCP, Anderson (1982) measured diquat residues following herbicide applications at a site in the Sacramento River near Tracy. The herbicide was applied at a rate of 1.5 pounds per acre diquat, and samples were collected from floating containers containing 500 mls Delta water that were stationed within the spray plot in order to measure instantaneous concentrations. Diquat concentrations in six samples ranged from 0 to 0.50 ppb, and averaged 0.25 ppb. Anderson estimated that only about 12 percent of the available diquat moved through the water hyacinth mat into the water, at which point it binds rapidly to sediment.

Anderson (2004) investigated diquat mixing characteristics in Delta sites after in-water application for the EDCP and found that herbicide mixing began between 7.5 and 30 minutes after application. Initially, most of the diquat was found in the upper one foot of water. Maximum diquat concentrations lasted less than 60 minutes due to mixing, turbulence, and turbidity.

EDCP monitoring conducted between 2001 and 2005 found a range of diquat levels within treatment sites and downstream of treatment sites (DBW 2006). Out of a total of 107 diquat samples taken immediately following and up to two weeks following treatment diquat was detected in just under 50 percent of the samples. The mean residue concentration among all 107 samples was 15.9 ppb. Among samples taken on the same day as treatment, the detection percentage was higher, at 66.7 percent, or 38 of 57 samples. The minimum detected residue immediately following treatment was 0.75 ppb, and the maximum detected level was 922 ppb. This high sample, from within the treatment site, was considered an outlier (DBW 2006). Of the 41 samples taken one to two weeks following treatment, only four had detectable diquat levels, ranging from 0.80 to 10 ppb. We would expect even lower diquat concentrations following SCP treatments because the herbicide will be applied to the weeds, with minimal overspray.

<u>Fate of SCP Herbicides in Water</u>

The second aspect of exposure relates to time – how long is a target (or non-target) species exposed to a certain chemical concentration? The time component is dependent on decomposition of the herbicide, and movement of Delta waters at the treatment site.

The SCP occurs within a highly dynamic, and vast, Delta. There are approximately 68,000 surface acres of waterways in the Delta and tributaries that encompass the SCP project area. Annual treatment acreage ranges from 20 to 1,000 acres assuming current infestation levels, and potentially as much as 2,500 acres if the spongeplant invasion reaches levels similar to water hyacinth. Thus, the SCP will treat between 0.03

percent and 3.7 percent of the project area waters in a year. As most SCP treatment locations are classified tidal, herbicide concentrations will not remain at their immediate post-treatment levels. Thus, any potential impacts resulting from SCP treatments will be highly localized and temporary.

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. Below, we summarize information on decomposition of each of the five SCP herbicides. Figures 3-7 to 3-11, later in this section, also provide a temporal component in summarizing toxicity and exposure data for SCP herbicides.

2,4-D

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 may also break down due to photodecomposition or by algal or bacterial decomposition (ESA/Madrone 1984). Westerdahl et al., (1983) found that the disappearance of 2,4-D in aquaria containing both plants and hydrosoil, and only hydrosoil, suggested that macrophytes, algae, fungi, and organic debris were the most likely sinks for 2,4-D. 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.

This will be the first time that 2,4-D will be utilized in the Delta for spongeplant. However, treatment of spongeplant will be similar to prior treatment of water hyacinth in the WHCP. As discussed, results of WHCP follow-up monitoring typically show declining 2,4-D concentrations (often to non-detectable levels) between two and seven days after treatment. Breakdown products of 2,4-D detected in laboratory experiments included 1,2,4-benzenetriol, 2,4-dichlorophenol (2,4-DCP), 2,4-dichloroanisole (2,4-DCA), 4-chlorophenol, chlorohydroquinone (CHQ), volatile organics, bound residues, and carbon dioxide. These degradates are expected to be of low occurrence in the environment and of low toxicity, or both (Gervais et al. 2008).

Glyphosate

Glyphosate does not appear to be persistent in the water column. Glyphosate binds tightly to sediment, removing the active ingredient from water. The half-life of glyphosate in pond water ranges from 12 days to 10 weeks (EXTONET 1996). DBW has utilized glyphosate for the WHCP, and evaluated persistence and concentrations following treatment. Treatment of spongeplant with glyphosate would be similar to treatment of water hyacinth, thus the studies summarized in this subsection are applicable to spongeplant, as well as water hyacinth.

At two Delta test plots, researchers applied 100 gallons of 6 pounds per acre glyphosate solution, somewhat higher than the labeled rate. The highest concentration of glyphosate was found after 4 hours (60 ppb), in a test spray area not subject to tidal flow (Corcoran et al. 1984). At a test site with tidal flow, the highest concentration of glyphosate (40ppb) was found one-half hour after treatment (Corcoran et al. 1984). When glyphosate was sprayed aerially at a rate of 5 pints per acre (also higher than the labeled rate), glyphosate was at its maximum concentration one-half day after treatment (0.28 ppm to 0.60 ppm). After six to eight days, glyphosate levels ranged from undetectable (<0.001 ppm) to 0.49 ppm (Henry et al. 1994). In turbid water, glyphosate is degraded by microorganisms (Siepmann 1995). Studies in Canada suggest that sediment adsorption and microbial degradation are responsible for glyphosate's loss from water (Schuette 1998).

Penoxsulam

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 (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.

Imazamox

Imazamox is highly soluble in water, and is mobile to highly mobile in soil (Washington DOE 2012; USEPA 2008). The organic carbon sorption coefficient, Koc, 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.

Diquat

Diquat is water soluble, non-volatile, and binds strongly to soil and sediment. Diquat dibromide rapidly disassociates to the diquat cation, and herbicide concentrations are typically measured in cation equivalence (c.e.). When diquat comes in contact with soil, it is strongly adsorbed to clay particles or organic matter for a long period of time (several years) (EXTOXNET 1993). Diquat is biologically inactive in this bound state, and is often unavailable for further degradation (EXTOXNET 1993, Washington DOE 2002). The Koc of diquat is 100,000 g/ml. Because of the high affinity to soil, there is little possibility that diquat will leach or result in groundwater contamination. Adsorbed diquat is subject to microbial degradation, where the herbicide is broken down into carbon dioxide (EXTOXNET 1993). In pure culture, isolates of bacteria are capable of degrading diquat; three separate metabolites have been isolated, but not identified (Washington DOE 2002). Hosea (2005) found diquat in Delta sediments following EDCP treatments in 2002 through 2005, but not at levels of concern.

Because diquat binds strongly to soils, it is not persistent in water, and dissipates rapidly to low levels. Several studies have demonstrated that diquat dissipated to levels lower than 0.01 ppm in four to twelve days, depending on the sediment type (Washington DOE 2002). Applications at the maximum diquat use rate of 0.37 ppm to a lake in New York dropped to 0.08 ppm c.e. after one day and 0.024 ppm after four days (Washington DOE 2002). Many other studies have found similar declines in diquat cation concentrations. The half-life of diquat in water is less than 48 hours (EXTOXNET 1993) due to its ability to bind to sediment in water; a factor that also limits the herbicide's efficacy in turbid waters. If it does not adsorb to sediment, diquat will photodegrade in surface layers of water in one to three weeks (EXTOXNET 1993). Diquat has a low octanol/water coefficient (Kow = 0.000025), indicating little or no likelihood of bioaccumulation (Washington DOE 2002).

There are no known impurities in the manufacture of diquat, and none of the inert ingredients in diquat have been classified as having toxicological concerns (Washington DOE 2002). The primary inert ingredient in the diquat product, Reward, is water (Washington DOE 2002).

Potential for Toxic Effects of SCP Herbicides

This impact assessment describes toxicity data for fish and reptiles, amphibians, or birds to assess direct toxicity of SCP herbicides. For each herbicide, we provide a graph that compares estimated environmental concentrations (EECs) over time, and toxicity endpoints (Figures 3-7 to 3-11). The lower horizontal axis of each graph is a log10 scale, with concentrations ranging from 1 ppb to 1,000,000 ppb. We assume that less than 1ppb is, for all intents and purposes, equivalent to non-detectable. The upper left corner of each graph also includes a time scale of estimated concentrations over several hours after application, and is based on prior monitoring data (where available) and tidal influence. The graphs also include the NPDES limit concentration, where applicable. The upper left corner of each graph provides three concentration estimates from Table 3-4:

- the concentration in 1 meter of water assuming 100 percent contact (i.e. if the herbicide was sprayed directly into the water)
- the concentration in 1 meter of water assuming 20 percent overspray (a conservative overspray estimate)
- the concentration in 2 meters of water assuming 20 percent overspray.

Each graph includes lines or data points illustrating species endpoint effects. The endpoints depend on the data available, and include lethal concentrations (LC50) and effective concentration (EC50) (for 50% of subjects, typically for immobility, reproduction and/or growth effects), non-observable effect concentration (NOEC) , and lowest observable effect concentration (LOEC) levels. In some cases we include other subchronic toxicity study endpoints. For ease of presentation, these figures provide toxicity endpoints for fish, amphibians, reptiles, and/or birds. We provide data on invertebrates and plants under Impact B4: Food Web Effects, including similar graphs for macroinvertebrates and plants (Figures 3-13 to 3-17).

Potential for Toxic Effects of SCP Herbicides on Fish

The levels of herbicide and adjuvant utilized by the SCP are unlikely to result in acute toxic effects to special status or other fish, including impacting movement of native resident or migratory fish.

Toxicity of 2,4-D to Listed Fish Species

Between 2001 and 2005, DBW commissioned toxicity testing of three fish species. The testing included water samples obtained following treatments. In addition, as part of their NPDES permit requirement, DBW sponsored several toxicity analyses using WHCP chemicals, three of which are the same as proposed SCP chemicals. These studies are indicative of actual environmental impacts, as they reflect Delta conditions, and/or laboratory results specifically related to WHCP, and now SCP. Below, we summarize results of these studies, as they relate to toxic impacts on fish species:

- Riley and Finlayson (2003) conducted 96-hour acute toxicity screening for 2,4-D on larval delta smelt, larval Sacramento splittail, and larval fathead minnows. The results of these studies are provided in **Table 3-8,** below. The study concluded that 2,4-D toxicity values for the three larval fish species were several orders of magnitude higher than detected concentrations in the environment (Riley and Finlayson 2003)

- Riley and Finlayson (2004) conducted 96-hour and seven day toxicity screening of WHCP, now SCP, chemicals on larval fathead minnows to determine chronic toxicity levels. For 2,4-D, the 96-hour LC50 value was 116 ppm, the seven day LC50 was 96.6 ppm, and the seven day maximum acceptable toxicant concentrations (MATC) was less than 40.5 ppm. These concentrations are orders of magnitude higher than concentrations resulting from SCP.

Table 3-9, on the next page, summarizes fish toxicity data for 2,4-D. DBW conducted an analysis of water quality and toxicity using monitoring data gathered from 2001 to 2005. DBW collected several hundred pre-treatment and post-treatment water samples and delivered these to California Department of Fish and Wildlife laboratories to conduct five different toxicology tests. Based on an examination of toxicology test results from post-treatment water samples, WHCP did not have a significant or consistent adverse effect on test organisms used by the laboratories (including fathead minnow). We would expect similar results for SCP.

In DBW's analysis, there were 20 samples which exceeded previous NPDES permit levels (20 ppb) for 2,4-D (NPDES permit levels are now 70 ppb for 2,4-D). These 20 samples were tested for fathead minnow survival and growth. None of these 20 samples had an adverse effect on survival, however five samples had an adverse effect on fathead minnow growth.

This series of studies provide no indication of acute toxic impacts on fish species as a result of WHCP treatments. All toxicity tests were conducted on the more sensitive larval stages of fish, providing further confidence in the results. While data are limited, there may be some impact of 2,4-D treatments (and/or simply from ambient Delta waters) on larval fish growth. However, it is not clear whether 2,4-D or other contaminants in Delta waters affected growth.

In an independent study of aquatic pesticide toxicity within the Delta, the San Francisco Estuary Institute (SFEI) conducted the Aquatic Pesticide Monitoring Program (APMP) (Siemering et al. 2008). The APMP, funded by the SWB, was part of the settlement of the 2001 *Headwaters, Inc. v. Talent Irrigation District* decision regarding the requirement to obtain an NPDES permit for aquatic pesticide use. The purpose of the APMP was to evaluate water quality impacts associated with the use of aquatic pesticides, and to evaluate non-chemical alternatives.

For 2,4-D, the risk quotient (RQ) values for Chinook salmon LC50, *Pimephales promelas* (fathead minnow) LC50, and delta smelt NOEC were all well below the level of concern (LOC) values. SFEI stated "this data indicates that there is no evidence of pesticide induced degradation at either of the sampling locations. In addition, no LOCs were exceeded by the maximum 2,4-D concentration measured" (Siemering et al. February 2005). While USEPA, USDA, NMFS and USFWS no longer utilize RQ values to evaluate impacts to listed species, these findings are still indicative of a likely low impact for the SCP.

In another study, SFEI analyzed DBW WHCP monitoring results, calculating RQ values and the number of LOC exceedances for monitoring data from 2003 to 2005. For the 1,799 2,4-D RQs that SFEI calculated for the three year period, there were no LOC exceedances.

Table 3-8
CDFW Study Results, Acute Toxicities of 2,4-D on Three Larval Fish Species, 96-Hour LC50 Values (in ppm)

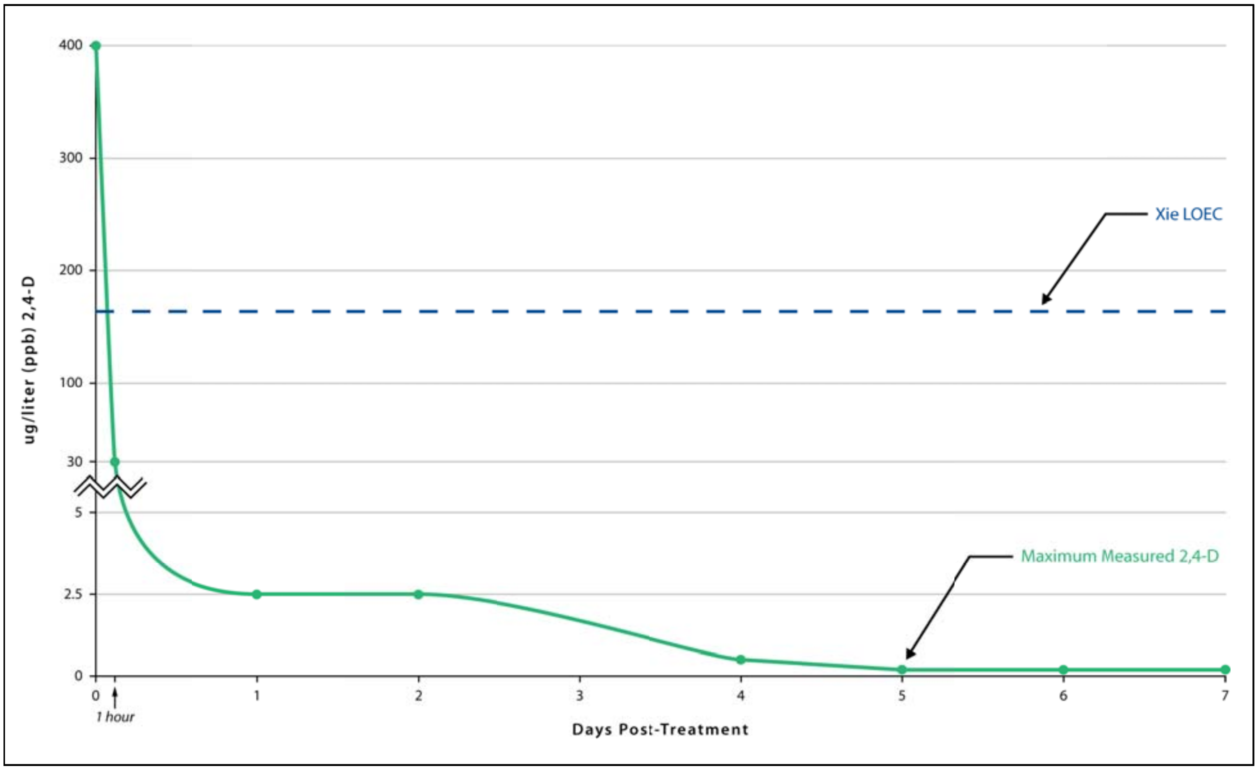
Fish Species	2,4-D LC50
Larval delta smelt	149 ppm
Larval Sacramento splittail	446 ppm
Larval fathead minnow	216 ppm

Table 3-9
Response of Various Fish Species to 2,4-D at LC50 Values

Species	Chemical	LC50	Time Period	Reference
Fathead minnow	2,4-D dimethylamine salt (DMA)	344 ppm	96 hr	Alexander et al., 1985
Fathead minnow	2,4-D DMA	335 ppm	96 hr	Johnson and Finley 1980
Fathead minnow	2,4-D DMA	318 ppm	96 hr	USEPA 2000
Fathead minnow fingerlings, swim-up fry	2,4-D DMA	320 ppm to 630 ppm	96 hr	Johnson and Finley 1980
Fathead minnow egg stage	2,4-D DMA	1,400 ppm	96 hr	Johnson and Finley 1980
Bluegill	2,4-D DMA	168 ppm	96 hr	Johnson and Finley 1980
Bluegill	2,4-D DMA	524 ppm	96 hr	Alexander et al., 1985
Bluegill	2,4-D DMA	166 ppm to 458 ppm	48 hr	HSDB 2001
Bluegill	2,4-D DMA	108 ppm to 524 ppm	96 hr	USEPA 2000
Juvenile rainbow trout	2,4-D DMA	494 ppm	96 hr	Fairchild et al. (2009)
Rainbow trout	2,4-D DMA	>100 ppm	96 hr	Johnson and Finley 1980
Rainbow trout	2,4-D DMA	250 ppm	96 hr	Alexander et al., 1985
Rainbow trout, Donaldson trout	2,4-D DMA	250 ppm	96 hr	USEPA 2000
Rainbow trout, Donaldson trout	2,4-D DMA	100 ppm to 1,360 ppm	96 hr	ECOTOX 2001
Cutthroat trout	2,4-D granular	64 ppm	96 hr	Johnson and Finley 1980
Lake trout	2,4-D granular	45 ppm	96 hr	Johnson and Finley 1980
Chinook salmon	2,4-D DMA	>100 ppm	96 hr	Johnson and Finley 1980
Coho salmon yearling	2,4-D DMA	>200 ppm	96 hr	HSDB 2001
Nile tilapia larvae	2,4-D DMA	28 ppm	48 hr	Sarikaya and Selvi 2005
Nile tilapia adults	2,4-D DMA	87 ppm	48 hr	Sarikaya and Selvi 2005
Channel catfish	2,4-D DMA	155 ppm	96 hr	Johnson and Finley 1980
Smallmouth bass	2,4-D DMA	236 ppm	96 hr	Johnson and Finley 1980
Largemouth bass	2,4-D DMA	350 ppm to 375 ppm	48 hr	HSDB 2001

Fairchild et al. (2009) conducted an ecological risk assessment of the exposure and effects of 2,4-D acid to rainbow trout. Fairchild identified an acute toxicity LD50 for juvenile rainbow trout of 494 ppm. In a test of 30-day chronic toxicity, Fairchild found no effects on juvenile rainbow trout at the maximum exposure of 108 ppm. In a test of 30-day chronic toxicity in the more sensitive rainbow trout swim-up larvae, Fairchild found a no observable effect level (NOEC) of 54 ppm, a lowest observable effect level (LOEC) of 108 ppm, and a maximum acceptable toxicant concentration (MATC) of 76 ppm. Length and weight were the chronic toxicity endpoints in these studies. All of these levels are well above SCP treatment concentrations. Fairchild also examined environmental exposure levels, and concluded that using 2,4-D for invasive weed control in aquatic and terrestrial habitats poses no substantial risk to growth or survival of rainbow trout or other salmonids.

Figure 3-6
Comparison of Measured 2,4-D Levels Post-Treatment with LOEC for Estrogenic Activity from Xie et al.



While the risk of acute toxicity to listed species or other fish resulting from the SCP is extremely low, there is some evidence of chronic/sublethal toxicity impacts from 2,4-D. Studies have identified two potential areas of concern related to sublethal exposure to 2,4-D: endocrine disruption (in the form of estrogenic activity) and oxidative stress.

Xie et al., (2005) identified dose-related increases of vitellogenin in juvenile rainbow trout exposed to 2,4-D. Vitellogenin is an egg yolk precursor protein used as an indicator of estrogenic activity in both females and males. Juvenile trout were exposed to either 0.00164, 0.0164, 0.164, or 1.64 mg/l 2,4-D (ppm) for seven days. The trout exposed at the 1.64 mg/l level had vitellogenin levels 93 times higher than the controls. The lowest observed effect concentration (LOEC) or lowest observed adverse effect concentration (LOAEC) was 0.164 mg/l (or 164 ppb). There was no observed effect at the lowest two exposure concentrations.

The endocrine disruption LOEC for 2,4-D of 164 micrograms per liter (ppb) was based on an exposure of seven days at this LOEC level (Xie et al. 2005). While the maximum WHCP in-treatment site measurement for 2,4-D was just under 400 ug/l (ppb), in one outlier case out of more than 100 samples taken between 2001 and 2005, this level of herbicide is not maintained in Delta waters. The maximum 2,4-D level found one hour post-treatment over six years of monitoring (2006 through 2011) was 30 ppb. Thirty-nine percent of 2,4-D samples taken one hour after treatment were less than 1 ppb. 2,4-D levels found between one and seven days post-treatment range from non-detectable to 2.5 ppb.

Figure 3-6, above, illustrates the Xie study LOEC level as compared to actual maximum 2,4-D levels found following WHCP treatments. Again, we would expect 2,4-D levels following spongeplant treatment to be similar. Figure 3-6 is conservative, because it utilizes the highest levels of 2,4-D found following treatment, not the average levels, which are lower. As Figure 3-6 illustrates, the SCP will not result in 2,4-D concentrations that exceed the LOEC levels for a long-enough period to result in sublethal impacts on estrogenic activity.

Sarikaya et al., (2005) examined 48 hour LC50 values for 2,4-D in larvae and adult Nile tilapia (*Oreochromis niloticus*). They observed changes among larvae and adults at various herbicide levels, and concluded that the toxicity of 2,4-D is related to oxidative stress. Behavioral and other changes included abnormal swimming behavior (hitting the walls of the tank), increased mucous secretion, faded coloring, sudden jerks, and anxiety.

Oruc and others (2000, 2002, 2004) examined antioxidant enzymes in carp and tilapia following exposure to 2,4-D. Oxidative stress results in the formation of free radicals, which cause cellular damage. Formation of free radicals also results in increased production of antioxidant enzymes, which can be measured in the laboratory. Carp and tilapia exposed to 87 ppm 2,4-D for 96 hours showed an increase in the antioxidant enzyme superoxide dismutase (SOD) in gills (but not kidney or brain). Oruc concluded that fish exposed to 2,4-D developed tissue-specific adaptive responses to protect cells against oxidative stress.

These studies raise potential concerns about sublethal toxicity, however the exposure levels of 2,4-D that resulted in estrogenic activity or oxidative stress in fish are higher than those likely to result from SCP.

Figure 3-7, on the next page, provides a visual representation of 2,4-D estimated EECs and LC50, NOEC, and/or LOEC levels for reptiles, amphibians and fish species. The concentration in 1 meter of water at 100 percent contact represents a highly conservative instantaneous maximum concentration, at 551 ppb. SCP will utilize spot treatments, spraying herbicide directly onto spongeplant. The 20 percent overspray concentration shown in Figure 3-7, at 103 ppb, is also conservative. From monitoring data, we assume that after approximately one hour, the herbicide will have mixed into 2 meters of water, with the concentration dropping to 51 ppb. Based on prior monitoring results, we expect that 2,4-D levels will continue to drop towards 1 ppb over the next several hours. Thus, at any treatment site, 2,4-D exposure following SCP treatments will be less than one day. The NPDES limit of 70 ppb 2,4-D falls between the expected concentrations at 1 meter and 2 meters. In prior WHCP monitoring, DBW has not exceeded the 70 ppb NPDES limit, except for one extreme outlier taken before 2005.

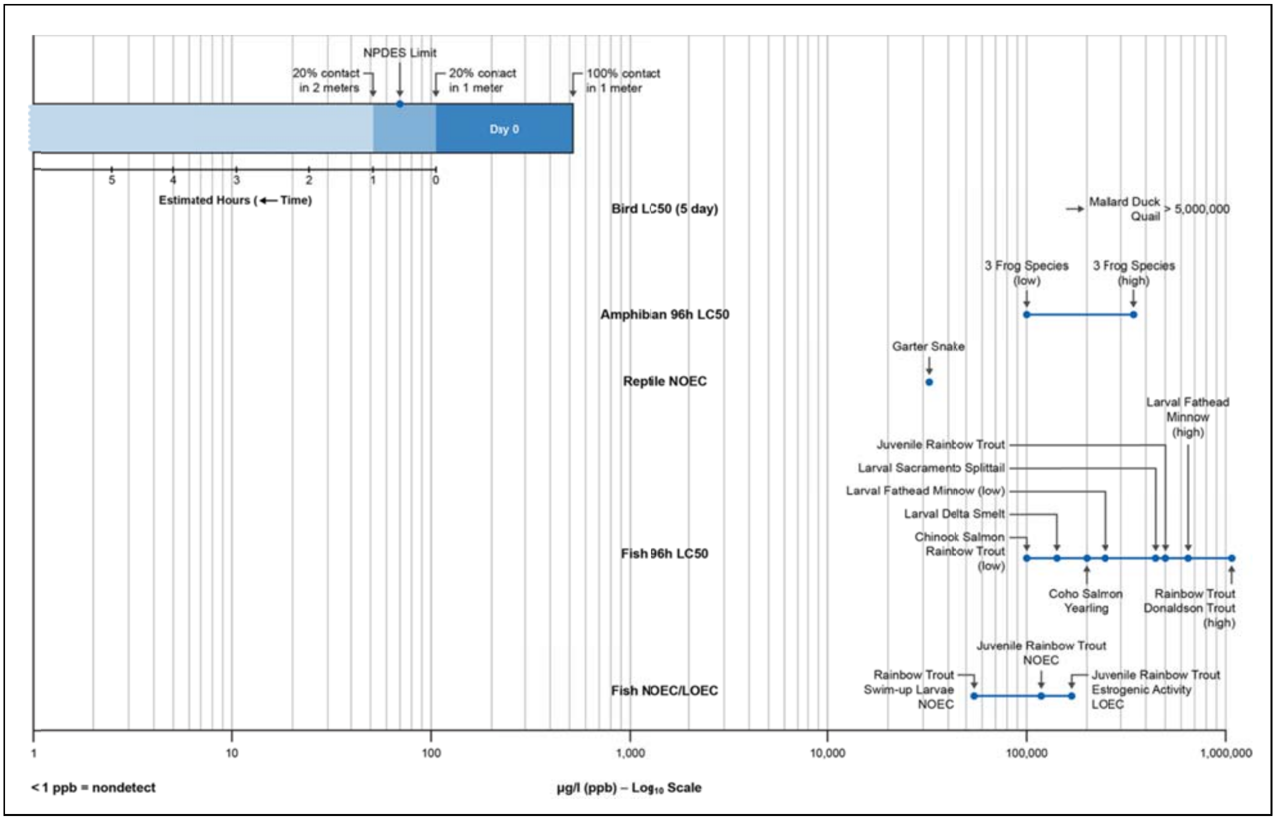
The series of horizontal lines in the figure represent high and low ranges of effect concentrations for birds, amphibians[2], reptiles, and fish. The lowest toxicity endpoint concentrations are well to the right of the EEC bar. This illustrates that there is no overlap between SCP EECs and toxicity levels. For example, the bird LC50 is more than five orders of magnitude above the 20 percent contact in one meter concentration and the amphibian LC50 value is three orders of magnitude above the 20 percent contact in one meter concentration, the estimated maximum 2,4-D concentration. The reptile NOEC level is over two orders of magnitude greater than the estimated maximum 2,4-D concentration.

For fish species, Figure 3-7 provides a range of LC50 values. The lowest LC50 is three orders of magnitude above the estimated maximum 2,4-D concentration, and the highest toxicity levels are four orders of magnitude greater. Fish NOEC and LOEC values, including an LOEC for estrogenic activity, are over two orders of magnitude greater than the estimated maximum 2,4-D concentration. As summarized previously, several of the 2,4-D sublethal toxicity studies evaluated growth, survival, and abnormal swimming.

Based on these analyses, we expect the direct effects of 2,4-D treatments on listed fish species, giant garter snake, or other listed species to be discountable. The already low potential for toxicity effects of 2,4-D can be further minimized by treating spongeplant early in the growing season, thus reducing the amount of herbicide needed.

[2] Toxicity of SCP herbicides to birds, reptiles and amphibians is summarized starting on page 3-75. We include and briefly discuss bird, reptile and amphibian data in this section with the figures for ease of presentation.

Figure 3-7
Comparison of Exposure Concentrations and Bird, Reptile/Amphibian and Fish Species Endpoint Effects for 2,4-D (µg/L or ppb)



Toxicity of Glyphosate to Listed Fish Species

DBW also commissioned toxicity testing of glyphosate on three fish species. The testing included water samples obtained following treatments. In addition, as part of their NPDES permit requirement, DBW sponsored several toxicity analyses using WHCP chemicals now proposed for the SCP. These studies are indicative of actual environmental impacts, as they reflect Delta conditions, and/or laboratory results specifically related to the SCP. Below, we summarize results of these studies, as they relate to toxic impacts of glyphosate on fish species:

- Riley and Finlayson (2003) conducted 96-hour acute toxicity screening for glyphosate on larval delta smelt, larval Sacramento splittail, and larval fathead minnows. The results of these studies are provided in **Table 3-10,** on the next page. The study concluded that glyphosate toxicity values for the three larval fish species were several orders of magnitude higher than detected concentrations in the environment (Riley and Finlayson 2003)
- Riley and Finlayson's (2004) testing of glyphosate on larval fathead minnows found a 96-hour LC50 value of 608 ppm, a seven day LC50 of 586 ppm, and a seven day MATC of less than 104 ppm. Again, these concentrations were orders of magnitude higher than concentrations resulting from the WHCP. Riley and Finlayson concluded that there were minimal impacts to fish and wildlife from WHCP. Glyphosate use for the SCP will be similar to the WHCP, thus we expect the same level of impacts.

Table 3-10
CDFW Study Results, Acute Toxicities of Glyphosate on Three Larval Fish Species, 96-Hour LC50 Values

Fish Species	Glyphosate LC50
Larval delta smelt	270 ppm
Larval Sacramento splittail	1,132 ppm
Larval fathead minnow	1,154 ppm

DBW conducted an analysis of water quality and toxicity using monitoring data gathered from 2001 to 2005. DBW collected several hundred pre-treatment and post-treatment water samples and delivered these to CDFW laboratories to conduct five different toxicology tests. Based on an examination of toxicology test results from post-treatment water samples, WHCP did not have a significant or consistent adverse effect on test organisms used by the laboratories (including fathead minnow).

In DBW's analysis, none of the glyphosate samples exceeded NPDES permit criteria (700 ppb), the CDFW laboratory conducted toxicity testing using the 18 samples with detectable levels of glyphosate. None of these 18 glyphosate samples had an adverse effect on fathead minnow survival, however three of the 18 samples had an adverse effect on fathead minnow growth. (Three of 52 samples without any detectable glyphosate also had an adverse effect on fathead minnow growth).

This series of studies provide no indication of acute toxic impacts on fish species as a result of WHCP treatments. All toxicity tests were conducted on the more sensitive larval stages of fish, providing further confidence in the results. While data are limited, there may be some impact of SCP treatments (and/or simply from ambient Delta waters) on larval fish growth.

In the APMP, SFEI prioritized aquatic pesticides for further study, analyzed three years of monitoring data, and conducted several special studies of high priority pesticides. Using an USEPA methodology, SFEI calculated risk quotients (RQ) for each pesticide. While NMFS and USFWS no longer utilize RQ values, these findings are still relevant.

For glyphosate, there were also no Level of Concern (LOC) exceedances. Of the eight aquatic pesticides evaluated, SFEI ranked glyphosate as the lowest risk (Siemering et al. 2008).

In another study, SFEI analyzed DBW WHCP monitoring results, calculating RQ values and the number of LOC exceedances for monitoring data from 2003 to 2005. For the 835 RQs that SFEI calculated for glyphosate, there were four LOC exceedances (one for delta smelt and three for Sacramento splittail). SFEI hypothesized that the small number of exceedances could result from overapplication, poor mixing and dispersion in the water column, or additional terrestrial sources of glyphosate (Siemering 2006). Siemering (2006) also noted that "only four exceedances in three years indicates that DBW glyphosate applications are not likely to pose a risk to the aquatic environment."

A study evaluating the toxicity of individual and herbicide mixes on fathead minnows found that glyphosate (Accord Concentrate) did not show any appreciable acute toxicity, either alone, or with surfactants (Chopper and Arsenal AC) (Tatum et al. 2011). No LC50 values could be calculated because less than 50 percent mortality was observed at the highest herbicide concentrations, which were equivalent to spraying the maximum application rate directly into a stagnant pond.

An Iranian study of the toxicity of three sturgeon species to glyphosate (Filizadeh and Rajabi Islami 2011) found 96-hour LC50 levels for sturgeon fry of between 19 mg/l and 26 mg/l, and 168-hour LC50 levels of between 8 mg/l and 13 mg/l. These levels are above the highest concentration found immediately following an WHCP treatment of 0.158 mg/l (ppm) (which was an outlier), indicating no risk to these sturgeon species. In addition, the glyphosate formulation used in this study was Roundup, which contains a surfactant known to be toxic to aquatic species.

Table 3-11, below, summarizes glyphosate acute toxicity testing on several fish species. The risk of acute toxicity to special status or other fish resulting from the SCP is extremely low, yet there is some evidence of chronic/ sublethal toxicity impacts from glyphosate.

While glyphosate did not result in estrogenic activity (Xie et al. 2005), other studies have found indications of reduced liver activity and immune suppression resulting from sublethal exposure to glyphosate. Li and Kole (2004) found an inhibitory effect on liver esterase as compared to controls with exposure to 1.0, 5.0, and 25 mg/l glyphosate for 65 days. Li and Kole cited other studies that noted behavioral changes to rainbow trout after one month of exposure to 46 ppb glyphosate, Li and Kole (2004) also noted increased enzyme activity, and interruption of immune response and protein biosynthesis in carp exposed to 2.5 to 10 mg/l glyphosate. SCP long-term exposure levels of glyphosate are significantly lower than the long-term exposure levels tested by Li and Kole. In samples taken since 2008, WHCP monitoring following treatments have not found detectable levels of glyphosate.

Table 3-11
Response of Various Fish Species to Glyphosate, at LC50 Values

Species	Chemical	LC50	Time Period	Reference
Fathead minnow	Glyphosate	97 ppm	96 hr	Folmar et al., 1979
Fathead minnow	Glyphosate	9.4 ppm to 97 ppm	96 hr	USEPA 2000
Bluegill	Glyphosate	140 ppm	96 hr	Folmar et al., 1979
Bluegill	Glyphosate	120 ppm	96 hr	Corcoran et al., 1984
Bluegill	Glyphosate, isopropylamine salt	>1,000 ppm	96 hr	Corcoran et al., 1984
Rainbow trout	Glyphosate	140 ppm	96 hr	Folmar et al., 1979
Rainbow trout, Donaldson trout	Glyphosate	8.2 ppm to 240 ppm	96 hr	USEPA 2000
Trout	Glyphosate, isopropylamine salt	>1,000 ppm	96 hr	Corcoran et al., 1984
Trout	Glyphosate	86 ppm	96 hr	Corcoran et al., 1984
Chinook salmon	Glyphosate	9.1 ppm to 1,440 ppm	96 hr	ECOTOX 2001
Pink salmon	Glyphosate	17 ppm to 48 ppm	96 hr	ECOTOX 2001
Chum salmon	Glyphosate	11 ppm to 58 ppm	72 hr	ECOTOX 2001
Coho salmon, silver salmon	Glyphosate	5.7 ppm to 55 ppm	96 hr	ECOTOX 2001
Sockeye salmon	Glyphosate	28 ppm	96 hr	ECOTOX 2001
Harlequin fish	Glyphosate	168 ppm	96 hr	Corcoran et al., 1984
Carp	Glyphosate	115 ppm	96 hr	Corcoran et al., 1984
Carp	Glyphosate, isopropylamine salt	>10,000 ppm	96 hr	Corcoran et al., 1984
Channel catfish	Glyphosate	130 ppm	96 hr	Folmar et al., 1979

Figure 3-8
Comparison of Exposure Concentrations and Bird, Reptile/Amphibian and Fish Species Endpoint Effects for Glyphosate (μg/L or ppb)

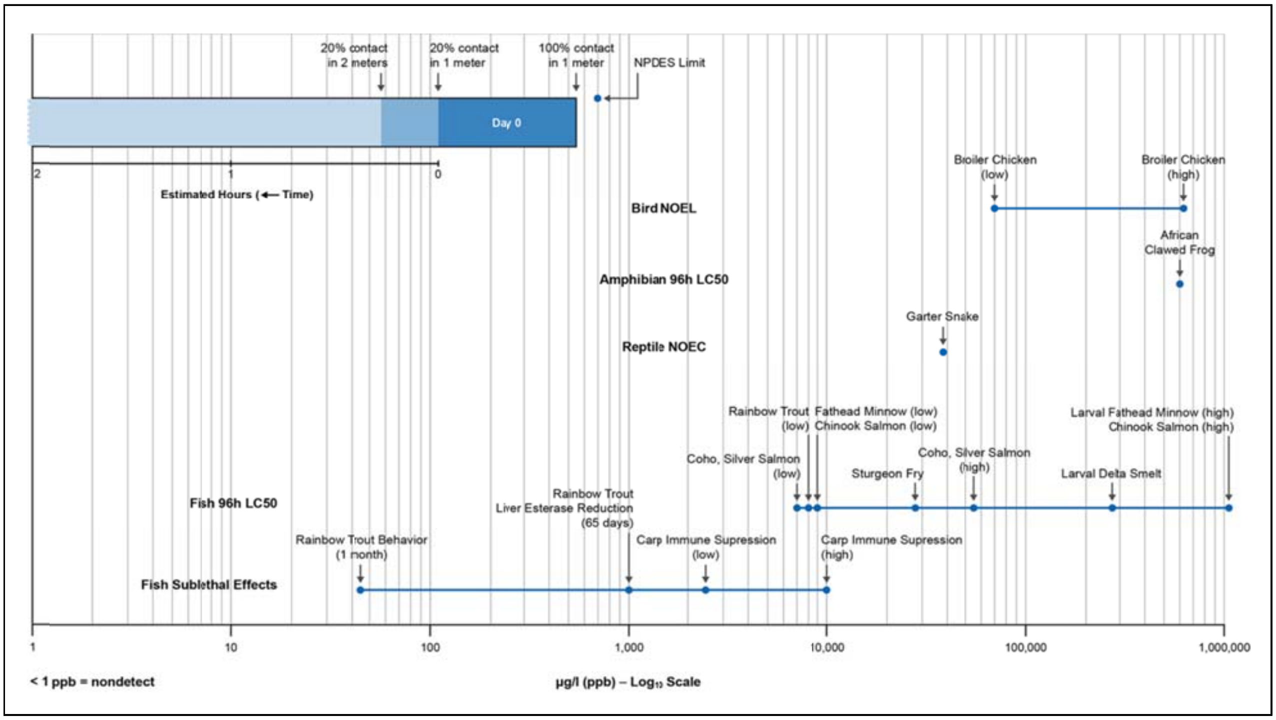


Figure 3-8, above, provides a visual representation of glyphosate estimated EECs and LC50, NOEC, and/or LOEC levels for birds, reptiles, amphibians and fish species. The concentration in 1 meter of water at 100 percent contact represents a highly conservative instantaneous maximum concentration, at 570 ppb. The NPDES limit is higher, at 700 ppb. In prior WHCP monitoring, DBW has not exceeded the 700 ppb NPDES limit. SCP will utilize spot treatments, spraying herbicide directly onto spongeplant. The 20 percent overspray concentration shown in Figure 3-8, at 113 ppb, is conservative. Based on monitoring data, we assume that after less than one hour, the herbicide will have mixed into 2 meters of water, with the concentration dropping to 57 ppb. Based on prior WHCP monitoring results, we expect that glyphosate levels will continue to drop towards 1 ppb, and be non-detectable within approximately two hours. Thus, at any treatment site, glyphosate exposure following SCP treatments will likely be less than two hours.

All but one of the bird, amphibian, reptile, and fish toxicity endpoint concentrations are to the right of the EEC bar. For the one data point that overlaps the EEC bar, rainbow trout behavior effects after one month of 46 ppb glyphosate exposure, the timeline shows that SCP is not likely to have a sublethal effect on fish. Figure 3-8 illustrates that there is no overlap between SCP EECs and standard toxicity levels. For example, the amphibian LC50 value is almost four orders of magnitude above the 20 percent contact in one meter concentration, the estimated maximum glyphosate concentration. The reptile NOEC level is over two orders of magnitude greater than the estimated maximum glyphosate concentration.

For fish species, Figure 3-8 provides a range of LC50 values. The lowest LC50 is almost two orders of magnitude above the estimated maximum glyphosate concentration, and the highest toxicity levels are four orders of magnitude greater. The larval delta smelt LC50 is over three orders of magnitude higher than the estimated maximum glyphosate concentration. Fish sublethal toxicity endpoints also cover a wide range, from 46 ppb to 10,000 ppb. With the exception of the 46 ppb endpoint, all endpoints are above the estimated maximum glyphosate concentration, and require long exposure periods that will not occur with SCP treatments.

Table 3-12
Response of Various Fish Species to Penoxsulam at LC50 Values

Species	Chemical	LC50	Time Period	Reference
Rainbow trout *(Oncorhynchus mykiss)*	Technical grade penoxsulam	>102 ppm (NOAEC)	96-hr	Marino et al. 2000
Rainbow trout	Degradates and end-use products	None	96-hr	USEPA January 2007
Bluegill sunfish *(Lepomis macrochirus)*	Technical grade penoxsulam	>103 ppm	96-hr	USEPA January 2007
Bluegill sunfish	Galleon or equivalent	>147 ppm	96-hr	USEPA January 2007
Bluegill sunfish	Degradates	None	96-hr	USEPA January 2007
Common carp *(Cyprinus carpio)*	Technical grade penoxsulam	>101 ppm	96-hr	USEPA January 2007
Common carp	Degradates and end-use products	None	96-hr	USEPA January 2007
Fathead minnow *(Pimephales promelas)*	Technical grade penoxsulam	10.2 ppm (NOAEC)	36 days	USEPA January 2007

Based on these analyses, we expect the direct effects of glyphosate treatments on listed fish species, giant garter snake, or other listed species to be discountable. The already low potential for toxicity effects of glyphosate can be further minimized by treating spongeplant early in the growing season, thus reducing the amount of herbicide needed.

<u>Toxicity of Penoxsulam to Listed Fish Species</u>

Penoxsulam is classified as practically non-toxic to freshwater and marine/estuarine fish, based on results of acute toxicity testing (USEPA January 2007). Species with LD50 values of greater than 100 ppm fall into the practically non-toxic category. Chronic toxicity studies show no treatment-related effects to growth and reproduction in freshwater fish at concentrations up to 10.2 ppm (USEPA January 2007), a concentration approximately 2,000 times greater than the estimated concentration of penoxsulam in one meter of water immediately following SCP treatment. The acute toxicity LC50 results in USEPA's Ecological Risk Assessment (USEPA January 2007) are also non-observable adverse effect concentrations (NOAEC), as there were no observable effects at the highest concentrations tested. For example, in an acute toxicity study of juvenile rainbow trout, Marino et al. (2000) found no effects at the highest level tested, 102 ppm. Marino concluded that the NOAEC was 102 ppm, and the LC50 and LOAEC were both over 102 ppm. Similarly, in the chronic toxicity testing of early life-stage fathead minnows, there were no observable effects at 10.2 ppm, the highest concentration of penoxsulam tested. **Table 3-12,** above, summarizes toxicity testing results for several fish species for penoxsulam and degradates.

Because penoxsulam is a relatively new herbicide (USEPA approval in 2007), there are few studies evaluating penoxsulam toxicity in the open literature. Most evaluations of penoxsulam ecotoxicity rely on the USEPA registration data (Washington DOE 2012, FOOTPRINT PPDB 2009). One study of the impact of penoxsulam in rice field conditions on carp found mixed signs of oxidative stress after 7, 21, or 72 days of penoxsulam exposure (Cattaneo et al. 2011). However, exposure levels were 23 ppb, more than ten times higher than the estimated concentration of penoxsulam immediately following SCP treatment. Furthermore, the calculated post-treatment SCP 2 ppb level would be expected to exist only a short time (at most a few hours) due to tidal flow, mixing, and dilution. Thus, SCP treatments would not result in levels that could produce this potential sub-lethal effect.

Figure 3-9
Comparison of Exposure Concentrations and Bird, Reptile/Amphibian Surrogate and Fish Species Endpoint Effects for Penoxsulam (µg/l or ppb)

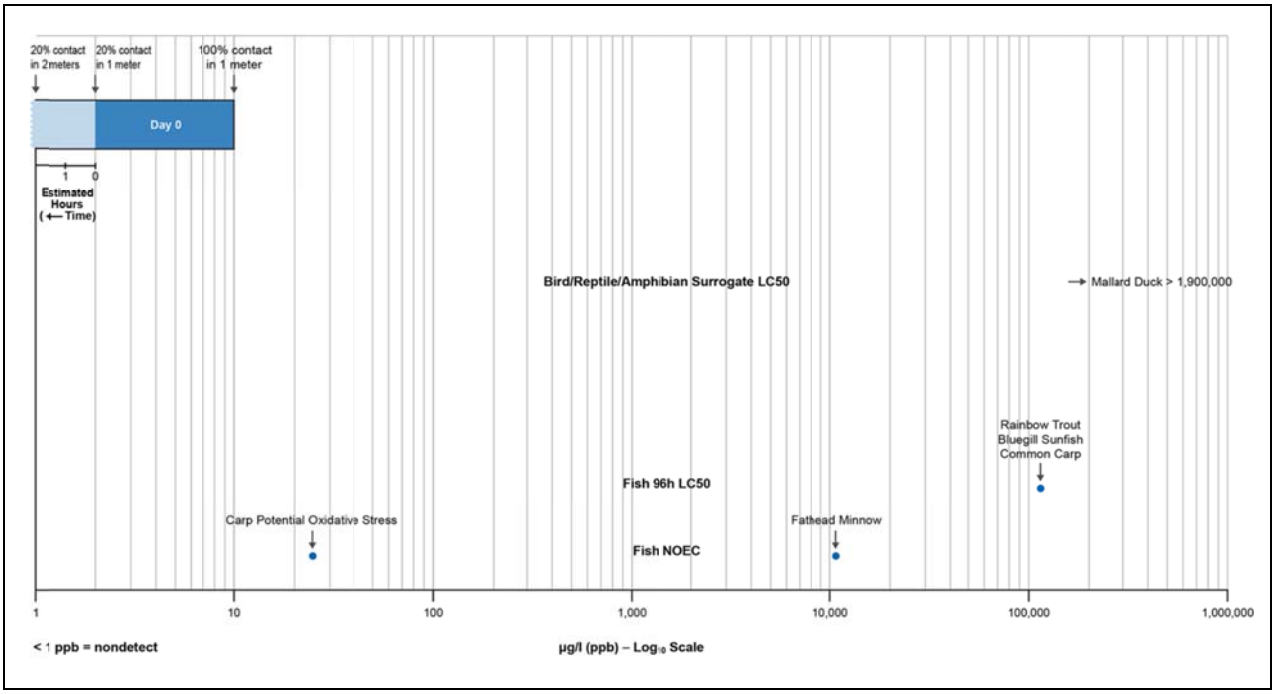


Figure 3-9, above, provides a visual representation of penoxsulam estimated EECs and LC50, NOEC, and/or LOEC levels for birds, reptiles, amphibians and fish species. One advantage of penoxsulam is the low concentration required for treatment, as evidenced by the concentration in 1 meter of water at 100 percent contact of only 9.8 ppb. This represents a highly conservative instantaneous maximum concentration. There is no NPDES limit or maximum monitoring trigger for penoxsulam. SCP will utilize spot treatments, spraying herbicide directly onto spongeplant. The 20 percent overspray concentration shown in Figure 3-9, at 2 ppb, is conservative. Based on tidal flow and mixing, we assume that after approximately two hours, the herbicide will have mixed into two meters of water, with the concentration dropping to 1 ppb (the limit for irrigation). Thus, at any treatment site, penoxsulam exposure following SCP treatments will be approximately two hours. DBW will closely monitor penoxsulam levels, as there is no existing experience with penoxsulam use in the Delta.

All of the bird (and reptiles/amphibian surrogate) and fish toxicity endpoint concentrations are to the right of the EEC bar. Figure 3-9 illustrates that there is no overlap between SCP EECs and standard toxicity levels. For example, the mallard duck (also a reptile surrogate) LC50 value is almost six orders of magnitude above the 20 percent contact in one meter concentration, the estimated maximum penoxsulam concentration.

For fish species, Figure 3-9 provides three LC50 values. All three species had no effects at the highest levels tested, over 100,000 ppb. The highest levels tested are almost 4.5 orders of magnitude above the estimated maximum penoxsulam concentration. There was one NOEC test, with no effect seen at the highest level tested, 3.5 orders of magnitude above the estimated maximum penoxsulam concentration. One study found mixed signs of oxidative stress, at one order of magnitude above the estimated maximum penoxsulam concentration. This study required a minimum of seven days of exposure.

Based on these analyses, we expect the direct effects of penoxsulam treatments on listed fish species, giant garter snake, or other species to be discountable. The already low potential for toxicity effects of penoxsulam can be further minimized by treating spongeplant early in the growing season, thus reducing the amount of herbicide needed.

The fact that there are few toxicity data points for penoxsulam creates some uncertainty; however, the available fish data points are between 1,000 and 10,000 times higher than the estimated maximum penoxsulam concentration in 1 meter of water. Four acute toxicity assays (juvenile bluegill sunfish, juvenile rainbow trout, silverside and common carp) found LC50 values of above 101 to 129 mg/l, in each case the highest concentrations tested (SePRO 2014). A fathead minnow early life state 36-hour NOEC test also found no effects at 102 mg/l, the highest concentration tested (SePRO 2014).

Toxicity of Imazamox to Listed Fish Species

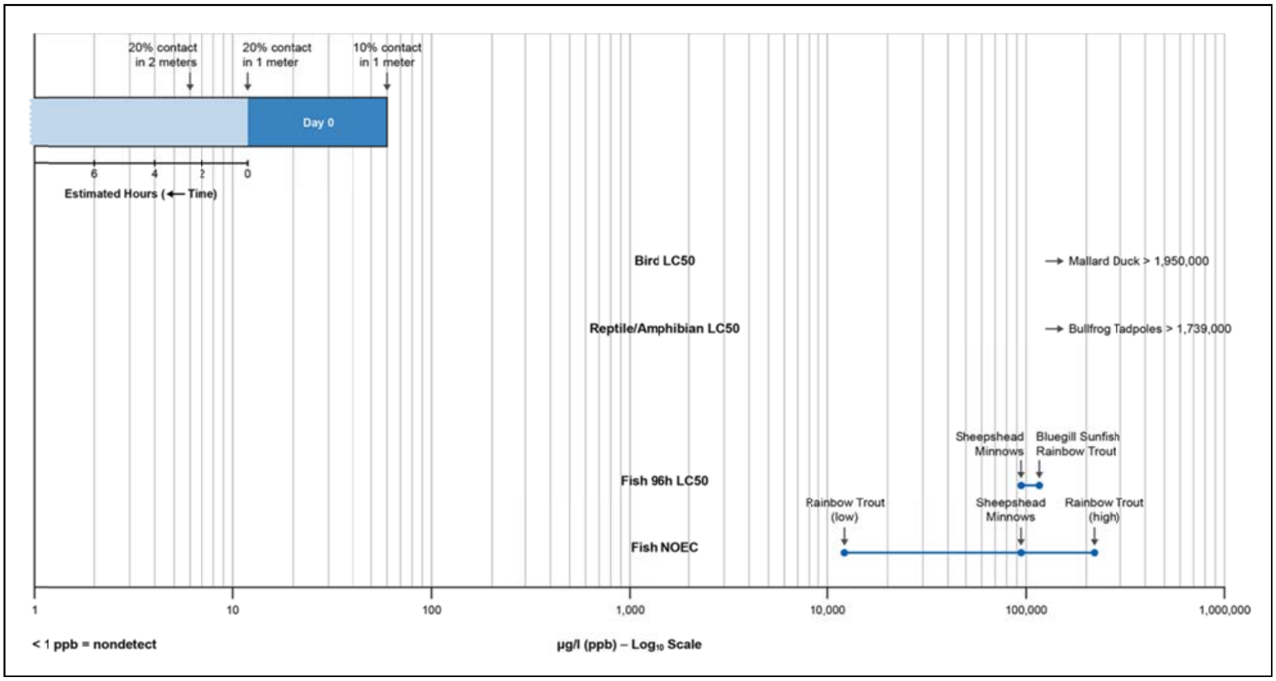
USEPA classified imazamox as practically non-toxic to fish. Supporting its low toxicity, imazamox was approved by USEPA as a “reduced risk” herbicide, and is the only synthetic herbicide granted a food residue tolerance exemption from USEPA (USFWS March 2012). The acute toxicity tests submitted to USEPA for the registration process found no observable effects at the highest concentrations of imazamox tested (approximately 100 ppm) (SERA 2010). There are relatively few toxicity studies evaluating the impact of imazamox on fish (or other) species; most cited studies were part of the USEPA pesticide registration process. Results of acute and chronic toxicity testing of imazamox in fish are provided in **Table 3-13,** below. No bioactive metabolites inducing toxicity greater than the parent compound were found in literature screening (Environ 2012).

Figure 3-10, on the next page, provides a visual representation of imazamox estimated EECs and LC50 and NOEC levels for bird, amphibian and fish species. One advantage of imazamox is the relatively low concentration required for treatment, as evidenced by the concentration in 1 meter of water at 100 percent contact of 59 ppb. This represents a highly conservative instantaneous maximum concentration. There is no NPDES limit or maximum monitoring trigger for imazamox. SCP will utilize spot treatments, spraying herbicide directly onto spongeplant. The 20 percent overspray concentration shown in Figure 3-10, at 11.9 ppb, is conservative. We assume that after approximately two hours, the herbicide will have mixed into 2 meters of water, with the concentration dropping to 5.9 ppb. Thus, at any treatment site, imazamox exposure following SCP treatments will be only a few hours. DBW will closely monitor imazamox levels, as there is no existing experience with imazamox use in the Delta.

Table 3-13
Response of Various Fish Species to Imazamox at LC50 Values

Species	Chemical	LC50	Time Period	Reference
Bluegill sunfish *(Lepomis macrochirus)*	Imazamox (technical)	>119 ppm NOEC = 119 ppm	96-hr	USEPA 2008
Rainbow *trout* *(Onchorhynchus mykiss)*	Imazamox (technical)	>122 ppm NOEC = 122 ppm	96-hr	USEPA 2008
Sheepshead minnow *(Cyprinodon variegates)*	Imazamox (technical)	>94.2 ppm NOEC = 94.2 ppm	96-hr	SERA 2010
Rainbow trout	Imazamox (technical)	>122 ppm (NOEC)	28-day	European Commission 2002
Rainbow trout	Imazamox (technical)	>11.8 ppm (NOEC)	96-day	European Commission 2002

Figure 3-10
Comparison of Exposure Concentrations and Bird, Reptile/Amphibian Surrogate and Fish Species Endpoint Effects for Imazamox (µg/l or ppb)



All of the bird, amphibian and fish toxicity endpoint concentrations are to the right of the EEC bar. Figure 3-10 illustrates that there is no overlap between SCP EECs and standard toxicity levels. For example, the mallard duck and bullfrog tadpole LC50 values are almost over five orders of magnitude above the 20 percent contact in one meter concentration, the estimated maximum imazamox concentration.

For fish species, Figure 3-10 provides three LC50 values. All three species had no effects at the highest levels tested, between 94,200 and 122,000 ppb. The highest levels tested are approximately four orders of magnitude above the estimated maximum imazamox concentration. There was one NOEC test, with no effect seen at three orders of magnitude above the estimated maximum imaxamox concentration.

Based on these analyses, we expect the direct effects of imazamox treatments on listed fish species, giant garter snake, or other listed species to be discountable. A recently completed assessment of the use of imazamox (Clearcast) to control Japanese eelgrass in Washington State also found no significant risks to fish (and aquatic invertebrates) (Environ 2012). The already low potential for toxicity effects of imazamox can be further minimized by treating spongeplant early in the growing season, thus reducing the amount of herbicide needed.

Toxicity of Diquat to Listed Fish Species

Diquat will only be utilized by SCP for emergency applications. Diquat will only be used from August 1st through November 30th of each year, and will be limited to a total of 50 treatment acres in the Delta per year (as a sum of the combined diquat acres treated in the EDCP and SCP). Emergency conditions are such that spongeplant growth completely impedes navigation of Delta waters, such as a completely blocked slough that would impair the movement of emergency response vessels.

In regards to USEPA toxicity classifications, diquat dibromide has a range of classifications for fish, depending on the species. For most species, diquat dibromide is classified as slightly toxic (LC50 values of >10 ppm to 100 ppm). However, species such as largemouth bass and walleye, are more sensitive, with LC50 values of <10 ppm. Test results for some species, such as bullhead and common carp, have LC50 values of over 100 ppm, in the practically non-toxic category (Washington DOE 2002).

As conditions of the early biological opinions, and in order to better understand the potential effects of the WHCP and EDCP on fish species in the Delta, DBW commissioned CDFW to conduct several studies of acute and chronic toxicity during the first few years of the program. Riley and Finlayson (2004a) examined the acute toxicity of diquat (as Reward) to larval delta smelt, larval fathead minnow, and larval Sacramento splittail. The 96-hour LC50 values for the larval form of these three species were 1.1 ppm, 0.43 ppm, and 3.7 ppm, respectively. Both larval fathead minnow LC50 values were close to the diquat dibromide application rate.

Chronic toxicity testing by Riley and Finlayson (2004b) utilized only larval fathead minnows, building on the previous study. The 7-day LC50 for fathead minnow was 0.40 ppm, and the 7-day MATC for larval fathead minnow was 0.37 ppm, the maximum application rate.

Washington DOE (2002) summarizes numerous fish species acute toxicity studies for diquat (as c.e.). In evaluating laboratory toxicity studies as compared to diquat exposure in the environment, it is important to consider that the actual diquat concentrations drop significantly after application, with a half-life of 0.75 days (Washington DOE 2002). Diquat is more toxic to some fish species and life stages, in particular sac-fry of several bass species, with LC50 values ranging from 0.54 ppm to 3.9 ppm. However, even these sensitive species are not adversely affected by field conditions following diquat treatments (Washington DOE 2002). Cold water species, including salmonids, are less sensitive to diquat in laboratory studies, with LC50 values in the 10 ppm to 30 ppm range.

Laboratory studies raise concerns about the effects of diquat on Coho salmon parr to smolt metamorphosis, with increased mortality when exposed to seawater as compared to controls at 5 ppm to 20 ppm diquat exposure (Washington DOE 2002). These exposures are two orders of magnitude higher than estimated maximum diquat concentrations in 1 meter of water following SCP treatment. However, lower concentrations (0.5 ppm diquat, still one order of magnitude greater) interfered with the ability of Coho salmon to migrate downstream. Timing diquat treatments to avoid periods when salmonids may be migrating through the Delta could reduce the potential for negative effects on migration. Dodson and Mayfield (1979, in Washington DOE 2002) found that diquat concentrations as low as 0.5 ppm decreased swimming speed in rainbow trout from 22.6 cm/second to 14.1 cm/second.

Tremblay (2003) conducted an in situ study of diquat exposure to the shortfin eel in the Avon River, New Zealand. Tremblay evaluated a number of biomarkers (liver mixed-function oxygenases, lysozyme activity, and plasma itellogenin) in eels exposed to diquat treatment of *Egeria densa* at a peak concentration of 3.51 ppm (decreasing after 1 hour to undetectable levels). Diquat had no significant effects on the physiological endpoints measured in eels caged downstream from a treatment area during a three-week exposure period (Tremblay 2003).

In a study of farmed catfish, Mitchell et al. (2010) found that short (10 minute) daily exposures of channel catfish eggs to 0.25 ppm diquat reduced fungus and increased hatch rates compared to controls (56 percent to 34 percent). The ten-minute per day exposure occurred during the entire incubation period.

There are relatively few studies on chronic toxicity of diquat to fish species, primarily because chronic exposure to diquat in the field is unlikely due to diquat binding to sediment. The only “well run” chronic toxicity test (28-days) for diquat was conducted on fathead minnow, and yielded a MATC of 0.2 ppm (Washington DOE 2002).

Table 3-14, on the next page, summarizes toxicity studies for diquat. This table focuses on studies conducted specifically for the WHCP and EDCP, plus studies of listed species or surrogates. There are dozens of other fish diquat toxicity LC50 studies in the literature, with a wide range of results, as noted above. However, the larval and *Oncorhynchus* spp. studies in Table 3-14 provide a good indication of toxicities relevant to SCP.

Table 3-14
Response of Various Fish Species to Diquat at LC50 Values

Species	LC50	Time Period	Reference
Larval delta smelt *(Hypomesus transpacificus)*	1.1 ppm	96-hour	Riley and Finlayson 2004a
Larval fathead minnow *(Pimephales promelas)*	0.43 ppm	96-hour	Riley and Finlayson 2004a
Larval Sacramento splittail *(Pogonichthys macrolepidotus)*	3.7 ppm	96-hour	Riley and Finlayson 2004a
Larval fathead minnow *(Pimephales promelas)*	0.40 ppm	7-day	Riley and Finlayson 2004b
Larval fathead minnow *(Pimephales promelas)*	0.37 ppm	7-day	Riley and Finlayson 2004b
Walleye *(Stizostedion vitreum)*	0.75 ppm	96-hr	Paul et al. 2004 in USEPA 2010
Coho salmon (fingerling) *(Oncorhynchus kisutch)*	20.5 ppm	96-hour	Washington DOE 2002
Coho salmon (yearling) *(Oncorhynchus kisutch)*	30 ppm	96-hour	Washington DOE 2002
Rainbow trout (fingerling) *(Oncorhynchus mykiss)*	9.46 ppm	96-hour	Washington DOE 2002
Rainbow trout (fingerling) *(Oncorhynchus mykiss)*	15 ppm	96-hour	Washington DOE 2002
Rainbow trout (fingerling) *(Oncorhynchus mykiss)*	37.8 ppm	48-hour	Washington DOE 2002
Chinook salmon (58 to 96 mm length) *(Oncorhynchus tshawytscha)*	16 ppm	48-hour	Washington DOE 2002
Fathead minnow (fingerling) *(Pimephales promelas)*	7.6 ppm	96-hour	Washington DOE 2002
Fathead minnow (47 mm length) *(Pimephales promelas)*	70 ppm	96-hour	Washington DOE 2002
Fathead minnow (eggs to fry) *(Pimephales promelas)*	0.2 ppm MATC	34-days Endpoint – weight reduction	Washington DOE 2002
Eastern brook trout (eggs to sac-fry) *(Salvelinis fontanalis)*	3.8 ppm MATC	Length not reported Endpoint = abnormal sac-fry	Washington DOE 2002

USEPA conducted a risk assessment of diquat dibromide use to delta smelt in 2010 (USEPA 2010). The assessment utilized RQ and LOC values, which are no longer recommended. Using RQ values combined with a weight-of-evidence approach, the risk assessment concluded that for diquat use applied directly to water, there is a potential for direct effects to delta smelt.

Figure 3-11, on the next page, provides a visual representation of diquat dibromide estimated EECs and LC50 and NOEC levels for bird, reptile/amphibian surrogates and fish species. The NPDES limit for diquat is 20 ppb. SCP will utilize spot treatments, spraying herbicide directly onto spongeplant. The 20 percent overspray concentration shown in Figure 3-11, at 44.8 ppb, is conservative. We assume that within a few hours, the herbicide will have mixed into 2 meters of water, with the concentration dropping to a maximum of 22.4 ppb. Because diquat binds readily to sediment, actual concentrations in the turbid Delta are likely to rapidly drop to levels below 22.4 ppb. Thus, at any treatment site, diquat exposure following SCP treatments will be only a few hours. DBW will closely monitor diquat levels, as there is no recent experience with diquat use in the Delta.

All of the bird, reptile/amphibian surrogates and fish toxicity endpoint concentrations are at, or to the right of, the EEC bar. Figure 3-11 illustrates that there is no overlap between SCP EECs and standard toxicity levels. For example, the Japanese quail LC50 value is over three orders of magnitude above the 20 percent contact in one meter concentration, the estimated maximum diquat concentration.

For fish species, Figure 3-11 provides a range of LC50 values. The lowest LC50 value is an order of magnitude above the estimated maximum diquat concentration. The highest LC50 value is more than three orders of magnitude above the estimated maximum diquat concentration. The lowest fish NOEC level, for fathead minnow, is more than four times higher than the estimated maximum diquat concentration.

Based on these analyses, we expect the direct effects of diquat treatments on listed fish species, giant garter snake, or other listed species to be discountable. The already low potential for toxicity effects of diquat can be further minimized by limiting total diquat acres treated, and utilizing diquat in emergency situations only.

Figure 3-11
Comparison of Exposure Concentrations and Bird, Reptile/Amphibian Surrogate and Fish Species Endpoint Effects for Diquat (µg/L or ppb)

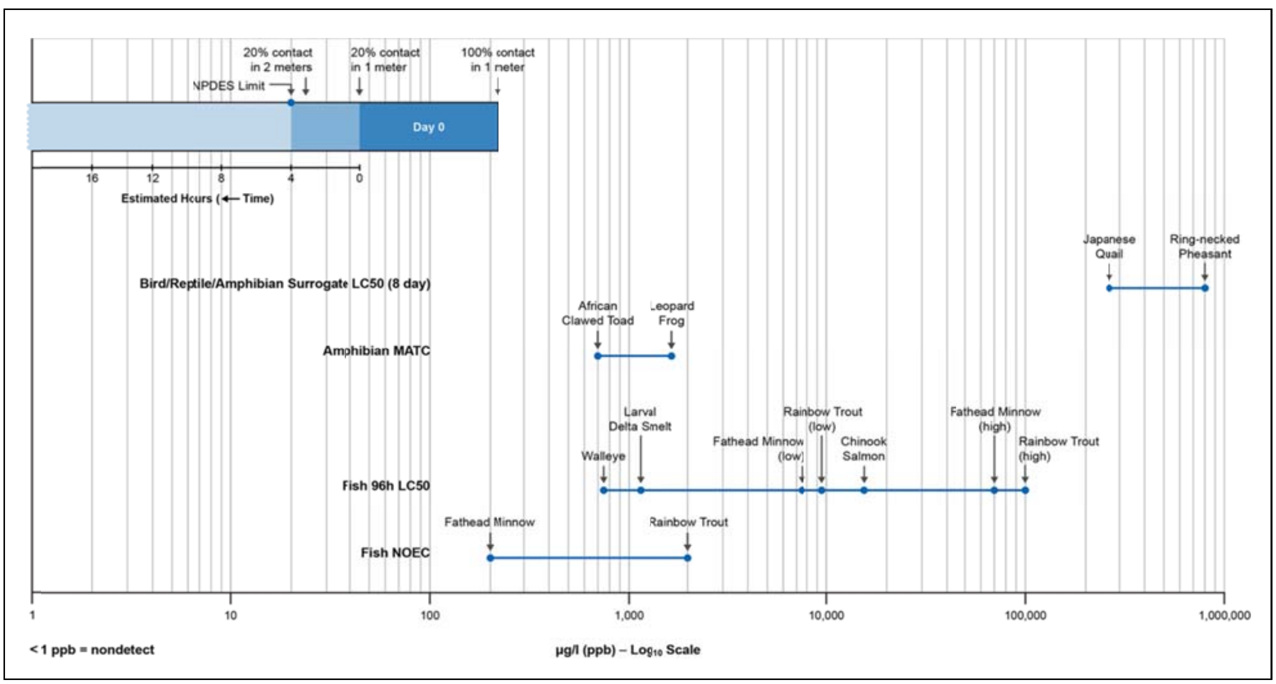


Table 3-15
Response of Rainbow Trout to Adjuvants at LC50 Levels

Species	Chemical	LC50	Time Period	Reference
Rainbow trout	Agridex	>1,000 ppm	96-hr	WSDA 2005
Rainbow trout	Competitor	95 ppm	96-hr	WSDA 2005

Toxicity of Agridex and Competitor to Listed Species

There has been relatively little research on the toxic effects of adjuvants. Nonylphenol ethoxylate (NPE) surfactants are more toxic to aquatic species than most aquatic pesticides, and may also cause endocrine disruption. As a result, DBW does not utilized NPE adjuvants such as R-11. The non-ionic adjuvant Agridex, which replaced R-11, has significantly lower toxicity, with LC50 levels greater than 1,000 mg/l (ppm). For 472 RQ values calculated for Agridex in 2004 and 2005, SFEI also found no LOC exceedances. The vegetable oil-based adjuvant Competitor has an LC50 of 95 ppm, five orders of magnitude above the expected concentration of Competitor in 1 meter deep water, assuming 20 percent overspray. **Table 3-15,** above, summarizes two toxicity studies for SCP adjuvants. The LC50 for Agridex is four orders of magnitude above the maximum expected concentration in 1 meter of water with 20 percent overspray. The LC50 for Competitor is three orders of magnitude above the maximum expected concentration in 1 meter of water with 20 percent overspray.

Toxicity of SCP Herbicides to Reptiles and Amphibians

Birds, reptiles, or amphibians could be adversely affected by exposure to herbicide-treated water, or by exposure to herbicide spray drift. While these exposure mechanisms are highly unlikely, there is potential for such exposure to occur.

As compared to fish, there is significantly less information related to the toxic effects of SCP herbicides and adjuvants to birds, amphibians and reptiles. However, the limited information that is available indicates that toxic impacts to birds, amphibians and reptiles resulting from SCP are highly unlikely. Figures 3-7 through 3-11 include bird, reptile, amphibian, or surrogate toxicity data and illustrate the order of magnitude differences between LC50 values and EECs.

Amphibians are thought to be more sensitive to chemical exposure than reptiles, because of their thinner skin and the fact that they inhabit both water and land. As a result, amphibian toxicity studies are often used to infer toxicity effects on reptiles, when specific reptile studies are not available. In addition, bird toxicity studies represent surrogates for terrestrial phase amphibians and reptiles, and fish may be surrogates for aquatic phase amphibians (USEPA January 2007).

Because of the scarcity of reptile studies, one of the conditions of WHCP's initial USFWS Biological Opinion was to conduct snake toxicity testing of WHCP herbicides. These results are applicable to the SCP. DBW provided funding to the CDFW to conduct acute oral and dermal toxicity studies on garter snakes (Hosea et al. 2004). CDFW utilized two surrogate species of garter snakes, common garter snake, *Thamnophis sirtalis*, and western terrestrial garter snake, *Thamnophis elegans*. These garter snake species are closely related to the threatened giant garter snake, *Thamnophis gigas*.

Snakes were exposed both orally and dermally to a solution of herbicide, herbicide-surfactant, or control (distilled water). The surfactant studied was R-11®, which has since been removed from DBW's aquatic weed programs due to its relative high toxicity to aquatic species. Both herbicides and surfactant were at concentrations equivalent to the mixing tanks (i.e. the concentration from the spray nozzle).

Table 3-16
Concentrations of Test Solutions and Calculated Exposure Ranges for Herbicides, Surfactants, and Mixtures from CDFW Garter Snake Acute Toxicity Study

Herbicide and/or Surfactant	Concentrations of Test Solutions (mg/l or ppm)	Experimental Oral Exposure Range (mg/kg)	Experimental Dermal Exposure Range (mg/kg)
2,4-D (Weedar 64)	3,000	28.791 to 32.895	28.791 to 32.895
Glyphosate (Rodeo)	3,900	37.055 to 39.494	37.055 to 39.494
Nonylphenol ethoxylates (NPE)(R-11)	2,360	22.056 to 30.256	22.056 to 30.256
2,4-D (Weedar 64) and NPE (R-11)	2,800	24.207 to 30.769	24.207 to 30.769
	1,160	10.029 to 12.747	10.029 to 12.747
Glyphosate (Rodeo) and NPE (R-11)	3,620	32.321 to 39.635	32.321 to 39.635
	2,200	19.643 to 24.088	19.643 to 24.088
Diquat (Reward)	0.66 mg/L	0.006 to 0.007	0.006 to 0.007

Table 3-16, above, provides the concentrations of test solutions and actual exposure range (in mg/kg body weight). CDFW observed the snakes for seven days following treatment. There were no acute lethal or sublethal effects. Snakes did not exhibit significant alterations in behavior following treatment, and did not develop skin lesions or other physical abnormalities. There was no significant difference in post exposure weight change between test groups. CDFW reported that “if snakes were inadvertently sprayed directly or were to consume any of the undiluted spray solution, there should be no acute toxicity” (Hosea et al. 2004).

Table 3-17, on the next page, summarizes toxicity studies of birds, reptiles, and amphibians to SCP herbicides. Studies of 2,4-D acute toxicity to three frog species, tusked frog, brown striped marsh frog, and western chorus frog, found 96 hour LC50 values from 100 ppm to 340 ppm (ECOTOX 2001). Another study found no effects on tadpoles in up to 50 ppm 2,4-D for 48 hours, and no effects on frog abundance as a result of partial treatment of Long Pond, New York, with granular 2,4-D (Halter 1980).

The active ingredient of Weedar 64, 2,4-D, is practically non-toxic to birds. Studies of several bird species have found lethal dietary concentrations (LD50) values of over 5,000 ppm, and oral dose LD50 values of over 272 mg/kg of body weight. Thus, toxic impacts to bird species are highly unlikely. These concentrations are significantly higher than potential exposures to 2,4-D from the SCP, either indirectly through contaminated food, or directly through spray from herbicide drift or contact with water.

Much of the amphibian toxicity data in the literature for glyphosate was based on the herbicide Roundup, and is not relevant for the SCP. Roundup is not approved for aquatic use because it includes a surfactant, polyethoxylated tallowamine (POEA), which is highly toxic to aquatic species. Because Roundup includes this surfactant, the herbicide is toxic to aquatic species, including amphibians (and not approved for aquatic use). There were some studies in the literature, discussed below, that utilized technical grade glyphosate or Rodeo (approved for aquatic use). Rodeo was previously utilized by the DBW, and is essentially the same formulation as Roundup Custom, the current SCP glyphosate herbicide.

Howe et al., (2004) examined the toxicity of four North American frog species to several glyphosate formulations (most with surfactant), as well as technical glyphosate. They found no significant acute toxicity with technical grade glyphosate. Edginton et al., (2004) conducted amphibian toxicity testing and compared two different study designs using African clawed frog (*Xenopus laevis*) and several glyphosate herbicides. Rodeo was the least toxic of the herbicide formulations tested, with LC levels dependent on pH. At pH 6.5, the *Xenopus* 96-hour LC10 (lethal concentration for 10 percent) ranged from 1,722 ppm to 3,024 ppm, and the LC50 ranged from 4,341 ppm to 6,419 ppm. Toxicity was greater at pH 8, but still far below SCP exposure levels. The 96-hour LC10 at pH 8 was 240 ppm to 395 ppm, and the LC50 was 604 ppm to 645 ppm (Edginton et al. 2004).

Table 3-17
Toxicity of Birds, Reptiles, and Amphibians to SCP Herbicides

Species	Chemical	LC50	Time Period	Reference
Northern bobwhite	2,4-D dimethylamine salt (DMA)	500 mg/kg dietary	14 days	Hammond 1996, USEPA 2000
Northern bobwhite	2,4-D DMA	>5,620 ppm	8-day dietary	Hammond 1996, USEPA 2000
Bobwhite quail	2,4-D DMA	>5,000 ppm	8-day dietary	ECOTOX 2001
Japanese quail	2,4-D DMA	>5,000 ppm	8-day dietary	ECOTOX 2001
Quails and pigeons	2,4-D DMA	668 mg/kg	Dietary	EXTONET 1996
Mallard duck	2,4-D DMA	>5,000 ppm	8-day dietary	ECOTOX 2001
Mallard duck	2,4-D DMA	>5,620 ppm	8-day dietary	Hammond 1996, USEPA 2000
Mallard duck	2,4-D DMA	1,000 mg/kg	dietary	EXTONET 1996
Pheasant	2,4-D DMA	272 mg/kg	Dietary	EXTONET 1996
Ring-necked pheasant	2,4-D DMA	>5,000 ppm	8-day dietary	HSDB 2001
Three frog species	2,4-D	100 ppm to 340 ppm	96-hr	ECOTOX 2001
Bobwhite quail	Glyphosate	>4,500 ppm	Dietary	ECOTOX 2001
Mallard duck	Glyphosate	>4,500 ppm	Dietary	ECOTOX 2001
Mallard duck	Glyphosate	178 lb/acre	1 time dose, 18 day study period	ECOTOX 2001
Mallard duck	Glyphosate	>33 lb/acre	1 time dose, 18 day study period	ECOTOX 2001
Broiler chickens	Glyphosate	60.8 ppm to 608 ppm	NOEL, diet for 21 days	HSDB 2001
Broiler chickens	Glyphosate	6,080 ppm	Not lethal, 50% decrease in body weight	HSDB 2001
African clawed frog *(Xenopus laevis)*	Glyphosate formulations	604 ppm	96-hr	Edington et al. 2004
Mallard duck *(anas platyrhynchos)*	Penoxsulam (technical)	>1,900 ppm	14-day	USEPA September 2007
Mallard duck	Imazamox (technical)	>1,950 ppm	96-hr	USEPA 2008
Japanese quail	Diquat dibromide	264 ppm	8-day	Washington DOE 2002
Ring-necked pheasant	Diquat dibromide	734 ppm	8-day	Washington DOE 2002
Bobwhite quail	Diquat dibromide	575 ppm	8-day	Washington DOE 2002
Leopard frog *(Rana pipiens)*	Diquat dibromide	1.7 ppm (MATC)	14-day	Washington DOE 2002
African clawed toad *(Xenopus laevis)*	Diquat dibromide	0.64 ppm (MATC)	14-day	Washington DOE 2002

Perkins et al., (2000) examined the effect of various glyphosate herbicides, including Rodeo, on the (*Xenopus laevis*), using the Frog Embryo Teratogenesis Assay – *Xenopus* (FETAX). Rodeo was found to be the least toxic, with a LC5 (lethal concentration for 5 percent) of 3,799 mg/l (ppm) and a LC50 of 5,407 mg/l. Roundup was 700 times more toxic than Rodeo, due to the surfactant POEA.

Sparling et al., (2006) examined the toxicity of a glyphosate herbicide (Glypro) and the acid/ buffer adjuvant LI700 on turtle embryos and early hatchlings. They exposed eggs of red eared sliders (*Trachemys scripta elegens*) to between 0 to 11,206 ppm herbicide and between 0 and 678 ppm adjuvant. There were dose related impacts on hatching success, hatchling weight, and somatic indices, primarily at the highest levels. The study concluded that "because of the high concentrations needed to produce effects… glyphosate with LI700 poses low levels of risk to red-eared slider embryos under normal field operations with regards to endpoints measured in the present study" (Sparling et al. 2006).

Glyphosate is practically nontoxic to birds. Toxicity studies for glyphosate are also summarized in Table 3-17. Dietary LD50 values for glyphosate are over 4,500 ppm glyphosate in the diet. The concentrations are significantly higher than potential exposures to glyphosate from the SCP, either indirectly through contaminated food sources or directly through spray from herbicide drift or contact with water. Thus, toxic impacts to bird species from glyphosate are highly unlikely.

Oliveira et al., (2006) examined the effects of Roundup® (glyphosate plus a POEA surfactant) on androgen and estrogen synthesis in mallard ducks (*Anas platyrhynchos*). Their study found effects were mostly dose dependent, "indicating that this herbicide may cause disorder in the morphophysiology of the male genital system of animals" (Oliveira et al. 2006). However, the LOEL and NOEL levels for tissue and enzyme impacts in their study were for 15 days exposure to between 5 mg/kg body weight and 100 mg/kg body weight (ECOTOX 2008), far higher than any potential SCP exposures. In addition, it is not clear whether impacts resulted from glyphosate or POEA exposure.

There is no amphibian or reptile toxicity testing data for penoxsulam. USEPA utilizes bird and fish toxicity testing to evaluate the terrestrial and aquatic impacts to amphibian and reptile species. Penoxsulam is practically non-toxic to fish and bird species. Testing for toxicity of penoxsulam in birds during a 14-day test period did not result in an LC50 calculation at the highest concentration tested of 1,900 ppm (USEPA January 2007).

There is no amphibian or reptile toxicity testing data for imazamox. USEPA utilizes bird and fish toxicity testing to evaluate the terrestrial and aquatic impacts to amphibian and reptile species. Imazamox is practically non-toxic to fish and bird species. Like the toxicity testing for fish, there were no concentrations of imazamox tested in birds that resulted in any signs of toxicity (SERA 2010).

There are no acute toxicity studies of diquat dibromide in reptiles or amphibians. Chronic (14-day) toxicity studies of diquat in early life-state amphibians found NOEC, MATC, and LOEC values of 1.08 ppm, 1.7 ppm, and 2.7 ppm of cation equivalent, respectively, for the leopard frog. Similar studies in the African clawed frog found NOEC, MATC, and LOEC values of 0.54 ppm, 0.64 ppm, and 0.68 ppm (Washington DOE 2002). Diquat dibromide cation toxicity testing in several bird species found 8-day dietary LC50 values ranging from 264 ppm to 734 ppm (Washington DOE 2002).

There are no known toxic effects of adjuvants on birds at the exposures proposed in the WHCP. The potential for special status or other birds to be exposed to SCP herbicides are minimal.

Figures 3-7 to 3-11 include toxicity endpoints for birds, reptiles, amphibians or surrogates, illustrating that direct toxic effects are discountable. There may be temporary indirect effects to birds, amphibians and reptiles as a result of herbicide treatment due to the overspray of herbicide on non-target plant species. These effects are likely to be insignificant, and can be mitigated with procedures described below.

SCP activities in any given treatment area are likely to be relatively brief (one to two days). While birds appear to tolerate a relatively high degree of human activity adjacent to their nests (DBW 2001), they are unlikely to place themselves immediately in treatment zones at the time of spraying.

A study in Florida found that bird species that forage in water hyacinth most often obtained prey that were located near the perimeter of the mats, and rarely hunted in the interior of the mats (Bartodziej and Weymouth 1995). Waterfowl tend to prefer native aquatic species for foraging, and in fact may avoid monospecific species. In an evaluation of waterfowl preferences, over 73 percent of the almost 4,000 bird observations occurred in native vegetation (Dick et al., 2004). The survey took place over a six-month period, and compared bird preferences in mixed native vegetation, hydrilla, and watermilfoil. We might expect birds to display similar patterns with spongeplant, as compared to water hyacinth.

* * * * *

It is extremely unlikely that there would be acute toxic impacts from SCP herbicide or adjuvants to special status fish, amphibians, reptiles, or birds, or that SCP herbicides would result in toxic effects that would impact native resident or migratory fish species. In addition, given the low levels of herbicides utilized, and the limited treatment acreage, the potential for sublethal toxic impacts to special status fish, amphibians, reptiles, or birds, or native resident and migratory fish is likewise low. However, should such sublethal toxic impacts result, they would constitute an **unavoidable or potentially unavoidable significant impact.** These impacts would potentially be reduced by implementing the following seven mitigation measures.

- **Mitigation Measure 1** – Avoid herbicide application near special status species, and sensitive riparian and wetland habitat; and other biologically important resources.

  Each year, prior to start of the treatment season, DBW will conduct field crew environmental awareness training. Under this training, crews will be informed about the presence and life histories of special status species; habitats associated with species; sensitive habitats and wetlands; the terms and conditions of the program's biological opinion and/or letter of concurrence; environmental survey procedures; incidental take procedures; and that unlawful take of an animal or destruction of its habitat is a violation of the Endangered Species Act.

  DBW will provide crews with a field guide (Species Identification Deck) for easy identification of special status species on-site. Prior to treating a site, crews will conduct a visual survey to determine whether special status plants, animals, or sensitive habitats are present. Crews will complete an Environmental Observations Checklist, following an established protocol, for each site to document the presence or absence of listed or special status species. If listed or special status species or sensitive habits are present at the site, the field crew will not perform treatments that could potentially affect the species or habitat.

  DBW Environmental Scientists will classify treatment sites as high, medium, or low potential for nesting birds. DBW also will examine CNDDB records to determine if special status bird species have been sited within SCP treatment locations, and prepare a map for field crews identifying such sites. For those treatment sites that have habitat characteristics that might support special status bird species, Environmental Scientists will survey the specific site. DBW will delay treatments at locations where nesting Swainson's hawks are present until after June 10th, the start of the post-fledging stage.

  At all treatment locations, crews will conduct a visual survey, following an established protocol, to determine whether special status plants, animals, or sensitive habitats are present, including bird nesting sites. Crews will complete an Environmental Observations Checklist for each site to document the presence or absence of bird nesting sites. If nesting yellow-headed blackbird, Swainson's hawk, or tricolored blackbird are known to be present at the site, the field crew will not perform any treatment within 200 yards of the nesting site until the post-fledging stage.

- **Mitigation Measure 3** – Conduct herbicide treatments in order to minimize potential for drift.

  In addition to complying with the label application requirements, DBW will, to the degree possible, schedule herbicide applications to occur at high tide, or at a point in the tidal cycle determined by the field supervisor to provide the least non-target impact at a particular site. In general, treatment at high tide will allow for better spray accuracy and access, and will provide for greater dilution volume of herbicides. DBW crews will change nozzle type and spray pressures whenever conditions warrant, limiting the amount of herbicide which may inadvertently contact non-target species or enter the water.

- **Mitigation Measure 4** – Conduct herbicide treatments using diquat only in emergency situations and for no more than 50 acres in total among DBW aquatic weed control programs.

  To minimize the potential for negative impacts to covered species from exposure to diquat dibromide, DBW will only utilize diquat in emergency situations. Diquat will only be utilized from August 1st through November 30th of each year, and will be limited to a total of 50 treatment acres in the Delta per year, as a sum of the combined diquat acres treated in the SCP and EDCP. Emergency conditions are such that spongeplant growth completely impedes navigation of Delta waters, such as a completely blocked slough that would impair the movement of emergency response vessels. DBW will consult with USFWS and NMFS prior to utilizing diquat to help ensure that covered fish species are not likely to be present at the time of treatment.

- **Mitigation Measure 6** – Implement temporal and spatial limitations and restrictions on herbicide treatments to minimize treatments during times, and at locations, where larval and/or migratory fish are likely to be present.

  The SCP will seek to adjust the timing of treatments to avoid periods when juvenile steelhead and salmon, delta smelt, or longfin smelt may be present. The SCP will base treatment dates, in part, on fish survey monitoring data showing that listed fish species are not likely to be present at a particular treatment site. DBW will review fish survey data between March 1st and July 1st to determine whether listed fish species are likely to be present, following the procedures below:

  For USFWS Areas 2, 3, and 4 (see Exhibit 2-1):

  - DBW's Environmental Scientist will obtain the potential treatment site list (based on field surveys of re-growing spongeplant and prioritization process) from Field Supervisor. Each week, the Environmental Scientist will check the following State and federal fish survey data to determine whether listed fish species are likely to be near, or in, any of the potential treatment sites. The Environmental Scientist will compare the list of potential treatment sites and the locations of listed fish species and determine which, if any, potential sites should not be treated that week. Between March 1st and July 1st, the Environmental Scientist will prepare a weekly summary list for USFWS, NMFS, and CDFW that identifies treatment sites where listed fish species are not likely to be present.
    - ✓ USFWS "DatCall" data (juvenile fish monitoring program through the Interagency Ecology Program (IEP))
    - ✓ California Department of Fish and Wildlife (CDFW) surveys and studies
    - ✓ Department of Water Resources (DWR) and United States Bureau of Reclamation (USBR) fish salvage data
    - ✓ FishBio San Joaquin Basin Update reports
    - ✓ CDFW Knights Landing Rotary Screw Trap data

  For USFWS Area 1 (see Exhibit 2-1), DBW will implement this same fish survey procedure during the month of June. To further minimize potential to impact delta smelt, SCP will not begin treatments in treatment sites likely to be used as spawning and rearing habitat for delta smelt until after June 1st. DBW will not conduct herbicide treatments in USFWS Area 1, covering much of the northern and central Delta, until after June 1st.

These treatment time restrictions minimize potential exposure of migratory salmonids and sensitive juvenile fish to SCP herbicides. **Figure 3-12,** on the next page, illustrates spawning and migration times for several special status fish, in relation to SCP treatment times.

Figure 3-12
Proposed Period of SCP Treatments; Periods of Peak Spawning in the Delta; and Migration and Emigration of Special Status Fish Species through the Sacramento-San Joaquin River System

<table>
<tr><th>Jan.</th><th>Feb.</th><th>Mar.</th><th>Apr.</th><th>May</th><th>June</th><th>July</th><th>Aug.</th><th>Sep.</th><th>Oct.</th><th>Nov.</th><th>Dec.</th></tr>
<tr><td></td><td></td><td colspan="4">SCP treatment at selected sites</td><td colspan="3">SCP peak treatment period</td><td colspan="2"></td><td></td></tr>
<tr><td></td><td></td><td colspan="5">Delta smelt spawning</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Longfin smelt spawning</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="6">Adult winter-run Chinook salmon migration</td><td></td><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td colspan="5">Juvenile winter-run Chinook salmon emigration</td><td></td><td></td><td></td><td colspan="4"></td></tr>
<tr><td></td><td></td><td colspan="5">Adult spring-run Chinook salmon migration</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="5">Juvenile spring-run Chinook salmon emigration</td><td></td><td></td><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td colspan="5">Central Valley steelhead migration</td><td></td><td></td><td colspan="5"></td></tr>
<tr><td colspan="12">Green sturgeon juveniles and spawning adult migration/emigration</td></tr>
</table>

- **Mitigation Measure 7** – Monitor herbicide and adjuvant levels to ensure that the SCP does not result in potentially toxic concentrations of chemicals in Delta waters.

  DBW will conduct comprehensive monitoring. This monitoring is in compliance with the general NPDES permit, and NMFS and USFWS Biological Opinions and/or Letters of Concurrence. DBW will collect samples prior to treatment, immediately after treatment, and post-treatment within one week of spraying. DBW will conduct water quality monitoring for visual parameters, physical parameters, and chemical parameters at one site per water body type for glyphosate and six sites per water body type for all other herbicides. Water samples will be submitted to a certified analytical laboratory to measure 2,4-D, glyphosate, penoxsulam, imazamox, diquat, and adjuvant levels. Should these levels exceed allowable limits, DBW will take immediate measures to reduce chemical levels at future treatment sites.

- **Mitigation Measure 8** – Implement an adaptive management approach to minimize the use of herbicides.

  Under an adaptive management approach, DBW will seek to improve efficacy and reduce environmental impacts over time as new and better information is available. Specifically, DBW will evaluate the need for control measures on a site by site, month-to-month, basis; select appropriate indicators for pre-treatment monitoring; monitor indicators following treatment and evaluate data to determine program efficacy and environmental impacts; support ongoing research to explore impacts of the SCP and alternative control methodologies; report findings to regulatory agencies; and adjust program actions, as necessary, in response to recommendations and evaluations by DBW staff, regulatory agencies and stakeholders.

  In addition to this adaptive management approach, DBW will follow maintenance control practices that from a program standpoint seek to reduce the number of acres of spongeplant to be treated each year, until treatment acreage reaches a minimal level. This will reduce the volume of herbicide utilized by the SCP.

- **Mitigation Measure 9** – Provide treatment crews with electronic mapping that identifies previously surveyed areas for giant garter snake habitat, valley elderberry shrub locations (see hard copy example in Exhibit 3-3), and nesting special status birds.

  Application crews will use these maps as tools for performing pre-application visual inspections for the presence of giant garter snakes, valley elderberry longhorn beetle, or nesting special status birds. If giant garter snakes are present, treatment crews will not treat at that location. If valley elderberry shrubs are within 100 feet of the potential spray area (or 50 feet with low wind conditions), crews will not treat at that location. If nesting special status birds are present, treatment crews will not perform any treatment within 200 yards of the nesting site until the post-fledging stage.

Impact B3 – Herbicide bioaccumulation: effects of herbicide bioaccumulation on special status species

The SCP is not likely to result in direct 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 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.

2,4-D

According to most sources, 2,4-D does not bioaccumulate in plants, and there is no evidence that 2,4-D accumulates to a significant level in mammals or other organisms (EXTONET 1996). The half-life of 2,4-D in living organisms is between 10 and 20 hours, and most 2,4-D is excreted in the urine (EXTONET 1996; NPTN 2008). The National Library of Medicine Hazardous Substance Data Bank states that 2,4-D is metabolized in fish and that bioconcentration is not expected to be appreciable (HSDB 2001). In a study exposing channel catfish and bluegill to 2 ppm 2,4-D by intraperitoneal injection, the fish excreted 90 percent of the herbicide within six hours (HSDB 2001). The researchers concluded there was no evidence for bioaccumulation in channel catfish and bluegills (Sikka et al. 1977).

Wang et al. (2004) evaluated bioaccumulation factors of 2,4-D, exposing carp and Nile tilapia to 0.5ppm 2,4-D. The 2,4-D bioaccumulation factor in carp dropped from 45 percent after seven days to 22 percent after 14 days. For Nile tilapia, the bioaccumulation factor dropped from 33 percent after five days to 17 percent after 14 days. This study indicates that 2,4-D does not bioaccumulate in fish.

Tu et al., (2001) reported on studies in Russia that found residues of 2,4-D in eggs, milk, and meat, however the type of 2,4-D was not reported. Tu et al., (2001) also reported on an Oregon study that found that 2,4-D risk to browsing wildlife is low. In aquatic species, the highest concentrations of 2,4-D were typically reached shortly after application, and dissipated within three weeks following exposure (Tu et al. 2001). After animals were removed from contaminated waters, they tended to excrete 2,4-D residues.

There is some evidence that fish take up 2,4-D, but seemingly at low levels that do not adversely affect fish or other species ingesting them. Folmar (1980) found fish present within a spray plot take up enough 2,4-D, or breakdown enough phenols, to impart an objectionable taste for the flesh for several days after spraying. Water column concentrations of 500 ppb imparted an "inferior" taste, while 100 ppb imparted an "acceptable" taste. These levels are significantly higher than those found even immediately after WHCP treatments, which would be similar to levels found after spongeplant treatments.

Glyphosate

Glyphosate has virtually no tendency to bioconcentrate (Siepmann 1995). Glyphosate is poorly absorbed from the digestive tract, and is largely excreted unchanged by mammals. It has no significant potential to accumulate in animal tissue, and a very low potential for glyphosate to build up in the tissues of aquatic invertebrates or other aquatic organisms (EXTONET 1996). Glyphosate is also not expected to bioaccumulate in plants (County of Lake 2005). Carp exposed to 0.05 ppm glyphosate had a bioaccumulation factor (concentration in fish/concentration in water) of 42 percent after seven days, decreasing to 25 percent after 14 days (Wang et al. 2004). The same 0.05 ppm exposure in Nile tilapia resulted in a 65 percent bioaccumulation factor after five days, decreasing to 13 percent after 14 days (Wang et al. 2004), indicating that glyphosate does not bioaccumulate in fish.

In a glyphosate product fact sheet, Monsanto (2002) states that "in laboratory studies conducted with glyphosate, bioconcentration factors were less than 1.0, indicating that glyphosate does not accumulate in fish. The low bioaccumulation factor is a result of glyphosate being readily soluble in water, and therefore subject to rapid elimination from organisms in water. Other animal species studied including marine mollusks and crustaceans, also showed low potential for bioaccumulation."

Penoxsulam

USEPA considers penoxsulam to have low potential to bioaccumulate in aquatic organisms (USEPA January 2007). A European risk assessment also determined a low bioaccumulation potential for penoxsulam in birds and mammals (Washington DOE 2012). The bioconcentration factor (BCF) of penoxsulam in crayfish after 14 days exposure was 0.02 ml/g (values less than 100 are considered low) (USEPA January 2007; FOOTPRINT PPDB 2009).

Imazamox

The potential for bioconcentration of imazamox is low (HSDB Database 2012). Imazamox did not significantly bioaccumulate in bluegill sunfish, and concentrations of imazamox in whole fish and edible tissue were less than the minimum detectable limit (USEPA 2008).

Diquat Dibromide

Diquat dibromide does not bioaccumulate in fish and aquatic invertebrate species (Washington DOE 2002). Those species that do adsorb diquat rapidly eliminated more than 50 percent of the herbicide within a few days, with the possible exception of bivalves, which may continue to release diquat for more than 28 days (Washington DOE 2002). The highest bioconcentration factor found in invertebrates was approximately 32, well below levels considered high. Bioconcentration factors in several fish species were less than one (Washington DOE 2002).

Diquat does adsorb in plants, with concentrations of over 1,000 ppm found in macrophytes and algae following treatment at less than one ppm diquat (Washington DOE 2002). Plants are an important removal pathway of diquat from water, and research suggests that diquat is adsorbed to the surfaces of plants by an ion exchange mechanism (Washington DOE 2002). Bacteria associated with the surface of dead and dying plants degrade about 32 percent of the plant-bound diquat, with the remainder rapidly binding to sediment, where it becomes biologically inactive.

Adjuvants

There is limited information on bioaccumulation of adjuvants. The Material Safety Data Sheet (MSDS) for Agridex states that bioaccumulation of the adjuvant is unlikely due to the low water solubility of the product (Bayer Crop Science 2004). The MSDS for the vegetable oil-based adjuvant Competitor indicates no chronic toxicity for the adjuvant (Wilbur-Ellis 2010). The primary ingredient in Competitor, ethyl oleate, is approved by the Food and Drug Administration as a regulated food additive (Bakke 2007).

Based on existing evidence, SCP herbicides and adjuvants are not likely to result in adverse effects on biological resources due to bioaccumulation of herbicide. **The impact of bioaccumulation on special status species is expected to be less-than-significant.** No mitigation measures are required.

Impact B4 – Food web effects: effect of treatment on food webs, and resulting impact on special status species, sensitive habitats, and migration of species

Special status fish species, or native resident or migratory fish, could be indirectly impacted if the SCP decreases the abundance of invertebrates, such as zooplankton, upon which these fish feed. While there is potential for toxic impacts to invertebrates due to the SCP, such food web effects are unlikely. Similarly, while there is potential for toxic impacts to phytoplankton upon which zooplankton and invertebrates feed, these effects are not likely to be significant enough to result in detrimental effects to the Delta food web.

Several of the invertebrates commonly found in water hyacinth (and perhaps spongeplant), in particular amphipods, chironomid larvae, and *Gammarus*, are consumed by special status fish species such as

Sacramento splittail, juvenile Chinook salmon, and delta smelt (Moyle 1976, Wang 1986, and Herbold 1987). Typical prey items of special status fish are listed below. Loss of a significant quantity of any of these invertebrates could adversely impact certain special status fish species.

- Juvenile Chinook salmon feed on various aquatic and terrestrial insects, crustaceans, chironomid larvae and pupae, caddisflies (in fresh water), and *Neomysis*, *Cammarus*, and *Crangon* in more saline water (Wang 1986).
- Steelhead feed on terrestrial and aquatic insects, amphipods, crustaceans and small fish (Wang 1986).
- Juvenile delta smelt primarily eat copepods, planktonic crustaceans, small insect larvae, and mysid shrimp, while older fish feed almost exclusively on copepods (Moyle 1976). Over recent years, there have been significant declines in delta smelt's preferred food resources due to invasive species such as the overbite clam (Bennett 2005).
- Sacramento splittail are opportunistic benthic foragers that consume copepods, dipterans, detritus, algae, clams, and amphipods (DBW 2001).
- Longfin smelt feed primarily on *Neomysis mercedis*, although copepods and other crustaceans are important at times, especially to small fish (Moyle 1995, 1976).
- Juvenile green sturgeon feed on *Neomysis mercedis* and amphipods (Corophium) (Radtke 1966). Adults may feed on sand lances, clams, and shrimp (Moyle 1995).
- White Sturgeon feed on algae, aquatic insects, small clams, fish eggs, and crustaceans, but their diets become more varied as they age. Since its introduction into the Delta in the late 1980s, overbite clam has also become a significant food source (BDCP, 2013).
- Pacific Lamprey prey on a wide variety of fishes, including salmon, Pacific herring, and flatfishes.
- Ammocoetes of the river lamprey feed on microscopic plants and animals (Wang 1986). As adults, river lamprey prey on a variety of fishes in the 10 to 30 cm size range, but the most common prey seems to be herring and salmon (Moyle 1995).

Below, we assess toxicity of SCP herbicides on macroinvertebrates, phytoplankton, and potential impacts to the food web.

Macroinvertebrates

Special status fish species, or native resident or migratory fish, could be indirectly impacted if SCP decreases the abundance of invertebrates, such as zooplankton, upon which these fish feed. While there is potential for toxic impacts to invertebrates due to SCP, such food web effects are unlikely.

In order to better understand the impact of non-native species on the food web, Toft et al., (2003) compared habitat structure, invertebrate assemblages, and diets of fish associated with water hyacinth and the native floating aquatic plant, pennywort. Toft's results are particularly relevant, as the study took place at three different locations in the Delta. While water hyacinth is similar in appearance to pennywort, the study found that pennywort is functionally superior to water hyacinth, in terms of habitat. Because spongeplant is a new invader, there is little understanding of spongeplant-specific impacts. Spongeplant grows in dense mats covering the surface, similar to water hyacinth. Thus, it is possible that studies of water hyacinth would have results similar to spongeplant.

Toft's study compared populations of epiphytic invertebrates (present in the plant roots), epibenthic invertebrates (present just above the sediment), benthic invertebrates (present in the sediment), and insects in the canopy, in water hyacinth and pennywort. The study also surveyed fish present in both plants, and analyzed fish stomach contents to determine diets. Toft et al., (2003) found that "invertebrates associated with hyacinth occur less in the diets of adjacent fish than do invertebrates associated with pennywort." One finding was that the non-indigenous amphipod, *Crangonyx floridanus*, was more abundant in water hyacinth than pennywort. While the amphipod was prevalent, *Crangonyx* was not found in fish diets. By comparison, *Hyalella azteca*, commonly found in fish diets, was typically more prevalent in pennywort.

There were significant differences between water hyacinth and pennywort in terms of epibenthic and benthic invertebrates. There was greater diversity among invertebrate species in pennywort than in water hyacinth. At one of the three sites, there were no amphipods or isopods under water hyacinth, possibly due to low dissolved oxygen levels. Similarly, there were more insects in pennywort canopies than in water hyacinth, again with greater taxa diversity. Toft et al., found that the two plants were not functionally equivalent, with the native pennywort providing better habitat and food sources for native invertebrates and fish species.

Earlier studies have shown that several of the invertebrates commonly found in water hyacinth, in particular amphipods, chironomid larvae, and *Gammarus*, are consumed by special status fish species such as Sacramento splittail, juvenile Chinook salmon, and delta smelt (Moyle 1976, Wang 1986, and Herbold 1987). We might expect these same invertebrates under spongeplant. Loss of a significant quantity of any of these invertebrates could adversely impact certain special status fish species.

Studies have found that control of macrophytes does not negatively impact macroinvertebrates. In a study comparing the long-term effects of macrophyte and algae management in two lakes in New York (one treated and one not), Harman et al. (2005) found no difference in richness and diversity of the biota between the lakes. Taxonomic richness and diversity were similar in the treated and non-treated lakes.

Juvenile Chinook salmon feed on various aquatic and terrestrial insects, crustaceans, chironomid larvae and pupae, caddisflies (in fresh water), and *Neomysis*, *Cammarus*, and *Crangon* in more saline water (Wang 1986). Steelhead feed on terrestrial and aquatic insects, amphipods, crustaceans and small fish (Wang 1986). Juvenile green sturgeon feed on *Neomysis mercedis* and amphipods (Corophium) (Radtke 1966). Adults may feed on sand lances, clams, and shrimp (Moyle et al. 1989).

Juvenile delta smelt primarily eat copepods, planktonic crustaceans, small insect larvae, and mysid shrimp, while older fish feed almost exclusively on copepods (Moyle 1976). Over recent years, there have been significant declines in delta smelt's preferred food resources due to invasive species such as the overbite clam (Bennett 2005).

Table 3-18, on the following pages, summarizes toxicity data for invertebrate species at various life stages for 2,4-D, glyphosate, penoxsulam, imazamox, diquat and two adjuvants. The EC50 toxicity endpoint for aquatic invertebrates and plants is the concentration of chemical that can be expected to cause a defined non-lethal effect in 50 percent of the test population. Typical endpoints are immobilization, reductions in growth, and reproductive effects.

When Weedar 64 (2,4-D) is applied at labeled rates, the herbicide is not likely to have toxic effects on aquatic invertebrates. In a study of invertebrate communities in artificial ponds, benthic macroinvertebrate communities showed no primary effects due to treatment (Stephenson and Mackie 1986). The LC50 in this study for various crustaceans and insects was over 100 ppm 2,4-D DMA. There were some subtle secondary effects, with lower benthic diversity in treated ponds almost one year after the initial treatment, however this response is not applicable to the tidal waters of the Delta. Washington State reported a NOEL for *Daphnia magna* exposed to 2,4-D of 27.5 ppm (Siemering 2006). Green and Abdelghani (2004) reported that high doses of 2,4-D in red swamp crawfish altered enzyme activity and gill structure, and disrupted liver function.

Toxicity levels for 2,4-D for a range of zooplankton are also higher than levels expected in SCP. EC50 values for most zooplankton were over 100 ppm 2,4-D, while two species had EC50 values ranging from 1 to 10 ppm 2,4-D (Halter 1980). Most LC50 values for 2,4-D for benthic invertebrates were found to be over 1,000 ppm and over 10 ppm in life-cycle invertebrate tests using eggs and early life stages (Halter 1980).

DBW conducted an analysis of water quality and toxicity using WHCP monitoring data gathered from 2001 to 2005. DBW collected several hundred pre-treatment and post-treatment water samples and delivered these to CDFW laboratories to conduct five different toxicology tests. Based on examination of toxicology test results from post-treatment water samples, WHCP did not have a significant or consistent adverse effect on the test organisms used by the laboratories (including the water flea, *Ceriodaphnia dubia*). We would expect similar results for the SCP's utilization of 2,4-D.

Table 3-18
Response of Various Invertebrate Species to SCP Chemicals, at LC50/EC50 Values

Page 1 of 3

Species	Chemical	EC50	Time Period	Reference
Daphnia magna	2,4-D dimethylamine salt (DMA)	184 ppm	48-hr	Alexander et al., 1985
Daphnia magna	2,4-D DMA	176 ppm	96-hr	WSDE 2001
Ceriodaphnia dubia	Weedar® 64	116 ppm	96-hr	CDFW 2003
Cypridopsis, seed shrimp	2,4-D DMA	8 ppm	48-hr	Johnson and Finley 1980
Common shrimp	2,4-D DMA	>10 ppm	48-hr	ECOTOX 2001
Grass shrimp	2,4-D DMA	>100 ppm	48-hr	ECOTOX 2001
Brown shrimp	2,4-D DMA	2 ppm	48-hr	PAN 2001
Gammarus fasciatus	2,4-D DMA	>100 ppm	96-hr	Johnson and Finley 1980
Aquatic sowbug	2,4-D DMA	>100 ppm	48-hr	PAN 2001
Crayfish	2,4-D DMA	>100 ppm	48-hr	PAN 2001
Red swamp crayfish, juvenile	2,4-D DMA	1,174 ppm to 1,681 ppm	96-hr	PAN 2001
Red swamp crayfish	2,4-D DMA	185 ppm	96-hr	Green and Abdelghani 2004
Daphnia magna	Rodeo	218 ppm	48-hr	Henry et al., 1994
Daphnia magna	Rodeo, X-77, and Chemtrol	130 ppm	48-hr	Henry et al., 1994
Daphnia	Glyphosate	780 ppm	96-hr	DBW 2001
Hyalella azteca	Rodeo	720 ppm	96-hr	Henry et al., 1994
Ceriodaphnia dubia	Rodeo	225 ppm to 415 ppm	48-hr	Tsui and Chu 2004
Ceriodaphnia dubia	Rodeo	608 ppm	96-hr	CDFW 2003
Hyalella azteca	Rodeo, X-77, and Chemtrol	218 ppm	96-hr	
Hyalella azteca	Rodeo	225 ppm to 415 ppm	48-hr	Tsui and Chu 2004
Chironomus riparius (midge)	Rodeo	1,216 ppm	48-hr	Henry et al., 1994
Chironomus riparius	Rodeo, X-77, and Chemtrol	300 ppm	48-hr	Henry et al., 1994
Nephelopsis obscura (leech)	Rodeo	1,177 ppm	96-hr	Henry et al., 1994
Nephelopsis obscura	Rodeo, X-77, and Chemtrol	116 ppm	96 hr	Henry et al., 1994
Stagnicola elodes (pond snail)	Rodeo, X-77, and Chemtrol	234 ppm	96 hr	Henry et al., 1994

Table 3-18
Response of Various Invertebrate Species to SCP Chemicals, at EC50 Values *(continued)*

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Species	Chemical	EC50	Time Period	Reference
Daphnia magna	Glyphosate	>2,000 ppm	48-hr	Pereira, 2009
Pseudokirchneriella subcapitala (algae)	Glyphosate	129 ppm	96-hr	Pereira, 2009
Midge	Glyphosate	55 ppm	96-hr	HSDB 2001
Atlantic oyster	Glyphosate	>10 ppm	48-hr	DBW 2001
Shrimp	Glyphosate	281 ppm	96-hr	DBW 2001
Fiddler crab	Glyphosate	934 ppm	96-hr	DBW 2001
Daphnia magna	Penoxsulam (technical)	>98 ppm	48-hr	USEPA September 2007
Daphnia magna	Penoxsulam degradates	>96 ppm to >100 ppm	48-hr	USEPA September 2007
Daphnia magna	Penoxsulam degradates	>1 ppm to >1.6 ppm	48-hr	USEPA September 2007
Midge (*Chironomus* sp.)	Penoxsulam (technical)	>140 ppm	48-hr	USEPA September 2007
Amphipod (*Gammarus* sp.)	Penoxsulam (technical)	>126 ppm	48-hr	USEPA September 2007
Daphnia magna	Galleon/equivalent	>90.1 ppm	48-hr	USEPA September 2007
Daphnia magna	Penoxsulam (technical)	9.76 ppm 2.95 ppm NOAEC 9.76 ppm LOAEC	21-day	USEPA September 2007
Chironomus reparius	Penoxsulam (technical)	7.1 ppm NOAEC 15 ppm LOAEC	28-day	USEPA September 2007
Daphnia magna	Imazapyr (technical)	>97.1 ppm NOEC	21-day	AMEC Geomatrix 2009
Daphnia magna	Imazamox (technical)	>122 ppm 122 ppm NOEC	96-hr	USEPA 2010
Mysid shrimp (*Mysidopsis bahia)*	Imazamox (technical)	>94.3 ppm 94.3 ppm NOEC	96-hr	SERA 2010
Daphnia magna	Imazamox (technical)	137 ppm	21-day	European Commission 2002
Ceriodaphnia dubia	Diquat dibromide (Reward)	0.14 ppm	96-hour	Riley and Finlayson 2004b
Ceriodaphnia dubia	Diquat dibromide (Reward)	0.078 ppm	7-day	Riley and Finlayson 2004b
Ceriodaphnia dubia	Diquat dibromide (Reward)	0.015 ppm	7-day MATC	Riley and Finlayson 2004b

Table 3-18
Response of Various Invertebrate Species to SCP Chemicals, at EC50 Values *(continued)*

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Species	Chemical	EC50	Time Period	Reference
Ceriodaphnia dubia	Diquat dibromide (Reward)	0.012 ppm	7-day NOEC	CDFW-ATL 2003
Daphnia magna	Diquat dibromide	1.62 ppm	48-hour	Washington DOE 2002
Eastern oyster *(Crassostrea virginica)*	Diquat dibromide	141 ppm	96-hour	Washington DOE 2002
Copepod (*Eucyclops* spp.)	Diquat dibromide	25.164	48-hour	Washington DOE 2002
Amphipod *(Hyallella azteca)*	Diquat dibromide	0.048 ppm	96-hour	Washington DOE 2002
Amphipod *(Hyallella azteca)*	Diquat dibromide	6.8 ppm	96-hour	Washington DOE 2002
Pocket shrimp *(Mysidopsis bahia)*	Diquat dibromide	0.42 ppm	96-hour	Washington DOE 2002
Caddisfly (*Limnephilus* spp.)	Diquat dibromide	33 ppm	96-hour	Washington DOE 2002
Daphnia magna	Diquat dibromide	0.045 ppm MATC 0.036 ppm NOEC 0.057 ppm LOEC	21-days Endpoint = reproduction and growth	Washington DOE 2002
Daphnia magna	Agridex	>1,000 ppm	48-hr	WSDA 2005
Daphnia magna	Competitor	>100 ppm	48-hr	WSDA 2005

In DBW's analysis, there were 20 samples which exceeded (then) NPDES permit levels (20 ppb) for 2,4-D, which were tested for water flea survival and growth. None of these samples adversely affected water flea survival. Two of the 20 samples adversely affected water flea reproduction. Because there were also adverse effects on water flea survival and progeny on samples that did not have detectable levels of 2,4-D, it is not possible to attribute the small number of cases with adverse effects on exposure to 2,4-D.

Chronic toxicity tests using SCP chemicals also found impact levels several orders of magnitude greater than likely exposure levels. The CDFW Aquatic Toxicology Laboratory, conducted seven day chronic toxicity tests on the water flea neonates, *Ceriodaphnia dubia* (CDFW 2003). The seven day LC50 for Weedar 64 (2,4-D) was 97 ppm. The seven day lowest observable effect concentration (LOEC) for Weedar was 40.5 ppm.

When glyphosate is applied at labeled rates, the herbicide is not likely to have a negative impact on aquatic invertebrates. Studies indicate that invertebrates are less sensitive to technical grade glyphosate than are fish (Siepmann 1995). Henry et al., (1994) concluded that Rodeo (with X-77 and Chem-Trol adjuvants) does not pose an acute hazard to native aquatic invertebrates because the concentrations of these chemicals found to be acutely toxic to invertebrates were much higher than their expected or measured concentrations in water from wetlands treated with the herbicide mix. In addition, in field studies conducted by Henry et al., (1994), resident invertebrates in all study wetlands were observed to be abundant during the study period. Kreutzweiser et al., (1989) found that application of glyphosate on or adjacent to small tributaries of a creek did not result in disturbance of stream invertebrates.

A study evaluating the toxicity of individual and herbicide mixes on *Daphnia* found that glyphosate (Accord Concentrate) did not show any appreciable acute toxicity, either alone or with surfactants (Tatum et al. 2011). Back (2010) evaluated gastropod abundance and dry mass of benthic organisms in glyphosate-treated and non-treated marsh and found that treatments had little effect on herbivore-producer relationships and gastropod diversity one-year post-spraying.

Chronic toxicity tests using SCP chemicals also found impact levels several orders of magnitude greater than likely exposure levels. The CDFW Aquatic Toxicology Laboratory, conducted seven day chronic toxicity tests on the water flea neonates, *Ceriodaphnia dubia* (CDFW 2003). The seven day LOEC for Rodeo (glyphosate) was 104 ppm.

In DBW's water quality and toxicity analysis, none of the glyphosate samples exceeded NPDES permit criteria (700 ppb). The CDFW laboratory conducted toxicity testing using the 18 samples with detectable levels of glyphosate. One of the 18 glyphosate samples had an impact on water flea survival. The glyphosate concentration of this sample was 84 ppb. Three of the 18 samples tested had glyphosate concentrations higher than 84 ppb, but had no impact on water flea survival or reproduction. Because there were adverse effects on water flea survival and progeny on samples that did not have detectable levels of glyphosate, it is not possible to attribute the small number of cases with adverse effects on exposure to glyphosate.

USEPA (September 2007) reported testing results for penoxsulam and metabolites on invertebrate species as part of the Ecological Risk Assessment. Tests were conducted for the pesticide registration process. Many of the degradate tests utilized only one concentration (approximately 1 ppm), and had no mortality or immobilization effects. Some tests utilized a range of concentrations, up to approximately 100 ppm, also with no mortality. Thus, the EC50 values for penoxsulam in Table 3-18 (and Figure 3-15) are conservative, and essentially equal to NOAEC levels (USEPA January 2007).

Acute toxicity testing with an end-use product equivalent or equal to Galleon (penoxsulam) found no toxicity to *Daphnia magna* at the maximum concentration of 90.1 ppm. There was minor immobilization impairment (5 percent to 10 percent) at the mid-range concentrations tested, but not the low and high concentrations (7.92 ppm and 90.1 ppm). The study determined that the 48-hour NOEAC level, based on mortality or immobilization, was 90.1 ppm (USEPA January 2007). Chronic toxicity testing of technical grade penoxsulam on *Daphnia* and chironomids found NOAEC levels of 2.95 ppm and 7.1 ppm, respectively, well above instantaneous concentrations expected from SCP treatments.

USEPA registration studies found that imazamox is practically non-toxic to aquatic invertebrates. As with fish, there are relatively few studies for this herbicide. The 96-hour EC50 values for *Daphnia magna* and mysid shrimp were close to 100 ppm, with no mortality and no signs of toxic effects at the highest concentrations tested (SERA 2010). Chronic toxicity testing also found no effect at imazamox concentrations greater than 100 ppm (European Commission 2002).

DBW commissioned studies of diquat (Reward) impacts on the cladoceran, *Ceriodaphnia dubia* (water flea), conducted by CDFW. The 96-hour EC50 for *C. dubia* was 0.14 ppm. The seven day EC50 was 0.078 ppm, and the seven day MATC was 0.015 ppm (Riley and Finlayson 2004b). These results indicate that there is the potential for impacts to cladocerans following treatment with diquat.

DBW conducted an analysis of water quality and toxicity using monitoring data gathered from 2001 to 2005. (Diquat was utilized for limited EDCP treatments during this time period, injected directly into the water at the treatment site). DBW collected several hundred pre-treatment and post-treatment water samples (many from inside the treatment area) and delivered these to CDFW laboratories to conduct five different toxicology tests. Based on examination of toxicology test results from post-treatment water samples, eight of the 13 diquat samples that exceeded 20 ppb did have an adverse effect on the test organisms (survival or growth) used by the laboratories (including the water flea, *Ceriodaphnia dubia*) (DBW 2006).

Studies in the literature on the effects of diquat on macroinvertebrates show a range of results, with some species more sensitive than others. Four species of invertebrates are highly susceptible to diquat: *Hyalella Azteca* (EC50 = 0.048 ppm), pocket shrimp (EC50 = 0.42 ppm), *Daphnia pulex* (EC50 = 0.16 ppm), and apple snail (EC50 = 0.34 ppm) (Washington DOE 2002). However, other species such as mayflies (EC50 = 16 ppm), oysters (EC50 = 55 to 141 ppm), *Daphnia magna* (EC50 = >1 ppm), and bloodworms (EC50 >100 ppm) are less susceptible to diquat. Chung et al. (2008) found a 96-hour LC50 of 1.624 ppm for larval grass shrimp, found in estuarine ecosystems, higher than potential SCP exposure.

Washington DOE concludes that "invertebrates will not be entirely safe from the effects of diquat" (p. 196), similar to earlier DBW conclusions that resulted in limiting use of diquat. While diquat poses a greater risk to macroinvertebrates than the other four SCP herbicides, several factors reduce the potential for negative effects to invertebrates following diquat treatment. The actual concentration of diquat in water decreases rapidly, particularly in the presence of sediment, as evidenced by the half-life of 0.75 days. In the typical diquat spot application scenario for SCP, one would expect concentrations of diquat to start at levels of 0.0448 ppm, and reduce to levels of 0.0224 ppm within approximately four hours. These levels are near EC50 levels for the more sensitive invertebrate species, but are not likely to be maintained for time periods similar to EC50 studies (48 hours or longer). In addition, DBW will treat a maximum of 50 acres per season with diquat (combined SCP and EDCP acres), and only in emergency situations. Limiting the area that is treated with diquat will further reduce the potential for significant effects on zooplankton. Finally, Wilson (1968, in Washington DOE 2002) noted that affected invertebrate species may be replaced by species of a similar size class, resulting in an overall minimal impact due to diquat.

Phytoplankton

Macroinvertebrates depend on phytoplankton, which serve as the base of the food web. Phytoplankton plays a fundamental role in primary productivity (Jassby et al. 2003). There is potential for SCP treatments to affect algae within treatment sites, which could in turn affect macroinvertebrates. However, the potential impact of SCP treatments on phytoplankton is minimal compared to larger scale influences on phytoplankton in the Delta. Jassby et al. (2002) examined Delta-wide primary productivity (the rate at which plants incorporate inorganic carbon into organic matter) between 1975 and 1995. During the 21-year time period, primary productivity in the Delta varied by a factor of five. Factors that contributed to the variability included: (1) decreased phytoplankton mass due to the invasion of the clam *Corbula amurensis*, (2) long-term declines in total suspended solids leading to increased water transparency and phytoplankton growth rate, (3) river inflow affecting biomass and growth rates through fluctuations in flushing and total suspended solids, and (4) an unknown factor resulting in a long-term decline in winter phytoplankton growth rate (Jassby et al. 2002).

An analysis of phytoplankton (as chlorophyll a) in the Delta and Suisun Marsh between 1996 and 2005 found increases in much of the Delta and substantial declines in Suisun Marsh (Jassby 2008). Chlorophyll a, a green pigment in plants, is used as an approximate index of algal biomass (Jassby et al. 2003). Overall, there has been a long-term declining trend in chlorophyll a from the 1970s to 2005, as well as a decline in larger-celled phytoplankton, which are preferred food sources (Kimmerer et al. 2012). Delta chlorophyll a sampling levels between 1987 and 2006 have rarely risen about the threshold level of 10 µg per liter that is considered the point at which crustacean zooplankton become food-limited (Jassby 2008, Kimmerer et al. 2012). Suisun Marsh, which is highly affected by *Corbula amurensis*, has seen even greater declines in chlorophyll a (Jassby 2008).

Changes in phytoplankton communities can result in differing nutrient values. For example, diatoms and cryptophytes are generally more nutritious for many zooplankton species than cyanobacteria (Jassby 2008). Researchers have concluded that long-term declines of phytoplankton in the Delta have contributed to long-term declines in fish abundance; however, phytoplankton decline does not appear to be a major factor in the more recent pelagic organism decline (Kimmerer et al. 2012). Vanderstukken (2012) conducted a series of experiments that demonstrated that water hyacinth plants reduced phytoplankton populations through shading, as well as alleopathic effects. Large spongeplant mats would have similar shading effects.

Algal toxicity studies evaluate the EC50, the concentration at which there is a 50 percent reduction in the log-phase growth after a time period (Washington DOE 2001). EC50 values higher than SCP herbicide concentrations would indicate a potential for treatments to acutely negatively affect algal growth. **Table 3-19,** on the next page, provides several species' EC50 values for SCP herbicides.

Table 3-19
Responses of Standard Algal, Diatom, and Cyanobacteria Species to SCP Herbicides *Page 1 of 2*

Species	Chemical	EC50 (NOEC)	Time Period	Reference*
Anabaena flosaquae (cyanobacteria)	2,4-D DMA	153 mg/l (68 mg/l)	5-days	Hughes 1990j
Selenastrum capricornutum (green algae)	2,4-D DMA	67 mg/l (19 mg/l)	5-days	Hughes 1990o
Navicula pelliculosa (freshwater diatom)	2,4-D DMA	5.28 mg/l (1.70 mg/l)	5-days	Hughes 1990d
Scenedesmus subspicatus (algae)	Aquamaster (isopropylamine salt of glyphosate)	72.9 mg/l	72 hours	SERA 2003
Selenastrum capricornutum (green algae)	Glyphosate	12.5 mg/l	4-days	USEPA 1993b
Navicula pelliculosa (freshwater diatom)	Glyphosate	39.9 mg/l	4-days	USEPA 1993b
Anabaena flosaquae (cyanobacteria)	Glyphosate	11.7 mg/l	4-days	USEPA 1993b
Chlorella fusca (algae)	Glyphosate	377 mg/l	24-hr	Faust et al. 1994
Chlorella pyrenoidosa (green algae)	Glyphosate	590 mg/l	4-days	Maule and Wright 1994
Chlorococcum hypnosporum (green algae)	Glyphosate	68 mg/l	4-days	Maule and Wright 1994
Zygnema cllindricum (green algae)	Glyphosate	88 mg/l	4-days	Maule and Wright 1994
Anabaena flosaquae (cyanobacteria)	Glyphosate	304 mg/l	4-days	Maule and Wright 1994
Scenedesmus acutus (green algae)	Glyphosate	10.2 mg/l LOEC 4 mg/l NOEC 2 mg/l	96-hr	Sanchez et al. 1997
Scenedesmus quadricauda (green algae)	Glyphosate	9.08 mg/l LOEC 4.08 mg/l NOEC 3.2 mg/l	96-hr	Sanchez et al. 1997
S. acutus, S. subspicatus, C. Chlorella vulgaris, C. saccharophila (microalgae)	Glyphosate	24.5 mg/l to 41.7 mg/l	72-hour	Vendrell et al. 2009
Scenedesmus quadricauda (green algae)	Penoxsulam (technical)	0.092 mg/l NOAEC 0.005 mg/l	96-hr Endpoint = cell density	USEPA September 2007
Scenedesmus quadricauda (green algae)	Penoxsulam (Galleon/ equivalent)	0.094 mg/l NOAEC 0.009 mg/l	96-hr Endpoint = biomass	USEPA September 2007

Table 3-19
Responses of Standard Algal, Diatom, and Cyanobacteria Species to SCP Herbicides *(continued)* *Page 2 of 2*

Species	Chemical	EC50 (NOEC)	Time Period	Reference*
Scenedesmus quadricauda (green algae)	Penoxsulam degradates	> 1.0 mg/l to > 10 mg/l (same for NOAEC)	96-hr Endpoints = growth rate, biomass, none	USEPA September 2007
Navicula pelliculosa (freshwater diatom)	Penoxsulam (technical)	> 49.6 mg/l (same for NOAEC)	120-hr Endpoint = none	USEPA September 2007
Anabaena flos-aquae (blue-green algae)	Penoxsulam (technical)	0.27 mg/l NOAEC 1.94 mg/l	120-hr Endpoint = cell density, biomass	USEPA September 2007
Navicula pelliculosa (freshwater diatom)	Imazamox	> 0.040 mg/l	120-hours Endpoint = growth reduction	USEPA 2008
Selenastrum capricornutum (green algae)	Imazamox	> 0.040 mg/l	120-hours Endpoint = growth reduction	USEPA 2008
Anabaena flos-aquae (blue-green algae)	Imazamox	> 0.040 mg/l	120-hours Endpoint = growth reduction	USEPA 2008
Anabaena flos-aquae (blue-green algae)	Diquat dibromide	0.05 mg/l	168-hours Endpoint = growth reduction	Washington DOE 2002
Anabaena flos-aquae (blue-green algae)	Diquat dibromide	0.042 mg/l	72-hours Endpoint = chlorophyll levels	Washington DOE 2002
Selenastrum capricornutum (green algae)	Diquat dibromide	0.48 mg/l	168-hours Endpoint = growth reduction	Washington DOE 2002
Selenastrum capricornutum (green algae)*	Diquat dibromide	0.019 mg/l	96-hours Endpoint = growth reduction	Washington DOE 2002
Chlorella vulgaris (green algae)	Diquat dibromide	0.395 mg/l	168-hours Endpoint = growth reduction	Washington DOE 2002
Navicula pelliculosa (freshwater diatom)	Diquat dibromide	0.065 mg/l	168-hours Endpoint = growth reduction	Washington DOE 2002
Euglena gracilis (Euglenophyte)	Diquat dibromide	2.94 mg/l	168-hours Endpoint = growth reduction	Washington DOE 2002

* 2,4-D references from Washington Department of Ecology. Herbicide Risk Assessment for the Aquatic Plant Management Final Supplemental Environmental Impact Statement. Appendix C Volume 2: 2,4-D. Washington DOE. February 2001. Publication Number 00-10-043. Glyphosate references from: Syracuse Environmental Research Associates, Inc. for USDA, Forest Service. Glyphosate – Human Health and Ecological Risk Assessment Final Report. USDA Forest Health Protection. 2003.

Washington DOE (2001) noted that 2,4-D DMA is not toxic to most aquatic algae. Washington DOE found lower EC50s for some other forms of 2,4-D such as the esters; however, SCP utilizes the less toxic DMA form of the chemical. 2,4-D may also result in algal growth, although this may be a result of decomposing plants, rather than the herbicide (Washington DOE 2012).

SERA (2003) summarized the effects of glyphosate on a variety of algal and diatom species, and found EC50 values ranging from 7.6 mg/l to 19 mg/l. The lowest freshwater species EC50 for glyphosate was 9.08 mg/l. Pesce et al (2009) compared the effects of 10 ppb glyphosate on riverine microbial communities in spring and summer. River water was analyzed after 14 days, with 6 days of glyphosate exposure at 10 ppb, and declining glyphosate levels the last 8 days. In the spring, Pesce found no significant differences between control and treated samples on community-level end-points such as chlorophyll a content, bacterial activity or on eukaryotic and prokaryotic community composition. There were differences only in algal community composition and eukaryotic community diversity in the summer, with no significant effects on bacterial or prokaryotic communities.

Vendrell et al. (2009) (in Galhano et al. 2011) evaluated the effects of glyphosate on four microalgae species collected at Albufera Lake in Valencia (Spain). The 72-hour EC50 for the four microalgae (*Scendesmus acutus, Scendesmus subspicatus, Chlorella vulgaris, and Chlorella saccharophilia*) ranged from 24.5 mg/l to 41.7 mg/l, and the concentrations resulting in 10 percent growth inhibition ranged from 1.6 mg/l to 3.0 mg/l. Galhano et al. concluded that the study showed that glyphosate had low microalgae toxicity.

Toxicity testing for USEPA registration of penoxsulam found EC50 values for various microalgae that were higher than the expected penoxsulam concentration immediately following SCP treatments (USEPA January 2007).

Imazamox has limited toxicity to algae species (Netherland et al. 2009). EC50 values for several algal species were greater than 40 ppb, well above expected concentrations following SCP treatments. Washington State University researchers found that imazamox had no toxic effect on sea lettuce and red algae when Clearcast was applied at 16 ounces per acre (Environ 2012).

The effect of diquat on phytoplankton is mixed. Schaffer and Sebetich (2004) evaluated the effect of three concentrations of diquat dibromide on phytoplankton growth using the C14 assimilation method. The lowest diquat concentration, 0.118 mg/liter, stimulated phytoplankton productivity at a rate of 117 percent as compared to controls. The two higher concentrations of diquat, 1.18 mg/l and 11.8 mg/l, inhibited phytoplankton productivity equivalent to 45 percent and 19 percent of controls, respectively. The SCP estimated maximum concentration in one meter is 0.045 mg/l, well below the 1.18 mg/l concentration that resulted in phytoplankton inhibition. In addition, due to the rapid binding of diquat to sediment and tidal movement, the concentration of diquat following SCP treatment will continue to drop within hours of treatment.

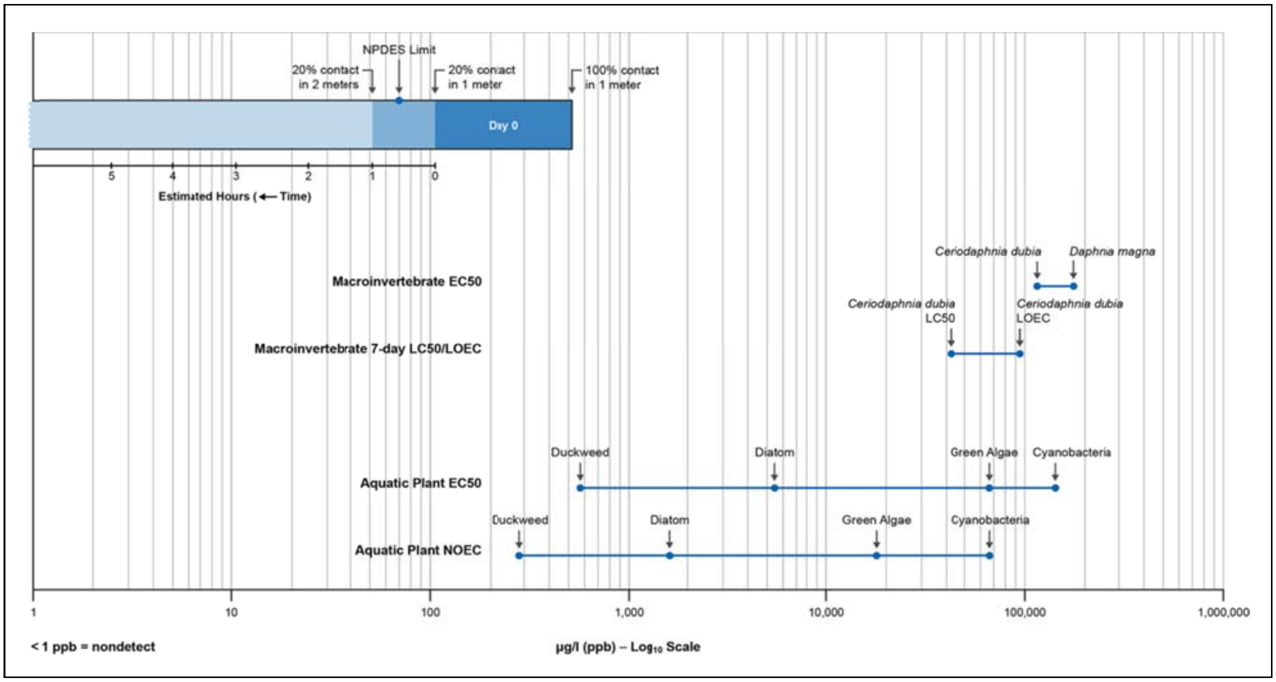
Studies on the effects of diquat on phytoplankton summarized in Washington DOE (2002) also found mixed results. Applied directly into water, diquat may affect growth of some, but not all, species of algae at the maximum use rate. The result may be a temporary shift in the diversity of phytoplankton, with less sensitive species becoming more dominant. For the SCP, only diquat entering the water through overspray would affect phytoplankton, thus it seems unlikely that diquat will have a significant direct impact on phytoplankton growth sufficient to adversely impact the food chain.

Summary of Food Web Effects

We present and summarize a food web effect graphic for each of the five SCP herbicides. These five figures provide a visual comparison of EECs and endpoints for macroinvertebrate and aquatic plant species.

Figure 3-13, on the next page, provides a comparison of 2,4-D estimated EECs and EC50 and NOEC levels for macroinvertebrate and aquatic plant species. The NPDES limit for 2,4-D is 70 ppb. SCP will utilize spot treatments, spraying herbicide directly onto spongeplant. For exposure to macroinvertebrates, algae and diatom, the 20 percent overspray concentration shown in Figure 3-13, at 103 ppb, is conservative. We assume that within a few hours, the herbicide will have mixed into 2 meters of water, with the concentration dropping to a maximum of 51 ppb. For exposure to duckweed, which would occur through drift, the 100 percent contact figure at 0.51 ppm is more relevant.

Figure 3-13
Comparison of Exposure Concentrations and Macroinvertebrate and Aquatic Plant Species Endpoint Effects for 2,4-D (µg/l or ppb)



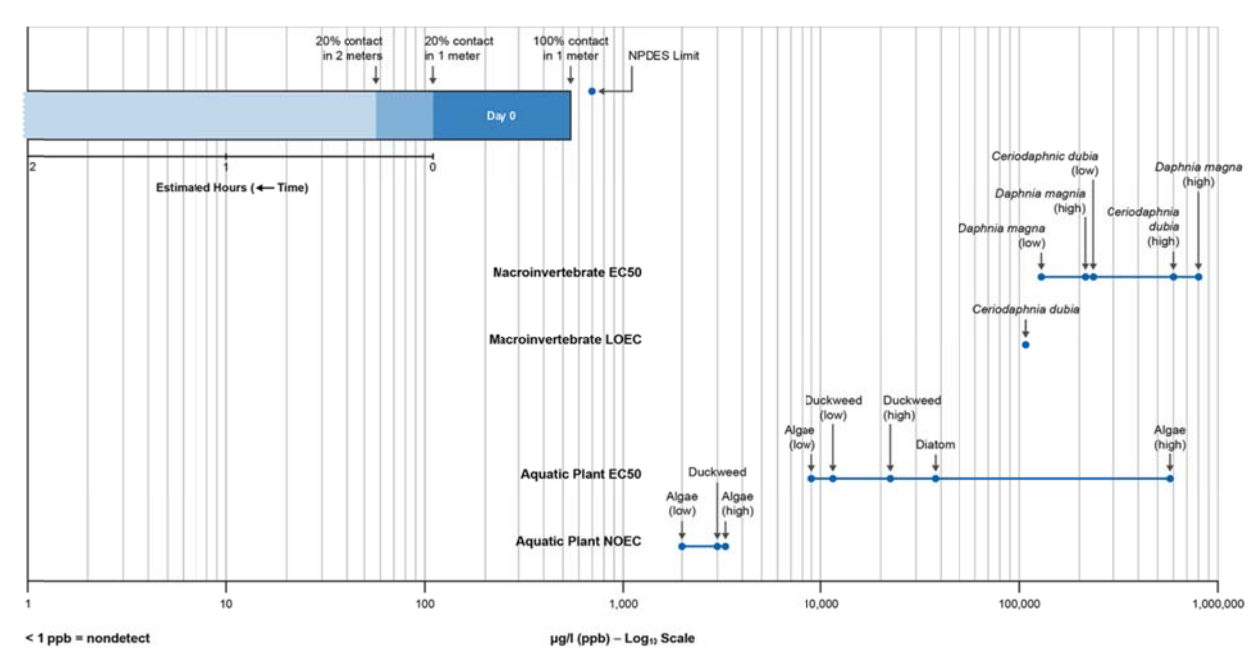
For macroinvertebrates, all of the toxicity endpoint concentrations are at, or to the right of, the EEC bar. Figure 3-13 illustrates that there is no overlap between SCP EECs and standard toxicity levels for *Daphnia magna* and *Ceriodaphnia dubia*. For example, the low macroinvertebrate endpoint is three orders of magnitude above the 20 percent contact in one meter concentration, the estimated maximum 2,4-D in-water exposure concentration. Considering longer-term exposure, the 7-day LC 50 value is over two orders of magnitude above the 20 percent contact in one meter concentration.

For diatom and algae, the EEC bar is to the right of the lowest EC50 and NOEC endpoints. The lowest EC50 endpoint for diatom is over an order of magnitude greater than the estimated maximum 2,4-D concentration, with 20 percent water contact in one meter. The diatom NOEC is slightly lower, but still an order of magnitude greater than the estimated concentration with 20 percent water contact in one meter. Algae and cyanobacteria were less sensitive to 2,4-D than diatom.

Duckweed is more sensitive to 2,4-D. The duckweed EC50 is slightly higher, and the NOEC for duckweed is below, the estimated concentration with 100 percent spray contact in one meter of water. If SCP 2,4-D treatments result in overspray of aquatic plants, there is potential that these plants would be negatively affected.

Figure 3-14, on the next page, provides a visual representation of glyphosate estimated EECs and EC50 and NOEC levels for macroinvertebrate and aquatic plant species. The NPDES limit for glyphosate is 700 ppb. SCP will utilize spot treatments, spraying herbicide directly onto spongeplant. For exposure to macroinvertebrates, algae and diatoms, the 20 percent overspray concentration shown in Figure 3-14, at 113 ppb, is conservative. We assume that within less than an hour, the herbicide will have mixed into 2 meters of water, with the concentration dropping to a maximum of 57 ppb. For exposure to duckweed, which would occur through drift, the 100 percent contact figure at 570 ppb is more relevant.

Figure 3-14
Comparison of Exposure Concentrations and Macroinvertebrate and Aquatic Plant Species Endpoint Effects for Glyphosate (µg/l or ppb)



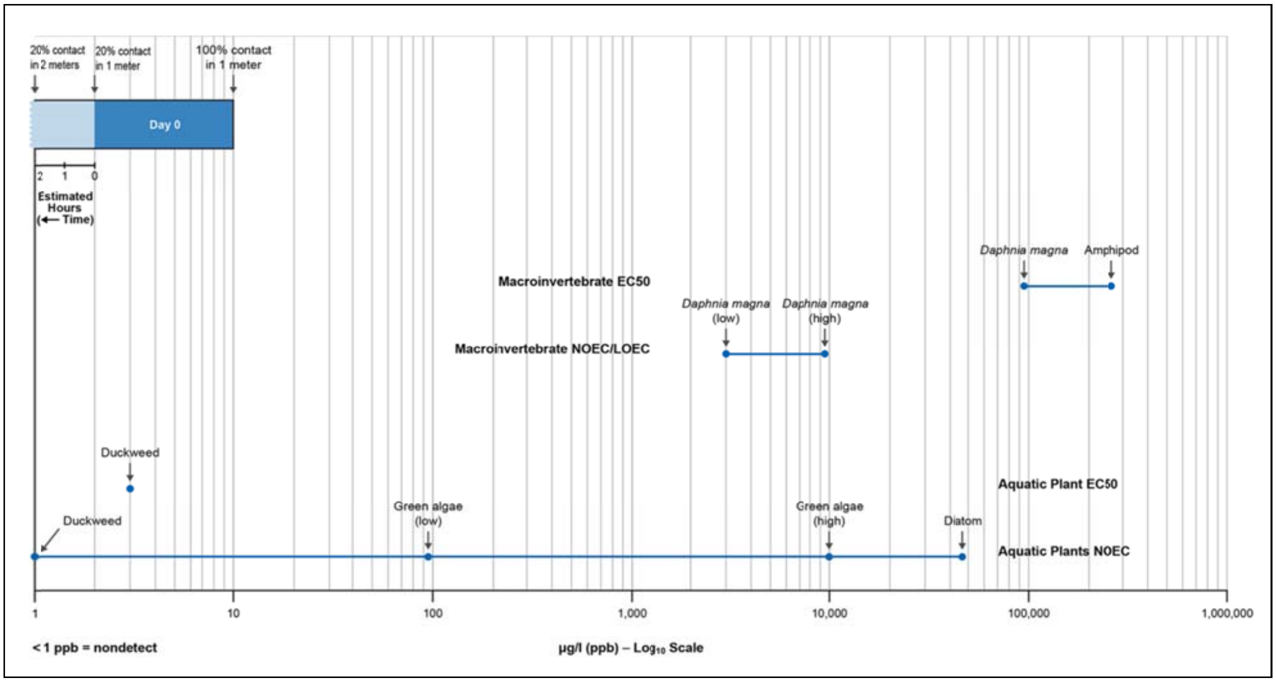
For macroinvertebrates, all of the toxicity endpoint concentrations are to the right of the EEC bar. Figure 3-14 illustrates that there is no overlap between SCP EECs and standard toxicity levels for *Daphnia magna* and *Ceriodaphnia dubia*. For example, the low macroinvertebrate endpoint is three orders of magnitude above the 20 percent contact in one meter concentration, the estimated maximum glypohosate in-water exposure concentration. The LOEC, for *Ceriodaphnia dubia*, is also three orders of magnitude above the 20 percent contact in one meter concentration.

For duckweed, diatom and algae, the EEC bar is to the right of the lowest EC50 and NOEC endpoints, indicating that these species are not sensitive to glyphosate. The lowest EC50 endpoint for, algae, is almost two orders of magnitude greater than the estimated maximum glyphosate concentration, with 20 percent water contact in one meter. The algae NOEC is lower, but still an order of magnitude greater than the estimated concentration with 20 percent water contact in one meter.

Duckweed is less sensitive to glyphosate than algae. The lowest duckweed EC50 is more than an order of magnitude higher, and the NOEC for duckweed is five times higher, than the estimated concentration with 100 percent spray contact in one meter of water. If SCP glyphosate treatments result in overspray of aquatic plants, it is unlikely that these plants would be negatively affected.

Figure 3-15, on the next page, provides a visual representation of penoxsulam estimated EECs and EC50 and NOEC/LOEC levels for macroinvertebrate and aquatic plant species. SCP will utilize spot treatments, spraying herbicide directly onto spongeplant. For exposure to macroinvertebrates, algae and diatoms, the 20 percent overspray concentration shown in Figure 3-15, at 2 ppb, is conservative. We assume that within approximately two hours, the herbicide will have mixed into 2 meters of water, with the concentration dropping to a maximum of 1 ppb. For exposure to duckweed, which would occur through drift, the 100 percent contact figure at 9.8 ppb is more relevant.

Figure 3-15
Comparison of Exposure Concentrations and Macroinvertebrate and Aquatic Plant Species Endpoint Effects for Penoxsulam (µg/l or ppb)



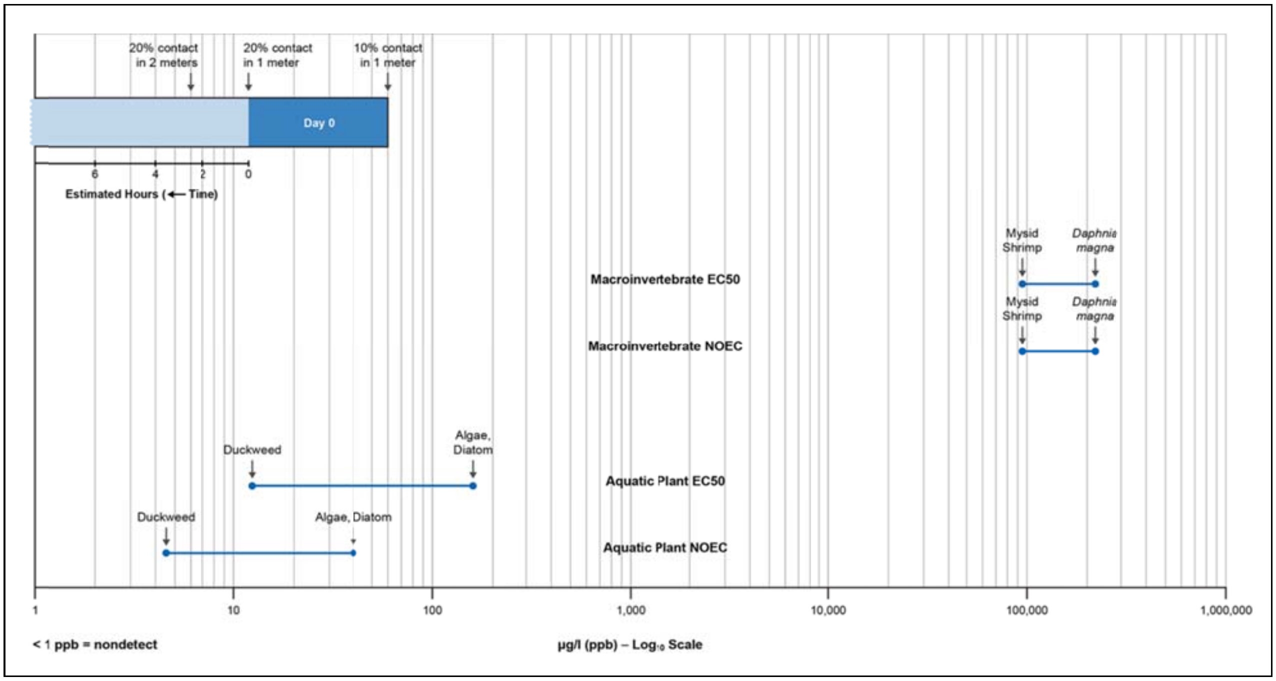
For macroinvertebrates, all of the toxicity endpoint concentrations are to the right of the EEC bar. Figure 3-15 illustrates that there is no overlap between SCP EECs and standard toxicity levels for *Daphnia magna* and amphipod. For example, the low macroinvertebrate EC50 endpoint is over four orders of magnitude above the 20 percent contact in one meter concentration, the estimated maximum penoxsulam in-water exposure concentration. The low NOEC/LOEC, for *Daphnia magna*, is three orders of magnitude above the 20 percent contact in one meter concentration.

For diatom and algae, the EEC bar is to the right of the lowest NOEC endpoints (no EC50 endpoints were available), indicating that these species are not sensitive to penoxsulam. The lowest NOEC endpoint for, green algae, is over an order of magnitude greater than the estimated maximum imazamox concentration with 20 percent water contact in one meter. The diatom NOEC is four orders of magnitude greater than the estimated concentration with 20 percent water contact in one meter.

Duckweed is very sensitive to penoxsulam, although a long exposure is required to kill the plant. The duckweed EC50 is below the estimated concentration with 100 percent spray contact in one meter of water. The duckweed NOEC is at 1ppb. If SCP penoxsulam treatments result in overspray of aquatic plants, it is likely that these plants would be negatively affected.

Figure 3-16, on the next page, provides a visual representation of imazamox estimated EECs and EC50 and NOEC levels for macroinvertebrate and aquatic plant species. SCP will utilize spot treatments, spraying herbicide directly onto spongeplant. For exposure to macroinvertebrates, algae and diatom, the 20 percent overspray concentration shown in Figure 3-16, at 11.9 ppb, is conservative. We assume that within approximately two hours, the herbicide will have mixed into 2 meters of water, with the concentration dropping to a maximum of 5.9 ppb. For exposure to duckweed, which would occur through drift, the 100 percent contact figure at 59 ppb is more relevant.

Figure 3-16
Comparison of Exposure Concentrations and Macroinvertebrate and Aquatic Plant Species Endpoint Effects for Imazamox (µg/l or ppb)



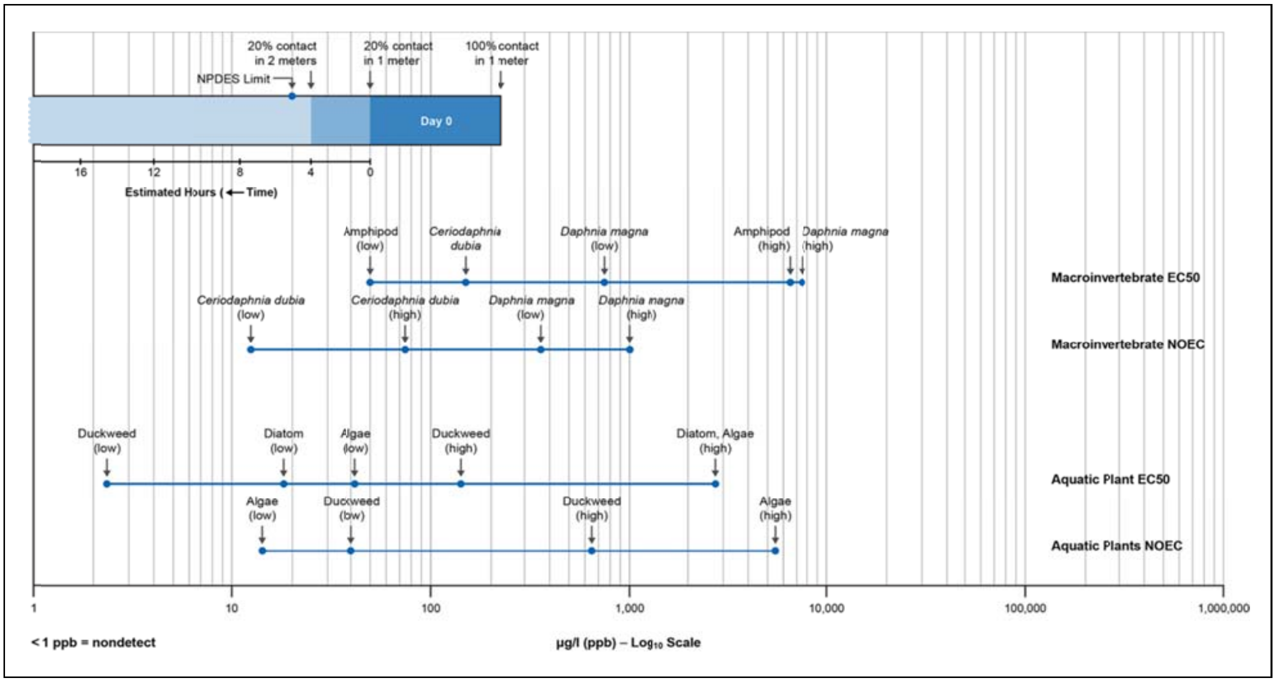
For macroinvertebrates, all of the toxicity endpoint concentrations are to the right of the EEC bar. Figure 3-16 illustrates that there is no overlap between SCP EECs and standard toxicity levels for *Daphnia magna* and mysid shrimp. For example, the low macroinvertebrate EC50 endpoint is almost four orders of magnitude above the 20 percent contact in one meter concentration, the estimated maximum imazamox in-water exposure concentration. The low NOEC, for mysid shrimp, is also almost four orders of magnitude above the 20 percent contact in one meter concentration. The EC50 and NOEC values are the same because no effects were seen at the highest levels tested (94 and 100 ppm).

For diatom and algae, the EEC bar is just to the right of the EC50 endpoints, indicating that these species likely are not sensitive to imazamox. The NOEC endpoint for algae and diatom also just above the expected maximum imazamox concentration in one meter with 20 percent overspray.

Duckweed is more sensitive to imazamox. The duckweed EC50 is approximately equal to the estimated concentration with 100 percent spray contact in one meter of water. The duckweed NOEC is less than the 100 percent spray contact concentration. If SCP imazamox treatments result in overspray of aquatic plants, it is likely that these plants would be negatively affected.

Figure 3-17, on the next page, provides a visual representation of diquat dibromide estimated EECs and EC50 and NOEC levels for macroinvertebrate and aquatic plant species. The diquat endpoints cover a wide range for both EC50 and NOEC tests. SCP will utilize spot treatments, spraying herbicide directly onto spongeplant. For exposure to macroinvertebrates, algae and diatom, the 20 percent overspray concentration shown in Figure 3-17, at 44.8 ppb, is conservative. We assume that within approximately four hours, the herbicide will have mixed into 2 meters of water, with the concentration dropping to a maximum of 22.4 ppb. For exposure to duckweed, which would occur through drift, the 100 percent contact figure at 220 ppb is more relevant. Diquat will bind readily with sediment, reducing concentrations to non-detectable levels within 24 hours.

Figure 3-17
Comparison of Exposure Concentrations and Macroinvertebrate and Aquatic Plant Species Endpoint Effects for Diquat (µg/l or ppb)



For macroinvertebrates, there are several toxicity endpoint concentrations that are within the EEC bar, and several endpoints to the right of the EEC bar. Figure 3-17 illustrates that some macroinvertebrates could be negatively affected by diquat. However, diquat concentrations will drop below toxic endpoint levels within approximately eight hours, thus exposure times will be shorter than toxicity test periods. The lowest macroinvertebrate EC50 level is approximately the same as the expected maximum diquat concentration in one meter, with 20 percent overspray. The highest macroinvertebrate EC50 endpoint is over two orders of magnitude above the expected concentration. The lowest NOEC endpoint is below the EEC, and the highest is above the EEC.

Diatom and algae also show mixed sensitivity to diquat, with some toxic endpoints above the EEC, and some below. Because diquat is a contact herbicide, it is likely that sensitive diatom and algae that come in contact with diquat would be negatively affected.

Duckweed is sensitive to diquat, with EC50 values below the maximum estimated concentration with 100 percent contact in one meter. The low duckweed NOEC is also below the EEC. It is likely that aquatic plants that come in contact with diquat, through drift exposure, will be negatively affected by diquat. Diquat only affects the portion of the plant that it comes in contact with. Thus, it is possible that exposed plants would be harmed, but not suffer permanent damage.

It is unlikely that there would be significant adverse effects to special status, resident native, or migratory fish from SCP impacts on the Delta food web. Given the (1) low levels of herbicides utilized, (2) low toxicity of SCP herbicides to macroinvertebrates and algae, and (3) limited treatment acreage, the potential for food web effects to impact special status fish, resident native or migratory fish, is likewise low. The already low potential for toxicity effects of SCP herbicides can be further minimized by treating spongeplant early in the growing season and minimizing the future spread of spongeplant, thus reducing the amount of herbicide needed.

However, should food web effects result, they would constitute an **unavoidable or potentially unavoidable significant impact.** These impacts would potentially be avoided or reduced by implementing the following five mitigation measures.

- **Mitigation Measure 1** – Avoid herbicide application near special status species, and sensitive riparian and wetland habitat; and other biologically important resources.

  Each year, prior to start of the treatment season, DBW will conduct field crew environmental awareness training. Under this training, crews will be informed about the presence and life histories of special status species; habitats associated with species; sensitive habitats and wetlands; the terms and conditions of the program's biological opinion and/or letter of concurrence; environmental survey procedures; incidental take procedures; and that unlawful take of an animal or destruction of its habitat is a violation of the Endangered Species Act.

  DBW will provide crews with a field guide (Species Identification Deck) for easy identification of special status species on-site. Prior to treating a site, crews will conduct a visual survey to determine whether special status plants, animals, or sensitive habitats are present. Crews will complete an Environmental Observations Checklist, following an established protocol, for each site to document the presence or absence of listed or special status species. If listed or special status species or sensitive habits are present at the site, the field crew will not perform treatments that could potentially affect the species or habitat.

  DBW Environmental Scientists will classify treatment sites as high, medium, or low potential for nesting birds. DBW also will examine CNDDB records to determine if special status bird species have been sited within SCP treatment locations, and prepare a map for field crews identifying such sites. For those treatment sites that have habitat characteristics that might support special status bird species, Environmental Scientists will survey the specific site. DBW will delay treatments at locations where nesting Swainson's hawks are present until after June 10th, the start of the post-fledging stage.

  At all treatment locations, crews will conduct a visual survey, following an established protocol, to determine whether special status plants, animals, or sensitive habitats are present, including bird nesting sites. Crews will complete an Environmental Observations Checklist for each site to document the presence or absence of bird nesting sites. If nesting yellow-headed blackbird, Swainson's hawk, or tricolored blackbird are known to be present at the site, the field crew will not perform any treatment within 200 yards of the nesting site until the post-fledging stage.

- **Mitigation Measure 3** – Conduct herbicide treatments in order to minimize potential for drift.

  In addition to complying with the label application requirements, DBW will, to the degree possible, schedule herbicide applications to occur at high tide, or at a point in the tidal cycle determined by the field supervisor to provide the least non-target impact at a particular site. In general, treatment at high tide will allow for better spray accuracy and access, and will provide for greater dilution volume of herbicides. DBW crews will change nozzle type and spray pressures whenever conditions warrant, limiting the amount of herbicide which may inadvertently contact non-target species or enter the water.

- **Mitigation Measure 4** – Conduct herbicide treatments using diquat only in emergency situations and for no more than 50 acres in total among DBW aquatic weed control programs.

  To minimize the potential for negative impacts to covered species from exposure to diquat dibromide, DBW will only utilize diquat in emergency situations. Diquat will only be utilized from August 1st through November 30th of each year, and will be limited to a total of 50 treatment acres in the Delta per year, as a sum of the combined diquat acres treated in the SCP and EDCP. Emergency conditions are such that spongeplant growth completely impedes navigation of Delta waters, such as a completely blocked slough that would impair the movement of emergency response vessels. DBW will consult with USFWS and NMFS prior to utilizing diquat to help ensure that covered fish species are not likely to be present at the time of treatment.

- **Mitigation Measure 7** – Monitor herbicide and adjuvant levels to ensure that the SCP does not result in potentially toxic concentrations of chemicals in Delta waters.

  DBW will conduct comprehensive monitoring. This monitoring is in compliance with the general NPDES permit, and NMFS and USFWS Biological Opinions and/or Letters of Concurrence. DBW will collect samples prior to treatment, immediately after treatment, and post-treatment within one week of spraying. DBW will conduct water quality monitoring for visual parameters, physical parameters, and chemical parameters at one site per water body type for glyphosate and six sites per water body type for all other herbicides. Water samples will be submitted to a certified analytical laboratory to measure 2,4-D, glyphosate, penoxsulam, imazamox, diquat, and adjuvant levels. Should these levels exceed allowable limits, DBW will take immediate measures to reduce chemical levels at future treatment sites.

- **Mitigation Measure 8** – Implement an adaptive management approach to minimize the use of herbicides.

  Under an adaptive management approach, DBW will seek to improve efficacy and reduce environmental impacts over time as new and better information is available. Specifically, DBW will evaluate the need for control measures on a site by site, month-to-month, basis; select appropriate indicators for pre-treatment monitoring; monitor indicators following treatment and evaluate data to determine program efficacy and environmental impacts; support ongoing research to explore impacts of the SCP and alternative control methodologies; report findings to regulatory agencies; and adjust program actions, as necessary, in response to recommendations and evaluations by DBW staff, regulatory agencies and stakeholders.

  In addition to this adaptive management approach, DBW will follow maintenance control practices that from a program standpoint seek to reduce the number of acres of spongeplant to be treated each year, until treatment acreage reaches a minimal level. This will reduce the volume of herbicide utilized by the SCP.

* * * * *

There also are potential positive impacts to the Delta food web resulting from the SCP. Rapid growth and invasion of spongeplant reduces open water habitat and impairs wetlands and sensitive riparian habitats, altering the natural food web.

Impact B5 – Dissolved oxygen levels: effects of treatment on local dissolved oxygen (DO) levels, and resulting impact on special status species, resident native or migratory fish, sensitive habitat, and wetlands

The SCP could result in adverse indirect effects to special status fish, resident and migratory fish, and sensitive riparian and wetland habitats due to the rapid decay of spongeplant, other aquatic macrophytes, and algae following herbicide application. Decomposition of vegetative material may create an increased organic carbon load, which could in turn reduce dissolved oxygen concentrations. Low DO can result in fish kills, impede migration of salmonids, and kill aquatic invertebrates. These effects in turn may, at least temporarily, impair sensitive riparian and wetland habitats. However, DWR and the U.S. Bureau of Reclamation (1994) noted that in the Delta in general, constituents such as dissolved oxygen have not changed on a large enough scale to affect mobile organisms, specifically delta smelt and splittail.

Dissolved oxygen is the content of oxygen found in water. DO is determined by temperature, weather, water flow, nutrient levels, algae, and aquatic plants. Until very high oxygen levels are reached, a higher level of DO is beneficial. Fish begin to experience oxygen stress or exhibit avoidance at levels below 5 mg/liter (5 ppm). DO levels drop in warmer temperatures, and increase with precipitation, wind, and water flow. Running water, such as tidal water in the Delta, dissolves more oxygen than still 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.

There is the potential that following herbicide treatment, the biomass of decaying spongeplant will create a large biological oxygen demand, resulting in decreases in dissolved oxygen. These decreases in dissolved oxygen could adversely affect fish species and aquatic invertebrates present at the treatment location, and potentially impair sensitive riparian or wetland habitats. The extent of the DO impact depends on the speed at which spongeplant decomposes following treatment (which is herbicide dependent) and the extent to which tides and wind move decaying plants away from the original location (which is variable).

SCP herbicide labels include provisions to address the potential for low dissolved oxygen following treatment, when appropriate. When herbicides are used according to label instructions, there will likely be no significant effect on DO, except to increase DO levels once the plants have completed decomposition. Label requirements related to DO impacts are as follows:

- The label for Weedar 64 (2,4-D) notes that decaying weeds use up oxygen, and recommends treating part of the infestation at one time. For example, the label recommends applying 2,4-D in lanes separated by untreated strips, and delaying treatment of these strips for 21 days, until the treated dead vegetation has decomposed
- The label for Roundup Custom (glyphosate) recommends treating an area in strips when there is full coverage of the weed in impounded areas to avoid oxygen depletion. The Delta does not contain impounded waters
- The label for Galleon (penoxsulam) does not include specific provisions related to DO
- The label for Clearcast (imazamox) does not include specific provisions related to DO
- The label for Reward (diquat) specifies that no more than one-third to one-half of a water body should be treated at one time, with a waiting period of 14 days for follow-up treatment of the remaining area.

Dissolved oxygen levels under dense spongeplant mats are expected to be low, similar to under water hyacinth mats. For water hyacinth, Toft (2000) and others have found lower levels of dissolved oxygen under hyacinth canopies. Average spot measures were below 5 ppm in hyacinth, and above 5 ppm in pennywort (Toft 2000). These results were supported by a study in Texas which found lower dissolved oxygen in hyacinth compared to other aquatic weeds, and a University of California, Davis study which found dissolved oxygen levels as low as 0 ppm below a solid water hyacinth mat (Toft 2000). Toft hypothesized that lower dissolved oxygen levels explained the absence of epibenthic amphipods and isopods beneath the hyacinth canopy at one of the test sites (Toft 2000). Thus, it is likely that fish and other mobile aquatic invertebrates will avoid areas under water hyacinth [or spongeplant] mats with low dissolved oxygen, even prior to treatment (NMFS April 2006).

Given current low spongeplant infestation levels, the potential for DO effects is likely to be lower than for water hyacinth. Below, as a baseline, we discuss WHCP DO monitoring results. DBW will conduct similar monitoring for the SCP to determine how spongeplant treatments will affect DO.

The WHCP tracks two sets of DO monitoring. At every herbicide application, treatment crews take DO samples immediately prior to treating, and immediately 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 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.

Table 3-20
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.

The data in **Table 3-20,** above, provide WHCP 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. Site 16 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, 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 monitor pre- and post-treatment DO levels for the SCP.

In 2013, DBW conducted a pilot study for DO monitoring to assess impacts of water hyacinth and herbicide treatments on DO. Again, we would expect large spongeplant mats to have similar DO effects. 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 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 concentrations occurring in the afternoon.

Even short-term, localized impacts on dissolved oxygen could result in adverse effects on special status fish, resident native, or migratory fish, or impair sensitive riparian or wetland habitats in SCP treatment sites. Such reductions in dissolved oxygen would represent avoidable significant impacts. **These avoidable significant impacts would be reduced to a less-than-significant level** by implementing the following two mitigation measures. DBW's Fish Passage Protocol, which incorporates these measures, is provided in Volume II of this PEIR.

- **Mitigation Measure 10** – Monitor dissolved oxygen levels pre- and post-treatment for all SCP treatments.

  Based on the pre-treatment DO levels, the application crew will determine whether to conduct treatment at that site. No treatment will be performed when dissolved oxygen levels are between 3 ppm (the level below which DO is considered to be detrimental to fish species) and the basin plan limits established by the CVRWQCB. The basin plan limits depend on location and time of year, and range from 5 ppm to 8 ppm. DBW will maintain written and map summaries of specific DO numeric limits. When pre-treatment levels are below 3 ppm, fish species are not likely to be present due to the extremely low oxygen levels. When pre-treatment levels are above the basin plan limit, SCP treatments, following label guidelines and mitigation measures, are not expected to adversely affect special status fish, resident native or migratory fish, or sensitive riparian or wetland habitats.

- **Mitigation Measure 11** – Implement the Fish Passage Protocol to provide a zone of passage through areas of low dissolved oxygen.

  In slow-moving and back-end sloughs infested with spongeplant, treat up to 30 percent of spongeplant mats at one time. Treat mats in up to 3 acre strips, leaving at least 100 foot buffer strips between treated areas. Treat the untreated buffer strips and remaining 70 percent of the spongeplant mat at least three more times following the initial treatment (in 30 percent increments). Conduct follow-up treatments in three week intervals.

  In Delta tidal waters, treat up to 50 percent of the spongeplant mat at one time. Treat mats in up to 3 acre strips, leaving at least 100 foot buffer strips between treated areas. Treat the untreated buffer strips and remaining 50 percent of the mat three weeks following the initial treatment for 2,4-D, and one week following the initial treatment for other herbicides.

  In treatment sites where DO levels are below 3 mg/l prior to SCP treatments, treat the entire area, without the 3 acre strips or buffer strips.

* * * * *

There also are positive impacts related to dissolved oxygen that will result from the SCP. Once dead spongeplant has decayed or floated away, dissolved oxygen levels at treatment sites will increase, improving fish habitat. Removing large patches of spongeplant will allow DO levels to increase, thus enhancing the ability of fish to move unimpeded in Delta waters. It could be argued that such a benefit outweighs the impact of short-term localized decreases in dissolved oxygen.

Impact B6 – Treatment disturbances: effects of treatment disturbances on special status species, resident native or migratory fish, sensitive habitat, and wetlands

Operational activities associated with SCP herbicide treatments, hand removal with nets, herding, and mechanical removal primarily using motorized watercraft, may result in operational-related disturbances on special status species, or resident native or migratory fish species located nearby. These disturbances may also temporarily result in impacts to sensitive riparian or wetland habitats. The following discussion of potential adverse effects is adopted from the *Clear Lake Integrated Aquatic Plant Management Plan Draft Program EIR* (County of Lake 2005, p 7-34 to 7-35).

Boat noise has been identified as inducing the startle and alarm responses in fish (Scholik and Yan 2002). These responses cause fish to flee an area (Boussard 1981). Boat noise has also been shown to temporarily reduce auditory sensitivity of some fish species (Scholik and Yan 2002). However, the Delta is already heavily used by motorboats, and the current level of DBW vegetation management activities using boats have been conducted for over 30 years. Thus, fish are likely habituated to a substantial degree of boat-related noise. The SCP is not expected to result in significant additional boat disturbance to fish.

The flush response in birds is defined as the instinct to abandon a current location in response to an external stimulus. While loud noise may stimulate the flush response of nesting, foraging, and resting waterfowl of any species, research suggests that rapid visual disturbance from approaching watercraft is a more influential factor in flushing waterfowl than noise (Rogers 1998, 2000). This appears to be particularly true for watercraft that displace a large amount of water into the air because of hull shape, motor behavior, velocity, and/or method of steering. However, because faster-moving boats produce more noise, flushing may be a combined effect of approach, velocity, and noise (Burger 1998). Direction of approach seems to make little difference.

In addition, loud noises (approximately 120dBA), usually generated by propane cannons, are successfully used to flush resting birds from the ponds of agricultural areas, open pit mines, and other locations where bird presence is undesirable. Thus, it can be concluded that very loud noise can elicit a flush response in birds. It should be noted that different species exhibit different levels of skittishness to external stimuli, and that nesting birds are more reluctant to flush than non-nesting birds of the same species. Some bird species have also shown an ability to develop tolerance to external stimuli.

In May 2003, SFEI initiated consultations with USFWS and NMFS to evaluate the impact of mechanical removal on endangered species. Both services issued letters indicating that formal consultation was not required, and approved the mechanical removal project with conditions. The conditions, included: (1) efforts be made to minimize the impacts on listed species; and (2) the project occur within the dates when sensitive species are least likely to be adversely affected (between July 15th and October 31st) (Greenfield et al. 2007).

San Francisco Estuary Institute evaluated the potential impacts of mechanical removal of water hyacinth in the Delta using specialized aquatic equipment in 2003 and 2004. Future mechanical removal of spongeplant would have similar effects. The extent that SCP will utilize mechanical removal approaches depends on the size of the spongeplant invasion. At current (2014) levels, mechanical removal will likely not be necessary.

Current SCP mechanical removal activities will have less potential of impacting listed species because the spongeplant will be directly removed from the water with conveyors. Removing plants will reduce the potential for lower dissolved oxygen due to plant decomposition. Greenfield also concluded that estuary-wide effects of mechanical removal using specialized aquatic equipment would be limited.

Airboat noise, mechanical removal, and related disturbances during SCP treatment are unlikely to result in significant impacts to special status fish; amphibians or reptiles; resident native or migratory fish; or sensitive riparian or wetland habitats. Airboat noise during SCP treatment has the potential to result in noise-related disturbances to waterfowl. Three special status bird species, yellow-headed blackbird (*Xanthocephalus xanthocephalus*), Swainson's hawk (*Buteo Swainsoni*), and tricolored blackbird (*Agelaius tricolor*), could nest adjacent to SCP treatment locations during summer treatment months. There is the potential that these species would be disturbed by SCP vessels. This disturbance would be temporary, and would occur at most one to two times per treated site. There is the potential that mechanical removal would disturb nesting birds, fish or reptile species. However, these disturbances would represent **an avoidable significant impact that would be reduced to a less-than-significant level** by implementation of the following three mitigation measures.

- **Mitigation Measure 1** – Avoid herbicide application near special status species, and sensitive riparian and wetland habitat; and other biologically important resources.

  Each year, prior to start of the treatment season, DBW will conduct field crew environmental awareness training. Under this training, crews will be informed about the presence and life histories of special status species; habitats associated with species; sensitive habitats and wetlands; the terms and conditions of the program's biological opinion and/or letter of concurrence; environmental survey procedures; incidental take procedures; and that unlawful take of an animal or destruction of its habitat is a violation of the Endangered Species Act.

  DBW will provide crews with a field guide (Species Identification Deck) for easy identification of special status species on-site. Prior to treating a site, crews will conduct a visual survey to determine whether special status plants, animals, or sensitive habitats are present. Crews will complete an Environmental Observations Checklist, following an established protocol, for each site to document the presence or absence of listed or special status species. If listed or special status species or sensitive habits are present at the site, the field crew will not perform treatments that could potentially affect the species or habitat.

  DBW Environmental Scientists will classify treatment sites as high, medium, or low potential for nesting birds. DBW also will examine CNDDB records to determine if special status bird species have been sited within SCP treatment locations, and prepare a map for field crews identifying such sites. For those treatment sites that have habitat characteristics that might support special status bird species, Environmental Scientists will survey the specific site. DBW will delay treatments at locations where nesting Swainson's hawks are present until after June 10th, the start of the post-fledging stage.

At all treatment locations, crews will conduct a visual survey, following an established protocol, to determine whether special status plants, animals, or sensitive habitats are present, including bird nesting sites. Crews will complete an Environmental Observations Checklist for each site to document the presence or absence of bird nesting sites. If nesting yellow-headed blackbird, Swainson's hawk, or tricolored blackbird are known to be present at the site, the field crew will not perform any treatment within 200 yards of the nesting site until the post-fledging stage.

- **Mitigation Measure 5** – Operate program vessels in a manner that causes the least amount of disturbance to the habitat.

  Operational procedures for DBW vessels will minimize boat wakes and propeller wash. These procedures will be particularly important in shallow water, or other sensitive habitats.

- **Mitigation Measure 12** – Follow environmental compliance measures for species avoidance, equipment operation, and disposal when conducting mechanical harvesting operations.

  DBW will implement a protocol similar to that for chemical treatment prior to conducting mechanical removal. Environmental scientists will check fish survey data to verify that listed fish species are not likely to be present at the removal site. The equipment operator will utilize the Environmental Checklist to evaluate presence of listed species or sensitive habitat prior to removal. If listed species or sensitive habitats are present, the operator will not conduct mechanical removal at that site. DBW will conduct mechanical removal of spongeplant in sensitive giant garter snake habitat or areas where giant garter snakes have been sighted in the past, only between October 1st and May 1st. The mechanical harvester will maintain a speed of 2 to 2.5 knots in areas outside of sensitive giant garter snake habitat, or areas where giant garter snake has been sighted in the past, during the active season, so that if giant garter snake were in the area, they could move out of the way. The operator will stop and reverse the mechanical harvester if a snake is seen within spongeplant during removal. DBW will dispose of all spongeplant collected by mechanical removal outside of the May 1st to October 1st giant garter snake active season at an approved disposal facility to ensure no hibernating giant garter snakes are buried under piles of collected spongeplant.

Impact B7 – Plant fragmentation: effects of plant fragmentation on sensitive habitat and wetlands

There is the potential for plant fragmentation resulting from SCP activities to impact sensitive habitats and wetlands. Hand removal with nets, herding, and mechanical removal have the potential to release spongeplant fragments.

With hand removal with nets, there is a possibility that some fragments of spongeplant will float away from the boat before the crew can scoop up the plants. With herding, there is a possibility that some plants will escape the "cage", and not be pushed out of the Delta. With mechanical removal, there is the possibility that some spongeplant will not be captured by the equipment, and will float away. The likelihood of these events occurring is low, as hand removal with nets, herding, and mechanical removal will take place under slow and deliberate conditions.

Spongeplant has been shown to successfully propagate from fragments (Akers 2010 b). Thus, to the extent that plants or fragments "escape" the physical removal processes, they may propagate into new spongeplants, and establish new spongeplant colonies. This would potentially impair sensitive habitats and wetlands in the Delta.

Further spread of spongeplant due to fragmentation would represent **an avoidable significant impact to sensitive habitats and wetlands, but would be reduced to a less-than-significant level** by implementation of the following two mitigation measures.

- **Mitigation Measure 12** – Follow environmental compliance measures for species avoidance, equipment operation, and disposal when conducting mechanical harvesting operations.

  DBW will implement a protocol similar to that for chemical treatment prior to conducting mechanical removal. Environmental scientists will check fish survey data to verify that listed fish species are not likely to be present at the removal site. The equipment operator will utilize the Environmental Checklist to evaluate presence of listed species or sensitive habitat prior to removal. If listed species or sensitive habitats are present, the operator will not conduct mechanical removal at that site. DBW will conduct mechanical removal of spongeplant in sensitive giant garter snake habitat or areas where giant garter snakes have been sighted in the past, only between October 1st and May 1st. The mechanical harvester will maintain a speed of 2 to 2.5 knots in areas outside of sensitive giant garter snake habitat, or areas where giant garter snake has been sighted in the past, during the active season, so that if giant garter snake were in the area, they could move out of the way. The operator will stop and reverse the mechanical harvester if a snake is seen within spongeplant during removal. DBW will dispose of all spongeplant collected by mechanical removal outside of the May 1st to October 1st giant garter snake active season at an approved disposal facility to ensure no hibernating giant garter snakes are buried under piles of collected spongeplant.

- **Mitigation Measure 13** – Collect plant fragments during and immediately following treatments.

  To maximize containment of plant fragments, crews will collect spongeplant fragments. Crews will also be trained on the importance of minimizing fragment escape.

Impact B8 – Disposal of harvested spongeplant: effects of disposal following hand removal with nets or mechanical removal on giant garter snake, sensitive habitat and wetlands

Disposal of spongeplant hand removed with nets or mechanically harvested, if not properly managed, could impair giant garter snake burrows, sensitive habitats and wetlands. Giant garter snakes typically inhabit small mammal burrows and other soil crevices throughout their winter dormancy period (October through April). This could include levees near spongeplant removal locations

To prevent disposal-related impacts, disposal of spongeplant will occur at previously surveyed areas with low habitat value. Crews will leave spongeplant in these dispersal areas to desiccate naturally, and will periodically monitor the areas to observe and record the fate of the spongeplant and any effects of dispersal activities. The **less-than-significant level impact** that would occur to sensitive habitats and wetlands from plant disposal will be further minimized by the following two mitigation measures.

- **Mitigation Measure 14** – Identify and utilize disposal areas that have no and/or low habitat value for the federal and State listed giant garter snake (*Thamnophis gigas*).

  DBW will provide crews electronic mapping that identifies previously surveyed areas for giant garter snake habitat. Crews also will conduct surveys to ensure that there are no other special status plant or animal species located within 100 feet of disposal sites.

- **Mitigation Measure 15** – Identify and utilize disposal areas that are at least 100 feet away from elderberry shrubs (*Sambucus* ssp.).

  Elderberry shrubs are potential habitat for the federally threatened valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*).

* * * * *

This section identified 15 mitigation measures to address the eight potential impacts to biological resources. Several mitigation measures apply to more than one impact. **Exhibit 3-4,** on the next page, summarizes these biological resource mitigation measures.

Exhibit 3-4
Summary of Potential Biological Resource Impacts and Mitigation Measures

Mitigation Measure Summary[1]	Impacts Applied To
1. Avoid herbicide application near special status species, and sensitive riparian and wetland habitat; and other biologically important resources	Impact B1: Herbicide overspray Impact B2: Herbicide toxicity Impact B4: Food web effects Impact B6: Treatment disturbances
2. Provide a 100 foot buffer between treatment sites and shoreline elderberry shrubs (*Sambucus* ssp.), host plant for the Valley elderberry longhorn beetle *(Desmocerus californicus dimorphus)* (reduced to 50 feet in some instances)	Impact B1: Herbicide overspray
3. Conduct herbicide treatments in order to minimize potential for drift	Impact B1: Herbicide overspray Impact B2: Herbicide toxicity Impact B4: Food web effects
4. Conduct herbicide treatments using diquat in only emergency situations and for no more than 50 acres in total among DBW aquatic weed control programs	Impact B1: Herbicide overspray Impact B2: Herbicide toxicity
5. Operate program vessels in a manner that causes the least amount of disturbance to the habitat	Impact B1: Herbicide overspray Impact B6: Treatment disturbances
6. Implement temporal and spatial limitations and restrictions on herbicide treatments to minimize treatments during times and at locations where larval and/or migratory fish are likely to be present	Impact B2: Herbicide toxicity
7. Monitor herbicide and adjuvant levels to ensure that the SCP does not result in potentially toxic concentrations of chemicals in Delta waters	Impact B2: Herbicide toxicity Impact B4: Food web effects
8. Implement an adaptive management approach to minimize the use of herbicides	Impact B2: Herbicide toxicity Impact B4: Food web effects
9. Provide treatment crews with electronic mapping that identifies previously surveyed areas for giant garter snake habitat, valley elderberry shrubs, and nesting special status birds	Impact B2: Herbicide toxicity
10. Monitor dissolved oxygen levels pre- and post-treatment for all WHCP treatments	Impact B5: Dissolved oxygen levels
11. Implement the Fish Passage Protocol to provide a zone of passage through areas of low dissolved oxygen	Impact B5: Dissolved oxygen levels
12. Follow environmental compliance measures for species avoidance, equipment operations, and disposal when conducting mechanical harvesting operations	Impact B7: Plant fragmentation Impact B8: Disposal of harvested spongeplant
13. Collect plant fragments during and immediately following treatments	Impact B7: Plant fragmentation
14. Identify and utilize disposal areas that have no and/or low habitat value for the federal and State listed giant garter snake *(Thamnophis gigas)*	Impact B8: Disposal of harvested spongeplant
15. Identify and utilize disposal areas that are at least 100 feet away from elderberry shrubs (*Sambucus* ssp.)	Impact B8: Disposal of harvested spongeplant

[1] Please refer to the text for the complete mitigation measure description.

Exhibit 3-5
Special Status Species in the Eleven (11) Counties within SCP Area, Not Likely to be Impacted by the SCP *Page 1 of 11*

Scientific Name	Common Name	Status*
Invertebrates		
1. *Apodemia mormo langei*	Lange's metalmark butterfly	FE
2. *Branchinecta conservatio*	Conservancy fairy shrimp	FE
3. *Branchinecta longiantenna*	longhorn fairy shrimp	FE, FCH
4. *Branchinecta lynchi*	vernal pool fairy shrimp	FT, FCH
5. *Elaphrus viridis*	delta green ground beetle	FT
6. *Euphydryas editha bayensis*	bay checkerspot butterfly	FT
7. *Lepidurus packardi*	vernal pool tadpole shrimp	FE, FCH
8. *Speyeria callippe callippe*	callippe silverspot butterfly	FE
Fish		
Scientific Name	**Common Name**	**Status***
1. *Archoplites interruptus*	Sacramento perch	CSC
2. *Eucyclogobius newberryi*	tidewater goby	FE, CSC
3. *Lampetra hubbsi*	Kern brook lamprey	CSC
4. *Lavinia symmetricus ssp. 1*	San Joaquin roach	CSC
5. *Lavinia symmetricus ssp. 3*	Red Hills roach	CSC
6. *Mylopharodon conocephalus*	hardhead	CSC
7. *Oncorhynchus (=Salmo) clarki henshawi*	Lahontan cutthroat trout	FT
8. *Oncorhynchus (=Salmo) clarki seleniris*	Paiute cutthroat trout	FT
9. *Oncorhynchus kisutch*	coho salmon central CA coast	FE, SE
10. *Oncorhynchus mykiss*	Central California Coastal steelhead	FT, FCH
Amphibians		
Scientific Name	**Common Name**	**Status***
1. *Ambystoma californiense*	California tiger salamander, central population	FT, FCH, CSC
2. *Bufo canorus*	Yosemite toad	CSC, FC
3. *Hydromantes platycephalus*	Mount Lyell salamander	CSC
4. *Rana boylii*	Foothill yellow-legged frog	CSC
5. *Rana muscosa*	mountain yellow-legged frog	FC, CSC
6. *Spea hammondii*	western spadefoot	CSC
Reptiles		
Scientific Name	**Common Name**	**Status***
1. *Anniella pulchra pulchra*	silvery legless lizard	CSC
2. *Gambelia (=Crotaphytus) sila*	blunt-nosed leopard lizard	FE, CE
3. *Masticophis flagellum ruddocki*	San Joaquin whipsnake	CSC
4. *Masticophis lateralis euryxanthus*	Alameda whipsnake	FT, FCH, CT
5. *Phrynosoma coronatum (frontale population)*	coast (California) horned lizard	CSC
6. *Thamnophis hammondii*	two-striped garter snake	CSC

Exhibit 3-5
Special Status Species in the Eleven (11) Counties within SCP Area, Not Likely to be Impacted by the SCP *(continued)* *Page 2 of 11*

Birds		
Scientific Name	**Common Name**	**Status***
1. *Ammodramus savannarum*	grasshopper sparrow	CSC
2. *Accipiter gentilis*	northern goshawk	CSC
3. *Asio flammeus*	short-eared owl	CSC
4. *Asio otus*	long-eared owl	CSC
5. *Athene cunicularia*	burrowing owl	CSC
6. *Charadrius alexandrinus nivosus*	western snowy plover	FT, CSC
7. *Charadrius montanus*	mountain plover	CSC
8. *Circus cyaneus*	northern harrier	CSC
9. *Coccyzus americanus occidentalis*	western yellow-billed cuckoo	FC, CE
10. *Coturnicops noveboracensis*	yellow rail	CSC
11. *Dendroica petechia brewsteri*	yellow warbler	CSC
12. *Empidonax traillii*	willow flycatcher	CE
13. *Falco peregrinus anatum*	American peregrine falcon	CE
14. *Geothlypis trichas sinuosa*	saltmarsh common yellowthroat	CSC
15. *Grus Canadensis Canadensis*	lesser sandhill crane	CSC
16. *Gymnogyps californianus*	California condor	FE
17. *Haliaeetus leucocephalus*	bald eagle	CE
18. *Icteria virens*	yellow-breasted chat	CSC
19. *Lanius ludovicianus*	loggerhead shrike	CSC
20. *Melospiza melodia maxillaris*	Suisun song sparrow	CSC
21. *Melospiza melodia pusillula*	Alameda song sparrow	CSC
22. *Melospiza melodia samuelis*	San Pablo song sparrow	CSC
23. *Pelecanus occidentalis californicus*	California brown pelican	FE
24. *Progne subis*	purple martin	CSC
25. *Rallus longirostris obsoletus*	California clapper rail	FE, CE
26. *Riparia riparia*	bank swallow	CT
27. *Rynchops niger*	black skimmer	CSC
28. *Sternula antillarum (=Sterna, =albifrons) browni*	California least tern	FE, CE
29. *Strix nebulosa*	great grey owl	CE
30. *Strix occidentalis caurina*	northern spotted owl	FT
31. *Toxostoma lecontei*	Le Conte's thrasher	CSC

Exhibit 3-5
Special Status Species in the Eleven (11) Counties within SCP Area, Not Likely to be Impacted by the SCP *(continued)* *Page 3 of 11*

Mammals		
Scientific Name	**Common Name**	**Status***
1. *Ammospermophilus nelson*	Nelson's (=San Joaquin) antelope squirrel	CT
2. *Antrozous pallidus*	pallid bat	CSC
3. *Aplodontia rufia californica*	Sierra Nevada mountain beaver	CSC
4. *Corynorhinus townsendii*	Townsend's big-eared bat	CSC
5. *Dipodomys ingens*	giant kangaroo rat	FE, CE
6. *Dipodomys nitratoides brevinasus*	short-nosed kangaroo rat	CSC
7. *Dipodomys nitratoides exilis*	Fresno kangaroo rat	FE, FCH, CE
8. *Dipodomys nitratoides nitratoides*	Tipton kangaroo rat	FE
9. *Euderma maculatum*	spotted bat	CSC
10. *Eumops perotis californicus*	western mastiff bat	CSC
11. *Gulo gulo*	California wolverine	CT
12. *Lasiurus blossevillii*	western red bat	CSC
13. *Lepus americanus tahoensis*	Sierra Nevada snowshoe hare	CSC
14. *Martes pennanti*	fisher	FC, CSC
15. *Microtus californicus sanpabloensis*	San Pablo vole	CSC
16. *Neotoma fuscipes annectens*	San Francisco dusky-footed woodrat	CSC
17. *Neotoma fuscipes riparia*	riparian (San Joaquin Valley) woodrat	FE, CSC
18. *Nyctinomops macrotis*	big free-tailed bat	CSC
19. *Onychomys torridus tularensis*	Tulare grasshopper mouse	CSC
20. *Ovis canadensis californiana*	Sierra Nevada (=California) bighorn sheep	FE, CE
21. *Reithrodontomys raviventris*	salt marsh harvest mouse	FE, CE
22. *Scapanus latimanus parvus*	Alameda Island mole	CSC
23. *Sorex lyelli*	Mount Lyell shrew	CSC
24. *Sorex ornatus sinuosus*	Suisun shrew	CSC
25. *Sorex vagrans halicoetes*	salt-marsh wandering shrew	CSC
26. *Sylvilagus bachmani riparius*	riparian brush rabbit	FE, CE
27. *Taxidea taxus*	American badger	CSC
28. *Vulpes macrotis mutica*	San Joaquin kit fox	FE, CT
29. *Vulpes vulpes necator*	Sierra Nevada red fox	CT

Exhibit 3-5
Special Status Species in the Eleven (11) Counties within SCP Area, Not Likely to be Impacted by the SCP *(continued)* *Page 4 of 11*

Plants		
Scientific Name	**Common Name**	**Status***
1. *Agrosti hendersonii*	Henderson's bent grass	CNPS 3.2
2. *Agrosti humilis*	mountain bent grass	CNPS 2.3
3. *Allium jepsonii*	Jepson's onion	CNPS 1B.2
4. *Allium sharsmithiae*	Sharsmith's onion	CNPS 1B.3
5. *Allium tribracteatum*	three-bracted onion	CNPS 1B.2
6. *Allium tuolumnense*	Rawhide Hill onion	CNPS 1B.2
7. *Allium yosemitense*	Yosemite onion	CNPS 1B.3
8. *Amsinckia grandiflora*	large-flowered fiddleneck	FE, CE, CNPS 1B.1
9. *Amsinckia lunaris*	bent-flowered fiddleneck	CNPS 1B.2
10. *Anomobryum julaceum*	slender silver moss	CNPS 2.2
11. *Arabis bodiensis*	Bodie Hills rock-cress	CNPS 1B.3
12. *Arctostaphylos auriculata*	Mt. Diablo manzanita	CNPS 1B.3
13. *Arctostaphylos manzanita ssp. laevigata*	Contra Costa manzanita	CNPS 1B.2
14. *Arctostaphylos nissenana*	Nissenan manzanita	CNPS 1B.2
15. *Arctostaphylos pallida*	pallid Manzanita (=Alameda or Oakland Hills manzanita)	FT, CE, CNPS 1B.1
16. *Astragalus rattanii var. jepsonianus*	Jepson's milk-vetch	CNPS 1B.2
17. *Astragalus ravenii*	Raven's milk-vetch	CNPS 1B
18. *Astragalus tener var. ferrisiae*	Ferris' milk-vetch	CNPS 1B.1
19. *Astragalus tener var. tener*	alkali milk-vetch	CNPS 1B.2
20. *Atriplex cordulata*	heartscale	CNPS 1B.2
21. *Atriplex depressa*	brittlescale	CNPS 1B.2
22. *Atriplex joaquiniana*	San Joaquin spearscale	CNPS 1B.2
23. *Atriplex minuscula*	lesser saltscale	CNPS 1B.1
24. *Atriplex persistens*	vernal pool smallscale	CNPS 1B.2
25. *Atriplex subtilis*	subtle orache	CNPS 1B.2
26. *Atriplex vallicola*	Lost Hills crownscale	CNPS 1B.2
27. *Balsamorhiza macrolepis var. macrolepis*	big-scale balsamroot	CNPS 1B.2
28. *Blepharizonia plumosa*	big tarplant	CNPS 1B.1
29. *Botrychium lineare*	slender moonwort	CNPS 1B.3
30. *Botrychium lunaria*	common moonwort	CNPS 2.3
31. *Botrychium minganense*	mingan moonwort	CNPS 2.2
32. *Botrychium montanum*	western goblin	CNPS 2.1
33. *Brodiaea pallida*	Chinese Camp brodiaea	FT, CE, CNPS 1B.1
34. *Bruchia bolanderi*	Bolander's bruchia	CNPS 2.2

Exhibit 3-5
Special Status Species in the Eleven (11) Counties within SCP Area, Not Likely to be Impacted by the SCP *(continued)* *Page 5 of 11*

Plants *(continued)*		
Scientific Name	**Common Name**	**Status***
35. *California macrophylla*	round-leaved filaree	CNPS 1B.1
36. *Calochortus pulchellus*	Mt. Diablo fairy-lantern	CNPS 1B.2
37. *Calycadenia hooveri*	Hoover's calycadenia	CNPS 1B.3
38. *Calyptridium pulchellum*	Mariposa pussy-paws	FT, CNPS 1B.1
39. *Calystegia atriplicifolia ssp. buttensis*	Butte County morning-glory	CNPS 1B.2
40. *Calystegia purpurata ssp. saxicola*	coastal bluff morning-glory	CNPS 1B.2
41. *Camissonia benitensis*	San Benito evening-primrose	FT, CNPS 1B.1
42. *Camissonia sierra ssp. alticola*	Mono Hot Springs evening-primrose	CNPS 1B.2
43. *Campanula exigua*	chaparral harebell	CNPS 1B.2
44. *Campanula sharsmithiae*	Sharsmith's harebell	CNPS 1B.2
45. *Carex limosa*	mud sedge	CNPS 2.2
46. *Carex praticola*	northern meadow sedge	CNPS 2.2
47. *Carex tompkinsii*	Tompkin's sedge	CNPS 4.3
48. *Carex virdula var. viridula*	green yellow sedge	CNPS 2.3
49. *Carex vulpinoidea*	brown fox sedge	CNPS 2.2
50. *Carlquistia muirii*	Muir's tarplant	CNPS 1B.3
51. *Carpenteria californica*	tree-anemone	CNPS 1B.2
52. *Castilleja campestris ssp. succulenta*	succulent (=fleshy) owl's-clover	FT, FCH, CE, CNPS 1B.2
53. *Castilleja rubicundula ssp. rubicundula*	pink creamsacs	CNPS 1B.2
54. *Caulanthus californicus*	California jewelflower	FE, CE, CNPS 1B.1
55. *Caulanthus coulteri var. lemmonii*	Lemmon's jewelflower	CNPS 1B.2
56. *Ceanothus purpureus*	holly-leaved ceanothus	CNPS 1B.2
57. *Centromadia parryi ssp. congdonii*	Congdon's tarplant	CNPS 1B.2
58. *Centromadia parryi ssp. parryi*	pappose tarplant	CNPS 1B.2
59. *Chaenactis douglasii var. alpina*	alpine dusty maidens	CNPS 2.3
60. *Chamaesyce hooveri*	Hoover's spurge	FT, FCH, CNPS 1B.2
61. *Chlorogalum grandiflorum*	Red Hills soaproot	CNPS 1B.2
62. *Chorizanthe biloba var. immemora*	Hernandez spineflower	CNPS 1B.2
63. *Chorizanthe cuspidata var. cuspidata*	San Francisco Bay spineflower	CNPS 1B.2
64. *Chorizanthe robusta var. robusta*	robust spineflower	FE, CNPS 1B.1
65. *Cirsium andrewsii*	Franciscan thistle	CNPS 1B.2
66. *Cirsium crassicaule*	slough thistle	CNPS 1B.1
67. *Cirsium fontinale var. campylon*	Mt. Hamilton fountain thistle	CNPS 1B.2
68. *Cirsium hydrophilum var. hydrophilum*	Suisun thistle	FE, FCHP, CNPS 1B.1

Exhibit 3-5
Special Status Species in the Eleven (11) Counties within SCP Area, Not Likely to be Impacted by the SCP *(continued)* *Page 6 of 11*

Plants *(continued)*		
Scientific Name	**Common Name**	**Status***
69. *Clarkia australis*	Small's southern clarkia	CNPS 1B.2
70. *Clarkia biloba ssp. brandegeeae*	Brandegee's clarkia	CNPS 1B.2
71. *Clarkia concinna ssp. automixa*	Santa Clara red ribbons	CNPS 4.3
72. *Clarkia franciscana*	Presidio clarkia	FE, CE, CNPS 1B.1
73. *Clarkia rostrata*	beaked clarkia	CNPS 1B.3
74. *Claytonia megarhiza*	fell-fields claytonia	CNPS 2.3
75. *Collomia rawsoniana*	Rawson's flaming trumpet	CNPS 1B.2
76. *Cordylanthus maritimus ssp. palustris*	Point Reye's bird's-beak	CNPS 1B.2
77. *Cordylanthus mollis ssp. hispidus*	Hispid bird's-beak	CNPS 1B.1
78. *Cordylanthus mollis ssp. mollis*	soft bird's-beak	FE, FCHP, CR, CNPS 1B.2
79. *Cordylanthus nidularius*	Mt. Diablo bird's-beak	CNPS 1B.1
80. *Cordylanthus palmatus*	palmate-bracted bird's beak	FE, CE, CNPS 1B.1
81. *Coreopsis hamiltonii*	Mt. Hamilton coreopsis	CNPS 1B.2
82. *Cryptantha crymophilia*	subalpine cryptantha	CNPS 1B.3
83. *Cryptantha hooveri*	Hoover's cryptantha	CNPS 1A
84. *Cryptantha mariposae*	Mariposa cryptantha	CNPS 1B.3
85. *Deinandra bacigalupii*	Livermore tarplant	CNPS 1B.2
86. *Deinandra halliana*	Hall's tarplant	CNPS 1B.1
87. *Delphinium californicum ssp. interius*	Hospital Canyon larkspur	CNPS 1B.2
88. *Delphinium inopinum*	unexpected larkspur	CNPS 4.3
89. *Delphinium recurvatum*	recurved larkspur	CNPS 1B.2
90. *Didymodon norrisii*	Norris' beard moss	CNPS 2.2
91. *Dirca occidentalis*	western leatherwood	CNPS 1B.2
92. *Downingia pusilla*	dwarf downingia	CNPS 2.2
93. *Draba asterophora var. asterophora*	Tahoe draba	CNPS 1B.3
94. *Draba incrassata*	Sweetwater Mountains draba	CNPS 1B.3
95. *Draba praealta*	tall draba	CNPS 2.3
96. *Draba sierrae*	Sierra draba	CNPS 1B.3
97. *Elymus scribneri*	Scribner's wheat grass	CNPS 2.3
98. *Epilobium howellii*	subalpine fireweed	CNPS 1B.3
99. *Eriastrum brandegeeae*	Brandegee's eriastrum	CNPS 1B.2
100. *Eriastrum hooveri*	Hoover's eriastrum	CNPS 4.2
101. *Erigeron aequifolius*	Hall's daisy	CNPS 1B.3
102. *Erigeron inornatus var. keilii*	keil's daisy	CNPS 1B.3

Exhibit 3-5
Special Status Species in the Eleven (11) Counties within SCP Area, Not Likely to be Impacted by the SCP *(continued)* *Page 7 of 11*

Plants *(continued)*		
Scientific Name	**Common Name**	**Status***
103. *Eriogonum apricum var. apricum*	Ione buckwheat	FE, CE, CNPS 1B.1
104. *Eriogonum eastwoodianum*	Eastwood's buckwheat	CNPS 1B.3
105. *Eriogonum luteolum var. caninum*	Tiburon buckwheat	CNPS 1B.2
106. *Eriogonum nervulosum*	Snow Mountain buckwheat	CNPS 1B.2
107. *Eriogonum nudum var. regirivum*	Kings River buckwheat	CNPS 1B.2
108. *Eriogonum ovalifolium var. monarchense*	Monarch buckwheat	CNPS 1B.3
109. *Eriogonum temblorense*	Temblor buckwheat	CNPS 1B.2
110. *Eriogonum truncatum*	Mt. Diablo buckwheat	CNPS 1B.1
111. *Eriophyllum nubigenum*	Yosemite woolly sunflower	CNPS 1B.3
112. *Eryngium aristulatum var. hooveri*	Hoover's button-celery	CNPS 1B.1
113. *Eryngium pinnatisectum*	Tuolumne button-celery	CNPS 1B.2
114. *Eryngium racemosum*	Delta button-celery	CE, CNPS 1B.1
115. *Eryngium spinosepalum*	spiny-sepaled button-celery	CNPS 1B.2
116. *Erysimum capitatum ssp. angustatum*	Contra Costa wallflower	FE, FCH, CE, CNPS 1B.1
117. *Erythronium pluriflorum*	Shuteye Peak fawn lily	CNPS 1B.3
118. *Erythronium taylorii*	Pilot Ridge fawn lily	CNPS 1B.2
119. *Erythronium tuolumnense*	Tuolumne fawn lily	CNPS 1B.2
120. *Eschscholzia rhombipetala*	diamond-petaled California poppy	CNPS 1B.1
121. *Festuca minutiflora*	small-flowered fescue	CNPS 2.3
122. *Fissidens aphelotaxifolius*	brook pocket moss	CNPS 2.2
123. *Fritillaria falcata*	talus fritillary	CNPS 1B.2
124. *Fritillaria liliacea*	fragrant fritillary	CNPS 1B.2
125. *Fritillaria pluriflora*	adobe-lily	CNPS 1B.2
126. *Fritillaria viridea*	San Benito fritillary	CNPS 1B.2
127. *Gilia yorkii*	Monarch gilia	CNPS 1B.2
128. *Glyceria grandis*	American manna grass	CNPS 2.3
129. *Gratiola heterosepala*	Bogg's Lake hedge-hyssop	CE, CNPS 1B.2
130. *Hackelia sharsmithii*	Sharsmith's stickseed	CNPS 2.3
131. *Harmonia hallii*	Hall's harmonia	CNPS 1B.2
132. *Helianthella castanea*	Diablo helianthella	CNPS 1B.2
133. *Helodium blandowii*	Blandow's bog moss	CNPS 2.3
134. *Hesperolinon breweri*	Brewer's western flax	CNPS 1B.2
135. *Hesperolinon drymarioides*	drymaria-like western flax	CNPS 1B.2
136. *Hesperolinon sp. nov. "serpentinum"*	Napa western flax	CNPS 1B.1

Exhibit 3-5
Special Status Species in the Eleven (11) Counties within SCP Area, Not Likely to be Impacted by the SCP *(continued)* *Page 8 of 11*

Plants *(continued)*		
Scientific Name	**Common Name**	**Status***
137. *Heterotheca monarchensis*	Monarch golden-aster	CNPS 1B.3
138. *Hoita strobilina*	Loma Prieta hoita	CNPS 1B.1
139. *Holocarpha macradenia*	Santa Cruz tarplant	FT, FCH, CE, CNPS 1B.1
140. *Horkelia cuneata ssp. sericea*	Kellogg's horkelia	CNPS 1B.1
141. *Hulsea brevifolia*	short-leaved hulsea	CNPS 1B.2
142. *Imperata brevifolia*	California satintail	CNPS 2.1
143. *Iris hartwegii ssp. columbiana*	Tuolumne iris	CNPS 1B.2
144. *Isocoma arguta*	Carquinez goldenbush	CNPS 1B.1
145. *Ivesia campestris*	field ivesia	CNPS 1B.2
146. *Ivesia unguiculata*	Yosemite ivesia	CNPS 4.2
147. *Juglans hindsii*	Northern California black walnut	CNPS 1B.1
148. *Juncus leiospermus var. ahartii*	Ahart's dwarf rush	CNPS 1B.2
149. *Juncus nodosus*	knotted rush	CNPS 2.3
150. *Lasthenia conjugens*	Contra Costa goldfields	FE, FCH, CNPS 1B.1
151. *Layia discoidea*	rayless layia	CNPS 1B.1
152. *Layia heterotricha*	pale-yellow layia	CNPS 1B.1
153. *Layia munzii*	Munz's tidy-tips	CNPS 1B.2
154. *Layia septentrionalis*	Colusa layia	CNPS 1B.2
155. *Legenere limosa*	legenere	CNPS 1B.1
156. *Lepidium jaredii ssp. album*	Panoche pepper-grass	CNPS 1B.2
157. *Lepidium latipes var. heckardii*	Heckard's pepper-grass	CNPS 1B.2
158. *Leptosiphon serrulatus*	Madera leptosiphon	CNPS 1B.2
159. *Lewisia congdonii*	Congdon's lewisia	CNPS 1B.3
160. *Lewisia disepala*	Yosemite lewisia	CNPS 1B.2
161. *Lomatium congdonii*	Congdon's lomatium	CNPS 1B.2
162. *Lomatium observatorium*	Mt. Hamilton lomatium	CNPS 1B.2
163. *Lomatium stebbinsii*	Stebbin's lomatium	CNPS 1B.1
164. *Lotus rubriflorus*	red-flowered bird's-foot-trefoil	CNPS 1B.1
165. *Lupinus citrinus var. citrinus*	orange lupine	CNPS 1B.2
166. *Lupinus gracilentus*	slender lupine	CNPS 1B.3
167. *Lupinus spectabilis*	shaggyhair lupine	CNPS 1B.2
168. *Madia radiata*	showy golden madia	CNPS 1B.1
169. *Malacothamnus aboriginum*	Indian Valley bush-mallow	CNPS 1B.2
170. *Malacothamnus arcuatus*	arcuate bush-mallow	CNPS 1B.2

Exhibit 3-5
Special Status Species in the Eleven (11) Counties within SCP Area, Not Likely to be Impacted by the SCP *(continued)* *Page 9 of 11*

Plants *(continued)*		
Scientific Name	**Common Name**	**Status***
171. *Malacothamnus hallii*	Hall's bush-mallow	CNPS 1B.2
172. *Meconella oregana*	Oregon meconella	CNPS 1B.1
173. *Meesia triquetra*	three-ranked hump moss	CNPS 4.2
174. *Meesia uliginosa*	broad-nerved hump moss	CNPS 2.2
175. *Mielichhoferia elongata*	elongate copper moss	CNPS 2.2
176. *Mimulus filicaulis*	slender-stemmed monkeyflower	CNPS 1B.2
177. *Mimulus gracilipes*	slender-stalked monkeyflower	CNPS 1B.2
178. *Mimulus norrisii*	Kaweah monkeyflower	CNPS 1B.3
179. *Mimulus pulchellus*	yellow-lip pansy monkeyflower	CNPS 1B.2
180. *Monardella douglasii ssp. venosa*	veiny monardella	CNPS 1B.1
181. *Monardella leucocephala*	Merced monardella	CNPS 1A
182. *Monardella villosa ssp. globosa*	robust monardella	CNPS 1B.2
183. *Monolopia congdonii (=Lembertia congdonii)*	San Joaquin wooly-threads	FE, CNPS 1B.2
184. *Myurella julacea*	small mousetail moss	CNPS 2.3
185. *Navarretia leucocephala ssp. bakeri*	Baker's navarretia	CNPS 1B.1
186. *Navarretia myersii ssp. myersii*	pincushion navarretia	CNPS 1B.1
187. *Navarretia nigelliformis ssp. radians*	shining navarretia	CNPS 1B.2
188. *Navarretia prostrata*	prostrate vernal pool navarretia	CNPS 1B.1
189. *Neostapfia colusana*	Colusa grass	FT, FCH, CE, CNPS 1B.1
190. *Oenothera deltoides ssp. howellii*	Antioch Dunes evening-primrose	FE, FCH, CE, CNPS 1B.1
191. *Orcuttia inaequalis*	San Joaquin Valley Orcutt grass	FT, FCH, CE, CNPS 1B.1
192. *Orcuttia pilosa*	hairy Orcutt grass	FE, FCH, CE, CNPS 1B.1
193. *Orcuttia tenuis*	slender Orcutt grass	FT, FCH, CE, CNPS 1B.1
194. *Orcuttia viscida*	Sacramento Orcutt grass	FE, FCH, CE, CNPS 1B.1
195. *Petrophyton caespitosum ssp. acuminatum*	marble rockmat	CNPS 1B.3
196. *Phacelia ciliate var. opaca*	Merced phacelia	CNPS 1B.3
197. *Phacelia phacelioides*	Mt. Diablo phacelia	CNPS 1B.2
198. *Plagiobothrys chorisianus var.*	Choris' popcorn-flower	CNPS 1B.2
199. *Plagiobothrys diffusus*	San Francisco popcorn-flower	CE, CNPS 1B.1
200. *Plagiobothrys glaber*	hairless popcorn-flower	CNPS 1A
201. *Plagiobothrys hystriculus*	bearded popcorn-flower	CNPS 1B.1
202. *Plagiobothrys uncinatus*	hooked popcorn-flower	CNPS 1B.2
203. *Poa lettermanii*	Letterman's blue grass	CNPS 2.3
204. *Pohlia tundrae*	tundra thread moss	CNPS 2.3

Exhibit 3-5
Special Status Species in the Eleven (11) Counties within SCP Area, Not Likely to be Impacted by the SCP *(continued)* *Page 10 of 11*

Plants *(continued)*		
Scientific Name	**Common Name**	**Status***
205. *Polygonum marinense*	Marin knotweed	CNPS 3.1
206. *Potamogeton filiformis*	slender-leaved pondweed	CNPS 2.2
207. *Potamogeton robbinsii*	Robbins' pondweed	CNPS 2.3
208. *Pseudobahia bahiifolia*	Hartweg's golden sunburst	FE, CE, CNPS 1B.1
209. *Pseudobahia peirsonii*	San Joaquin adobe sunburst	FT, CE, CNPS 1B.1
210. *Ribes menziesii var. ixoderme*	aromatic canyon gooseberry	CNPS 1B.2
211. *Salix nivalis*	snow willow	CNPS 2.3
212. *Sanicula maritima*	adobe sanicle	CNPS 1B.1
213. *Sanicula saxatilis*	rock sanicle	CNPS 1B.2
214. *Schizymenium shevockii*	Shevock's copper moss	CNPS 1B.2
215. *Senecio aphanactis*	chaparral ragwort	CNPS 2.2
216. *Senecio clevelandii var. heterophyllus*	Red Hills ragwort	CNPS 1B.2
217. *Senecio (=Packera) layneae*	Layne's butterweed (=ragwort)	FT, CR, CNPS 1B.2
218. *Sidalcea keckii*	Keck's checker-mallow (=checkerbloom)	FE, FCH, CNPS 1B.1
219. *Sphagnum strictum*	pale peat moss	CNPS 2.3
220. *Sphenopholis obtusata*	prairie wedge grass	CNPS 2.2
221. *Streptanthus albidus ssp. peramoenus*	most beautiful jewel-flower	CNPS 1B.2
222. *Streptanthus fenestratus*	Tehipite Valley jewel-flower	CNPS 1B.3
223. *Streptanthus gracilis*	alpine jewel-flower	CNPS 1B.3
224. *Streptanthus hispidus*	Mt. Diablo jewel-flower	CNPS 1B.3
225. *Streptanthus insignis ssp. lyonii*	Arburua Ranch jewel-flower	CNPS 1B.2
226. *Streptanthus oliganthus*	Masonic Mountain jewel-flower	CNPS 1B.2
227. *Suaeda californica*	California seablite	FE, CNPS 1B.1
228. *Trifolium amoenum*	two-fork clover	FE, CNPS 1B.1
229. *Trifolium bolanderi*	Bolander's clover	CNPS 1B.2
230. *Trifolium depauperatum var. hydrophilum*	saline clover	CNPS 1B.2
231. *Triquetrella californica*	coastal triquetrella	CNPS 1B.2
232. *Tropidocarpum capparideum*	caper-fruited tropidocarpum	CNPS 1B.1
233. *Tuctoria greenei*	Greene's tuctoria (=Orcutt grass)	FE, FCH, CR, CNPS 1B.1
234. *Tuctoria mucronata*	Solano grass (=Crampton's tuctoria)	FE, CE, CNPS 1B.1
235. *Utricularia intermedia*	flat-leaved bladderwort	CNPS 2.2
236. *Verbena californica*	Red Hills (=California) vervain	FT, CT, CNPS 1B.1
237. *Viburnum ellipticum*	oval-leaved viburnum	CNPS 2.3
238. *Viola pinetorum ssp. grisea*	grey-leaved violet	CNPS 1B.3

Exhibit 3-5
Special Status Species in the Eleven (11) Counties within SCP Area, Not Likely to be Impacted by the SCP *(continued)* *Page 11 of 11*

* Status Key

- FE – federal endangered
- FT – federal threatened
- FCH – federal critical habitat specified for this species
- FC – federal candidate for consideration of endangered or threatened
- FCHP – federal critical habitat for this species is proposed
- CE – California endangered
- CT – California threatened
- CR – California rare
- CSC – California species of special concern
- CNPS – California Native Plant Society listings:
  - 1A: plants presumed extinct in California
  - 1B.1: plants rare, threatened, or endangered in California and elsewhere; seriously threatened in California
  - 1B.2: plants rare, threatened, or endangered in California and elsewhere; fairly threatened in California
  - 1B.3: plants rare, threatened, or endangered in California and elsewhere; not very threatened in California
  - 2.1: plants rare, threatened, or endangered in California, but more common elsewhere; seriously threatened in California
  - 2.2: plants rare, threatened, or endangered in California, but more common elsewhere; fairly threatened in California
  - 2.3: plants rare, threatened, or endangered in California, but more common elsewhere; not very threatened in California
  - 3.2: plants about which we need more information; fairly threatened in California
  - 4.2: plants of limited distribution; fairly threatened in California
  - 4.3: plants of limited distribution; not very threatened in California

Section 4

Hazards and Hazardous Materials Impacts Assessment

4. Hazards and Hazardous Materials Impacts Assessment

This chapter analyzes the effects of the SCP related to hazards and hazardous materials. The chapter is organized as follows:

A. *Environmental Setting*

B. *Impact Analysis and Mitigation Measures.*

The environmental setting describes existing conditions related to hazards and hazardous materials in the Delta. The impact analysis provides an assessment of the specific environmental impacts due to hazards and hazardous materials potentially resulting from program operations. The discussion utilizes findings from DBW environmental monitoring and research projects, technical information from scientific literature, government reports, relevant information on public policies, and program experience. The impact assessment is based on technical and scientific information.

For each of the potential SCP impacts related to hazards and hazardous materials we provide a description of the impact, analyze the impact, classify the impact level, and identify mitigation measures to reduce the impact level. For Impact H2: Treatment crew exposure, we provide a lengthy assessment of potential hazards and impacts related to worker exposure to the two primary SCP herbicides: 2,4-D and glyphosate, and a shorter assessment of the three new SCP herbicides: penoxsulam, imazamox, and diquat. Because of the many uncertainties inherent in long-term human exposure to chemicals, this discussion is more detailed than many of the other impacts assessments.

The mitigation measures are specific actions that DBW will undertake to avoid, or minimize, potential environmental impacts. DBW has undergone, and will continue to undergo, consultation with various local, State, and federal agencies regarding impacts and mitigation measures. Proposed mitigation measures may be revised, and/or additional mitigation measures incorporated, as a result of this ongoing consultation with regulatory agencies.

A. Environmental Setting

There are numerous laws and regulations at the federal, State, and local levels that address hazardous materials. The most relevant federal law relating to the SCP is the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). FIFRA establishes jurisdiction over the distribution, sale, and use of pesticides. At the State level, the California Department of Pesticide Regulation (DPR) implements one of the most rigorous pesticide oversight programs in the country. DPR oversight includes product evaluation and registration, environmental monitoring, residue testing of fresh produce, and local use enforcement through the County Agricultural Commissioners.

There are two major State laws related to hazardous materials. The first law is the Hazardous Materials Release Response Plans and Inventory Act of 1985. This law requires businesses using hazardous materials to prepare a hazardous materials business plan. The second law is the Hazardous Waste Control Act, which creates the State's hazardous waste management program. The California program is more stringent than the federal Resource Conservation and Recovery Act (RCRA) that regulates hazardous waste.

1. Health Hazards

The Delta is a drinking water source for approximately 23 million Californians. If Delta projects compromise the quality of drinking water, more extensive treatment may be required. We discuss drinking water in Chapter 5, and water utility intake pumps in Chapter 6.

2. Hazardous Materials and Waste

Hazardous material and wastes are those substances that, because of their physical, chemical, or other characteristics, may pose a risk of endangering human health or safety or of endangering the environment (California Health and Safety Code Section 25260). In the Delta, hazardous waste sites associated with agricultural production activities include storage facilities and agricultural ponds or pits contaminated with fertilizers, herbicides, or insecticides.

Petroleum products and other materials may be present in the soil and groundwater near leaking underground storage tanks used to store these materials. Leaking or abandoned pesticide storage containers also may be present on farmland. Water from agricultural fields on which fertilizers and pesticides are applied may drain into ponds, and rinse water from crop duster tanks and other application equipment routinely is dumped into pits. Evaporation can increase chemical concentrations in pond water and cause chemicals to be deposited in underlying soil. Surface water percolation can pollute groundwater and expand the area of soil contamination.

Spills and leaking tanks or pipelines from industrial and commercial sites also can be sources of contaminants, such as petroleum hydrocarbons and polychlorinated biphenyls from old electrical transformers.

B. Impact Analysis and Mitigation Measures

For purposes of this analysis, we considered an impact related to hazards and hazardous materials to be significant and require mitigation if it would result in any of the following:

- Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials
- Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment
- Emit hazardous emissions or handle acutely hazardous materials, substances, or wastes within one-quarter mile of an existing or proposed school
- Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5
- For a project located within an airport land use plan, or where such a plan has not been adopted, within two miles of a public airport or public use airport, result in a safety hazard for people residing or working in the project area
- For a project within the vicinity of a private airstrip, result in a safety hazard for people residing or working in the project area
- Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan
- Expose people or structures to a significant risk, injury, or death involving wildland fires.

Exhibit 4-1, on the next page, provides a summary of the potential SCP impacts for hazards and hazardous materials significance areas which could potentially be affected. Exhibit 4-1 also explains those hazards and hazardous materials significance areas in which there will be no impacts or beneficial impacts.

Impact H1 – General public exposure: there is potential for the SCP to create a significant hazard to the public through the routine transport, use, or disposal of SCP herbicides

The general public could be exposed to SCP herbicides through: consumption of drinking water contaminated with herbicides, consumption of fish or other aquatic organisms that have bioaccumulated SCP herbicide residues, or swimming or water skiing in areas recently treated with SCP herbicides.

Exhibit 4-1
Crosswalk of Hazards and Hazardous Materials Significance Criteria, Impacts, and Benefits of the SCP

Significance Criteria and Impacts	Mitigation Measures	Unavoidable or Potentially Unavoidable Significant Impact	Avoidable Significant Impact	Less than Significant Impact	No Impact	Beneficial Impact
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?						
Impact H1: General public exposure	16			X		
Impact H2: Treatment crew exposure	3, 4,8, 17, 18,19		X			
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?						
Impact H3: Accidental spills	18		X			
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?					SCP will not emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school	
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?					SCP will not be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5	
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?					SCP will not be located within an airport land use plan, or within two miles of a public airport or public use airport	
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?					SCP will not be located within the vicinity of a private airstrip or result in a safety hazard for people residing in or working in the project area	
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?					SCP will not impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan	Removal of spongeplant could improve access to waterways used by emergency boats
h) Expose people or structures to a significant risk of loss, injury or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?					SCP will not expose people or structures to wildland fires	

We discuss the potential for drinking water contamination by SCP herbicides in Chapter 5. The potential for SCP herbicides to be present in concentrations in excess of USEPA Maximum Contaminant Levels (MCLs) of 70 ppb for 2,4-D, 700 ppb for glyphosate, and 20 ppb for diquat, is extremely low. In addition, DBW will implement mitigation measures (including Mitigation Measure 20, directed specifically at drinking water quality) to further reduce the potential for drinking water contamination by the SCP.

We discuss the potential for SCP herbicides to bioaccumulate in fish or other aquatic organisms in Chapter 3. None of the five SCP herbicides are expected to bioaccumulate in fish or aquatic species.

Potential exposure of the general public to SCP chemicals through water recreation is unlikely. We discuss the toxicity of SCP herbicides to humans under Impact H2, below. Herbicide exposure levels for the general public following SCP treatments are orders of magnitude lower than potentially toxic herbicide levels.

SCP treatments generally take place in heavily infested waterways, which are unsuitable for water recreation. It is unlikely that recreationists or nearby inhabitants would be close enough to SCP treatments to come in contact with herbicides. Inhalation exposure basically applies to just applicators, not the general public (WDOE 2001). In addition, inhalation exposure for both glyphosate and 2,4-D are low. The vapor pressure of glyphosate is very low, and inhalation of spray droplets was found to be a minor route of glyphosate exposure (Acquavella et al. 2004). Exposure to glyphosate appeared to be very limited for those not in the immediate area of mixing, loading, or application activities (Acquavella et al. 2004 and 2005). Ibrahim et al. (1991) reported that studies of applicators showed that only 2 percent of the 2,4-D body burden was through respiratory exposures. No adverse effects are anticipated from single exposure to penoxsulam mist (SePRO 2009). Imazamox is relatively non-toxic after short-term inhalation (SePRO 2010). Diquat has a low vapor pressure, and there is no evidence of volatility (USEPA 2010).

The Weedar 64 (2,4-D) label does not specify a waiting period for water recreation following aquatic weed control. Treated water should not be used for drinking water for three weeks, or until the 2,4-D level is no more than 0.1 ppm (100 ppb). WHCP monitoring results, which we expect to be similar to SCP results, show 2,4-D levels significantly lower than 0.1 ppm, even one hour after treatment. The Roundup Custom label states that there are no restrictions on the use of treated water for recreation or domestic purposes. There are no restrictions on the use of penoxsulam treated water for potable use or recreation, including swimming and fishing. Similarly, there are no restrictions on the use of imazamox treated water for domestic use, swimming, or fishing. Following treatment with diquat, there are no restrictions on fishing and swimming, and between 1 and 3 days wait period for drinking water (Syngenta 2005).

Based on existing research evidence, program operations, and monitoring results, SCP herbicide treatments are not likely to result in adverse effects on the general public due to drinking water exposure, consumption of aquatic species that have bioaccumulated SCP herbicides, or exposure to herbicides during recreation. **The potential for the SCP to create a significant hazard to the public through routine transport, use, or disposal is expected to be less-than-significant.** No mitigation measures are required, however several of the mitigation measures that reduce the potential for herbicide exposure identified in Chapters 3 and 5 will further minimize the already low risk of hazard to the general public. In addition, DBW will implement the following Mitigation Measure to further reduce potential for public exposure to SCP herbicides.

- **Mitigation Measure 16** – Minimize public exposure to herbicide treated water.

  Prior to treatments, DBW will notify marina and dock owners regarding timing of treatments. SCP treatments generally take place in heavily infested waterways, which are usually unsuitable for water recreation. If recreationists are present when treatment occurs, treatments crews will inform recreationists about the treatment, asking them to move to a different location, or move treatments to a different location.

Scientific Terminology Related to Animal and Human Health Studies

Case-control epidemiological study – a study in human populations in which individuals with a specific diagnosis (e.g. non-Hodgkin lymphoma (NHL)) are identified and compared to similar controls in the population without the diagnosis. Typically these studies use questionnaires or telephone interviews to identify exposure and other characteristics of each group. Results are typically adjusted for other non-exposure factors related to the disease (e.g. smoking, age). The most commonly cited problem with case-control studies is recall bias on exposure information.

Cohort epidemiological study – a study of a group of people, a cohort, usually with a common characteristic, such as occupation. Subjects are evaluated over an extended period of time, comparing diseases among the cohort to diseases among the general population or subgroups within the cohort. Cohort studies also use questionnaires to determine exposure, but may also employ biomonitoring to measure exposure. Cohort studies may examine disease and exposure in the past (retrospective), or future (prospective). To prove linkages, cohort studies require a large number of participants, particularly if the disease being studied is rare.

Odds ratio (OR) – is a comparison of the odds of a condition existing among the exposure group, as compared to the odds of a condition existing among the control group. In pesticide epidemiological studies, it is often used to compare exposure to a pesticide among the case group (with the disease), to exposure to a pesticide among the control group (without the disease). The OR equation is:

$$OR = \frac{p_1/q_1}{p_2/q_2}$$

An OR of 1 means that there are equal odds of the exposure occurring among both groups. An OR of greater than one means that the group with the disease (the case group) had a greater chance of having been exposed than the control group. An OR of below one means that the case group had less chance of exposure than the control group. An OR of 2 means that the case group was twice as likely to be exposed to the pesticide as the control group. All figures are typically expressed with a 95 percent confidence interval (CI): for example, OR 1.3 (95 percent CI of 0.7 to 3.4). An OR is not considered statistically significant unless the lower bound CI is greater than one (although an OR with a lower bound of less than one may still be indicative of a need for further study or a potential risk). The following is an example OR: in one case-control study, 32 of 170 NHL patients (cases) treated seeds with fungicides, as compared to 105 of 948 controls. The example showed an elevated risk (almost double) of NHL among those that used fungicides, with an OR of 1.9 (Hoar 1986):

$$\text{Cases: } \frac{32}{170} = 0.19 \qquad \text{Controls: } \frac{105}{948} = 0.11$$

$$OR = \frac{p_1/q_1}{p_2/q_2} = \frac{\frac{0.19}{0.81}}{\frac{0.11}{0.89}} = 1.91$$

Risk ratio (RR) – or relative risk ratio, is a comparison of the disease rates among exposed and non-exposed groups over a specific time period. RR is typically used in cohort studies to compare the risk of a particular cancer or disease in the cohort, to the risk in a non-exposed population (often further adjusted for age, sex, etc.). Similar to the OR, a RR of one means that there is equal risk among the exposed and non-exposed groups, while a RR of greater than one means that there is a greater risk among the exposed group, and a RR of less than one means that there is less risk among the exposed group. RRs are also typically reported with a 95 percent confidence interval. For example, in a cohort study, 63 of 40,376 farmers exposed to glyphosate developed melanoma (0.16 percent), while 12 of 13,280 farmers not exposed to glyphosate developed melanoma (0.09 percent). The RR is equal to 0.16/0.09, or 1.8. This means there was an 80 percent increased risk of melanoma associated with glyphosate use (De Roos et al., 2005).

Standard Mortality Ratio (SMR) – is the ratio of observed deaths to expected deaths, for a particular disease. If there were one out of 2,500 (0.04 percent) melanoma deaths in the cohort being studied, and the expected deaths from melanoma was two per 100,000 (0.002 percent), the SMR would be equal to 0.04/0.002, or 20.

In vitro – experiments conducted in a controlled environment, outside of a living organism. In vitro experiments typically use cellular material, cell cultures, or tissue cultures.

In vivo – experiments conducted using whole living organisms. In vivo experiments include animal testing and clinical trials.

Reference Dose (RfD) – is the dose to humans, as determined by USEPA, at which there is a reasonable certainty of no harm. It is usually calculated by taking the lowest animal NOEL, and dividing by a safety factor of at least 100. The safety factor is determined by multiplying by 10 for each point of uncertainty. For example, a safety factor of 100 is based on a factor of 10 for sensitivity between species (assuming humans are more sensitive than animals), and a factor of 10 for sensitivity among species (for sensitive populations such as children). For 2,4-D, the safety factor is 1,000, as there is an third factor of 10 due to uncertainty in the database of studies. RfDs may be calculated for acute and chronic exposure. For chronic exposure, since the NOEL is based on lifetime exposure, the RfD represents the tolerable daily dose over a lifetime.

Hazard Quotient (HQ) – is calculated by dividing the exposure level by the RfD. An HQ of 1 or greater indicates a level for which there is concern related to long-term exposure. The higher the HQ, the greater the level of concern for the development of adverse health outcomes. An HQ of below 1 indicates that adverse health outcomes would not be expected.

Weight-of-evidence review (WOE) – is generally a qualitative review in which an individual or panel rates and assesses the scientific literature addressing a particular hypothesis, typically the relationship between a compound and a disease outcome (Krimsky 2005). A WOE considers all varieties of evidence and types of studies (in vivo, in vitro, epidemiological studies). Reviewers may give greater weight to certain types of studies or to studies based on statistical significance of results. Krimksy notes that WOEs often "use a process methodology that is low on transparency and high on subjectivity." However, it is often not possible or ethical to conduct human testing on toxic or potentially toxic agents. Thus, the WOE is an important tool particularly in cases of environmental exposure to chemicals, when no single study resolves issues related to exposure and causation.

Chlorphenoxy, Phenoxy, or Phenoxyacetic Acid Herbicides
The SCP herbicide 2,4-D (2,4-dichlorophenoxyacetic acid), is one of a family of herbicides known as chlorphenoxy, phenoxy, or phenoxyacetic acid herbicides. Many of the studies discussed in this section included phenoxy herbicides as a group, not specifically 2,4-D. Phenoxy herbicides were developed in the 1940s, and have been used extensively worldwide since that time. The family name is based on the presence of chlorine, and phenoxyacetic acid. Two other herbicides in this group are MCPA (4-chloro-2-methylphenoxyacetic acid), and 2,4,5-T (2,4,5-trichlorophenoxyacetic acid). The 50:50 combination of 2,4-D and 2,4,5-T, known as Agent Orange, was used in Vietnam as a defoliant. 2,4,5-T contains dioxin (2,3,7,8-tetrachlorodibenzo-p-dioxin) as an impurity. Dioxin is highly toxic to humans, and as a result 2,4,5-T was banned in the United States, and in most other countries, by 1985. There has been some concern about impurities in 2,4-D, although typically it is thought not to contain dioxins (USFS 2006). In addition, most studies used in 2,4-D risk assessments use technical grade 2,4-D, which would include any impurities that do exist in the herbicide (USFS 2006). There are multiple forms of 2,4-D, including acid, dimethylamine salt (the form used in the SCP), and esters. Generally, these types of 2,4-D are thought to have similar toxicity in mammals.

Impact H2 – Treatment crew exposure: there is potential for the SCP to create a significant hazard to treatment crews through the routine transport, use, or disposal of SCP herbicides; and/or through heat exposure

The potential for the SCP to create a significant hazard to treatment crews through the routine transport, use, or disposal of SCP herbicides depends on the same two factors discussed for Biological Resources toxicity impacts: exposure and toxicity. However, in relation to humans, there are even greater uncertainties regarding exposure levels and short- and long-term toxicity of SCP herbicides.

Pesticide workers, such as DBW treatment crews, are exposed to higher levels of herbicides, and over longer time horizons, than the general public (Burns 2005). Some DBW crew members have been with the program for over twenty years. Each year, treatments take place as many as four days a week, over a six month period. This small group of individuals is uniquely exposed to program herbicides over relatively long periods of time.

While animal toxicity studies can be used to assess the potential for human toxicity, particularly acute toxicity, it is much more difficult to determine whether there are long-term human impacts resulting from exposure to herbicides. Alavanja et al. (2004) noted that there are questions as to whether laboratory short-term toxicity studies of a single chemical are adequate to determine human exposure to a mix of chemicals over a lifetime, stating “neither animal testing alone or its interpretation in setting policy is sufficient to protect public health.”

In reviewing the use of herbicides, the USEPA, World Health Organization (WHO), United States Forest Service (USFS), and other agencies evaluate the extensive scientific literature on each chemical, and identify exposure levels intended to ensure worker and public safety. These agencies reevaluate herbicide safety every few years as new studies are released. In the discussions below, we draw on recent agency analyses, as well as scientific literature on potential exposure levels and impacts of SCP herbicides on humans.

In addition to potential hazards from herbicide exposure, SCP treatment crews are potentially at risk due to heat exposure. Below, we assess the potential for herbicide exposure, short-term toxic impacts of herbicides, long-term chronic effects of herbicides to treatment crews, and heat exposure.

<u>Exposure to SCP Herbicides</u>

It is extremely difficult to measure exposure levels to pesticides in humans – either in pesticide applicators, their family members, or the general public. An estimated 25 million agricultural workers worldwide experienced unintentional pesticide exposure each year during the 1990s (Alavanja et al. 2004).

In many exposure studies, pesticide worker exposures are based on answers to written or telephone questionnaires about their historical use of various chemicals, and/or about current chemical use. When subjects are deceased, researchers must rely on family members to answer detailed questions about past chemical exposure. Recall bias can result in both overestimating and underestimating chemical exposure.

In some cases, researchers adjust reported exposure levels using exposure algorithms (e.g. increasing exposure factors if the worker does not wear personal protective equipment (PPE)). Even if there was perfect recollection of chemicals used and worker safety practices, these studies cannot measure actual amounts of chemical absorbed or inhaled.

Researchers also conduct biomonitoring to identify actual body loads of chemicals in exposed workers. Barr et al. (2006) note that biomonitoring can provide a "rough estimate of internal dose", given assumptions about factors such as chemical uptake, metabolism, and steady-state excretion. Exposure to chemicals is usually in mg per kg body weight per day (mg/kg/day), or simply mg/kg body weight (mg/kg).

Biomonitoring includes measures of skin absorption, inhalation, and internal metrics. The amount of chemical absorbed by skin can be measured with patches, washing and wiping, and fluorescent tracers (Fenske 2005; Dosemeci et al. 2002). Inhalation is measured through personal air or air sampling (Fenske 2005). Internal chemical concentrations can be measured in urine, saliva, sweat, semen, and blood (Fenske 2005; Dosemeci et al. 2002).

Urine samples are another tool for measuring actual body load of chemicals that are excreted in urine. Urine samples must be adjusted for volume, depending on whether they are 24 hour samples, first void samples, or spot samples (Barr et al. 2006). A single spot urine sample measurement can provide information on whether exposure occurred, and some information on the magnitude of the exposure, but cannot provide information on total body load of the chemical. There are methods of extrapolating from single urine samples to total urine volume (and thus to determine total body load), for example using urine creatinine concentrations. The creatinine method introduces some uncertainty into the measurement, but is valuable in cases when it is not practical to obtain 24 hour urine samples.

We can estimate SCP treatment crew exposure based on results of other studies that have evaluated pesticide applicator exposures in an agricultural or forestry setting. Exposure depends on characteristics of the chemical, conditions during application, and worker safety factors.

Numerous studies (Alavanja 2007; Hoar et al. 1986; Zahm and Blair 1992; Acquavella et al. 2004 and 2005; Mandel et al. 2005; Lavy et al. 1982) have shown that pesticide applicators that use PPE have lower risk and lower pesticide levels in blood or urine. In a talk to the North American Pesticide Applicator Certification and Safety Education Workshop in 2007, Dr. Michael Alavanja of the Agricultural Health Study, noted that proper glove use was the most influential item of PPE to mitigate chronic pesticide exposure (Alavanja 2007). Factors that increased exposure levels included fixing equipment during treatments, and more frequent mixing and loading of chemicals (Acquavella et al. 2004). In studies of urinary 2,4-D levels in applicators, predictors of herbicide levels included pesticide formulation, protective clothing and gear (especially gloves), handling practices, application equipment, personal hygiene, and type of spray nozzle used (Fenske 2005). Attitudes toward risk (as determined by questionnaires) played an important role in chronic exposure, as well (Alavanja 2007).

Exposure levels can also be influenced by outside factors and conditions. For example, USFS (2006) reported that several studies have found that sunscreen enhanced dermal absorption of 2,4-D. In addition, individuals that are pregnant, immune-compromised, malnourished, or have sickle-cell anemia, may be more sensitive to herbicides such as 2,4-D (USFS 2006).

SCP treatment crews follow herbicide label requirements for PPE. This includes use of coveralls, chemical resistant gloves, safety goggles, and waterproof shoes. DBW uses a laundry service to clean coveralls after a single day use. Herbicides are mixed using a feeder tube to draw chemical into the mixing tank, so that direct contact with the chemicals is not required. Potential exposure routes include dermal exposure when rinsing, or in the event that a feeder tube is broken. More likely exposure may occur through inhalation of drift in the event that the wind shifts during treatment. None of these exposure routes is likely, although they may occur.

<u>2,4-D</u>

Given the time and location restrictions for use of 2,4-D, the SCP use of 2,4-D is likely to be limited. Because it has been widely used, there are a number of studies in the literature on pesticide applicator exposure to 2,4-D. Chlorphenoxy herbicides are absorbed well from the gastrointestinal (GI) tract, less well from the lungs, and minimally from skin (Reigart and Roberts 1999).

Dermal exposure studies have found low dermal penetration of 2,4-D (WDOE 2001). One study found that approximately six percent of a dose was absorbed through the skin over a five day period. Other studies have found somewhat higher dermal absorption, ranging from seven percent to 14 percent (WDOE 2001).

Inhalation uptake of 2,4-D in humans has not been well studied, but rat studies found that 2,4-D was rapidly absorbed in lungs (Ibrahim et al. 1991). However, data from studies of applicators showed that respiratory sources only contributed two percent of total 2,4-D body burden (Ibrahim et al. 1991). In USEPA's 2005 review of 2,4-D, USEPA considered 2,4-D to be of low toxicity via acute inhalation exposure. USEPA also recommended that more inhalation studies be conducted to determine how rapidly the herbicide is absorbed via inhalation (USFS 2006). The half-life of 2,4-D in humans is 12 to 33 hours, thus most 2,4-D is excreted in urine within a few days.

Below, we summarize the results of several 2,4-D exposure studies. All studies focused on pesticide applicators, including farmers, forestry workers, or manufacturing workers.

- As part of the Farm Family Exposure Study, Mandel et al. (2005) examined 2,4-D levels in the urine of 34 farmers. Chemical levels were measured the day before treatment, the day of treatment, and for each of three days following treatment with 2,4-D. The geometric mean concentration of urinary 2,4-D was 64 ppb on the day of treatment, with a wide range of 2 ppb to 1,856 ppb. Skin contact and repairing equipment during treatment were associated with increased exposure. A relatively high 71 percent of applicators had detectable 2,4-D in their urine even before treatment, with a pre-treatment geometric mean of 4 ppb. This Farm Family Exposure Study also evaluated levels of glyphosate and chlorpyrifos after treatment with those herbicides. The study found higher urinary 2,4-D levels for farmers using 2,4-D, than corresponding urinary herbicide levels for farmers using glyphosate or chlorpyrifos
- Garry et al. (2001) evaluated 2,4-D urinary levels in forest pesticide applicators, by application method. Garry found that the highest 2,4-D levels were in forest pesticide applicators using back pack sprayers, closely followed by boom sprayers, then aerial application, skidders, and non-exposed controls, in that order. Garry found a ten-fold difference between the average urinary 2,4-D concentrations in back pack and boom sprayers (380.1 ppb) and the average urinary 2,4-D concentrations in aerial and skidder closed-cab applicators (33.2 ppb)
- Garry et al. (2001) also reported on a previous study that found workers employed in chlorophenoxy herbicide manufacture could have urinary 2,4-D levels over 1,000 ppb. This was significantly higher than most applicator studies, which typically found urinary 2,4-D levels in the range of 45 to 326 ppb
- Lavy et al. (1982) measured exposure to 2,4-D during aerial application, using respiratory exposure, skin patches, and urine levels. Workers applied herbicide at the rate of 4 lbs acid equivalent per acre, the same rate as the SCP. Lavy tested 2,4-D levels in 18 forestry workers, including pilots, mechanics, mixers, supervisors, and flagmen. Using respiratory monitoring, only one worker (a mixer) had measurable 2,4-D levels, at 0.03 μg/kg. Using skin patches, most workers had non-detectable levels, and those with detectable levels ranged from 0.0005 mg/kg to 0.0409 mg/kg. Thirteen workers had detectable 2,4-D in urine, with 2,4-D levels in urine ranging from 0.00044 mg/kg to 0.0337 mg/kg (0.44 ppb to 33.7 ppb). Urine was measured over eight days total
- A Canadian study of 2,4-D acid residues in semen of 97 Ontario farmers that had recently used the herbicide found that 50 percent of samples had detectable 2,4-D residues of greater than 5ppb (Arbuckle et al. 1999)
- Studies of occupational exposure to 2,4-D reported in Ibrahim et al. (1991) found the highest daily exposure dose of 3.4 to 4.9 mg/day (equivalent to 0.05 to 0.07 mg/kg/day for a 70 kg person) for individuals using back pack sprayers on right-of-ways. The next highest exposures were found in farmers driving tractors (0.48 mg/day), and hand and tank commercial lawn sprayers (0.29 mg/day). There was a wide range of 2,4-D exposures in helicopter and airplane applicators, from 0.005 to 1.04 mg/day
- USFS (2006) exposure assessments for workers for 2,4-D were approximately 0.02 mg/kg/day for broadcast ground spray workers. The upper exposure range for broadcast ground spray workers was

0.15 mg/kg/day, with a lower exposure range of 0.0007 mg/kg/day. Among the USFS worker categories, broadcast ground spray worker exposures are most similar to SCP treatment crews, in terms of likely exposure. However, USFS assumptions include treatment of a significantly higher acreage than the SCP boat treatments, at 66 acres to 168 acres per day. This difference means that USFS total daily work exposure estimates are much higher than for SCP treatment areas that will likely treat approximately two to three acres per day.

Table 4-1, below, summarizes worker exposure studies most similar to SCP treatment exposures. USFS (2006) developed a model to determine worker exposure levels based on Forest Service practices and treatment methods (boom spray or broadcast ground spray application, direct foliar application, and aerial application).

USFS (2006) estimated average 2,4-D exposure for a boom spray worker was 0.0002 mg/kg per lb of active ingredient (a.e.) handled per day, with a range of 0.00001 to 0.0009 mg/kg/lb a.e.

USFS (2006) also reported on a study of four workers applying liquid formulation 2,4-D by airboat handguns. For airboat applicators, USFS found exposure rates estimated at 0.0009 mg/kg/lb a.e. handled, with a range of 0.0004 to 0.002 mg/kg/lb a.e.. Airboat exposures were slightly higher than the ground-based boom spray, which might take place from an enclosed cab. Although only four workers were monitored, we utilized this study to estimate exposure for SCP treatment crews.

We estimated SCP treatment crew exposure using USFS exposure metrics. The highest potential SCP treatment exposure to 2,4-D occurs during the months of July through September. During these three months in 2007, the six WHCP treatment crews each applied, on average, approximately 8.6 pounds a.e. 2,4-D per day, four days per week. Using the USFS airboat exposure estimates, WHCP treatment crews were exposed to 0.008 mg/kg/day (with a range of 0.003 to 0.017 mg/kg/day). Assuming an average 70 kg weight (154 pounds), the exposure per crew member was approximately 0.56 mg/day (with a range of 0.21 to 1.19 mg/day). These values are likely conservative as compared to potential SCP 2,4-D exposure.

Glyphosate

Glyphosate is poorly absorbed through the skin (USFS 2003). Lavy et al. (1992) found that even though forestry sprayers had significant dermal exposure to glyphosate, biomonitoring results indicated no absorption of glyphosate. Dermal studies have shown absorption of less than 2 percent glyphosate (Acquavella et al., 2004). In addition, the vapor pressure of glyphosate is very low, and inhalation of spray droplets was found to be a minor route of glyphosate exposure (Acquavella et al., 2004).

Table 4-1
Pesticide Applicator Exposure Estimates for 2,4-D

Type of Application	Exposure in mg/kg/lb a.e.	Exposure in mg/kg/day	Exposure in mg/day	Source
1. Back pack sprayer		0.05 to 0.07*	3.4 to 4.9	Ibrahim et al. 1991
2. Boom spray from tractor		0.007*	0.48	Ibrahim et al. 1991
3. Broadcast ground spray	0.0002 (0.00001 to 0.0009)	0.02 (0.0007 to 0.15)	1.4* (0.05 to 10.5)	USFS 2006
4. Airboat handgun	0.0009 (0.0004 to 0.002)			USFS 2006
5. Calculated WHCP Crew (July to September 2007) (similar to SCP)	0.0009 (0.0004 to 0.002) based on USFS 2006	0.008 (0.003 to 0.017)	0.56* (0.21 to 1.19)	Calculated using 8.6 lb a.e. per crew

*Calculated based on 70 kg person (154 pounds).

While glyphosate exposure has not been as heavily studied as 2,4-D, there are still a large number of studies evaluating potential exposure to glyphosate among pesticide applicators.

- In the Farm Family Exposure Study, Acquavella et al. (2004 and 2005) examined urinary glyphosate levels in 48 farmers just prior to glyphosate treatment, the day of treatment, and three days following. The geometric mean concentration of glyphosate in farmers was 3 ppb, with a maximum of 233 ppb, and a minimum below the limit of detection (LOD) of 1ppb. Farmers that didn't use rubber gloves had a higher geometric mean (10 ppb for those without gloves, versus 2 ppb for those with gloves). Only 50 percent of farmers that did wear gloves had urinary glyphosate values above the LOD, while 86 percent of those that didn't wear gloves had levels above the LOD. Based on urinary levels, Acquavella calculated the maximum systemic dose was 0.004 mg/kg, and the geometric mean systemic dose was 0.001 mg/kg. Generally, glyphosate exposure was low, as 40 percent of farmers didn't have detectable urinary levels on the day of application. In this Family Farm Exposure Study, urinary glyphosate levels were lower than the other two herbicides monitored, 2,4-D and chlorpyrifos
- Acquavella et al. (2004) reported that a study of forest workers found the highest urinary levels at 14 ppb glyphosate. This same forest worker study estimated a maximum systemic dose of 0.006 mg/kg
- USFS (2003) worker exposure estimates are 0.026 mg/kg/day glyphosate, with a range of 0.0009 to 0.16 mg/kg/day for direct ground spray. Broadcast ground spray, with a boom, has slightly higher exposure estimates, of 0.045 mg/kg/day, with a range of 0.001 to 0.3 mg/kg/day. Similar to the USFS estimates for 2,4-D, the broadcast ground spray figures are likely closest to the potential exposure for SCP treatment crews. However, these USFS estimates are similar to the USFS estimates for 2,4-D (USFS 2006), in that they assume that crews treat approximately 100 acres per day
- Solomon et al. (2005) reported on other studies with glyphosate worker exposure estimates, with a peak estimated glyphosate exposure at 0.056 mg/kg, and chronic exposure of 0.0085 mg/kg/day based on an 8 hour day and 5 day work week. Among farmers, the greatest estimated systemic dose was 0.004 mg/kg.

Table 4-2, on the next page, summarizes estimates of glyphosate exposure levels among pesticide applicators. USFS (2003) developed a model to determine worker exposure levels based on Forest Service practices and treatment methods (boom spray or broadcast ground spray application, direct foliar application, and aerial application).

USFS glyphosate estimates for broadcast ground spray with a boom were based on a figure of 0.0002 mg/kg/lb a.e. applied, with a range of 0.00001 to 0.0009 mg/kg/lb a.e. (USFS 2003). To estimate potential SCP treatment crew exposure to glyphosate, we use an estimate of 12 pounds a.e. per day for ten days of WHCP glyphosate treatments in the first two weeks of October 2007. This was the highest application period for glyphosate during the 2007 treatment period. Even during October 2007, only three crews were using glyphosate. Based on USFS estimates, glyphosate exposure to treatment crews during this time period was 0.0024 mg/kg/day, with a range of 0.0012 to 0.0108 mg/kg/day. For a 70 kg person, this is equivalent to glyphosate exposure of 0.168 mg/day, with a range of 0.084 to 0.756 mg/day.

<u>Short-Term or Acute Toxicity of SCP Herbicides to Humans</u>

Acute toxicity of pesticides in humans is generally extrapolated from several different types of sources: acute toxicity studies in laboratory mammals, biomonitoring of exposed workers, and intentional or accidental human poisoning cases. It is highly unlikely that SCP activities would result in acute toxicity to SCP treatment crews. The levels of either herbicide required to induce acute toxicity are several orders of magnitude higher than any potential exposure, even in the unlikely event of an accident. The discussion on short-term toxicity of these herbicides is provided below for background. For penoxsulam, imazamox, and diquat, we discuss both short and long-term toxicity data below.

Table 4-2
Pesticide Applicator Exposure Estimates for Glyphosate

Type of Application	Exposure in mg/kg/lb a.e.	Exposure in mg/kg/day	Exposure in mg/day	Source
1. Tractor with boom spray		0.001 (max 0.004)	0.07* (max 0.28)	Acquavella et al. 2004
2. Forestry workers (method not specified)		0.006	0.42*	Acquavella et al. 2004
3. Direct ground spray		0.026 (0.0009 to 0.16)	1.82* (0.063 to 11.2)	USFS 2003
4. Broadcast ground spray (boom)	0.0002 (0.00001 to 0.0009)	0.045 (0.001 to 0.3)	3.15* (0.07 to 21)	USFS 2003
5. Agricultural workers		0.0085 to 0.056	0.6* to 3.92	Solomon et al. 2005
6. Calculated WHCP Crew (October 2007) (similar to SCP)	0.0002 (0.00001 to 0.0009) based on USFS 2003	0.0024 (0.0012 to 0.0108)	0.168* (0.084 to 0.756)	Calculated using 12 lb a.e. per crew

*Calculated based on 70 kg person (154 pounds).

2,4-D Short-Term and Acute Toxicity

2,4-D is considered moderately toxic (Ibrahim 1991). The MSDS warns that 2,4-D is corrosive, and causes irreversible eye damage (Nufarm 2006). Existing respiratory and skin problems may also be aggravated by exposure (Nufarm 2006). In 1996, phenoxy herbicides were listed ninth among pesticides causing symptomatic illnesses (acute toxicity), with 453 total cases (63 children less than six years, and 387 cases age six and older), based on data from National Poison Control Centers (Reigart and Roberts 1999).

The reference, *Recognition and Management of Pesticide Poisonings* (Reigart and Roberts 1999) states that phenoxy herbicides are moderately irritating to skin, eyes, respiratory, and GI linings. In humans, ingestion of large amounts (accidental or suicidal) results in metabolic acidosis, electrocardiographic changes, myotonia (stiffness and in-coordination of muscles, including the inability to relax contracted muscle), muscle weakness, and myoglobinurea (presence of myoglobin, an oxygen-carrying muscle protein, in the urine). Several of these symptoms reflect injury to striated muscle. Clinical poisoning cases also often result in hyperthermia (elevated body temperature).

Most fatal outcomes of phenoxy herbicide poisoning involve renal failure, acidosis, electrolyte imbalance, and resultant multiple organ failure. In patients with phenoxy herbicide poisoning, clinicians may see vomiting, diarrhea, headache, confusion, and bizarre or aggressive behavior, peculiar odor on breath, hyperventilation, muscle weakness, tachycardia, and hypotension. These changes are indicative of liver cell injury. Levels of 2,4-D exposure required to achieve these symptoms are high. Herbicide applicators with blood 2,4-D levels at, or below, one mg/l (ppm) to two mg/l may have no symptoms. Cases of 2,4-D poisoning in which the patient was unconscious reported blood levels from 80 mg/l to 1,000 mg/l 2,4-D (Reigart and Roberts 1999).

In large doses to experimental animals, phenoxy herbicides caused vomiting, diarrhea, anorexia, weight loss, ulcers of mouth and pharynx, myotonia, and toxic injury to liver, kidneys, and the central nervous system (Reigart and Roberts 1999). Mammal 2,4-D LD50 values ranged from 100 mg/kg for dogs to 1,000 mg/kg for guinea pigs (Ibrahim et al. 1991). The 2,4-D salt form had LD 50s ranging from 375 mg/kg for mice to 2,000 mg/kg for rats. Most LD 50s, except dogs, range from 300 to 1,000 mg/kg (Ibrahim et al. 1991).

The Washington State Department of Ecology (WDOE 2001) reviewed a range of 2,4-D toxicity studies. The WDOE review found that neurotoxicity studies of 2,4-D were negative, and recent studies did not provide evidence that 2,4-D was immunotoxic. These studies did conclude that when 2,4-D was administered to test animals in high doses, there were histopathological changes in many organ systems, but primarily the kidney and liver. Researchers believe that once kidney function is compromised, mammals cannot excrete 2,4-D effectively. This, in turn, increases the amount of chemical in the animal's system, causing more harmful impacts. In a study examining the thymus and spleen of rats following exposure to 2,4-D at a dose of one-half the LD50 (228 mg/kg), Kaioumova et al. (2001) concluded that 2,4-D appeared to be causing hemolytic activity, destroying the vascular integrity of thymus and causing cell depletion in white pulp of spleen.

In a study of forest pesticide applicators following one-time application of 2,4-D, Garry et al. (2001) examined chromosome aberrations, reproductive hormone levels, and polymerase chain reaction-based rearrangements (indicative of altered genomic stability) . The study compared these biomarkers to urinary 2,4-D levels in 24 applicators and 15 controls. Applicators using hand-held backpack sprayers had the highest 2,4-D urinary levels, averaging 453.6 ppb. Among applicators, researchers found serum luteinizing hormone(LH) levels increased, correlated with urinary 2,4-D levels. They did not see similar changes in follicle stimulating hormone or testosterone. Chronically increased LH can lead to significant increases in testosterone, but the increases seen in this study were not of immediate clinical concern, and Garry was not sure what impact these reproductive hormone disruptions might have on male reproductive potential. Applicators with higher 2,4-D exposure levels (measured by urine 2,4-D) had rearrangements of DNA, but follow-up ten months later suggested that these DNA changes were reversible and temporary. The 2,4-D levels were not correlated with chromosome aberration frequencies. Garry et al.'s previous laboratory work had suggested that most phenoxy herbicides were not genotoxic at the chromosome level, and that these herbicides (or their adjuvants) may have had some endocrine disrupting activity. Garry et al. determined that "acute, high-level exposure to 2,4-D as measured by urinary concentration with or without adjuvant use, is not associated with detectable chromosome damage in G-banded lymphocytes."

<u>Glyphosate Short-Term and Acute Toxicity</u>

Glyphosate is not hazardous according to the federal Occupational Safety and Health Administration (OSHA) Hazard Communications Standard (Monsanto 2005). In humans, glyphosate can be irritating to eyes, skin, and upper respiratory tract (Reigart and Roberts 1999).

Among California occupational illnesses likely due to pesticides between 1991 and 1995, glyphosate was listed seventh, with nine systemic cases and 94 topical cases (skin, eye, or respiratory), for 103 total glyphosate illnesses reported (Reigart and Roberts 1999).

USFS (2003) reported on toxic impacts of glyphosate exposure to humans, creating a dose-response scale. Many of these exposures resulted from intentional ingestion of glyphosate. At calculated doses of 184 mg/kg in humans, there were "no apparent effects" from glyphosate. At the higher dose of 427 mg/kg, there was "mild poisoning," including transient signs and symptoms in oral mucosa or GI tract. More than double this dose (1,044 mg/kg) resulted in "moderate poisoning," with GI irritation, transient hepatic or renal damage, decreased blood pressure, and pulmonary dysfunction. Finally, "severe poisoning," which was fatal, occurred in patients that had consumed about 1,282 mg/kg. The lowest dose of 184 mg/kg would require drinking just under one ounce of Aquamaster™, while the highest dose of 1,282 mg/kg would require drinking just over ¾ of a cup of Aquamaster™. Neither of these scenarios is realistic within the framework of the SCP.

Acute toxicity levels for glyphosate in animal studies were similarly high, with LD50 values ranging from 2,000 to 6,000 mg/kg in a number of test animals (USFS 2003). Toxic effects of glyphosate are thought to be related to uncoupling of oxidative phosphorylation (the process that converts energy from nutrients to storage in high-energy phosphate bonds). This uncoupling results in loss of energy and eventual death, and inhibition of hepatic mixed function oxidases (enzymes that are involved in metabolism of a wide range of endogenous compounds and xenobiotics) (USFS 2003).

<u>Penoxsulam Acute and Chronic Toxicity</u>

United States Environmental Protection Agency (USEPA) and California Department of Pesticide Regulation (CDPR) evaluations of the human health effects of penoxsulam have found no adverse effects in acute, subchronic, and chronic studies. CDPR's summary of toxicology data for penoxsulam found "no data gap, no adverse effects" for chronic toxicity in rats and dogs, oncogenicity in mice, reproduction in rats, teratology in rats and rabbits, gene mutation, chromosome effects, DNA damage, and neurotoxicity (CPDR 2005). There were possible adverse effects in an oncogenicity study in rats (CDPR 2005). When animal toxicity studies found effects from penoxsulam, they occurred at doses that were orders of magnitude higher than potential SCP exposures. Potential SCP exposures for penoxsulam are low. For example, the calculated concentration of penoxsulam out of the herbicide spray nozzle is 105 ppm, and the calculated concentration of penoxsulam if sprayed directly into the water (as opposed to onto the water hyacinth mat) is 9.8 ppb (USDA-ARS 2012).

Chronic toxicity studies in rats, mice, and dogs, summarized below, found No Observable Effects Levels (NOEL) of 450 ppm to 900 ppm, or at oral doses of between 25 mg/kg/day to 2,000 mg/kg/day (CDPR 2005). USEPA calculated an oral reference dose (the maximum acceptable oral dose of a toxic substance) of 0.147 mg/kg/day for penoxsulam based on a NOEL of 14.7 mg/kg/day in a one-year dog feeding study and an uncertainty factor of 100. By comparison, drinking water with 150 ppb would contribute approximately 0.004 and 0.015 mg/kg/day for adults and children respectively (Washington DOE 2012). The 150 ppb penoxsulam concentration is 15 times higher than the concentration if penoxsulam was sprayed directly into the water instead of onto water hyacinth, a highly unlikely scenario.

Below, we briefly summarize representative mammal toxicity studies for penoxsulam:

- An acute oral toxicity study of penoxsulam in rats did not result in deaths at a dose of 5,000 mg/kg body weight (USEPA 2004a)
- An acute inhalation study in rats found an LC50 of greater than 3.5 mg/l, the highest attainable concentration, concluding that a single inhalation of mist from liquid formulations is not likely to cause adverse effects (Washington DOE 2012)
- Acute and chronic neurotoxicity studies found no effects doses of up to 2,000 mg/kg and 250 mg/kg/day, respectively (New York DEC 2008), and the USEPA Hazard Identification Assessment Review Committee concluded that there was no concern for neurotoxicity resulting from exposure to penoxsulam (Washington DOE 2012)
- A 28-day dermal toxicity study in rats found no dermal or systemic toxicity (USEPA 2004b)
- Short-term dermal toxicity studies did not identify a toxicity endpoint, and penoxsulam was not very acutely toxic or irritating to skin and eyes (New York DEC 2008). The Material Safety Data Sheet (MSDS) states that penoxsulam may cause slight but temporary irritation to eyes and slight irritation to skin (SePRO 2011)
- A chronic toxicity/oncogenicity study in rats found possible adverse effects in male rats. There were elevated large granular lymphocyte (LGL) leukemia incidence in all treatment groups. However, distribution of severity was not affected in treated males, and there was a lack of dose-response over a 50-fold treatment range (CDPR 2005). Because of the weak findings, USEPA classified penoxsulam as "suggestive evidence of carcinogenicity, but not sufficient to assess human carcinogenic potential" (Washington DOE 2012)
- A chronic toxicity study in dogs found a NOEL of 450 ppm (CDPR 2005)
- Chronic and oncogenicity studies in mice found no oncogenic effects. NOEL values were 10 mg/kg/day in males and 100 mg/kg/day in females. There were signs of toxicity to the liver and bladder at high penoxsulam levels
- Reproduction and teratology studies in rats, and teratology studies in rabbits, found no reproductive effects and NOELs of 30 to 300 mg/kg/day for offspring and parents. The development toxicity study in rabbits found a NOEL of 25 mg/kg/day (CDPR 2005)
- Subchronic feeding studies in mice and dogs found NOELs of 450 to 900 ppm in dogs and 10 mg/kg/day in mice. There were histopathological effects to dogs at high doses (4,500 ppm and above). In mice, liver weights were greater in mice exposed to 500 and 1,000 mg/kg/day.

These studies demonstrate that penoxsulam does not result in acute or chronic toxicity in mammals at very high doses. Some minor effects were seen, but not at doses, and levels, to raise concern. The treatment doses in these studies were orders of magnitude higher and required many more days of exposure than what could occur with possible accidental one-time exposure of treatment crews to penoxsulam.

Imazamox Acute and Chronic Toxicity

USEPA and CDPR evaluations of the human health effects of imazamox have found no adverse effects in acute, subchronic, and chronic studies. CDPR's Summary of Toxicology Data (2000) for imazamox found "no data gap, no adverse effects" for chronic toxicity in rats and dogs, oncogenicity in rats and mice, reproduction in rats, teratology in rats and rabbits, and no gene mutation, chromosome effects, DNA damage, or neurotoxicity.

Toxicity studies, utilizing high levels of imazamox exposure, found little or no signs of toxic effects at doses that were orders of magnitude higher than potential SCP exposures. Potential SCP exposures to imazamox are low. For example, the calculated concentration of imazamox directly out of the herbicide spray nozzle is 635 ppm, and the calculated concentration of imazamox if sprayed directly into the water (as opposed to onto the spongeplant mat) is 59 ppb (USDA-ARS 2014). Chronic toxicity studies in rats, mice, dogs, and rabbits, summarized below, found NOELs of 7,000 ppm to 40,000 ppm, or from 300 mg/kg/day to approximately 1,200 mg/kg/day.

In animal studies using oral and dermal exposure routes, USEPA chronic and subchronic toxicity studies found no hazard at the highest dose required in toxicity studies (SERA 2010). USEPA originally calculated an oral reference dose of 3.0 mg/kg/day based on a NOEL of 300 mg/kg/day from a development toxicity study in rabbits and an uncertainty factor of 100 (Washington DOE 2012). USEPA later increased the oral reference dose to 9.0 mg/kg/day because the original study was based on weight reduction, which was not determined to be an adequate biological response. The higher oral reference dose is based on a NOEL of 900 mg/kg/day in rabbits (Washington DOE 2012). By comparison, a 150 pound person would need to drink 1 liter of the imazamox coming directly from the spray nozzle to be exposed to 9 mg/kg/day. The maximum potential exposure calculated for an aquatic applicator wearing contaminated gloves for one hour is approximately 0.8 mg/kg/day (SERA 2010). Calculated margins of safety (the ratio of the NOEL to the estimated exposure level) for potential imazamox exposures were extremely high – ranging from 150 to 450,000, resulting in a rating of low hazard for imazamox (Thurston County 2011).

Below, we briefly summarize representative mammal toxicity studies for imazamox:

- An acute toxicity study found no mortality and no clinical signs of toxicity in male and female rats that received a single oral dose of 5,000 mg/kg formulation (SERA 2010)
- An acute toxicity study of an imazamox soil metabolite found an LD50 of 2,274 mg/kg in rats, although many of the toxic effects may have been due to large amounts of the test substance in the GI tract (SERA 2010)
- Inhalation and dermal studies found that imazamox is relatively non-toxic by inhalation, slightly toxic by the dermal route, non-to-slightly irritating to skin, and slightly-to-moderately irritating to eyes (USEPA 1997). Imazamox is not a dermal sensitizer, based on assays using guinea pigs (SERA 2010)
- Acute, subchronic, developmental, reproduction, and chronic studies for the pesticide registration process found no evidence of neurotoxic effects (SERA 2010)
- A chronic oncogenicity study in mice found no carcinogenic effects or other findings of toxicological significance with dietary administration of up to 1,348 mg/kg/day (7,000 ppm) (CDPR 2000)
- A two generation reproduction study in rats found no adverse effects, with the exception of a reduction in weight gain without any dose response relationship for parental systemic, reproductive, and developmental factors. NOELs were 20,000 ppm in all three categories (CDPR 2000)
- Teratology studies in rats and rabbits found no adverse effects, with maternal NOELs of 300 mg/kg/day to 500 mg/kg/day based on reductions in weight gain, and developmental NOELs of 900

mg/kg/day to >1,000 mg/kg/day (CPDR 2000). [Note that this reduction in weight gain was not considered by USEPA to be a biologically significant endpoint]

- Subchronic toxicity studies with between 28 and 90 days exposure in dogs and rats found no adverse effects and NOELs of between 1,000 mg/kg/day and 1,550 mg/kg/day (equal to 20,000 ppm to 40,000 ppm) (CDPR 2000).

These studies demonstrate that imazamox does not result in acute or chronic toxicity in mammals at very high doses. The treatment doses in these studies were orders of magnitude higher, and required many more days of exposure, than what could occur with possible accidental exposure of treatment crews to imazamox.

<u>Diquat Dibromide Acute and Chronic Toxicity</u>

Diquat is classified as a moderately toxic chemical. CDPR identifies no data gaps for diquat; however, CDPR identified possible adverse effects in several categories (CDPR 1995). The primary toxic effects of diquat are due to eye irritation, specifically formation of cataracts following chronic exposure to mid-level and high-level doses (Washington DOE 2002). USEPA classified diquat as Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) Category II (moderately toxic) due dermal exposure (skin and eye irritation), and Category III (slightly toxic) for oral exposure (Washington DOE 2002). Washington DOE (2002, page 380) summarizes the human health risk of diquat as follows: “based on a review of the diquat chemical and physical properties, use-rates, rapid removal from the aquatic environment by adsorption to particular, vegetation, and sediments, toxicology studies, biotransformation, exposure estimates and risk assessments, it appears that the label directed use of the herbicide for aquatic weed control purposes is not expected to result in any significant adverse health effects.”

CDPR and USEPA have interpreted chronic rat toxicity studies of diquat differently. USEPA identified a NOAEL of 0.65 mg/kg/day, and CDPR identified a NOAEL of 0.22 mg/kg/day (Washington DOE 2002). The primary endpoint of chronic toxicity studies is cataracts. There is no evidence of carcinogenicity. USEPA used the lower 0.22 mg/kg/day value to calculate the RfD. Based on Bureau of Land Management (BLM) estimates of diquat exposure to applicators (ENSR 2005), SCP maximum application rates, a 70 kg person, and 3 acres per day diquat treatment, the potential DBW treatment crew exposure is very low, between 0.01 mg/kg/day and 0.06 mg/kg/day.

Acute overexposure to concentrated diquat can result in systemic renal toxicity and severe eye irritation (EXTOXNET 2012, Washington DOE 2002). Diquat is poorly absorbed through the skin, and because of low vapor pressure and large droplet size, inhalation to spray mist is not expected to be a significant health risk (Washington DOE 2002). However, if it occurs, inhalation of concentrated diquat could result in irritation of the upper respiratory tract and possible systemic toxicity. The potential for subchronic or chronic exposure to diquat is unlikely given the rapid dissipation of the chemical, as well as the infrequent use of diquat by DBW treatment crews.

Below, we briefly summarize representative mammalian toxicity studies for diquat:

- Rabbit acute dermal toxicity studies identified acute dermal LD50 values of 262 mg/kg for males and 315 mg/kg for females (Clark and Hurst 1970, Bullock 1980)
- Rat acute inhalation toxicity studies identified a combined-sexes diquat acute inhalation LC50 of 0.97 mg/L, resulting in a FIFRA classification of III (slightly toxic) (Bradfield 1980, Bruce 1985)
- A combined chronic diet toxicity study in rates identified nephrotoxic effects and hematologic changes at 75 ppm and 375 ppm, and cataract development at 15 ppm, 75 ppm, and 375 ppm (CDPR 1995)
- A one-year feeding study in dogs identified possible adverse effects and a NOEL of 0.5 mg/kg/day (CDPR 1995)
- Reproductive and teratology studies have identified possible adverse effects, with CDPR assessing the data more conservatively than USEPA (Washington DOE 2002). USEPA identified maternal toxicity and developmental NOAELs of 1 mg/kg/day and 3 mg/kg/day, respectively.

Chronic Effects of SCP Herbicides 2,4-D and Glyphosate to Humans

Long-term or chronic toxicity effects include cancer, reproductive toxicity, teratogenicity, endocrine disruption, immunotoxicity, genotoxicty, mutagenicity, mental and emotional functioning, and damage to specific tissues or organs. Long-term toxicity can be evaluated through in vivo and in vitro studies, as well as epidemiological studies. Many epidemiological studies focus on farmers and pesticide applicators, as they tend to be exposed to pesticides over a long time period. SCP treatment crew exposure may be similar to both of these groups.

Very little is understood about the health effects of low doses of pesticide exposure over a long time period. For every published study indicating that a particular pesticide or group of pesticides causes cancer, there is another published study indicating that the same pesticide does not cause cancer. It is extremely difficult to prove causation, and to sort out confounding factors such as exposure to multiple chemicals. In this section, we will first discuss general findings and issues related to the effects of long-term pesticide exposure, followed by discussion of studies specific to 2,4-D[1] and glyphosate. We briefly discussed potential chronic effects of penoxsulam, imazamox, and diquat, above. There has been considerably more research relevant to the SCP on the chronic effects of 2,4-D and glyphosate, which have been utilized be DBW for over thirty years.

General long-term effects

There have been hundreds of studies examining the effects of chronic pesticide exposure over the last several decades. Many of these studies have shown a wide range of impacts including solid tumors, haematological cancers, genotoxic effects, mental and emotional functioning, and reproductive effects (Cohen 2007). For cancers, one of the key factors to consider is the link between exposure and biological plausibility. Is there a mechanism by which the pesticide in question could have induced the resulting cancer?

There is controversy as to whether chronic exposure to pesticides (as a broad category) is neurotoxic, and epidemiological studies linking pesticides and human cancers are inconsistent (Alavanja et al. 2004).

Generally, insecticide exposure is thought to be linked to neurotoxic effects, with less linkage for herbicides (Kamel et al. 2005). One study found that increased neurological symptoms were linked to increased cumulative lifetime days of exposure, particularly for organophosphate and organochlorine insecticides (although all classes of insecticides showed increases). Hong et al. (2006) examined neurobehavioral performance in organic farmers and pesticide using farmers in Korea. Hong found, based on a variety of tests, no apparent effect on either the peripheral or central nervous system in the pesticide users.

In one study, that did not identify specific herbicides and adjuvants, Burroughs et al. (1999) examined hormone levels in the bloodstream of agricultural workers in four groups: (1) controls; (2) herbicide only applicators; (3) herbicide and adjuvant applicators; and (4) applicators using herbicides, fumigants, and insecticides. Only the herbicide only applicator group showed a significant difference in hormone levels from controls. The herbicides evaluated included, but were not limited to, phenoxy herbicides. Burroughs also looked at in vitro impacts on genotoxicity, and found that all four adjuvants had a dose-response curve showing genotoxicity, but only one (unspecified) herbicide showed genotoxicity.

López et al. (2007) examined antioxidant enzymes in 81 pesticide applicators during the spraying season. López saw decreased enzyme activity during the spraying season, but was not sure if this decreased enzyme activity was related to adverse health effects. This study did not look at specific pesticides.

Blair and Zahm (1995) reviewed studies of agricultural exposure and cancer in the literature. Farmers were generally healthier than the overall population, but they appeared to have increased risks of some cancers, including: leukemia, NHL, multiple myeloma, soft-tissue sarcoma (STS), and cancers of the skin, lip, stomach, brain, and prostate. Blair and Zahm noted that the number of excess cancers were not large, but were noticeable because farmers were otherwise healthier than normal, and because the tumors were not smoking related. The study did not identify any established etiological factors for the cancers, but

[1] Many of the studies of long-term impacts of 2,4-D are for phenoxy herbicides more generally, or for each of several phenoxy herbicides.

stated that some were associated with immune system deficiencies (Blair and Zahm 1995). The study also noted the need to evaluate exposures to materials other than pesticides, such as fuels, oils, engine exhausts, organic solvents, dusts, and microbes.

One of the largest efforts aimed at identifying long-term health impacts related to pesticides is the Agricultural Health Study (AHS). AHS is a prospective cohort study of over 89,000 farmers, pesticide applicators and spouses in Iowa and North Carolina. The study is sponsored by the National Institute of Health (NIH) and USEPA. The goal of the AHS is to "investigate the effects of environmental, occupational, dietary, and genetic factors on the health of the agricultural population."

Through the AHS, government scientists and collaborating academics and others have conducted a number of studies using the entire AHS cohort, as well as specific sub-groups. Data gathering has been ongoing. When they entered the program between 1993 and 1997, farmers and spouses completed questionnaires, and many completed a second, more detailed, take-home questionnaire. A Phase 2 follow-up took place between 1999 and 2003 (this included buccal (mouth) cell collection, a computer assisted telephone interview, and a mailed dietary questionnaire). A Phase 3 follow up began in 2005 (this included a third interview, DNA analysis, and questionnaire validation).

Overall, farmers and spouses in the AHS have a lower than expected risk of cancer than the general public in North Carolina and Iowa. However, for some specific cancers, such as prostate cancer, AHS participants have higher risks. While some cancers among AHS participants may be related to specific pesticides, there is not enough data yet to make any such conclusions (Alavanja et al. 2005). The AHS has shown that individuals that applied pesticides more than 400 days in their lifetimes had a higher risk of Parkinson's disease (as self-reported), compared with those that applied pesticides for fewer days. Again, there was not enough data to link the occurrence of Parkinson's to certain pesticides, although it is still being studied (Kamel 2006).

In the AHS examination of prostate cancer among male pesticide applicators, researchers evaluated over 55,000 applicators and 45 pesticides. They also controlled for known and suspected risk factors. While the overall risk of prostate cancer among AHS participants was higher, there were no elevated risks for prostate cancer among farmers exposed to glyphosate-family and phenoxy herbicides (Alavanja et al. 2003).

A more recent study of AHS pesticide applicators (Belseler et al. 2008) found a link between depression and pesticide exposure, suggesting that both acute high-intensity and cumulative pesticide exposure may contribute to depression in pesticide applicators. Three percent of the study population of almost 18,000 applicators reported depression symptoms. The highest level of lifetime days of exposure (over 752 days) showed a statistically significant relationship to depression. When researchers examined depression by exposure to major pesticide groups, use of herbicides showed a strong association with diagnosed depression, with an odds ratio (OR) of 2.0. The 95 percent confidence interval (CI) was not statistically significant, ranging from 0.76 to 5.54. For insecticides, the OR was 1.96, with a statistically significant 95 percent CI of 1.29 to 3.27. Belseler et al., (2008) concluded that "results suggest that pesticide exposure may contribute to depression in farmer applicators and the importance of minimizing pesticide exposures. Future work on neurological effects of pesticide exposure should include measures of affective disorders, including depression and anxiety."

These examples illustrate the significant uncertainty as it relates to pesticide exposure and long-term health impacts in humans. The uncertainties are even greater when one considers specific well-studied pesticides, such as 2,4-D and glyphosate. While researchers attempt to adjust their results for exposure to multiple chemicals and other risk factors such as age and smoking, it is extremely difficult to draw specific conclusions about the long-term impacts of these herbicides.

<u>2,4-D long-term effects</u>

Worldwide, 2,4-D is one of the most widely used herbicides. The chemical has been extensively studied, and while there are many conflicting studies, regulatory agencies at all levels consistently state that when used as specified, 2,4-D does not pose human health risks.

The Industry Task Force II on 2,4-D Research Data (Task Force), an industry funded research organization, provided a news release in 2006 summarizing several assessments on 2,4-D. The Task Force cited a 2004 USEPA review that concluded “there is no additional evidence that would implicate 2,4-D as a cause of cancer.” USEPA stated that none of the recently reviewed epidemiological studies “definitely linked human cancer causes to 2,4-D.” The release also cited assessments by WHO, and Health Canada’s Pest Management Regulatory Agency that did not identify health risks from 2,4-D. The Task Force identified 23 separate regulatory decisions or expert panel reviews, dating from 1987 to 2005, that have concluded that 2,4-D does not present an unacceptable risk when used according to product instructions (Industry Task Force II 2006).

Despite these assessments on the safety of 2,4-D, there continues to be conflicting results and studies on various potential long-term impacts of 2,4-D. This uncertainty is evident in the California Department of Pesticide Regulation (DPR) assessment of 2,4-D. In the DPR Summary of Toxicology Data for 2,4-D (which was last updated in August 2006), there were five impact categories for 2,4-D that were identified as having a “possible adverse effect” – chronic toxicity rat, chronic toxicity dog, oncogenicity mouse, reproduction rat, and DNA damage.

One of the most controversial issues surrounding the use of 2,4-D is the potential link between 2,4-D and NHL. We discuss studies on NHL separately, following discussions of other potential long-term impacts of 2,4-D and glyphosate.

Another set of controversy surrounds the potential genotoxicity, mutagenicity, neurotoxicity, immunotoxicity, endocrine disruption, and/or reproductive effects of 2,4-D. There have been numerous published studies, at all levels, with both positive and negative effects. There are two primary potential reasons cited for the differing results: 1) the use of different grades of 2,4-D (reagent versus commercial), and 2) the differing endpoints of these various studies, in terms of media and timing (Tuschl and Schwab 2003; Madrigal-Bujaidar et al. 2001).

These studies demonstrate significant conflicting evidence surrounding the long-term effects of 2,4-D. Many studies that show negative effects of 2,4-D utilize relatively high doses, and/or cellular culture systems that do not include normal in vivo protective mechanisms. However, given the difficulty in measuring impacts of any chemical or combination of chemical and environmental factors, particularly over the long-term, it seems prudent to minimize worker exposure to 2,4-D to the greatest extent possible.

Further reflecting the controversy surrounding potential impacts of 2,4-D, in December 2008, the USEPA published an announcement seeking comments on a National Resources Defense Council (NRDC) petition to revoke all tolerances and cancel all registrations for 2,4-D (Federal Register 2008). One of the comments surrounding the USEPA evaluation of pesticides, including 2,4-D, is that the USEPA relied on studies submitted by industry for the registration process, and not on the open scientific literature. The comment period for the NRDC petition ended February 23, 2009; however, there was no published time frame for further USEPA action on 2,4-D. As of June 2009, the USEPA had received over 500 comments on the petition. In May 2009, the NRDC asked the USEPA to first address residential uses of 2,4-D, rather than agricultural uses. USEPA denied the petition on April 18, 2012 (Regulations.gov 2014).

Researchers have used a wide range of methodologies to examine long-term impacts of herbicides such as 2,4-D. The studies summarized below include in vitro, in vivo, and epidemiological studies, and several weight-of-evidence reviews. While a comprehensive summary of all studies on 2,4-D is beyond the scope of this Final PEIR, we include a sampling of summaries of these studies to illustrate the issues related to potential impacts of long-term exposure to 2,4-D.

In vitro analyses of 2,4-D include a wide variety of tests using various forms of 2,4-D in cellular cultures. Media evaluated include yeast, salmonella (Ames test), human erythrocytes, hamster ovary cells, germ cells, and others. There are published studies that illustrate various cytotoxic, genotoxic, mutagenic, or other effects, and studies that do not. As noted above, the use of different grades of 2,4-D, and different media and endpoints, may explain some of the variability. Several of these studies illustrate mechanisms of action for 2,4-D, some of which may be negated by in vivo protective mechanisms. For example, oxidation resulting from 2,4-D may be reduced by natural anti-oxidant systems in the cell. Most in vitro studies involve exposing the cellular medium to varying concentrations of 2,4-D for a set time period, then evaluating various end points. Most exposure levels are well above those likely to result from SCP treatments, typically in the ppm, rather than ppb, range.

- Morelmans et al. (1984) found no mutagenic activity in four Salmonella strains tested with 2,4-D and other phenoxy herbicides at 2,4-D levels of 10 and 100 μg/test plate
- Mustonen et al. (1986) found that pure 2,4-D did not increase chromosome aberrations in human peripheral lymphocyte cultures, but a commercial 2,4-D formulation did increase chromosome breaks and aberrations at concentrations ranging from 54 to 217 ppm
- Holland et al. (2002) found increased effects with commercial as compared to pure 2,4-D; however genotoxic and cell cycle effects were relatively minimal for both. At 1 ppm commercial 2,4-D, they found a marginally significant increase in replicative index, a metric that indicates changes in cell cycle kinetics. There was also an increase in micronucleus formation at higher concentrations (217 ppm). Micronucleus formation is a marker of genotoxicity
- Gollapudi et al. (1999) and Charles et al. (1999) found no evidence of genotoxicity in cultures of rat lymphocytes and Chinese hamster ovary cells exposed to 2,4-D
- Venkov et al. (2000) found increases in gene conversions, reverse mutations, and moderate cytotoxic effects that were time and dose related in yeast cells exposed to 1,736 ppm 2,4-D
- Maire et al. (2007) found that 2.5 and 5 ppm 2,4-D induced cell transformation, but not apoptosis (cell death) in Syrian hamster cells
- Lin and Garry (2000) examined commercial and reagent grade 2,4-D in MCF-7, a breast cancer cell line. They found that higher doses of the commercial grade induced cell proliferation at the higher doses. As there were no impacts with the reagent grade, they hypothesized that additives in the commercial product were responsible for the estrogen-like receptor mediated proliferation. They also noted that because internal cell mechanisms would likely dampen the estrogen-like effects, one would not necessarily see these results in a clinical trial
- Tuschl and Schwab (2003) examined changes in cell cycle progression in the human hepatoma cell line (HepG2 cells) following exposure to 868 ppm, 1,736 ppm, or 3,472 ppm 2,4-D. The highest dose resulted in apoptosis due to reduced mitochondrial membrane potential. The lower two doses resulted in changes in cell cycle progression
- Bukowska et al. (2008) demonstrated that 2,4-D induced oxidation in human erythrocytes through the formation of free radicals. Effects, seen at doses ranging from 9.8 ppm to 542 ppm, ranged from changes in mitochondria potential, capase (an enzyme) dependent reactions, and apoptosis. 2,4-D induced oxidation in a time and dose dependent manner, although it did not result in denaturation of haemoglobin
- Gonzalez et al. (2005) found that 2,4-D at 6 ppm and 10 ppm increased sister chromatid exchange (sister chromatid exchange is an indicator of genotoxicity), reduced mitotic index (a measure of cell proliferation), and increased DNA damage in Chinese hamster ovary cells
- Bharadwaj et al. (2005) found indications of cell proliferation, changes in gene expression, and cytotoxicity at 22 ppm, 217 ppm, and 868 ppm 2,4-D in human hepatoma HepG2 cells
- Teixeira et al. (2004) evaluated the level of free radicals in yeast cells exposed to 2,4-D, and found that 2,4-D induced the formation of free radicals and stimulated the activity of anti-oxidant enzymes in a dose and time dependent fashion. Concentrations of 2,4-D ranged from 98 ppm to 141 ppm
- Moliner et al. (2002) exposed cerebellar granule cells to 217 ppm and 434 ppm 2,4-D. They found reduced cell viability, increases in apoptotic cells, increased capase 3 activation, and reduced cytochrome c. They concluded that 2,4-D induced apoptosis by direct effect on mitochondria
- Zeljezic et al. (2004) examined the genotoxic effect of 2,4-D on human lymphocytes at relatively low levels (86 ppb and 868 ppb). Both concentrations resulted in an increase in chromatid and chromosome breaks, increased number of micronuclei, and increased number of nuclear buds, all signs of genotoxicity

- Soloneski et al. (2007) examined the genotoxic effects of 10 ppm to 100 ppm 2,4-D on human lymphocytes with, and without, erythrocytes present. They found the highest dose to be cytotoxic, with delays in cell cycle progression and reduced mitotic index at the lower doses. They also noted that with erythrocytes present, none of the concentrations induced sister chromatid exchange, indicating that erythrocytes in the culture system modulated the DNA and cellular damage inflicted by 2,4-D
- Bukowska (2003) identified changes in anti-oxidant enzyme systems in human erythrocytes exposed to 250 ppm and 500 ppm, indicative of the oxidative effect of 2,4-D. In a later study, Bokowska et al. (2006) examined acetylcholinesterase activity in human erythrocytes, showing reduced enzyme activity at 500 ppm and 1,000 ppm 2,4-D, again indicative of oxidative activity of 2,4-D
- Bongiovanni et al. (2007) evaluated the oxidative stress produced by 2,4-D in rat cerebellar granule cells. They measured oxidation properties in cells exposed to 217 ppm 2,4-D, with and without the presence of melatonin, a known anti-oxidant. Melatonin countered most of the oxidative changes induced by 2,4-D, supporting the efficacy of melatonin as a neuroprotector
- Mi et al. (2007) examined the oxidative impacts of 2,4-D with, and without, another anti-oxidant, quercetin. Without quercetin, 50 ppm 2,4-D resulted in a number of oxidative impacts on chicken embryo spermatogonial cells, including: condensed nuclei, vacuolated cytoplasm, reduced cell viability, increased lactate dehydrodgenase, increased malondialdehyde, reduced glutathione, and reduced superoxide dismutase. Exposure to 2,4-D with quercetin reduced impacts to the same levels as controls, indicating that dietary quercetin may attenuate the negative effects of environmental toxicants.

In vivo analyses of 2,4-D exposure in laboratory animals typically involve feeding animal subjects 2,4-D at various doses, specified as mg/kg/day. Most laboratory study doses are well above potential worker exposure levels.

- Ibrahim et al., (1991) note that the dog subchronic NOEL is 10 mg/kg/day and rat chronic NOEL is 30 mg/kg/day. There was a NOEL for reproductive effects in rats of 10 mg/kg/day. This study found decreased birth weight in offspring even without apparent maternal toxicity
- de la Rosa et al. (2004) examined the impact of the herbicides propanil and 2,4-D in combination, and separately, on thymus weight (i.e. immune system impacts) in an in vivo experiment in mice. While the combination of the two herbicides did reduce thymus weight, propanil and 2,4-D alone did not
- USFS (2006) reported that a LOEL in canines of only 3 to 3.75 mg/kg/day (dogs are more sensitive to 2,4-D because they cannot excrete organic acids), and a LOEL in rodents of 75 to 100 mg/kg/day. At these doses, impacts included decreased body weight and food consumption, and adverse effects in the liver and kidney
- Charles and others conducted a number of studies for the 2,4-D Industry Task Force on chronic and subchronic effects of 2,4-D. Charles et al. (1996a) found reduced weight gain and other effects at up to 7.5 mg/kg/day in subchronic and chronic tests in dogs, but did not identify any immunotoxic or oncogenic impacts. In another 1996 study (Charles et al. 1996b) of 2,4-D chronic toxicity in rats and mice, the researchers identified impacts such as reduced weight gain, opthamalic impacts, and hematological impacts at higher doses, but no oncogenicity. Mattsson et al. (1997) identified mild, transient locomotor effects from high-level (250 mg/kg) acute exposure to 2,4-D, and retinal degeneration from high-level chronic exposure in female rats. They identified a NOEL for acute neurotoxicity of 15 mg/kg/day, and for chronic neurotoxicity of 75 mg/kg/day. In 2001, Charles et al. conducted developmental toxicity studies of 2,4-D in rats and rabbits, and concluded that no adverse fetal effects were noted at dose levels that did not also produce evidence of maternal toxicity, or exceed renal clearance of 2,4-D
- A group of scientists at the School of Biochemical and Pharmaceutical Sciences at the National University of Rosario in Argentina has investigated the impacts of 2,4-D since the mid-1990s. Many studies involved feeding pregnant and/or nursing rats doses of approximately 70/mg/kg/day (below the NOEL) to 100 mg/kg/day, and evaluating effects on both rat pups and mothers. In numerous published articles, the group has identified: reversible and irreversible behavioral alternations in pups (Bortolozzi et al. 1999); reduced body weight and central nervous system myelin deficits in rat pups (Duffard et al. 1996); neuron cell changes in rat pups (Brusco et al. 1997); transfer of 2,4-D from exposed dams to neonates (Stürz

et al. 2000); changes in neurotransmitter receptors and brain weight in rat pups (Bortolozzi et al. 2004; Garcia et al. 2004); increases in 2,4-D milk residues as compared to maternal doses, reduced milk lipid content, changes in milk proteins and fatty acids, and impaired rat pup nutrition (Stürtz 2005); evidence of oxidative stress in brains of neonates exposed to 2,4-D in milk (Ferri et al. 2007); and disruptions in material behavior and neurotransmitter levels in exposed dams (Stürtz et al. 2008)

- Rawlings et al. (1998) found reductions in thryoxine levels, as compared to controls, in ewes receiving 10 mg/kg 2,4-D three times per week for 36 days. There were no overt signs of toxicity, including no effect on body weight. There were no reductions in other measured hormones, including leutenizing hormone (LH), insulin, estradiol, or cortisol
- Linnainmaa (1984) examined sister chromatid exchange frequency in the blood lymphocytes of rats and hamsters exposed one time to 100 mg/kg 2,4-D, and found no differences between treated and controlled rodents
- Mustonen et al. (1986) found no changes in cell cycle kinetics or chromosomal aberrations in the lymphocytes of workers exposed to 2,4-D. All workers did have measurable levels of 2,4-D in urine
- Lee et al. (2001) evaluated immune function in offspring of rats fed 8.5 mg/kg, 37 mg/kg, or 370 mg/kg 2,4-D during gestation. They found “subtle immune alterations” in offspring of the highest treatment group
- Chernoff et al. (1990) fed pregnant rats 2,4-D at the LD50 level, and four lower doses. They identified a number of effects, including reduced maternal weight, increased supernumary ribs in pups, and reduced thymus weight in pups
- After 12 and 24 hours, Venkov et al. (2000) found increases in chromosome aberrations and reduced mitotic index in mice intraperitoneally administered 3 to 5 mg/kg 2,4-D. They hypothesized that the cytotoxicity and mutagenicity were induced by the presence of chlorine atoms at positions 2 and/or 4 in the benzene ring of 2,4-D
- Madrigal-Bujaidar et al. (2001) found that 2,4-D induced moderate increases in sister chromatid exchange in both somatic and germ cells of mice exposed to a 50 to 200 mg/kg oral dose of 2,4-D
- Several studies suggested that 2,4-D adversely affects reproductive organs, particularly testes. Rats had lower testicular and ovarian weights at a dose of 75 mg/kg/day. Dogs had similar impacts at doses of 3 mg/kg/day. Impacts in both rats and dogs included lower testicular weights, inactive prostates, and deficient sperm production (USFS 2006).

Epidemiological studies of pesticide applicators and workers exposed to 2,4-D have examined a number of potential impacts (additional studies examining linkages between 2,4-D and NHL are described further below). Many of these studies identify areas of potential concern related to 2,4-D exposure, however it is nearly impossible to link chronic exposure to 2,4-D, with certainty, to any diseases.

- Swan et al. (2003) examined semen quality in relation to pesticide levels in blood for healthy men in Missouri and Minnesota to test whether reduced semen quality found in Missouri was linked to higher exposure to pesticides. Swan found strong odds ratios linking lower sperm quality to exposure to the pesticides alachlor, atrazine, and diazinon. They found “borderline with small and somewhat inconsistent associations” for 2,4-D and metolachlor. A small study in Argentina showed decreased sperm concentration and morphology related to high urinary levels of 2,4-D
- Faustini et al. (1996) examined blood levels of various immunological factors in ten farmers prior to exposure, within one to 12 days of exposure, and 50 to 70 days after exposure to 2,4-D and MCPA . They found immunosuppressive effects during the one to 12 days of exposure period, however most of the effects were short-term, and were no longer in evidence by 50 to 70 days after exposure
- Figgs et al. (2000) compared urinary and blood levels of 2,4-D in exposed workers, replicative index, micronuclei, and lymphocyte immunophenotypes in exposed workers. They found increased replicative index scores, indicative of stimulated cell growth, but no changes in lymphocyte immunophenotypes or micronuclei. Figgs et al concluded that there was no evidence of human chromosome damage at urinary levels of 12 to 1,285 ppb 2,4-D, and no support for genotoxicity of 2,4-D

- Holland et al. (2002) found that the lymphocyte replicative index, but not the mitotic index, was affected in applicators exposed solely to 2,4-D during a three-month period
- In a very general article, Buranatrevedh and Roy (2001) identified 2,4-D as endocrine disrupting, citing a 1988 study by Bond of chemical workers
- Burns (2005) (of Dow Chemical) reviewed several studies of pesticide applicators and manufacturers and cancer. Burns noted that while there are hundreds of such studies, few have focused on a single pesticide or class of pesticide, and that "limitations in sample size, exposure assessment, and the small number of studies make causal inference difficult." Burns noted that several studies of phenoxy herbicides, including 2,4-D, have found no increased risk of cancer. Other studies have shown an association between some of the lymphopoietic cancers and the use of phenoxy herbicides. Some, but not all, case-control studies have shown an association between 2,4-D and NHL. Some studies examining exposure to herbicides in general have identified higher risk of NHL (for small farms), and for multiple myeloma. One meta-analysis of studies of farmers identified increased risk of NHL, but provided no details on exposures
- There is some indication that there is a potential link between 2,4-D exposure (in DOW workers) and ALS (amyotrophic lateral sclerosis) (Burns et al. 2001). There were only three cohort members in the study with ALS, which makes it difficult to draw conclusions. At least one researcher Freedman (2001) noted that this potential linkage warrants serious attention in future studies.

There have been a number of comprehensive weight-of-evidence reviews of 2,4-D conducted by scientists. In addition, regulatory agencies have conducted risk assessments that considered potential impacts of 2,4-D on workers. These evaluations identified several relevant conclusions.

- In 1992, Munro et al. conducted a comprehensive integrated review and evaluation of the scientific evidence relating to the safety of 2,4-D. All authors were from private research groups in Canada and Washington DC. Munro integrated data from worker exposure studies, whole animal studies, metabolic studies, and epidemiological studies
- Munro (1992) summarized that case-control studies linking 2,4-D with cancers were inconclusive, and that epidemiological studies, "provide, at best, only weak evidence of an association between 2,4-D and the risk of cancer"
- Munro (1992) also identified one of the most commonly cited criticisms of the potential link between 2,4-D and cancer, that the chemical structure of the herbicide, and animal studies, do not support that 2,4-D would be a carcinogen
- Munro (1992) further cited a large body of negative studies on genotoxicity of 2,4-D. These negative genotoxicity studies, together with the negative metabolic studies "clearly indicates that 2,4-D is highly unlikely to be a genotoxicity carcinogen." Munro also reviewed and found no evidence for adverse effects on immune system, endocrine system, neurotoxic effects, and reproductive effects (except at high acute toxic doses). Finally, Munro noted that historical exposure to 2,4-D was higher than current exposures, due to label changes and increased safety precautions that have been implemented
- In a weight-of-evidence analysis conducted by 12 scientists (and funded by the Industry Task Force II on 2,4-D), Ibrahim et al. (1991) evaluated the research (through 1989) on 2,4-D impacts. The panel reviewed published data, considered all evidence, and made weight-of-evidence judgments. The diverse panelists were not expected to all agree, and tried to capture their differences in the article. On mutagenicity, they found that: "although it has been one of the most rigorously tested compounds, the available evidence on the mutagenicity of 2,4-D and its related products is equivocal to negative. Evidence indicates it does not exhibit the gene-damaging potential of a classic mutagen." In vitro tests have shown both positive and negative mutagenicity results
- Ibrahim et al.'s (1991) analysis of carcinogen bioassays only considered those conducted after 1986, when procedures were refined. They summarized two two-year studies conducted in 1986 and 1987. One study on rats found a significant increase in brain tumors at the highest dose of 45 mg/kg/day 2,4-D, and two tumors in the second highest dose, 15 mg/kg/day. A similar study repeated on mice,

did not find effects. The panel concluded, "considered together, these two animal studies do not provide impressive evidence that exposure to 2,4-D causes cancer in animals. Based on results from the rat study, the workshop participants concluded that there was weak evidence supporting an excess of brain cancer occurrence in the male Fischer 344 rats receiving the highest dose"

- Ibrahim et al. (1991) also examined the cohort studies of 2,4-D and concluded, "in summary, the cohort studies provide little evidence to suggest that 2,4-D exposure increases the risk for more common types of cancers in humans." They only evaluated three of the six cohort studies that had been completed at the time, because the other three studies had small cohorts or low statistical power
- In Ibrahim (1991), the workshop participants did not find strong evidence between the exposure of 2,4-D and any other type of cancer, besides NHL, and were also not convinced that there was a cause-effect relationship between 2,4-D and cancer. Eleven of 13 participants said that it was "possible" that 2,4-D could cause cancer in humans, with one thinking the possibility was pretty strong, and five thinking that it was pretty weak. Two participants thought that it was unlikely that 2,4-D causes cancer in humans. Several panelist said that there was barely enough evidence to support any conclusions regarding carcinogenicity of 2,4-D
- WDOE (2001) summarize that 2,4-D is not considered to be a teratogen or reproductive hazard if administered below maternally toxic doses. This evaluation noted that there have been conflicting results on mutagenicity studies, but that an USEPA panel concluded, "2,4-D does not pose a mutagenic hazard and there is no concern for mutagenicity at this time." Animal carcinogenicity studies have not been positive. WDOE noted that epidemiological studies of 2,4-D exposed workers have been "controversial", and that studies haven't definitively demonstrated an association between 2,4-D and NHL or other cancer
- In 2002, Garabrant and Philbert conducted a review of human toxicity and cancer risks related to 2,4-D. This review, conducted for the Industry Task Force II on 2,4-D Research, focused on studies conducted between 1995 and 2001. Garabrant and Philbert focused their review on animal and epidemiological studies. They noted that "it is clear from the large amount of data available that 2,4-D, its salts, and esters are not teratogenic in mice, rats, or rabbits unless the ability of the dam to excrete the chemical is exceeded" (p.236). They also noted that it is unlikely that 2,4-D has any neurotoxic potential at doses below those that result in systemic toxicity. While Garabrant and Philbert discussed results of some in vitro studies, none of the three studies that they identified had positive results. The review concludes that despite several in vitro and in vivo studies, there is no experimental evidence that under physiologic conditions, 2,4-D causes DNA damage or is immunotoxic
- Garabrant and Philbert (2002) also summarized a large number of epidemiological studies. They noted many of the study weaknesses that had been previously identified, such as limited exposure data. The review did not find any compelling evidence among the case-control and cohort studies that 2,4-D was linked to soft tissue sarcoma, non-Hodgkin lymphoma, or Hodgkin lymphoma
- As part of the 2005 pesticide reregistration process, USEPA made a number of conclusions about 2,4-D, including that it had: low acute toxicity based on dermal, oral, and inhalation exposures; was a severe eye irritant; a Group D, non-classifiable carcinogen, based on the fact that it was not mutagenic, but that there were cytogenic effects (USEPA 2005). In the USEPA's reregistration approval of 2,4-D, they requested that a number of additional studies be completed to address areas of uncertainty related to 2,4-D's impacts. These included: a subchronic (28 day) inhalation study, a repeat two-generation reproduction study to address concerns related to endocrine disruption, and a developmental neurotoxicity study. USEPA noted that the endocrine disruption study should address concerns related to thyroid effects, immunotoxicity, and a more thorough assessment of the gonads and reproductive/developmental endpoints (USEPA 2005)
- In their risk analysis, USFS (2006) noted that 2,4-D is toxic to the immune system in recent studies, especially in combination with other herbicides. The toxicity mechanism is through cell membrane disruption and cellular metabolic processes. The herbicide was found to result in genetically programmed cellular death (apoptosis). Toxic effects started at the cellular membrane. In disrupting cellular metabolism, researchers hypothesized that because 2,4-D is similar to acetic acid, it forms analogues of the enzyme

acetyl-Co-A, which is involved in glucose metabolism, and production of cholesterol, steroid hormones, and acetylcholine. By forming these analogues, 2,4-D disrupts these processes. 2,4-D may also cause apoptosis by directly damaging mitochondria, which initiates apoptosis in human lymphocytes.

The USEPA and other agencies determine pesticide levels that are considered safe for both long-term and short-term exposure. These agencies also make determinations about the carcinogenicity of various chemicals. Below (for 2,4-D), and in **Table 4-3,** on the next page, we summarize current metrics for 2,4-D, and relevant figures for the SCP, based on the exposure estimates in Table 4-1.

- USEPA maintains that 2,4-D is a Class D carcinogen, which is "not classified as to human carcinogenicity". The International Agency for Registration of Carcinogens (IARC) classifies 2,4-D as 2B, "possible carcinogen to humans". The World Health Organization (WHO) does not regard 2,4-D as genotoxic or carcinogenic (USFS 2006)
- USEPA uses a chronic NOEL of 5 mg/kg/day in rats, and a safety factor of 1,000 to calculate the chronic exposure RfD for 2,4-D of 0.005 mg/kg/day. The safety factor of 1,000 is based on safety factors of 10 each for sensitivity between species, sensitivity within species, and uncertainty in the database of study results. That is, the RfD is 1,000 times lower than the chronic NOEL, providing three orders of magnitude protection compared to the animal study NOEL. This RfD means that USEPA considers a daily lifetime exposure of 0.005 mg/kg/day to be safe (0.35 mg/day for a 70 kg person). This chronic RfD value is relevant for determining the potential risk of 2,4-D exposure to WHCP treatment crews
- USEPA uses two different acute NOEL values to determine acute RfDs. The lower acute NOEL of 25 mg/kg/day is for females of reproductive age, while the higher 67 mg/kg/day is for the general population. These NOELs are based on animal acute toxicity studies. The acute RfD values are 1,000 times lower, at 0.025 mg/kg/day, and 0.067 mg/kg/day, for reproductive age females and the general population, respectively
- WHO identified an acceptable daily intake (ADI) for 2,4-D of between 0 and 0.01 mg/kg/day, based on a NOEL of 1 mg/kg/day
- USFS calculated a hazard quotient of 16 for backpack and aerial spray, and 30 for ground spray. These HQ values are based on the expected forest worker exposure, divided by the chronic RfD. An HQ greater than one indicates potential hazard. As a result, USFS (2006) noted that "based on upper bound hazard quotients, adverse health outcomes are possible for workers who could be exposed repeatedly over a longer-term period of exposure." The USFS exposure values, as summarized in Table 4-1, utilize significantly higher acreage per day treatment than the WHCP
- In Table 4-3, we calculate HQ values for estimated SCP exposure, based on the exposure estimates for SCP crews in Table 4-2, and the RfD of 0.005 mg/kg/day. Because SCP crews are exposed to 2,4-D for only part of the year, these HQ values of over 1 may not be as potentially hazardous as it appears. The estimated SCP HQ for 2,4-D is 1.6, with a range of 0.6 to 3.4. Thus, there is potential hazard to SCP treatment crews from long-term exposure to 2,4-D.

<u>Glyphosate long-term effects</u>

Like 2,4-D, glyphosate is also a widely utilized and extensively studied herbicide. Similarly, glyphosate is generally considered safe for humans when used as specified. Another commonality is the conflicting results and ongoing controversy regarding the potential impacts of long-term exposure to glyphosate. In the DPR Summary of Toxicology Data for glyphosate (last updated November 1992), there were two impact categories identified as having a "possible adverse effect" – oncogenicity in mouse, and oncogenecity in rat. Monroy et al. (2005) stated that while glyphosate is considered to be of low health risk to humans, the occurrence of possible harmful side effects of glyphosate are not well documented and are controversial. Monroy notes that there have been studies that suggested glyphosate could alter various cellular processes in animals.

Below, we provide a summary of research on glyphosate to reflect the range of concerns that have been expressed. A full review of all such studies is beyond the scope of this PEIR.

Table 4-3
Toxicity and Exposure Standards for SCP Herbicides, Compared to Potential SCP Exposure

Exposure Standard	2,4-D	Glyphosate	Penoxsulam	Imazamox	Diquat
1. USEPA Chronic NOEL	5 mg/kg/day	175 mg/kg/day	15 mg/kg/day	300 mg/kg/day	0.22 mg/kg/day
2. USEPA Safety Factor	1,000	100	100	100	100
3. USEPA Chronic RfD	0.005 mg/kg/day	2 mg/kg/day	0.15 mg/kg/day	3 mg/kg/day	0.002 mg/kg/day
4. USEPA Acute NOEL	25 mg/kg/day (females) 67 mg/kg/day (general pop.)	175 mg/kg/day	>2,000 mg/kg	>5,000 mg/kg	75 mg/kg
5. USEPA Acute RfD	0.025 mg/kg/day (females) 0.067 mg/kg/day (general pop.)	2 mg/kg/day	0.15 mg/kg/day	3 mg/kg/day	0.75 mg/kg/day
6. Allowable Daily Intake (ADI)	0 to 0.01 mg/kg/day	0.3 mg/kg/day	0.05 mg/kg BW/day	2.8 mg/kg BW/day	0.005 mg/kg/day
7. USFS HQ	16 to 30	0.2	NA	NA	NA
8. SCP Estimated Exposure	0.008 mg/kg/day (0.003 to 0.017)	0.0024 mg/kg/day (0.0012 to 0.0108)	0.0002 mg/kg/day[a]	0.001 mg/kg/day[a]	0.01 to 0.06 mg/kg/day[b]
9. SCP Estimated HQ	1.6 (0.6 to 3.4)	0.0012 (0.0006 to 0.0054)	0.001	0.0003	0.013 to 0.08

[a] Based on USFS estimate for 2,4-D of 0.0009 mg/kg/lb. active ingredient for airboat handgun application, maximum SCP application rates, and 3 acres per day.

[b] Based on BLM exposure estimates, maximum SCP application rates, and 3 acres per day.

In recent years there have been a number of in vitro studies that have raised concerns related to glyphosate. Generally, in vitro studies provide a first-level assessment of potential toxicity and mechanisms, and can indicate a need for further analyses.

- Monroy et al. (2005) examined the toxicity and genotoxicity of glyphosate to normal human cells and human fibrosarcoma cells. Monroy noted a dose-dependent effect, with cytotoxic and genotoxic effects at concentrations of 4.0 to 6.5 millimolar (mM) (equivalent to 676 to 1,098 ppb). They concluded that the mechanism of action of glyphosate was not limited to plant cells
- Hokanson et al. (2007) noted that the general chronic toxicity of glyphosate has not been determined, but that it is considered to be an endocrine disrupter. Hokanson examined the possibility that glyphosate interrupts estrogen-related gene expression in an in vitro DNA microarray analysis. The study found that 680 of 1,550 genes were dysregulated by in vitro exposure to commercial glyphosate, but that many of the changes were minor. Hokanson concluded that “there remains an unclear pattern of very complex events following exposure of human cells to low levels of glyphosate.” They noted that exposure was complicated and potentially damaging to adult and fetal cells
- Glyphosate has generally been considered as harmless in normal usage, but Marc et al. (2004a) noted conflicting evidence. In a study of five glyphosate formulations (all with surfactant) on sea urchin embryos[2], Marc et al. identified a dose-dependent effect, proportional to the amount of glyphosate. Some of the five

[2] Sea urchin embryos have been found to be a good indicator of cell development in all species.

glyphosate products produced impacts at 1mM (169 ppb), while others required levels of 8 to 12 mM (1,352 to 2,028 ppb). Marc saw dysfunction and a delay in morphological changes in the cell cycle at 10 times higher doses, but saw no aberrant chromosome morphology. Marc concluded that the effect appeared to be common to a group of glyphosate products, but did not establish a direct link with development of cancer

- In a follow-up study of sea urchin embryo development using Roundup, Marc et al. (2004b) found that glyphosate at 10mM (1,690 ppb) delayed occurrence of the first cell cycle by 30 minutes. The delay was caused by glyphosate interfering with DNA replication. Marc determined that the effect was due to glyphosate acting in synergy with surfactants. Glyphosate concentrations in soil or water are expected to be in the nanomolar range, and there is no indication that they would result in genotoxic effects at those lower levels, but formulated glyphosate is sprayed at a concentration of 40mM (6,760 ppb) – so applicators could potential inhale micro-droplets at these levels shown to be toxic to sea urchins.

In vivo animal studies have historically shown glyphosate chronic toxicity only at high levels. However, some recent studies indicate that there may be cellular responses to glyphosate at lower concentrations. Exposure levels, even in the chronic toxicity studies, are still several orders of magnitude higher than potential exposures to SCP crews.

- Daruich et al. (2001) studied the activity of several enzymes in pregnant rats and fetuses exposed to glyphosate, and found a variety of functional abnormalities in enzyme activity
- Benedetti et al. (2004) examined glyphosate in rats, examining hepatic effects at three dose levels for 75 days. The doses were 4.87 mg/kg, 48.7 mg/kg, and 487 mg/kg. At even the lowest concentrations of glyphosate, Benedetti found leakage of hepatic intracellular enzymes, suggesting irreversible damage in hepatocytes
- Dallegrave et al. (2003) examined the teratogenic potential of Roundup in rats, at relatively high doses of 500 mg/kg, 750mg/kg, and 1,000 mg/kg. At the highest dose, there was 50 percent mortality of dams. Dallegrave found 33 percent of fetuses at the lowest 500 mg/kg dose had skeletal alternations.

There are fewer epidemiological studies of exposure to glyphosate than of 2,4-D. These studies generally show little, to no, chronic health concerns related to glyphosate.

- In introducing their study of cancer incidence among glyphosate-exposed pesticide applicators in the AHS, De Roos et al. (2005) noted that there have been conflicting results of genotoxicity studies related to glyphosate. Some studies have found no genotoxic activities of glyphosate, while others have found genotoxic effects. In the early 1990s, USEPA and WHO concluded that glyphosate was non-mutagenic, but some more recent case-control studies have suggested associations between glyphosate and NHL. This study by De Roos et al. examined risk of cancers among the AHS participants with exposure to glyphosate, adjusting for five other pesticides highly associated with glyphosate use. De Roos also adjusted for age, demographic, and lifestyle factors. Unlike many cohort studies, this study had large cohorts. There were 13,280 participants that had never been exposed to glyphosate, 15,911 participants with low exposure to glyphosate, and 24,465 participants with high exposure to glyphosate (as measured by questionnaires). The total number of cancers among all participants was 2,088. The researchers found no association between glyphosate exposure and increase in all cancers combined. Among specific cancers, they found an association between glyphosate exposure and melanoma, with a risk ratio of 1.8 (and a 95 percent CI of 1 to 3.4) when adjusted for age only. When adjusted for age and other lifestyle factors, the RR decreased to 1.6 (and a 95 percent CI of .8 to 1.6). The study did not observe any association between glyphosate and NHL. De Roos noted that the association between glyphosate and melanoma was based on a small number of cases. The association could result from spurious associations or chance, however some details were internally consistent indicating it was more than chance. The researchers were not sure of a causal pathway
- As reported by USFS (2003), the Ontario Farm Health Study, a retrospective cohort study of almost 2,000 farm couples, did not find linkages between glyphosate exposure and miscarriage, spontaneous abortion, or fecundity

- As part of their risk assessment in Columbia, Solomon et al. (2005) reported on a study evaluating whether glyphosate exposure was associated with adverse reproductive effects. They conducted a retrospective cohort study of 600 women of reproductive age in each of five regions in Columbia, comparing reproductive health to known pesticide use. They found no associations between fecundity and glyphosate spraying.

While not as extensively analyzed as 2,4-D, there have been a number of regulatory agency and third-party reviews of glyphosate.

- Williams et al. (2000) conducted a "current and comprehensive safety evaluation and risk assessment of glyphosate and Roundup" (including POEA) for humans. They evaluated regulatory studies and published research reports. The review found low oral and dermal absorption of glyphosate, no bioaccumulation, and no significant glyphosate toxicity in acute, subchronic, and chronic studies. Williams did find that direct contact with glyphosate could result in ocular irritation, but noted that the potential for worker exposure was low
- Williams et al. (2000) applied a weight-of-evidence approach and standard evaluation criteria for genotoxicity data, and determined there was no convincing evidence for DNA damage in vitro or in vivo. They also did not find evidence of tumorigenic potential from multiple lifetime feeding studies in animals, and no effects indicative of reproductive, teratogenic, or endocrine disruption
- In their risk assessment of glyphosate, USFS (2003) reported that there were no neurotoxic, immune, or endocrine effects for glyphosate. USFS noted that there was potential for endocrine effects, because such effects have not been extensively evaluated
- USFS (2003) reported that a consistent sign of subchronic or chronic glyphosate toxicity is loss of body weight. Glyphosate likely acts as an uncoupler of oxidative phosphorylation, and may cause liver and kidney toxicity
- Solomon et al. (2005) report that "overall, there is little epidemiological evidence to link glyphosate to any specific disease in humans." Their risk assessment of spraying coca and poppy with glyphosate in Columbia concluded that the risks to humans and human health were negligible.

USEPA and other agencies have determined glyphosate levels that are considered safe for both long-term and short-term exposure. These agencies also make determinations about the carcinogenicity of various chemicals. Below (for glyphosate), and in Table 4-3, we summarize current metrics for glyphosate exposure, and relevant figures for the SCP, based on the exposure estimates in Table 4-1.

- USEPA assigned glyphosate as Class E, "evidence of non-carcinogenicity in humans (no evidence in at least two adequate animal tests in different species or in both epidemiological and animal studies)". WHO has assigned a similar carcinogenicity classification for glyphosate
- USEPA utilizes a NOEL for both acute and chronic exposure to glyphosate of 175 mg/kg/day, based on a teratogenicity study in rabbits. The safety factor for glyphosate is 100, based on factors of 10 each for sensitivity between species and sensitivity within species. The acute and chronic RfD for glyphosate is 2 mg/kg/day, calculated by dividing 175 mg/kg/day by 100, and rounding up to 2
- Based on a regression analyses of human and animal toxicity data, the RfD is conservative, and appears to be very protective for both short- and long-term exposures (USFS 2003)
- WHO determined an ADI of 0.3 mg/kg/day, based on a NOEL of 31.5 mg/kg, and an uncertainty factor of 100. These values are lower than the corresponding USEPA figures, and are based on a life-time feeding study in rats
- USFS (2003) noted that for glyphosate, the highest calculated HQ for workers, 0.2, was still well below one, the level at which there is concern
- The estimated HQ for glyphosate exposure of WHCP treatment crews, even using conservative exposure assumptions, is only 0.0012. This HQ is three orders of magnitude below one, the level at which there is potential for concern. Thus, long-term exposure of WHCP treatment crews following program operational procedures, is considered safe.

Non-Hodgkin Lymphoma

Some of the most studied linkages between pesticides and cancer are those of non-Hodgkin lymphoma and 2,4-D, phenoxy herbicides, and/or pesticides in general. Much of this research followed a study by the Swedish researcher Hardell in 1981 that showed a link between phenoxy herbicides and NHL. As many of these studies described below illustrate, the evidence, in both directions, is conflicting. Below, we summarize several of the epidemiological studies on NHL and pesticides, including both 2,4-D and glyphosate.

- Hardell and Ericksson were among the first to report potential linkages between NHL and phenoxy herbicides. They have continued to evaluate linkages between NHL and pesticides since the early 1980s. Over the years, their studies have been both criticized and confirmed
- In one of several such studies, Hardell and Eriksson (1999) examined the risk of NHL among subjects exposed to herbicides in Sweden. This was a case-control study, with 400 cases and 700 controls. The team used questionnaires to estimate exposure. If the subject was deceased, a living relative answered the questionnaire (which was one of the (many) criticisms of their work). Hardell and Ericksson found an increased risk of NHL for herbicide exposure in general, with an OR of 1.6 (95 percent CI 1.0 to 2.5). For fungicide exposure the OR was 3.7 (95 percent CI 1.1 to 13), for phenoxyacetic acid exposure the OR was 1.5 (95 percent CI 0.9 to 2.4), and for MCPA exposure the OR was 2.7 (95 percent CI 1.0 to 6.9). This study did not consider 2,4-D exposure alone. Hardell and Ericksson also noted an increased risk of NHL with glyphosate exposure, with an OR of 2.3 (95 percent CI 0.4 to 13). The glyphosate risk was based on only four cases and three controls with exposure, and was not statistically significant. After conducting multivariate analyses, the odds ratios were somewhat reduced, and the researchers determined that they could not make conclusions about linkages between NHL and specific chemicals
- The fact that Hardell and Ericksson raised concerns about glyphosate and NHL caused several individuals to criticize Hardell's 1999 study. Researchers from Monsanto, Harvard, and Yale commented that Hardell and Eriksson did not address the other evidence that glyphosate was not carcinogenic, that there were problems with the questionnaire approach to gathering exposure information, and that the conclusions were based on only a small number of cases (Acquavella and Farmer 1999; Cullen 1999; Adamie and Trichopoulos (no date)).
- In a recent study, Eriksson et al. (2008) again examined pesticides as a risk factor for NHL in Sweden, with 910 cases and 1,106 controls. Exposure was also based on questionnaires. General herbicide exposure resulted in an OR of 1.72 (95 percent CI 1.18 to 2.51), MCPA exposure resulted in an OR of 2.81 (95 percent CI 1.27 to 6.22), and glyphosate exposure had an OR of 2.02 (95 percent CI 1.16 to 4.40). Eriksson concluded that this study confirmed an association between phenoxyacetic acids and NHL, and strengthened understanding of association with glyphosate
- In their first of several studies, Hoar et al. (1986) examined agricultural herbicide use and risk of lymphoma and soft tissue sarcoma (STS) in a population based case-control study of Kansas residents. The researchers chose Kansas due to high use of 2,4-D. This study looked at NHL, Hodgkin's disease, and STS cases from 1976 to 1982. There were just fewer than 1,000 controls, matched to between 120 and 170 cases for each of the three cancers. The researchers conducted interviews of cases and controls to answer exposure and lifestyle questions. For the 130 farming subjects, Hoar also confirmed exposure by examining pesticide supplier records. Hoar analyzed the data using a variety of approaches. They found a six-fold increased risk of NHL among high intensity 2,4-D users, which was cause for concern. Among all 2,4-D users, there was an OR of 2.2 (95 percent CI 1.2 to 4.1). There was also higher risk of NHL if the subject didn't use protective equipment when applying pesticides. This study confirmed Hardell's work in Sweden, however Hoar noted that there were no carcinogenicity studies in animals, or evidence of immunosuppression by 2,4-D[3]
- In a follow up study Zahm (formerly Hoar) and Blair (1992) reviewed the possible role of pesticides in increases in NHL. They noted a link between NHL and 2,4-D in studies in Sweden, Kansas, Nebraska, and Canada. In addition, canine malignant lymphoma was associated with dog owner use of 2,4-D and commercial pesticide treatments. Zahm and Blair commented that several other chemicals were found

3 Immunosuppression is linked to NHL.

to have possible links to NHL, including triazine herbicides, organophosphate insecticides, fumigants, and fungicides. Zahm and Blair reviewed 21 cohort studies of farmers that provided data on NHL and farming. These studies had risk ratios ranging from 0.6 to 2.6. Eleven of the studies reported higher risks of NHL with exposure to chemicals, but only three studies were statistically significant. Zahm and Blair commented that, "both the descriptive and analytical data tend to show excesses [of NHL], but are not impressive overall"

- De Roos et al. (2003) noted that "an increased rate of non-Hodgkin lymphoma (NHL) has been repeatedly observed among farmers, but identification of specific exposures that explain this observation has proven difficult." De Roos examined case-control data from the 1980s, with a total sample sized of over 3,500. The studies, based in the Midwest, looked at 47 pesticides simultaneously, and controlled for confounding factors. They found associations with several pesticides, including glyphosate, but not 2,4-D. De Roos noted that these types of studies need to consider multiple exposures
- Wigle et al. (1990) looked at records of 70,000 male farmers in Saskatchewan to compare mortality records with Census of Agriculture records for pesticide use. They did not find an excess of mortalities among any specific causes of death, but did find dose-dependent increases in NHL risk for acres sprayed in 1970 with herbicides, and dollars spent on fuel and oil
- Pearce and McLean (2005) noted that, "farmers have an increased risk of non-Hodgkin lymphoma (NHL), several studies have found increased risks of NHL among producers or sprayers of pesticides. The findings are markedly inconsistent across countries and studies, but overall there is evidence of an increased risk among production workers and professional pesticide sprayers with heavy exposure." Pearce and McLean summarized 15 studies (and 22 endpoints) of phenoxy herbicides and risk of NHL. They found risk ratios ranging from 0.9 to 4.9, with only five of the endpoints with significant 95 percent confidence intervals lower bounds of over 1.0. The range of CIs among the studies was between 0.4 and 27.0. Pearce and McLean concluded that an increased risk of NHL due to phenoxy exposure was uncertain. They also noted that exposure to arsenic, solvents, organophosphate insecticides, organochlorine insecticides, and zoonotic viruses may explain increased risk of NHL among farmers
- Alavanja (2004) reviewed 29 studies examining pesticides and NHL. Alavanja noted that while there is growing evidence for a link, there is no consistent pattern. He evaluated studies of NHL and exposure to phenoxy acetic acids (2,4-D), organochlorine, and organophosphate pesticides. Eighteen of 29 studies had a higher OR for NHL, with an average of 1.3, and a 95 percent CI of 1.17 to 1.55
- Burns et al. (2001) provided a follow-up report on Dow Chemical Company employees that manufactured 2,4-D between 1945 and 1994. The study looked at mortality among these 2,4-D workers compared to other company employees. Burns found no significant risk for NHL, using a standardized mortality ratio (SMR). The SMR for 2,4-D workers was 1.0 compared to the United States population, and 2.63 (95 percent CI 0.85 to 8.33) compared to other Dow employees
- Kogevinas et al. (1995) examined an international cohort of workers exposed to 2,4-D, 2,4,5-T, and dioxins using data from the IARC. For 2,4-D exposure and STS, with 9 cases and 24 controls, they calculated an OR of 5.72 (95 percent CI of 1.14 to 28.65). The OR for NHL was lower, based on 12 cases and 56 controls, for an OR of 1.11 (95 percent CI of 0.46 to 2.65, i.e. not significant). However, there was a dose-response relationship, with number of NHL cases (and the OR) increasing with increased exposure to 2,4-D
- Bond et al. (1989) report that "the weight-of-evidence currently available does not support a conclusion that the phenoxy herbicides present a carcinogenic hazard to humans." They noted that others have not been able to replicate Hardell's studies, and that there have been inconsistent results in various studies. Bond evaluated eight studies, with ORs ranging from 0.8 to 6.8 for soft tissue sarcoma or NHL. Bond noted that uncontrolled confounding could cause the large ORs in Hardell's studies
- McDuffie et al. (2001) conducted a cross-Canada study of pesticides and health and noted that there was elevated risk of NHL with exposure to multiple pesticides. For phenoxy herbicides, the OR was 1.38 (95 percent CI 1.06 to 1.81). For 2,4-D specifically, the OR was 1.32 (95 percent CI 1.01 to 1.73 CI), based on 517 cases and 1,506 controls

- In their weight-of-evidence review, Ibrahim et al. (1991) evaluated case-control studies of 2,4-D, summarizing a number of studies with varying results (many mentioned above). One of their concerns was that many of the earlier studies were on phenoxy herbicides in general, not just 2,4-D. These studies included 2,4,5-T, which has been banned in most countries. Ibrahim summarizes, "the case-control findings for NHL, taken as a whole, suggest an association with use of phenoxy herbicides, although the evidence is not entirely consistent. Less clear but still suggestive is the evidence for an association between NHL and exposure to 2,4-D." They also noted, "one cannot dismiss the possibility that 2,4-D has been falsely implicated or that the ORs for 2,4-D are suppressed inappropriately when the adjustments are made for use of other herbicides."

While Ibrahim made these observations in 1991, studies in the seventeen years since do not seem to have clarified the potential linkages between 2,4-D, glyphosate, or pesticides in general, and NHL.

Exposure to Heat

DBW treatment crews work outdoors during the hottest summer months. Without proper precautions, there is potential for workers to suffer from heat illness. Heat illness is defined as a serious medical condition resulting from the body's inability to cope with a particular heat load, and includes heat cramps, heat exhaustion, heat syncope, and heat stroke (CCR Title 8, Section 3395). In response to a high number of heat-related deaths among outdoor workers in 2005, the State of California implemented Heat Illness Prevention Standards. These regulations outline preventative measures for employers to take to reduce the risk of heat illness among their employees.

CalOSHA, the State's job safety agency, further reviewed heat-related illness in early 2009. This additional review occurred in response to seven deaths and 60 worker injuries during 2008, despite the implementation of the Heat Illness Prevention Standards (Ferriss 2008).

Heat illness covers a range of types and symptoms, ranging from headaches and nausea to death. Heat illness is preventable, but it is important to treat the first signs of heat illness seriously. Symptoms of several types of heat illness, as provided by CalOSHA, are listed below (CalOSHA 2008a):

- **Heat rash** – also called prickly heat, may occur in hot, humid environments where sweat is not easily removed from skin by evaporation. Heat rash can become serious if extensive, or infected
- **Fainting** – also called heat syncope, is a stage of heat stroke. Fainting may occur when a worker not acclimated to heat simply stands still in the heat
- **Heat cramps** – muscle spasms that occur when workers are hydrated, but have not replaced electrolytes lost in sweat
- **Heat exhaustion** – occurs when workers become dehydrated and/or have lost electrolytes. Workers will sweat, but may experience extreme weakness, fatigue, giddiness, nausea, or headache. Skin may become clammy and moist, complexion pale or flushed, and body temperate may be slightly higher than normal
- **Heat stroke** – is the most serious form of heat illness, and can result in death. Heat stroke is caused by the failure of the body's internal mechanism to regulate its core temperature. Sweating stops and the body can no longer rid itself of excess heat. Symptoms include: mental confusion, delirium, loss of consciousness, convulsions, coma, and high body temperature (106 degrees Farenheit or more). Skin of heat stroke patients may be hot, dry, red, mottled, or bluish.

California's Heat Illness Prevention Standard includes four steps to preventing heat illness: training, water, shade, and planning. The regulations require employers to provide training on heat illness prevention; provide enough fresh water so that each employee can drink at least one quart per hour (and encourage them to do so); provide access to at least five minutes of rest in the shade when needed for preventative recovery; and develop and implement written procedures for complying with the heat illness prevention standard. DBW follows CalOSHA's heat illness prevention guidelines, including the "85 degree" rule to ensure that shade is available and accessible.

CalOSHA encourages employers to proactively address heat illness by monitoring weather conditions, providing additional training on hot days, adjusting work shifts to avoid the heat, and promoting a “buddy system” so that workers can monitor each other (CalOSHA 2008a). CalOSHA also recently published a guide for employees to carry out tailgate training for workers (CalOSHA 2008b).

DBW treatment crews may be outside during hot weather for extended periods of time. In addition, use of coveralls and other PPE make workers more susceptible to heat illness. Workers may also be more susceptible to heat illness if they have not acclimated to warm temperatures. There is potential for DBW treatment crews to suffer adverse impacts to their health as a result of exposure to heat during normal SCP operations.

* * * * *

To minimize exposure to herbicide, DBW treatment crews are required to utilize personal protective equipment (PPE) as specified on the herbicide labels, and described in the WHCP/SCP Operations Management Plan.

DBW treatment crews are required to follow the PPE requirements specified on the 2,4-D label. These requirements are more stringent than those of the other SCP herbicides.PPE requirements include: coveralls, chemical-resistant gloves, chemical resistant footwear, chemical-resistant headgear for overhead exposure, and protective eye wear. In addition, a chemical-resistant apron should also be worn when cleaning equipment, mixing, or loading. Masks will also be available to treatment crews, if they prefer additional facial protection. Proper use of PPE has been proven to reduce herbicide exposure.

It is extremely unlikely that there would be acute health impacts to DBW treatment crews as a result of exposure to herbicides. It is also unlikely that there would be chronic health impacts to DBW treatment crews as a result of exposure to herbicides. However, given the uncertainties related to the long-term human health impacts of low level exposure to herbicides, it is important that DBW minimize the potential for adverse health outcomes as a result of long-term, low-level, exposure of DBW treatment crews to herbicides. There is also potential for acute health impacts to DBW treatment crews as a result of heat exposure during SCP treatments. **These potential impacts to DBW treatment crew health would be avoidable significant impacts.** These impacts would potentially be avoided, or reduced to a less-than-significant, level by implementing the following six mitigation measures.

- **Mitigation Measure 3** – Conduct herbicide treatments in order to minimize potential for drift.

  In addition to following the label requirements, DBW will, to the degree possible, schedule herbicide applications to occur at high tide, or at a point in the tidal cycle determined by the field supervisor to provide the least non-target impact at a particular site. In general, treatment at high tide will allow for better spray accuracy and access and will provide for greater dilution volume of herbicides. DBW crews will change nozzle type and spray pressures whenever conditions warrant, limiting the amount of herbicide which may inadvertently contact non-target species or enter the water.

- **Mitigation Measure 4** – Conduct herbicide treatments using diquat only in emergency situations and for no more than 50 acres in total among DBW aquatic weed control programs.

  To minimize the potential for negative impacts to covered species from exposure to diquat dibromide, DBW will only utilize diquat in emergency situations. Diquat will only be utilized from August 1st through November 30th of each year, and will be limited to a total of 50 treatment acres in the Delta per year, as a sum of the combined diquat acres treated in the SCP and EDCP. Emergency conditions are such that spongeplant growth completely impedes navigation of Delta waters, such as a completely blocked slough that would impair the movement of emergency response vessels. DBW will consult with USFWS and NMFS prior to utilizing diquat to help ensure that covered fish species are not likely to be present at the time of treatment.

- **Mitigation Measure 8** – Implement an adaptive management approach to minimize the use of herbicides.

  Under an adaptive management approach, DBW will seek to improve efficacy and reduce environmental impacts over time as new and better information is available. Specifically, DBW will evaluate the need for control measures on a site by site basis; select appropriate indicators for pre-treatment monitoring; monitor indicators following treatment and evaluate data to determine program efficacy and environmental impacts; support ongoing research to explore the impacts of the SCP and alternative control methodologies; report findings to regulatory agencies; and adjust program actions, as necessary, in response to recommendations and evaluations by regulatory agencies and stakeholders.

  In addition to this adaptive management approach, DBW will follow maintenance control practices that seek to limit the growth and further spread of spongeplant. This will reduce the volume of herbicide utilized by the SCP.

- **Mitigation Measure 17** – Require treatment crews to participate in training on herbicide and heat hazards.

  DBW will provide training to ensure that treatment crews have the knowledge and tools necessary to conduct the program in a safe manner. Training will include reading, understanding, and following herbicide label requirements; purpose and proper use of PPE; symptoms of herbicide poisoning and minimization of exposure; avoidance, symptoms, and treatment of heat exposure; and emergency medical procedures.

- **Mitigation Measure 18** – Follow best management practices to minimize the risk of spill, and to minimize the impact of a spill, should one occur.

  The best management practices includes several provisions to reduce the potential for spill, such as: fastening herbicide containers securely in boats in original, watertight containers; carrying a marker buoy and anchor line to mark any spills in water; reporting spills immediately to appropriate State and local agencies; immediately stopping movement of land spills using absorbing materials; marking and monitoring spills in water for herbicide residues and environmental impacts, if appropriate. Treatment crews will include at least one person with a Qualified Applicators Certificate (QAC), and all crew members will participate in annual training on herbicide handling procedures.

- **Mitigation Measure 19** – Implement safety precautions on hot days to prevent heat illness.

  In addition to annual training on heat illness prevention, and compliance with CalOSHA's California Heat Illness Prevention Standard, DBW Field Supervisors will conduct special training sessions on days when weather is expected to be hot. This training will cover the symptoms of heat illness, and immediate actions to take should any symptoms occur. Field Supervisors will cancel treatments if the weather is exceptionally hot. DBW will also provide bimini tops (shade covers) for SCP treatment boats.

Impact H3 – Accidental spill: there is potential for the SCP to create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment

A catastrophic spill of an SCP herbicide could result in adverse impacts to human health due to exposure of concentrated herbicides. In concentrated form, SCP herbicides could have acute toxic or corrosive effects if inhaled, ingested, or upon direct contact with skin or eyes. Such a spill could also result in adverse impacts to aquatic wetland and intertidal habitat and associated flora and fauna, including special status plants, fish, and wildlife. Impacts could occur to public water supplies, and agricultural production and operations following a spill. The degree of harm would depend on the amount and type of chemical spilled, environmental conditions (flow, tidal action, weather), and emergency response time.

DBW's WHCP/SCP Operations Management Plan identifies best management practices (BMP), including a Spill Avoidance (BMP #3). The BMP provides procedures for spill prevention, cleanup, and notification. DBW follows these procedures to minimize the risk of spill, and to minimize the impact of a spill, should one occur. In 30 years of operation, there have not been any accidental spills of herbicide during DBW aquatic weed control operations.

Table 4-4
Summary of Potential Hazards and Hazardous Materials Impacts and Mitigation Measures

Mitigation Measure Summary[1]	Impacts Applied To
3. Conduct herbicide treatment in order to minimize potential for drift	Impact H2: Treatment crew exposure
4. Conduct herbicide treatments using diquat only in emergency situations and for no more than 50 acres in total among DBW aquatic weed control programs	Impact H2: Treatment crew exposure
8. Implement an adaptive management approach to minimize the use of herbicides	Impact H2: Treatment crew exposure
16. Minimize public exposure to herbicide treated water	Impact H1: General public exposure
17. Require treatment crews to participate in training on herbicide and heat hazards	Impact H2: Treatment crew exposure
18. Follow best management practices to minimize the risk of spill, and to minimize the impact of a spill, should one occur	Impact H2: Treatment crew exposure Impact H3: Accidental spill
19. Implement safety precautions on hot days to prevent heat illness	Impact H2: Treatment crew exposure

[1] Please refer to the text for the complete mitigation measure description.

Should an accidental spill of SCP herbicides occur, it would represent a significant impact. The potential for the SCP to result in an accidental spill is **an avoidable significant impact, reduced to a less-than-significant level by implementing the following mitigation measure.**

- **Mitigation Measure 18** – Follow best management practices to minimize the risk of spill, and to minimize the impact of a spill, should one occur.

  The best management practice includes several provisions to reduce the potential for spill, such as: fastening herbicide containers securely to boats in original, watertight containers; carrying a marker buoy and anchor line to mark any spills in water; reporting spills immediately to appropriate State and local agencies; immediately stopping movement of land spills using absorbing materials; marking and monitoring spills in water for herbicide residues and environmental impacts, if appropriate. Treatment crews will include at least one person with a Qualified Applicators Certificate (QAC), and all crew members will participate in annual training on herbicide handling procedures.

This section identified seven mitigation measures to address three potential impacts related to hazards and hazardous materials. Three mitigation measures (#3, #4, #8) were also identified in Chapter 3. The remaining four mitigation measures (#16 to #19) apply specifically to hazards and hazardous materials. **Table 4-4,** above, combines and summarizes the hazards and hazardous materials mitigation measures.

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Section 5

Hydrology and Water Quality Impacts Assessment

5. Hydrology and Water Quality Impacts Assessment

This chapter analyzes the effects of the SCP on hydrology and water quality. The chapter is organized as follows:

A. *Environmental Setting*

B. *Impact Analysis and Mitigation Measures.*

The environmental setting describes the hydrology and water quality status of the Delta. This discussion covers water quality requirements, surface water quality, surface water hydrology, Delta exports, and groundwater.

The impact analysis provides an assessment of the specific environmental impacts to hydrology and water quality potentially resulting from program operations. The discussion utilizes findings from SCP environmental monitoring and research projects, technical information from scientific literature, government reports, relevant information on public policies, and program experience. The impact assessment is based on technical and scientific information.

For each of the potential SCP impacts to hydrology and water quality we provide a description of the impact, analyze the impact, classify the impact level, and identify mitigation measures to reduce the impact level. The mitigation measures are specific actions that the DBW will undertake to avoid, or minimize, potential environmental impacts. The DBW has undergone, and will continue to undergo, consultation with various local, State, and federal agencies, including the Central Valley Regional Water Quality Control Board (CVRWQCB) regarding impacts and mitigation measures. Proposed mitigation measures may be revised, and/or additional mitigation measures incorporated, as a result of this ongoing consultation with regulatory agencies and water providers.

The SCP is a new aquatic weed control program for a new invasive species. At the time this PEIR is being prepared, the extent of the spongeplant invasion is small. In any given treatment season, the scope of the treatment approaches, and resulting impacts, will be scaled to the level of invasion. At the current low levels of spongeplant invasion, SCP approaches will consist of spot treatments with herbicides and hand removal with pool-skimmer nets. Only if spongeplant spreads extensively in the future will SCP utilize herding and/or mechanical removal methods. DBW and USDA-ARS are incorporating all potential treatment approaches into the proposed action because there is the potential for the extent of spongeplant in the Delta to increase significantly. Similarly, the potential impacts of the SCP will depend on the scale of the program.

A. Environmental Setting

1. Water Quality Regulatory Setting

The State Water Resources Control Board (SWB) regulates water quality in California, through the federal Clean Water Act (CWA), and the Porter-Cologne Water Quality Control Act. The State Water Code gives Regional Water Boards primary responsibility for formulating and adopting water quality control plans in each of the State's nine regions.

There are two plans that jointly specify water quality controls for the Delta, the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta Plan), and the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins. The Bay- Delta Plan, developed by the SWB, is complementary to the Basin Plan developed by the CVRWQCB. Water quality plans must also be approved by the USEPA.

Both plans consist of beneficial uses to be protected, water quality objectives, and a program for implementation of the water quality objectives. A primary goal of the water quality planning process is to identify and protect beneficial uses for surface and groundwater in a given region. **Table 5-1,** on the next page, summarizes several of the beneficial uses for Delta waters.

Table 5-1
Beneficial Uses in Delta Waters

Beneficial Use	Abbreviation
Municipal and domestic supply	MUN
Industrial service supply	IND
Industrial process supply	PRO
Agricultural supply	AGR
Groundwater recharge	GWR
Navigation	NAV
Water contact recreation	REC-1
Non-contact water recreation	REC-2
Shellfish harvesting	SHELL

Beneficial Use	Abbreviation
Commercial and sport fishing	COMM
Warm freshwater habitat	WARM
Cold freshwater habitat	COLD
Migration of aquatic organisms	MIGR
Spawning, reproduction, and/or early development	SPWN
Estuarine habitat	EST
Wildlife habitat	WILD
Rare, threatened, or endangered species	RARE
Preservation of biological habitats of special significance	BIOL

Water quality objectives are "the limits or levels of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area" (Water Code Section 13050(h), in CVRWQCB 2007). In establishing water quality objectives, the Regional Water Boards must consider the following:

- Past, present, and probable future beneficial uses;
- Environmental characteristics of the hydrographic unit under consideration, including the quality of water available thereto;
- Water quality conditions that could reasonably be achieved through the coordinated control of all factors which affect water quality in the area;
- Economic considerations;
- The need for developing housing within the region;
- The need to develop and use recycled water (Water Code Section 13241).

The SWB and Regional Water Boards refine their respective plans over time to take into account new water quality issues. The most recent Bay-Delta Plan was published in December 2006, and the SWB is currently undergoing a four-phased process to develop and enact updates to the plan and flow objectives for priority tributaries to the Delta. The Basin Plan was most recently revised in October 2011. These plans specify surface water quality objectives for a range of categories, including: bacteria, biostimulatory substances, chemical constituents, color, dissolved oxygen, floating material, methylmercury, oil and grease, pH, pesticides, radioactivity, salinity, sediment, settleable material, suspended material, tastes and odors, temperature, toxicity, and turbidity. The Bay-Delta Plan identifies additional requirements for chloride, salinity, dissolved oxygen, delta outflow, river flows, and export limits. These Bay-Delta Plan water quality objectives are intended to protect municipal, industrial, agricultural, and fish and wildlife beneficial uses. The Bay-Delta Plan requirements supersede those of the Basin Plan.

One mechanism that the CVRWQCB uses to implement the Bay-Delta and Basin Plans is a National Pollutant Discharge Elimination System (NPDES) permit. NPDES permits are issued to entities that discharge to waterways, known as point source dischargers. In the 2001 Headwaters, Inc. v. Talent Irrigation case, the Ninth Circuit Court of Appeals held that discharges of pollutants from the use of aquatic pesticides to waters of the United States required coverage under a NPDES permit (CVRWQCB 2006). The DBW obtained an individual NPDES permit in March 2001, and operated under this permit for the WHCP and EDCP until April 2006. In April 2006, the DBW applied to operate under the General NPDES Permit for the Discharge of Aquatic Pesticides for Aquatic Weed Control in Waters of the United States – General Permit No. CAG990005 (General Permit).

After the Talent decision, there was some confusion regarding the need to obtain an NPDES permit for aquatic pesticide use. In November 2006, the USEPA issued a regulation stating that application of a pesticide in compliance with relevant requirements of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) does not require a NPDES permit when the application is made directly in waters to control pests in the water, or when the application of the pesticide is made to control pests that are over (or near) waters (Federal Register 2006). The rulemaking was based on the USEPA's interpretation of the term "pollutant" under the Clean Water Act.

In theory, this regulation eliminated the need for a NPDES permit. However, there were at least two legal challenges to this regulation, and SWB legal counsel recommended that the SWB not rescind their general NPDES permits related to aquatic pesticides (SWB 2007). The USEPA ruling did mean that agencies operating under the General Permit had the option to terminate their coverage by the General Permit. The DBW elected to maintain coverage under the General Permit until legal challenges to the ruling were resolved. In January 2009, an appeals court vacated the USEPA rule that had allowed pesticides to be applied to U.S. waters without an NPDES permit. This ruling does not change DBW operations because DBW maintained permit coverage.

The key NPDES requirements for the SCP under the General Permit, as of December 2013, are as follows:

- **Dissolved oxygen** – specific DO limits depend on the location and season, but range from 5.0 mg/l (ppm) to 8.0 mg/l (ppm). DO levels are not to drop below these levels as a result of SCP treatments
- **Turbidity** – specific turbidity standards are not to increase above a specified number or percent of Nephelometric Turbidity Units (NTUs), depending on the initial level of natural turbidity. Generally, the SCP shall not increase turbidity more than 10 to 20 percent
- **pH** – SCP discharges shall not cause pH to fall below 6.5, or exceed 8.5, or change by more than 0.5 units
- **2,4-D residues** – maximum 2,4-D levels are based on EPA municipal drinking water standards, and shall not exceed 70 µg/l, or 70 ppb
- **Glyphosate residues** – maximum glyphosate levels are based on EPA municipal drinking water standards, and shall not exceed 700 µg/l, or 700 ppb
- **Diquat** – maximum diquat levels are based on EPA municipal drinking water standards, and shall not exceed 20 µg/l, or 20 ppb
- **Penoxsulam** - there are no specified limits for penoxsulam; however, DBW is required to monitor penoxsulam levels
- **Imazamox** – there are no specified limits for imazamox; however, DBW is required to monitor imazamox levels
- **Adjuvant residues** – there are no specified limits for adjuvants; however, DBW is required to monitor adjuvant levels
- **Monitoring** – requires a monitoring protocol. Monitoring is required at 6 treated sites for each chemical and water body type with the exception of glyphosate, which will require monitoring at one location for each water body type. Sampling stations are identified as: "A" (where treatment occurred), "B" (downstream of the treatment area), and "C" (control, typically upstream). Sampling times are identified as: "1" (pre-treatment), "2" (immediately post-treatment), and "3" (within seven days after treatment). Thus, sample 2B is taken immediately post-treatment, downstream of the treatment location
- **Reporting** – the DBW is required to submit an annual report by March 1st of each year.

2. Surface Water Quality

The Bay-Delta Plan notes that "the Bay-Delta Estuary itself is one of the largest ecosystems for fish and wildlife habitat and production in the United States. Historical and current human activities (e.g. water development, land use, wastewater discharges, introduced species, and harvesting), exacerbated by variations in natural conditions, have degraded the beneficial uses of the Bay-Delta Estuary, as evidenced by the declines in populations of many biological resources of the Estuary" (SWB 2006).

Pollutants in Delta waterways include: pesticides (chlorpyrifos, DDT, diazinon, furan compounds, and Group A pesticides[1]), exotic species, mercury, salinity, dissolved oxygen, pathogens, and PCBs (CVRWQCB 2006). Potential sources of these pollutants include: agriculture, municipal point sources, urban runoff, storm sewers, resource extraction, and hydromodification. Concerns have been raised about ammonia levels in the Delta. One study concluded that ammonia concentrations present in the Sacramento River are not acutely toxic to delta smelt, but raised the concern that ammonia may be chronically toxic to delta smelt and other sensitive fish species (Werner, 2008). Another study indicated that ammonia discharge from the Sacramento Regional Wastewater Treatment Plant inhibited phytoplankton nitrate uptake and decreased phytoplankton growth rates (Parker, 2010).

While evidence of gross pollution in the Delta has been largely eliminated, the recent rapid growth in population and industrial activity in tributary areas has left some problems unsolved and has created new ones. Existing water quality problems may be categorized as 1) eutrophication and associated dissolved oxygen fluctuations, 2) suspended sediments and turbidity, 3) salinity, 4) toxic material, and 5) bacteria.

Pesticides are found in the water and bottom sediments throughout the Delta. The more persistent chlorinated hydrocarbon pesticides are consistently found at higher levels than the less persistent organophosphate compounds. Sediments in the western Delta have the highest pesticide content. Pesticides have concentrated in aquatic life, but long-term effects and the effects of intermittent exposure are not known. There are now concerns about the aquatic toxicity of pyrethroid-based pesticides, which are replacing organophosphorus pesticides such as diazinon and chlorpyrifos.

Bacteriological quality, as measured by the presence of coliform bacteria, varies depending on the proximity to waste discharges and significant runoff. The highest concentration of coliform organisms is generally in the western Delta and near major municipal waste discharges.

The most serious enrichment in the Delta is due to a high influx of nutrients. Enrichment problems in the Delta occur along the lower San Joaquin River and in certain areas receiving waste discharges but having little or no net freshwater flow. These problems occur mainly in the late summer and coincide with low streamflow, high temperature, and the harvest season when fruit and vegetable canneries are in full operation. Deepening channels for navigation has further depressed dissolved oxygen levels to the point that at times levels are insufficient to support aquatic life. In the fall, these circumstances, combined with reverse flows due to export pumping, have created conditions unsuitable for salmon passage through the Delta to spawning areas in the San Joaquin Valley.

Warm, shallow, dead-end sloughs of the eastern Delta support populations of potentially toxic planktonic blue-green algae during the summer. Floating, semi-attached and attached aquatic plants such as water primrose *(Ludwigia peploides),* water hyacinth *(Eichhornia crassipes),* hornwort or coontail *(Ceratophyllum demersum),* eurasian milfoil *(Myriophylum spicatum), an*d *Egeria densa* frequently clog Delta waterways during summer. Spongeplant infestations also have the potential to grow densely in Delta waterways. Extensive growth of these plants interferes with small boat traffic and contributes to the total organic load as these plants break loose and move downstream in the fall and winter.

Most Delta waters are turbid as a result of suspended silt, clay, and organic matter. Most of these sediments enter the Delta system with flow from major tributaries. Some enriched areas are turbid as a result of planktonic algal populations, but inorganic turbidity tends to suppress nuisance algal populations in much of the Delta. Continuous dredging to maintain deep channels for shipping also has contributed to turbidity and has been a significant factor in the temporary destruction of bottom organisms through displacement and suffocation.

Salinity control is necessary in the Delta because it is contiguous with the ocean and its channels are at, or below, sea level. Unless repelled by continuous seaward flow of fresh water, ocean water will advance up the estuary and degrade water quality. During winter and early spring, flows through the Delta are usually

1 Group A pesticides include: aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexane, endosulfan, and toxaphene.

above the minimum required to control salinity (described as “excess water conditions”). At least for a few months in summer and during the fall of most years, however, salinity must be carefully monitored and controlled for “balanced water conditions”. The Central Valley Project and State Water Project monitor and control salinity, and salinity levels are regulated by the State Water Resources Control Board under its water right authority (through the Bay-Delta and Basin Plans). There are concerns that Delta salinity is increasing as more water is diverted through the SWP and CVP.

Salinity intrusion is a problem mainly during years of below-normal runoff, although in recent years with higher export levels, salinity has also been a concern. The degree of seawater intrusion into the Delta, and thus one source of salinity, is a result of daily tidal fluctuations, freshwater inflow to the Delta from the Sacramento and San Joaquin Rivers, the rate of export at the SWP and CVP intake pumps, and the operation of various control structures such as the Delta Cross-Channel Gates and Suisun Marsh Salinity Control System (USBR 2003).

In the eastern Delta salinity is largely associated with agricultural drainage and the high concentration of salts carried by the San Joaquin River. The Banks and Jones pumping plant operations draw high quality Sacramento River water across the Delta and restrict the low quality area to the southeastern corner. In areas such as dead-end sloughs, irrigation returns cause localized problems. In the western Delta, incursion of saline water from San Francisco Bay is one of the main water quality problems.

Another concern is that Delta water contains trihalomethane (THM) precursors. THMs are suspected carcinogens produced when chlorine used for disinfection reacts with natural substances during the water treatment process. Dissolved organic compounds that originate from decayed vegetation act as precursors by providing a source of carbon in THM formation reactions. During periods of reverse Delta flow, bromides from the ocean mix with Delta water at the western edge of Sherman Island. When bromides occur in water along with organic THM precursors, THMs are formed that contain bromine as well as chlorine. Drinking water supplies taken from the Delta are treated to meet THM standards, set at 0.080 mg/l, MRDL (maximum residual disinfectant level) (USBR 2003). Contra Costa Water District (CCWD) reports that bromide in the Delta is 6.5 times above the national average (Taugher 2005). To reduce THM formation, CCWD has reduced the amount of chlorine used in their treatment process.

3. Surface Water Hydrology

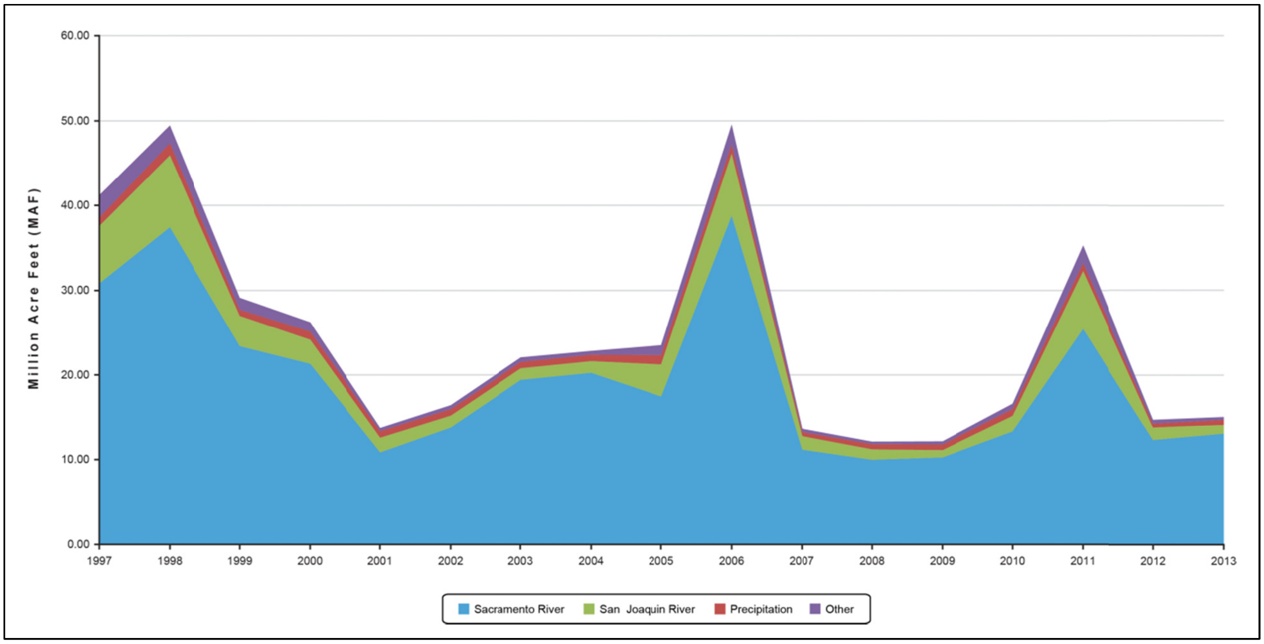
Prior to the mid-1800s, the Delta was a floodplain consisting of marshes and tidal channels. Beginning around the 1850s, European settlers constructed levees to reclaim marshes and floodplains for farming. There are approximately 1,100 miles of levees in the Delta.

The Sacramento and San Joaquin Rivers unite at the western end of the Delta at Suisun Bay. Over 40 percent of the State’s runoff drains into the Delta. The Sacramento River contributes roughly 80 percent of the Delta inflow in most years, the San Joaquin River contributes 15 percent, with the remaining 5 percent of flows contributed from the Mokelumne, Cosumnes, and Calaveras rivers. From Suisun Bay, water flows through Carquinez Strait into San Pablo Bay (the northern half of San Francisco Bay) and then through the Golden Gate to the Pacific Ocean.

Most of the Delta is subject to tidal action with mean fluctuations of approximately two to three feet. This tidal influence is important throughout the Delta. Historically, when mountain runoff dwindled during the summer, ocean water intruded upstream as far as Sacramento. During winter and spring, fresh water from heavy rains pushed the salt water back, sometimes past the mouth of San Francisco Bay.

With the addition of Shasta, Folsom, and Oroville dams, salt water intrusion during summer has been controlled by reservoir releases. Peaks in winter and spring flows have been dampened, and summer and fall flows have been increased. The result is relatively consistent salinity levels in the Delta throughout the year. However, in very wet years reservoirs are unable to control runoff, so during the winter and spring the upper bays become fresh and even the upper several feet of water at the Golden Gate can be fresh.

Figure 5-1
Delta Water Balance in Million Acre Feet (MAF)
(1997 to 2013)



Source: California Department of Water Resources (2014)

On average, about 24 million acre-feet of water reaches the Delta annually, but actual inflow varies widely from year-to-year and within the year (DWR 2005). **Figure 5-1,** above, provides the Delta water balance from 1997 to 2013. During this period, inflow ranged from 12 million acre-feet to 49 million acre-feet. There was even greater variation between extreme water years prior to 1997. For example, in 1977, a year of extraordinary drought, Delta inflow totaled about 5 million acre-feet (URS Corporation 2007). Inflow for 1983, an exceptionally wet year, was about 60 million acre-feet (URS Corporation 2007). On a seasonal basis, average natural flow to the Delta varies by a factor of more than 10 between the highest month in winter or spring and the lowest month in fall. Because of the large tidal flows compared to inflows, outflow must be calculated rather than measured. Calculated outflows are reasonably accurate on time scales longer than a few weeks but not at all accurate for shorter periods.

Delta hydraulics are complex. The influence of the tide is combined with freshwater outflow, resulting in flow patterns that vary daily. Inflow varies seasonally and is affected by upstream diversions. Hydraulics are further complicated by a multitude of agricultural, industrial, and municipal diversions for use in the Delta itself and by exports for the CVP and SWP. The primary factors currently influencing Delta hydrodynamic conditions are: river inflow from the Sacramento and San Joaquin Rivers; daily tidal inflow and outflow through the San Francisco Bay, and export pumping from the south Delta through the Harvey O. Banks Pumping Plant and the C.W. “Bill” Jones Pumping Plant (USBR 2003). Delta hydraulics are likely to be further modified in the future due to climate change, sea level rise, and risk of levee failure.

4. Delta Exports

The CVP, operated by the U.S. Bureau of Reclamation, and the SWP, operated by the Department of Water Resources, coordinate operations to manage the flow of water into, and out of, the Delta. Both agencies monitor and manage releases from upstream reservoirs and export pumping at the SWP Banks and CVP Jones pumping plants (DWR 2005).

To minimize water level fluctuation caused by the SWP intake along Old River, Clifton Court Forebay is operated so water is drawn through the gates at high tides and the gates are closed at low tides. This operation provides a more constant head for the pumps and allows the Department of Water Resources to maintain optimum velocities in the channel and across the fish screens. The CVP draws water directly from the channels over the entire tidal cycle, resulting in a continuous flow toward the Jones Pumping Plant whenever it is operating.

Operational changes of the SWP and CVP can affect flow in the lower San Joaquin River along Sherman Island. When outflow is low, increases in export and internal use results in a net reverse flow in this portion of the river, so that net movement of water is upstream toward the pumps. Although they are small in relation to tidal flows, there is concern that net reverse flows may harm fish, including salmon, steelhead, delta smelt, and planktonic eggs and larvae of striped bass.

The CVP can pump a maximum of 4,600 cubic feet per second (cfs) into the Delta-Mendota Canal. This is equivalent to a maximum annual export volume of 3.33 million acre-feet; however, CVP export has historically averaged approximately 2.5 million acre-feet per year (DWR 2006). Adding the Contra Costa Canal brings the CVP export capacity to 4,900 cfs. The SWP can pump 10,300 cfs at Banks Pumping Plant (up to 4.2 maf annually, but an agreement with the U.S. Army Corps of Engineers limits pumping to 6,680 cfs).

The SWP typically exports approximately 2.6 million acre-feet per year, down from approximately 3 million acre-feet in 2005 (DWR 2012). The reduction is primarily attributable to the operational restrictions imposed on the SWP by the biological options (BOs) issued by the USFWS in December 2008 and the NMFS in June 2009.

Although significant changes to export mechanisms in the Delta are unlikely for many years, there are several initiatives to evaluate around-Delta export mechanisms (see Chapter 7 for additional discussion).

5. Groundwater

The groundwater hydrology of the Sacramento-San Joaquin Delta, as with the geology, is contiguous with that of the Sacramento River Basin. Large amounts of water are stored in thick sedimentary deposits in the Sacramento Valley groundwater basin. Groundwater is used intensively in some areas but only slightly in areas where surface water supplies are abundant.

Groundwater occurs in various degrees of confinement in the Sacramento Valley basin. Groundwater is generally unconfined in the relatively shallow alluvial fan, flood plain, and stream channel deposits and partially confined in and under the flood basin deposits. In the older Pleistocene and Pliocene formations, especially at deeper levels, water is confined beneath impervious thick clay and mudflow strata.

Groundwater levels fluctuate according to supply and demand on daily, seasonal, annual, and even longer bases. Short-term and long-term water level changes have been recorded for wells since the first documented measurements in 1929. In the low-lying central portion of the Sacramento Valley Basin, from the Delta north to Glenn and Butte counties, depth to water in wells is 10 feet or less.

Groundwater is replenished through deep percolation of streamflow, precipitation, and applied irrigation water. Recharge by subsurface inflow is negligible compared to other sources. Groundwater quality is generally excellent throughout the area and is suitable for most uses, although at shallow depths within the Delta the water is often saline.

B. Impact Analysis and Mitigation Measures

For purposes of this analysis, we considered an impact to hydrology and water quality to be significant and require mitigation if it would result in any of the following:

- Violate any water quality standards or waste discharge requirements

- Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level
- Substantially alter the existing drainage pattern of the site or area in a manner which would result in substantial erosion or siltation on- or off-site
- Substantially alter the existing drainage pattern of the site or area in a manner which would result in flooding on- or off-site
- Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff
- Otherwise substantially degrade water quality
- Otherwise substantially degrade drinking water quality
- Place housing within a 100-year flood hazard area
- Place structures which would impede or redirect flood flows within a 100-year flood hazard area
- Expose people or structures to a significant risk of loss, injury, or death involving flooding
- Inundation by seiche, tsunami, or mudflow.

Exhibit 5-1, starting on the next page, provides a summary of the potential SCP impacts for hydrology and water quality significance areas which could potentially be affected. Exhibit 5-1 also explains potential benefits, and those hydrology and water quality significance areas in which there will be no impacts. We discuss potential impacts of the SCP on water intake pump systems in Chapter 6.

The first three potential impacts, Impact W1: Chemical constituents; Impact W2: Pesticides; and Impact W3: Toxicity; are closely related. We discuss each of these potential impacts and their mitigation measures separately. However, to minimize duplication, within one particular impact, we may reference discussions within either of the other two related impacts. In addition, we reference more detailed discussions of Biological Resource impacts related to herbicide toxicity in Chapter 3.

Impact W1 – Chemical constituents: following SCP herbicide treatment, waters may potentially contain chemical constituents that adversely affect beneficial uses, violating water quality standards or otherwise substantially degrading water quality or drinking water quality

SCP herbicide treatments involve spraying chemical constituents onto spongeplant plants growing in the Delta and its tributaries. Anderson (1982) determined that 10 to 20 percent of herbicide reaches the water following water hyacinth treatment, either moving through the water hyacinth mat, or as a result of drift. We expect that SCP treatments will result in similar amounts of overspray. This herbicide is considered a chemical constituent in the water.

The Basin Plan water quality objectives related to chemical constituents are as follows: *"Waters shall not contain chemical constituents in concentrations that adversely affect beneficial uses… At a 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) specified in the following provisions of Title 22 of the California Code of Regulations…"* (CVRWQCB 2007). The relevant MCL levels for the SCP are:

- 70 ppb or μg/l for 2,4-D
- 700 ppb or μg/l for glyphosate
- 20 ppb or μg/l for diquat.

For purposes of compliance with these MCLs, the relevant chemical concentrations are in receiving waters, e.g., waters downstream of the treatment site. We briefly discuss the potential for the SCP to result in chemical constituents, below. Refer to Chapter 3, Impact B2, for a more detailed description of calculated and actual maximum herbicide and adjuvant levels immediately following SCP treatments. Chapter 3, Impact B2, also includes a discussion of the fate of SCP herbicides in water.

Exhibit 5-1
Crosswalk of Hydrology and Water Quality Significance Criteria, Impacts, and Benefits of the SCP

Page 1 of 2

	Mitigation Measures	Unavoidable or Potentially Unavoidable Significant Impact	Avoidable Significant Impact	Less than Significant Impact	No Impact	Beneficial Impact
a) Violate any water quality standards or waste discharge requirements?						Removal of spongeplant through SCP efforts could improve Delta water quality so that measurements are more closely aligned with standards (e.g. increased dissolved oxygen, and reduced fragments)
Impact W1: Chemical constituents	3, 4, 7, 8, 20	[X]				
Impact W2: Pesticides	1, 3, 4, 5, 7, 8, 20	[X]				
Impact W3: Toxicity	1, 3, 4, 5, 7, 8, 20	[X]				
Impact W4: Dissolved oxygen levels	10, 11	[X]				[X]
Impact W5: Floating material	13, 20, 21		[X]			[X]
Impact W6: Turbidity	5			[X]		
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?					SCP will not deplete groundwater supplies or interfere substantially with groundwater recharge	
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?					SCP will not alter the existing drainage pattern of the site or area in a manner which would result in erosion or siltation on- or off-site	
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?					SCP will not alter the existing drainage pattern of the site or area, or increase the rate of runoff, in a manner which would result in flooding on- or off-site	
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?					SCP will not create or contribute runoff water or provide additional sources of polluted runoff	

Exhibit 5-1
Crosswalk of Hydrology and Water Quality Significance Criteria, Impacts, and Benefits of the SCP *(continued)*

Page 2 of 2

	Mitigation Measures	Unavoidable or Potentially Unavoidable Significant Impact	Avoidable Significant Impact	Less than Significant Impact	No Impact	Beneficial Impact
f) Otherwise substantially degrade water quality?						Removal of spongeplant through SCP efforts could improve Delta water quality so that measurements are more closely aligned with standards (e.g. increased dissolved oxygen, and reduced fragments). The SCP will also improve several beneficial uses of Delta waterways
Impact W1: Chemical constituents	3, 4, 7, 8, 20	[X]				
Impact W2: Pesticides	1, 3, 4, 5, 7, 8, 20	[X]				
Impact W3: Toxicity	1, 3, 4, 5, 7, 8, 20	[X]				
Impact W4: Dissolved oxygen levels	10, 11	[X]				[X]
Impact W5: Floating material	13, 20, 21		[X]			[X]
Impact W6: Turbidity	5			[X]		
g) Otherwise substantially degrade drinking water quality?						
Impact W1: Chemical constituents	3, 4, 7, 8, 20	[X]				
Impact W2: Pesticides	1, 3, 4, 5, 7, 8, 20	[X]				
Impact W3: Toxicity	1, 3, 4, 5, 7, 8, 20	[X]				
h) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?					SCP will not place housing within a 100-year flood hazard area	
i) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?					SCP will not place structures within a 100-year flood hazard area	
j) Expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam?					SCP will not expose people or structures to risk of loss, injury, or death involving flooding	
k) Inundation by seiche, tsunami, or mudflow?					SCP will not result in inundation by seiche, tsunami, or mudflow	

Table 5-2
Concentrations of 2,4-D Downstream of WHCP Treatments, 1 Hour Post-Treatment (2006 to 2012)

Concentration (ppb or ug/l)	Number of Sites
No Detect (ND)	21
< 1 ppb	25
1 to < 10 ppb	19
10 to < 30 ppb	3
Total	68

Table 5-3
Concentrations of Glyphosate Downstream of WHCP Treatments, 1 Hour Post-Treatment (2006 to 2012)

Concentration (ppb or ug/l)	Number of Sites
No Detect (ND)	57
<1 ppb	1
1 to < 10 ppb	4
10 to < 22 ppb	1
Total	63

WHCP monitoring results provide data on actual herbicide residue levels following treatments. We would expect similar results from SCP's utilization of 2,4-D and glyphosate. Between 2001 and 2005, DBW obtained chemical residue tests on 219 post-treatment water samples, collected inside, and downstream of, treatment areas. Samples were obtained from 48 different sites, and throughout the treatment season (for both chemicals at some sites). Over the five year period, only six of the 149 2,4-D samples (4 percent) were above the MCL of 70 ppb. None of the 70 glyphosate samples were above the MCL of 700 ppb.

Over the last seven years of environmental monitoring (2006 to 2012), DBW monitored receiving waters directly downstream of the treatment sites, one hour after treatment. As in previous years, environmental scientists also returned to each site two to seven days later to sample upstream, within, and downstream of the treatment site. All samples were taken at two to three feet depth. Over the seven year period, DBW conducted 68 sampling events for 2,4-D, and 63 sampling events for glyphosate. All 117 samples of the adjuvant Agridex were at non-detectable levels. **Tables 5-2** and **5-3,** above, summarize these results.

None of the 2,4-D samples were above the MCL of 70 ppb, and the highest 2,4-D sample was significantly lower than 70 ppb, at 16.3 ppb. None of the glyphosate samples were above the MCL of 700 ppb, and the highest glyphosate sample was also significantly lower than 700 ppb, at 22 ppb. In both cases, given the time and location of sampling, it was unlikely that these highest sample readings were not a result of WHCP treatments, but rather were due to ambient herbicide levels in Delta waters.

The calculated, test plot, and actual WHCP herbicide levels indicate that 2,4-D, glyphosate, and adjuvant levels in the Delta following herbicide treatment are low. Maximum 2,4-D levels immediately following spraying within a treatment site have reached levels as high as 390 ppb, although this occurred one time in monitoring conducted immediately after treatment, under a water hyacinth mat, out of over 100 samples taken between 2001 and 2005. Maximum 2,4-D levels immediately downstream of the site were less than 1 ppb in 68 percent of samples, between 1 ppb and 10 ppb in 31 percent of samples, and have never been measured at levels higher than 30 ppb (30 ppb was measured once out of 68 samples). Maximum glyphosate levels within a treatment site, immediately after spraying, may reach as high as 158 ppb, but are likely to be less than 30 ppb. Maximum glyphosate levels immediately downstream are likely to be less than 2 ppb. Herbicides may remain at these maximum levels for a relatively short period of time (for example, the downstream sampling typically occurs within one hour of treatment). We would expect similar results from the SCP.

Since penoxsulam and imazamox have not been used before by DBW and diquat was recently re-introduced, data on their post-treatment residue levels are not available. Their levels will be closely monitored, and we expect their residue measurements to be similarly minimal.

The potential for SCP herbicide treatments to be present in water at concentrations that would adversely affect beneficial uses, or result in violations of MCL levels is low. However, should SCP herbicide levels occur at such concentrations, it would constitute an **unavoidable or potentially unavoidable significant impact.** This impact would potentially be reduced by implementing the following five mitigation measures.

- **Mitigation Measure 3** – Conduct herbicide treatments in order to minimize potential for drift.

  In addition to complying with the label application requirements, DBW will, to the degree possible, schedule herbicide applications to occur at high tide, or at a point in the tidal cycle determined by the field supervisor to provide the least non-target impact at a particular site. In general, treatment at high tide will allow for better spray accuracy and access and will provide for greater dilution volume of herbicides. DBW crews will change nozzle type and spray pressures whenever conditions warrant, limiting the amount of herbicide which may inadvertently contact non-target species or enter the water.

- **Mitigation Measure 4** – Conduct herbicide treatments using diquat only in emergency situations and for no more than 50 acres in total among DBW aquatic weed control programs.

  To minimize the potential for negative impacts to covered species from exposure to diquat dibromide, DBW will only utilize diquat in emergency situations. Diquat will only be utilized from August 1st through November 30th of each year, and will be limited to a total of 50 treatment acres in the Delta per year, as a sum of the combined diquat acres treated in the SCP and EDCP. Emergency conditions are such that spongeplant growth completely impedes navigation of Delta waters, such as a completely blocked slough that would impair the movement of emergency response vessels. DBW will consult with USFWS and NMFS prior to utilizing diquat to help ensure that covered fish species are not likely to be present at the time of treatment.

- **Mitigation Measure 7** – Monitor herbicide and adjuvant levels to ensure that the SCP does not result in potentially toxic concentrations of chemicals in Delta waters.

  DBW will conduct comprehensive monitoring. This monitoring is in compliance with the general NPDES permit, and NMFS and USFWS Biological Opinions and/or Letters of Concurrence. DBW will collect samples prior to treatment, immediately after treatment, and post-treatment within one week of spraying. DBW will conduct water quality monitoring for visual parameters, physical parameters, and chemical parameters at one site per water body type for glyphosate and six sites per water body type for all other herbicides. Water samples will be submitted to a certified analytical laboratory to measure 2,4-D, glyphosate, penoxsulam, imazamox, diquat, and adjuvant levels. Should these levels exceed allowable limits, DBW will take immediate measures to reduce chemical levels at future treatment sites.

- **Mitigation Measure 8** – Implement an adaptive management approach to minimize the use of herbicides.

  Under an adaptive management approach, DBW will seek to improve efficacy and reduce environmental impacts over time as new and better information is available. Specifically, DBW will evaluate the need for control measures on a site by site month to month basis; select appropriate indicators for pre-treatment monitoring; monitor indicators following treatment and evaluate data to determine program efficacy and environmental impacts; support ongoing research to explore impacts of the SCP and alternative control methodologies; report findings to regulatory agencies; and adjust program actions, as necessary, in response to recommendations and evaluations by regulatory agencies and stakeholders.

  In addition to this adaptive management approach, DBW will follow maintenance control practices that seek to limit the growth and further spread of spongeplant. This will reduce the volume of herbicide utilized by the SCP.

- **Mitigation Measure 20** – Follow the protocol for herbicide applications within one mile of drinking water intake facilities.

  In order to treat within one mile of a drinking water intake, DBW must notify the appropriate jurisdiction at least two weeks in advance, and make every reasonable attempt to schedule applications during periods when intakes are shut down for environmental or maintenance reasons, allowing at least two complete tidal cycles between application and restart. This measure is primarily aimed at reducing the potential for drinking water contamination from the SCP. DBW has a formal Memorandum of Understanding (MOU) regarding applications near drinking water intakes with the Contra Costa Water District (CCWD), but also follows the same protocol with other jurisdictions, such as the City of Stockton and the City of Antioch. In Contra Costa County, generally, no applications shall occur within Rock Slough, or within one mile of the confluence of Rock Slough and Old River, or within one mile of CCWD's Old River or Mallard Slough intake pumps without consensual agreement between CCWD and DBW. Herbicide applications within one mile of CCWD's water intakes may only occur with prior consent of CCWD.

Impact W2 – Pesticides: following SCP herbicide treatment pesticides may potentially be present in concentrations that adversely affect beneficial uses, violating water quality standards or otherwise substantially degrading water or drinking water quality

SCP herbicide treatments entail spraying of 2,4-D, glyphosate, penoxsulam, imazamox, diquat, and adjuvants on spongeplant plants located in Delta and tributary waterways. These treatments have the potential to adversely affect beneficial uses, violating water quality standards or otherwise substantially degrading water or drinking water quality. The following water quality objectives for pesticides are potentially relevant to the SCP:

- *"No individual pesticide or combination of pesticides shall be present in concentrations that adversely affect beneficial uses.*
- *Discharges shall not result in pesticide concentrations in bottom sediments or aquatic life that adversely affect beneficial uses.*
- *Pesticide concentrations shall not exceed those allowable by applicable antidegradation policies (see State Water Resources Control Board Resolution No. 68-16 and 40 C.F.R. Section 131.12).*
- *Pesticide concentrations shall not exceed the lowest levels technically and economically achievable.*
- *Waters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of pesticides in excess of the Maximum Contaminant Levels set forth in California Code of Regulations, Title 22, Division 4, Chapter 15" (CVRWQCB 2007).*

Below, we discuss these five water quality objectives and the potential for SCP herbicide treatments to adversely affect beneficial uses related to these objectives. Several of these potential impacts are discussed in Chapter 3, and for Impacts W1 and W3.

Presence of SCP Herbicides in Concentrations that Adversely Affect Beneficial Uses

The beneficial uses that are most likely to be affected by SCP herbicide treatments are MUN, AGR, WARM, COLD, WILD, BIOL, RARE, MIGR, and SPWN. As noted above under Impact W1, the potential for SCP herbicides to be present in concentrations that would affect MUN beneficial uses (e.g. to exceed the MCLs) is low. As noted in Chapter 6, the potential for SCP herbicides to be present in concentrations that would affect AGR beneficial uses are avoidable, and can be mitigated to a less-than significant level.

The potential for SCP herbicide treatments to impact the biological resource beneficial uses, WARM, COLD, WILD, BIOL, RARE, MIGR, and SPWN are discussed in Chapter 3. These impacts represent unavoidable or potentially unavoidable impacts that could adversely affect beneficial uses. Below, and in Chapter 3, we identify a number of mitigation measures that can reduce these potential impacts to biological resource beneficial uses.

Presence of SCP Herbicides in Bottom Sediments or Aquatic Life

SCP herbicides are not considered to bioaccumulate in aquatic plant or animal life forms. The herbicides are excreted and/or metabolized following exposure. We discuss the potential for SCP herbicide bioaccumulation in Chapter 3, Impact B3. In Chapter 3, we determined that the impact of bioaccumulation of SCP herbicides on special status species is expected to be less than significant. Similarly, the potential for SCP herbicides to be present in any other aquatic life forms in concentrations that would adversely affect beneficial uses is less than significant.

Herbicide characteristics related to sediment are not necessarily the same as herbicide characteristics related to bioaccumulation. The five potential SCP herbicides exhibit very different characteristics in sediment, however none of the herbicides is likely to accumulate in sediment in a biologically active form, or to result in toxic effects to species present in sediment. The potential for SCP herbicide treatments to result in concentrations that would adversely affect beneficial uses is less than significant.

The soil adsorption coefficient, K_{OC}, for 2,4-D is relatively low, at 48 μg/g (University of California 2005). This means that 2,4-D does not persist in soil or sediments. The half life of 2,4-D in soil is also relatively short, at 10 days (University of California 2005). The major method of 2,4-D breakdown in soil is microbial degradation (Walters 1999).

Glyphosate binds strongly to soil and sediment and becomes biologically unavailable (Monsanto 2002; Monsanto 2005). The soil adsorption coefficient for glyphosate , K_{OC}, is 24,000 μg/g (University of California 2005). This is one of the highest K_{OC} values among pesticides, and indicates extremely strong binding to sediments. The half life of glyphosate in soil is 47 days (University of California 2005). Once bound to sediments, glyphosate does not move back into the water, but is degraded by soil microbes and fungi to aminomethylphosphonic acid (AMPA), and then carbon dioxide and phosphate. AMPA also strongly adsorbs to soil (NPTN 2000), and is characterized as having little toxicity to non-target organisms (Monsanto 2005).

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).

Imazamox is mobile to highly mobile in soil (Washington DOE 2012; USEPA 2008). The organic carbon sorption coefficient, Koc, of imazamox is between 5 and 143 (indicating weak adsorption).

Diquat binds strongly to soil and sediment. When diquat comes in contact with soil, it is strongly adsorbed to clay particles or organic matter for a long period of time (several years) (EXTONET 1996). Diquat is biologically inactive in this bound state, and is often unavailable for further degradation (EXTONET 1996; Washington DOE 2002).

Presence of SCP Herbicides in Concentrations that Exceed Applicable Antidegradation Policies

In 1968, the SWB passed Resolution 68-16, *Statement of Policy with Respect to Maintaining High Quality Water in California* (SWB 1968, CVRWQCB 2007). This resolution addresses the USEPA Clean Water Act requirement to adopt an “antidegradation” policy. The goal of the policy is to maintain high quality waters. This policy generally restricts Regional Water Boards and dischargers from reducing the water quality of surface or groundwaters even though such a reduction in water quality might still allow the protection of beneficial uses associated with the water (CVRWQCB 2007).

The waters of the Delta and its tributaries within the SCP project area are not high quality waters. Significant portions of the Delta and its tributaries are considered impaired due to pesticides, dissolved oxygen, salinity, mercury, exotic species, pathogens, and other discharges. If antidegradation policies did apply in the Delta, the relatively small volumes of SCP herbicides, applied annually to 20 to 2,500 of the project area’s approximately 68,000 water acres, would be extremely unlikely to exceed any such antidegradation policies.

Presence of pesticides at levels that shall not exceed the lowest levels technically and economically achievable

Through their adaptive management approach and maintenance control (see Mitigation Measure 8), DBW seeks to minimize the amount of herbicide utilized in the SCP. Thus, the SCP will not result in pesticide levels in the Delta and tributaries that exceed the lowest levels technically and economically achievable.

Presence of SCP Herbicides in Concentrations in Excess of MCLs

The potential for SCP herbicide treatments to exceed MCLs is discussed extensively under Impact W1, above, and in Chapter 3, Impact B2. The potential for SCP herbicides to be present in concentrations in excess of MCLs of 70 ppb for 2,4-D, 700 ppb for glyphosate, and 20 ppb for diquat, is low.

Pesticides present in Delta waters following SCP herbicide treatments are unlikely to bioaccumulate in species or accumulate in sediment, are unlikely to affect antidegradation policies, and are unlikely to be present in concentrations that exceed MCLs. The DBW will not apply SCP herbicides at levels that exceed the lowest levels technically and economically achievable.

It is also unlikely that pesticide concentrations resulting from SCP herbicide treatments will adversely affect beneficial uses, violate water quality standards, or otherwise substantially degrade water or drinking water quality. However, should such concentrations result, it would represent **an unavoidable or potentially unavoidable significant impact.** This impact would be reduced by implementing the following seven mitigation measures.

- **Mitigation Measure 1** – <u>Avoid herbicide application near special status species, and sensitive riparian and wetland habitat; and other biologically important resources</u>.

  Each year, prior to start of the treatment season, DBW will conduct field crew environmental awareness training. Under this training, crews will be informed about the presence and life histories of special status species; habitats associated with species; sensitive habitats and wetlands; the terms and conditions of the program's biological opinion and/or letter of concurrence; environmental survey procedures; incidental take procedures; and that unlawful take of an animal or destruction of its habitat is a violation of the Endangered Species Act.

  DBW will provide crews with a field guide (Species Identification Deck) for easy identification of special status species on-site. Prior to treating a site, crews will conduct a visual survey to determine whether special status plants, animals, or sensitive habitats are present. Crews will complete an Environmental Observations Checklist, following an established protocol, for each site to document the presence or absence of listed or special status species. If listed or special status species or sensitive habits are present at the site, the field crew will not perform treatments that could potentially affect the species or habitat.

  DBW Environmental Scientists will classify treatment sites as high, medium, or low potential for nesting birds. DBW also will examine CNDDB records to determine if special status bird species have been sited within SCP treatment locations, and prepare a map for field crews identifying such sites. For those treatment sites that have habitat characteristics that might support special status bird species, Environmental Scientists will survey the specific site. DBW will delay treatments at locations where nesting Swainson's hawks are present until after June 10th, the start of the post-fledging stage.

  At all treatment locations, crews will conduct a visual survey, following an established protocol, to determine whether special status plants, animals, or sensitive habitats are present, including bird nesting sites. Crews will complete an Environmental Observations Checklist for each site to document the presence or absence of bird nesting sites. If nesting yellow-headed blackbird, Swainson's hawk, or tricolored blackbird are known to be present at the site, the field crew will not perform any treatment within 200 yards of the nesting site until the post-fledging stage.

- **Mitigation Measure 3** – <u>Conduct herbicide treatments in order to minimize potential for drift</u>.

  In addition to complying with the label application requirements, DBW will, to the degree possible, schedule herbicide applications to occur at high tide, or at a point in the tidal cycle determined by the field supervisor to provide the least non-target impact at a particular site. In general, treatment at high tide will allow for better spray accuracy and access and will provide for greater dilution volume of herbicides. DBW crews will change nozzle type and spray pressures whenever conditions warrant, limiting the amount of herbicide which may inadvertently contact non-target species.

- **Mitigation Measure 4** – <u>Conduct herbicide treatments using diquat only in emergency situations and for no more than 50 acres in total among DBW aquatic weed control programs</u>.

  To minimize the potential for negative impacts to covered species from exposure to diquat dibromide, DBW will only utilize diquat in emergency situations. Diquat will only be utilized from August 1st through November 30th of each year, and will be limited to a total of 50 treatment acres in the Delta per year, as a sum of the combined diquat acres treated in the SCP and EDCP. Emergency conditions are such that spongeplant growth completely impedes navigation of Delta waters, such as a completely blocked slough that would impair the movement of emergency response vessels. DBW will consult with USFWS and NMFS prior to utilizing diquat to help ensure that covered fish species are not likely to be present at the time of treatment.

- **Mitigation Measure 5** – Operate program vessels in a manner that causes the least amount of disturbance to the habitat.

  Operational procedures for DBW vessels will minimize boat wakes and propeller wash. These procedures will be particularly important in shallow water, or other sensitive habitats.

- **Mitigation Measure 7** – Monitor herbicide and adjuvant levels to ensure that the SCP does not result in potentially toxic concentrations of chemicals in Delta waters.

  DBW will conduct comprehensive monitoring. This monitoring is in compliance with the general NPDES permit, and NMFS and USFWS Biological Opinions and/or Letters of Concurrence. DBW will collect samples prior to treatment, immediately after treatment, and post-treatment within one week of spraying. The DBW will conduct water quality monitoring for visual parameters, physical parameters, and chemical parameters at one site per water body type for glyphosate and six sites per water body type for all other herbicides. Water samples will be submitted to a certified analytical laboratory to measure 2,4-D, glyphosate, penoxsulam, imazamox, diquat, and adjuvant levels. Should these levels exceed allowable limits, DBW will take immediate measures to reduce chemical levels at future treatment sites.

- **Mitigation Measure 8** – Implement an adaptive management approach to minimize the use of herbicides.

  Under an adaptive management approach, DBW will seek to improve efficacy and reduce environmental impacts over time as new and better information is available. Specifically, DBW will evaluate the need for control measures on a site by site basis; select appropriate indicators for pre-treatment monitoring; monitor indicators following treatment and evaluate data to determine program efficacy and environmental impacts; support ongoing research to explore the impacts of the SCP and alternative control methodologies; report findings to regulatory agencies; and adjust program actions, as necessary, in response to recommendations and evaluations by regulatory agencies and stakeholders.

  In addition to this adaptive management approach, DBW will follow maintenance control practices that seek to limit the growth and further spread of spongeplant. This will reduce the volume of herbicide utilized by the SCP.

- **Mitigation Measure 20** – Follow the protocol for herbicide applications within one mile of drinking water intake facilities.

  In order to treat within one mile of a drinking water intake, DBW must notify the appropriate jurisdiction at least two weeks in advance, and make every reasonable attempt to schedule applications during periods when intakes are shut down for environmental or maintenance reasons, allowing at least two complete tidal cycles between application and restart. This measure is primarily aimed at reducing the potential for drinking water contamination from the SCP. DBW has a formal Memorandum of Understanding (MOU) regarding applications near drinking water intakes with the Contra Costa Water District (CCWD), but also follows the same protocol with other jurisdictions, such as the City of Stockton and the City of Antioch. In Contra Costa County, generally, no applications shall occur within Rock Slough, or within one mile of the confluence of Rock Slough and Old River, or within one mile of CCWD's Old River or Mallard Slough intake pumps without consensual agreement between CCWD and DBW. Herbicide applications within one mile of CCWD's water intakes may only occur with prior consent of CCWD.

* * * * *

Pesticide applications in the Delta and its tributaries, through the SCP, are intended to result in improvements to a number of beneficial uses. One of the causes of impaired use in the Delta and its tributaries is exotic species, including spongeplant. The goal of the SCP is to keep waterways safe and navigable by controlling the growth and spread of spongeplant.

By reducing the amount of spongeplant clogging pumps and intake pipes, the SCP will improve municipal and domestic supply (MUN), industrial service supply (IND), and agricultural supply (AGR) beneficial uses. These benefits are discussed in Chapter 6, and below under Impact W5.

By reducing the amount of spongeplant clogging Delta and tributary waterways, the SCP will improve navigation (NAV), and recreation beneficial uses (REC-1 and REC-2). By removing monospecific mats of spongeplant from Delta and tributary waterways, the SCP will result in increased DO levels, and improved native habitats for aquatic species. Control of spongeplant in Delta waterways expands habitat suitable for native species. These benefits, discussed in more detail under Impact W4, and in Chapter 3, will result in improvements to warm freshwater habitat (WARM), cold freshwater habitat (COLD), migration of aquatic organisms (MIGR), spawning, reproduction, and/or early development (SPWN), and estuarine habitat (EST) beneficial uses.

Impact W3 – Toxicity: following SCP herbicide treatment toxic substances may potentially be found in waters in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life, violating water quality standards or otherwise substantially degrading water or drinking water quality

Application of SCP herbicides to Delta waters and tributaries could result in concentrations of chemicals that produce toxic responses. The water quality objectives for toxicity are as follows:

> *"All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life. The objective applies regardless of whether the toxicity is caused by a single substance or the interactive effect of multiple substances. Compliance with this objective will be determined by analyses of indicator organisms, species diversity, population density, growth anomalies, and biotoxicity tests of appropriate duration or other methods as specified by the Regional Water Board" (CVRWQCB 2007).*

In response to the SWB's initial interim NPDES permit for aquatic pesticides, prepared in 2001 (Order 2001-12-DWQ), Waterkeepers Northern California filed a lawsuit against the SWB. As part of the settlement with Waterkeepers Northern California, the SWB agreed to fund a comprehensive aquatic pesticide monitoring program to assess toxicity of pesticides in receiving water following aquatic pesticide treatments. The SWB contracted with the San Francisco Estuary Institute (SFEI) to conduct the study. In their 2004 study, SFEI found no toxicity for two SCP herbicides, 2,4-D and glyphosate.

DBW monitoring, and a review of scientific literature, as discussed in Chapter 3, Impact B2, also found no evidence of acute toxicity at herbicide levels likely to be present following SCP treatments. As discussed in Chapter 3, there is some evidence of potential sublethal effects on aquatic species, although data are not conclusive, particularly for likely herbicide levels following SCP treatments.

At the concentrations at which they will be applied, SCP herbicides are known to be toxic to plants and algae. The method of action of 2,4-D, glyphosate, penoxsulam, imazamox, and diquat on plants is discussed in Chapter 3, Impact B1. Any broadleaf vegetation subject to overspray is vulnerable to 2,4-D activity. Exposure of any non-target plant to glyphosate, penoxsulam, imazamox, or diquat could result in loss of plant species.

The potential for impacts resulting from herbicide overspray depend on the amount of exposure, concentration of herbicide, and proximity of sensitive habitats, wetlands, and plants. One study found that only three to four percent of 2,4-D droplets drift beyond the target zone, and no significant amount of material is collected as drift (HSDB 2001). Blankenship and Associates (2004) found that using conservative application rates, detectable adverse effects could result from less than one percent spray drift of glyphosate or 2,4-D.

The concentration of active ingredient leaving the spray nozzle is high enough (ranging from 100 ppm to 6,000 ppm) to cause adverse effects. Thus, there is the potential that uncontrolled herbicide overspray could affect nearby non-target vegetation.

Treatment of spongeplant could result in loss of native submerged aquatic vegetation growing in and around treatment areas. While loss of non-target plant species could constitute a significant impact under certain conditions, it is expected to be less than significant for the SCP. Dense canopies of spongeplant reduce light levels for submerged plant photosynthesis and thus can effectively shade out native vegetation. The benefit to native submerged aquatic vegetation from removal of spongeplant is expected to outweigh any losses due to herbicide toxicity.

While there is a potential toxic risk to plants due to herbicide overspray, the likelihood of such effects occurring is low. Herbicide application will be focused directly on target plants to decrease the possibility that concentrated herbicides will come in contact with non-target plants. The DBW will follow herbicide label application instructions that reduce herbicide drift. These steps include using the largest size spray droplets, and lowest spray pressure, that will provide sufficient coverage and control. Furthermore, DBW will not treat at a particular site if the wind is greater than 10 mph (or 7 mph in Contra Costa County).

Should any acute or sublethal toxic effects to non-target plants or aquatic species occur, it would represent a significant impact. These impacts would be **unavoidable or potentially unavoidable significant impacts.** These impacts could be reduced by implementing the following mitigation measures. The seven mitigation measures for this impact are identical to the seven mitigation measures for Impact W2. Both sets of mitigation measures are directed toward reducing the potential for pesticide toxicity impacts following SCP treatments.

- **Mitigation Measure 1** – Avoid herbicide application near special status species, and sensitive riparian and wetland habitat; and other biologically important resources.

  Each year, prior to start of the treatment season, DBW will conduct field crew environmental awareness training. Under this training, crews will be informed about the presence and life histories of special status species; habitats associated with species; sensitive habitats and wetlands; the terms and conditions of the program's biological opinion and/or letter of concurrence; environmental survey procedures; incidental take procedures; and that unlawful take of an animal or destruction of its habitat is a violation of the Endangered Species Act.

  DBW will provide crews with a field guide (Species Identification Deck) for easy identification of special status species on-site. Prior to treating a site, crews will conduct a visual survey to determine whether special status plants, animals, or sensitive habitats are present. Crews will complete an Environmental Observations Checklist, following an established protocol, for each site to document the presence or absence of listed or special status species. If listed or special status species or sensitive habits are present at the site, the field crew will not perform treatments that could potentially affect the species or habitat.

  DBW Environmental Scientists will classify treatment sites as high, medium, or low potential for nesting birds. DBW also will examine CNDDB records to determine if special status bird species have been sited within SCP treatment locations, and prepare a map for field crews identifying such sites. For those treatment sites that have habitat characteristics that might support special status bird species, Environmental Scientists will survey the specific site. DBW will delay treatments at locations where nesting Swainson's hawks are present until after June 10th, the start of the post-fledging stage.

  At all treatment locations, crews will conduct a visual survey, following an established protocol, to determine whether special status plants, animals, or sensitive habitats are present, including bird nesting sites. Crews will complete an Environmental Observations Checklist for each site to document the presence or absence of bird nesting sites. If nesting yellow-headed blackbird, Swainson's hawk, or tricolored blackbird are known to be present at the site, the field crew will not perform any treatment within 200 yards of the nesting site until the post-fledging stage.

- **Mitigation Measure 3** – Conduct herbicide treatments in order to minimize potential for drift.

  In addition to complying with the label application requirements noted above, DBW will, to the degree possible, schedule herbicide applications to occur at high tide, or at a point in the tidal cycle determined by the field supervisor to provide the least non-target impact at a particular site. In general, treatment at high tide will allow for better spray accuracy and access and will provide for greater dilution volume of herbicides. DBW crews will change nozzle type and spray pressures whenever conditions warrant, limiting the amount of herbicide which may inadvertently contact non-target species.

- **Mitigation Measure 4** – Conduct herbicide treatments using diquat only in emergency situations and for no more than 50 acres in total among DBW aquatic weed control programs.

  To minimize the potential for negative impacts to covered species from exposure to diquat dibromide, DBW will only utilize diquat in emergency situations. Diquat will only be utilized from August 1st through November 30th of each year, and will be limited to a total of 50 treatment acres in the Delta per year, as a sum of the combined diquat acres treated in the SCP and EDCP. Emergency conditions are such that spongeplant growth completely impedes navigation of Delta waters, such as a completely blocked slough that would impair the movement of emergency response vessels. DBW will consult with USFWS and NMFS prior to utilizing diquat to help ensure that covered fish species are not likely to be present at the time of treatment.

- **Mitigation Measure 5** – Operate program vessels in a manner that causes the least amount of disturbance to the habitat.

  Operational procedures for DBW vessels will minimize boat wakes and propeller wash. These procedures will be particularly important in shallow water, or other sensitive habitats.

- **Mitigation Measure 7** – Monitor herbicide and adjuvant levels to ensure that the SCP does not result in potentially toxic concentrations of chemicals in Delta waters.

  DBW will conduct comprehensive monitoring. This monitoring is in compliance with the general NPDES permit, and NOAA-Fisheries and USFWS Biological Opinions. DBW will collect samples prior to treatment, immediately after treatment, and post-treatment within one week of spraying. The DBW will conduct water quality monitoring for visual parameters, physical parameters, and chemical parameters at one site per water body type for glyphosate and six sites per water body type for all other herbicides. Water samples will be submitted to a certified analytical laboratory to measure 2,4-D, glyphosate, penoxsulam, imazamox, diquat, and adjuvant levels. Should these levels exceed allowable limits, DBW will take immediate measures to reduce chemical levels at future treatment sites.

- **Mitigation Measure 8** – Implement an adaptive management approach to minimize the use of herbicides.

  Under an adaptive management approach, DBW will seek to improve efficacy and reduce environmental impacts over time as new and better information is available. Specifically, DBW will evaluate the need for control measures on a site by site basis; select appropriate indicators for pre-treatment monitoring; monitor indicators following treatment and evaluate data to determine program efficacy and environmental impacts; support ongoing research to explore the impacts of the SCP and alternative control methodologies; report findings to regulatory agencies; and adjust program actions, as necessary, in response to recommendations and evaluations by regulatory agencies and stakeholders.

  In addition to this adaptive management approach, DBW will follow maintenance control practices that seek to limit the growth and further spread of spongeplant. This will reduce the volume of herbicide utilized by the SCP.

- **Mitigation Measure 20** – Follow the protocol for herbicide applications within one mile of drinking water intake facilities.

  In order to treat within one mile of a drinking water intake, DBW must notify the appropriate jurisdiction at least two weeks in advance, and make every reasonable attempt to schedule applications during periods when intakes are shut down for environmental or maintenance reasons, allowing at least two complete tidal cycles between application and restart. This measure is primarily aimed at reducing the potential for drinking water contamination from the SCP. DBW has a formal Memorandum of Understanding (MOU) regarding applications near drinking water intakes with the Contra Costa Water District (CCWD), but also follows the same protocol with other jurisdictions, such as the City of Stockton and the City of Antioch. In Contra Costa County, generally, no applications shall occur within Rock

Slough, or within one mile of the confluence of Rock Slough and Old River, or within one mile of CCWD's Old River or Mallard Slough intake pumps without consensual agreement between CCWD and DBW. Herbicide applications within one mile of CCWD's water intakes may only occur with prior consent of CCWD.

Impact W4 – Dissolved oxygen: following SCP herbicide treatment, dissolved oxygen may potentially be reduced below Basin Plan and Bay-Delta Plan objectives, violating water quality standards or otherwise substantially degrading water quality

Dissolved oxygen levels may potentially be reduced below Basin Plan and Bay-Delta Plan objectives following SCP herbicide treatments, and the resulting rapid decay of spongeplant, other aquatic macrophytes, and algae. Decomposition of vegetative material may create an organic carbon slug, which could in turn reduce dissolved oxygen concentrations.

The Basin Plan water quality objectives for dissolved oxygen in the SCP project area are as follows:

"Within the legal boundaries of the Delta, the dissolved oxygen concentration shall not be reduced below:

7.0 mg/l in the Sacramento River (below the I Street Bridge) and in all Delta waters west of the Antioch Bridge; 6.0 mg/l in the San Joaquin River (between Turner Cut and Stockton, 1 September through 30 November); and 5.0 mg/l in all other Delta waters except for those bodies of water which are constructed for special purposes and from which fish have been excluded or where the fishery is not important as a beneficial use.

For surface water bodies outside the legal boundaries of the Delta, the monthly median of the mean daily dissolved oxygen (DO) concentration shall not fall below 85 percent of saturation in the main water mass, and the 95 percentile concentration shall not fall below 75 percent saturation. The dissolved oxygen concentrations shall not be reduced below the following minimum levels at any time:

- *Waters designated WARM 5.0 mg/l*
- *Waters designated COLD 7.0 mg/l*
- *Waters designated SPWN 7.0 mg/l" (CVRWQCB 2007).*

In addition, there are more stringent requirements for the Merced River from Cressy to New Exchequer Dam, of 8.0 mg/l (all year), and for the Tuolumne River from Waterford to La Grange, of 8.0 mg/l from October 15^{th} to June 15^{th}.

Dissolved oxygen 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. Fish begin to experience oxygen stress or exhibit avoidance at levels below 5 mg/l (5 ppm).

DO levels drop in warmer temperatures, and increase with precipitation, wind, and water flow. Running water, such as tidal water in the Delta, dissolves more oxygen than still 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.

There is the potential that following herbicide treatment, the biomass of decaying spongeplant will create a large biological oxygen demand, resulting in decreases in dissolved oxygen. These decreases in dissolved oxygen could adversely affect fish species and aquatic invertebrates present at the treatment location, and potentially impair sensitive riparian or wetland habitats. The extent of the DO impact depends on the speed at which spongeplant decomposes following treatment (which is herbicide dependent) and the extent to which tides and wind move decaying plants away from the original location (which is variable).

SCP herbicide labels include provisions to address the potential for low dissolved oxygen following treatment, when appropriate. When herbicides are used according to label instructions, there will likely be no significant effect on DO, except to increase DO levels once the plants have completed decomposition. Label requirements related to DO impacts are as follows:

- The label for Weedar 64 (2,4-D) notes that decaying weeds use up oxygen, and recommends treating part of the infestation at one time. For example, the label recommends applying 2,4-D in lanes separated by untreated strips, and delaying treatment of these strips for 21 days, until the treated dead vegetation has decomposed
- The label for Roundup Custom (glyphosate) recommends treating an area in strips when there is full coverage of the weed in impounded areas to avoid oxygen depletion. The Delta does not contain impounded waters
- The label for Galleon (penoxsulam) does not include specific provisions related to DO
- The label for Clearcast (imazamox) does not include specific provisions related to DO
- The label for Reward (diquat) specifies that no more than one-third to one-half of a water body should be treated at one time, with a waiting period of 14 days for follow-up treatment of the remaining area.

Dissolved oxygen levels under dense spongeplant mats are expected to be low, similar to under water hyacinth mats. For water hyacinth, Toft (2000) and others have found lower levels of dissolved oxygen under hyacinth canopies. Average spot measures were below 5 ppm in hyacinth, and above 5 ppm in pennywort (Toft 2000). These results were supported by a study in Texas which found lower dissolved oxygen in hyacinth compared to other aquatic weeds, and a University of California, Davis study which found dissolved oxygen levels as low as 0 ppm below a solid water hyacinth mat (Toft 2000). Toft hypothesized that lower dissolved oxygen levels explained the absence of epibenthic amphipods and isopods beneath the hyacinth canopy at one of the test sites (Toft 2000). Thus, it is likely that fish and other mobile aquatic invertebrates will avoid areas under water hyacinth [or spongeplant] mats with low dissolved oxygen, even prior to treatment (NMFS April 2006).

Given current low spongeplant infestation levels, the potential for DO effects is likely to be lower than for water hyacinth. Below, as a baseline, we discuss WHCP DO monitoring results. DBW will conduct similar monitoring for the SCP to determine how spongeplant treatments will affect DO.

WHCP tracks two sets of DO monitoring. At every herbicide application, treatment crews take DO samples immediately prior to treating, and immediately 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 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 5-4,** on the next page, provide WHCP 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. Site 16 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, 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 monitor pre- and post-treatment DO levels for the SCP.

Table 5-4
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.

In 2013, DBW conducted a pilot study for DO monitoring to assess impacts of water hyacinth and herbicide treatments on DO. Again, we would expect large spongeplant mats to have similar DO effects. 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 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 concentrations occurring in the afternoon.

In the history of the WHCP, reductions in DO levels below Basin Plan limits have occurred only infrequently as a result of WHCP treatments, and when they did occur, they were short-lived. We would expect similarly minimal effects from the SCP. However, should SCP treatments result in violations of the Bay-Delta Plan or Basin Plan water quality objectives for dissolved oxygen, it would constitute an **unavoidable or potentially unavoidable significant impact.** These impacts would potentially be reduced by implementing the following two mitigation measures.

- **Mitigation Measure 10** – Monitor dissolved oxygen (DO) levels for all SCP treatments.

  Based on the pre-treatment DO levels, the application crew will determine whether to conduct treatment at that site. No treatment will be performed when dissolved oxygen levels are between 3 ppm (the level below which DO is considered to be detrimental to fish species) and the basin plan limits established by the CVRWQCB. The basin plan limits depend on location and time of year, and range from 5 ppm to 8 ppm. The DBW will maintain written and map summaries of specific DO numeric limits. When pre-treatment levels are below 3 ppm, fish species are not likely to be present due to the extremely low oxygen levels. When pre-treatment levels are above the basin plan limit, SCP treatment, following label guidelines and mitigation measures, are not expected to adversely affect dissolved oxygen levels. The current dissolved oxygen map summaries are shown in **Exhibits 5-2a** and **5-2b,** on the following pages.

Exhibit 5-2a
SCP Dissolved Oxygen Limits – Northern Sites

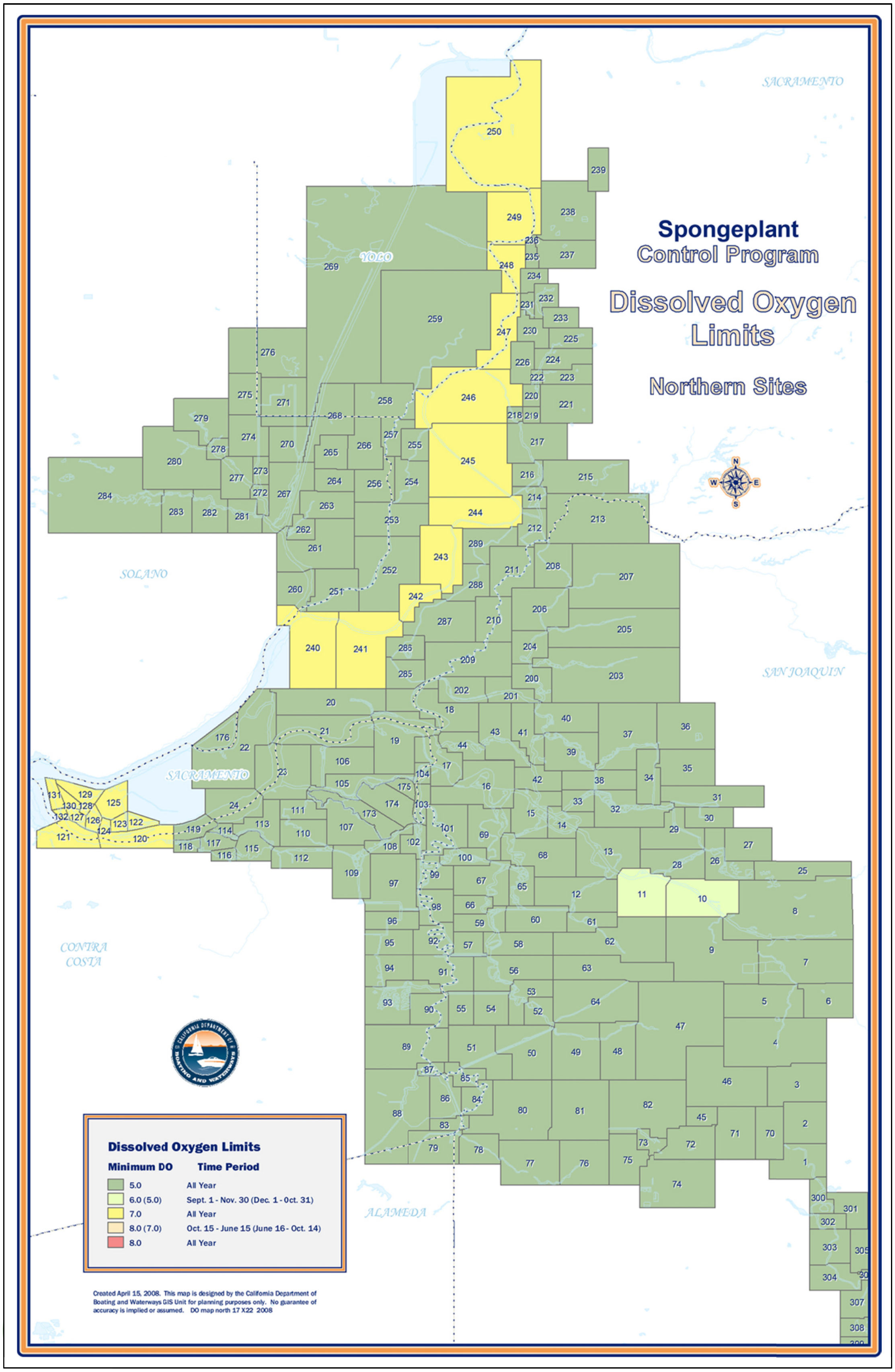
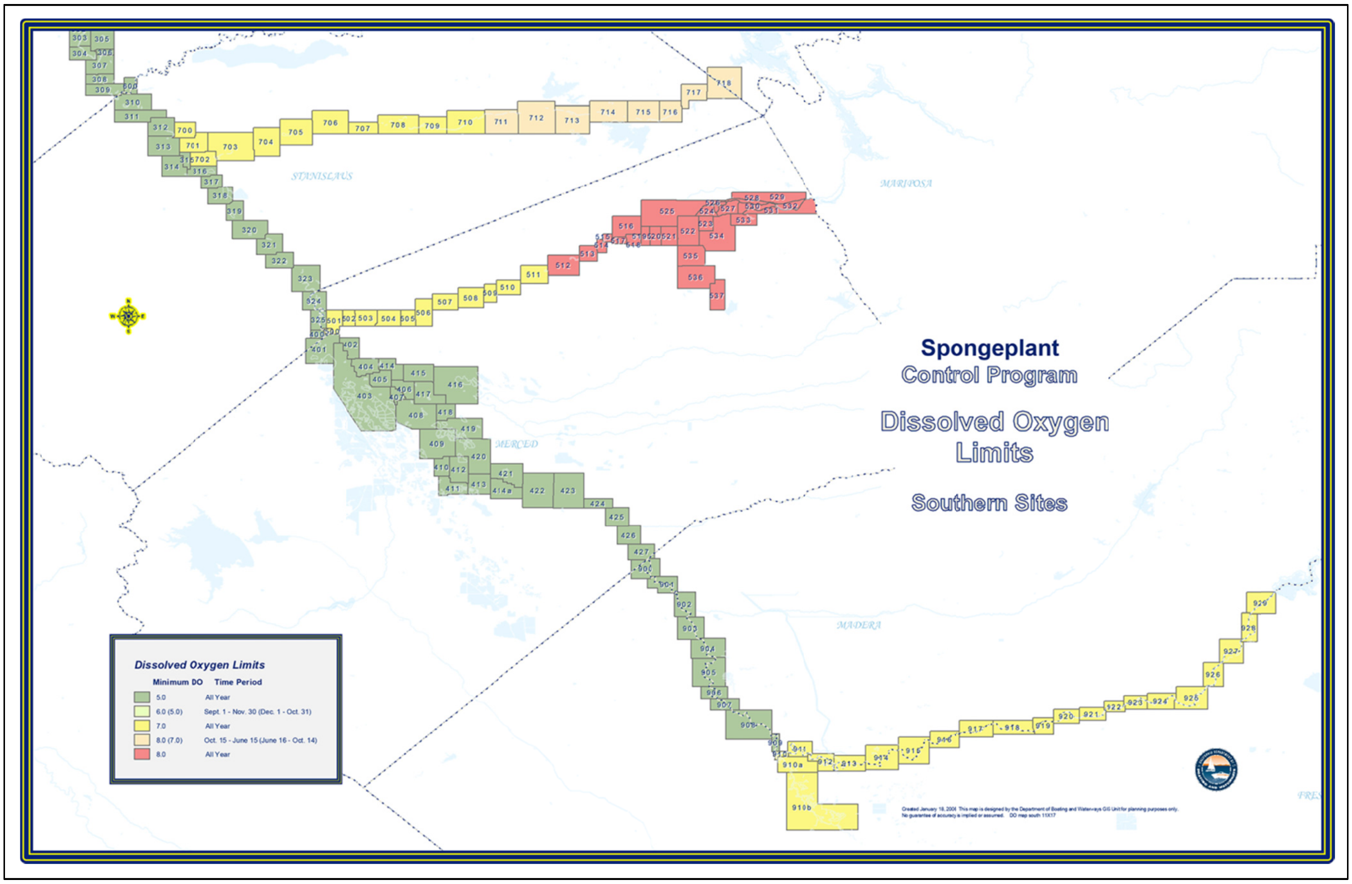


Exhibit 5-2b
SCP Dissolved Oxygen Limits – Southern Sites



- **Mitigation Measure 11** – Implement the Fish Passage Protocol to provide a zone of passage through areas of low dissolved oxygen.

  In slow-moving and back-end sloughs infested with spongeplant, treat up to 30 percent of spongeplant mats at one time. Treat mats in up to 3 acre strips, leaving at least 100 foot buffer strips between treated areas. Treat the untreated buffer strips and remaining 70 percent of the spongeplant mat at least three more times following the initial treatment (in 30 percent increments). Conduct follow-up treatments in three week intervals.

  In Delta tidal waters, treat up to 50 percent of the spongeplant mat at one time. Treat mats in up to 3 acre strips, leaving at least 100 foot buffer strips between treated areas. Treat the untreated buffer strips and remaining 50 percent of the mat three weeks following the initial treatment for 2,4-D, and one week following the initial treatment for other herbicides.

  In treatment sites where DO levels are below 3 mg/l prior to SCP treatments, treat the entire area, without the 3 acre strips or buffer strips.

* * * * *

There are also positive impacts related to dissolved oxygen that will result from the SCP. Dissolved oxygen levels at treatment sites will increase, improving compliance with water quality standards, once dead spongeplant have decayed or floated away. Removing large patches of spongeplant will allow DO levels to increase, thus enhancing the beneficial uses of Delta waters. It can be argued that such a benefit can outweigh the impact of short-term localized decreases in dissolved oxygen.

Impact W5 – Floating material: following SCP treatment, waters may potentially contain floating spongeplant fragments in amounts that cause nuisance or adversely affect beneficial uses, violating water quality standards or otherwise substantially degrading water quality

Herbicide treatments, hand removal with nets, and herding may break fragments of spongeplant loose in Delta waterways. These spongeplant fragments could result in nuisance or adversely affect beneficial uses. The Basin Plan specifies that *"water shall not contain floating material in amounts that cause nuisance or adversely affect beneficial uses"* (CVRWQCB 2007).

As discussed in Chapter 6, potential negative impacts from floating debris include increasing debris loading at water utility intake facilities and agricultural irrigation intakes. Municipal and domestic supply, industrial service supply, and agricultural supply, are designated beneficial uses of Delta waters.

The potential for spongeplant fragments resulting from SCP treatments to result in violations of water quality standards or otherwise substantially degrade water quality is low. However, should spongeplant debris resulting from the SCP cause nuisance or adversely affect beneficial uses, it would represent a significant impact. This impact would be an **avoidable significant impact, reduced to a less-than-significant level by implementing the following three mitigation measures:**

- **Mitigation Measure 13** – Collect plant fragments during and immediately following treatments.

  To maximize containment of plant fragments, crews will collect spongeplant fragments. Crews will also be trained on the importance of minimizing fragment escape.

- **Mitigation Measure 20** – Follow the protocol for herbicide applications within one mile of drinking water intake facilities.

  In order to treat within one mile of a drinking water intake, DBW must notify the appropriate jurisdiction at least two weeks in advance, and make every reasonable attempt to schedule applications during periods when intakes are shut down for environmental or maintenance reasons, allowing at least two complete tidal cycles between application and restart. This measure is primarily aimed at reducing the potential for drinking water contamination from the SCP. DBW has a formal Memorandum of Understanding (MOU) regarding applications near drinking water intakes with the Contra Costa Water District (CCWD), but also follows the same protocol with other jurisdictions, such as the City of

Stockton and the City of Antioch. In Contra Costa County, generally, no applications shall occur within Rock Slough, or within one mile of the confluence of Rock Slough and Old River, or within one mile of CCWD's Old River or Mallard Slough intake pumps without consensual agreement between CCWD and DBW. Herbicide applications within one mile of CCWD's water intakes may only occur with prior consent of CCWD.

- **Mitigation Measure 21** – Notify County Agricultural Commissioners about SCP activities.

  Before an application may occur, DBW shall file Pesticide Use Recommendations (PUR) and a Notice of Intent (NOI) with the appropriate County Agricultural Commissioner (CAC) office. Each NOI will include the site number, spray dates, locations, and herbicides and adjuvants to be used. NOIs will be submitted prior to each treatment week. Based on information in the NOIs, CAC's could inform land owners of particular periods of time during which irrigation should not occur. If necessary, DBW shall also obtain a Restricted Use Permit (RUP) from all appropriate CACs.

* * * * *

The potential increase in floating material resulting from the SCP is likely to be outweighed by the benefits to water utility and agricultural intake pump systems that result from removing spongeplant from Delta waterways. One concern resulting from water hyacinth's invasion in the Delta in the 1980s was untreated plants blocking CVP and SWP pumps (U.S. Army Corps of Engineers 1985). In fact, the Bureau of Reclamation estimated that the WHCP saved the Bureau $400,000 per year in reduced operating and maintenance costs associated with removing water hyacinth from just the C.W. "Bill" Jones Pumping Plant (DBW 2001). While the spongeplant currently has a significantly smaller footprint in the Delta than the water hyacinth, its removal is similarly expected to have similar positive impacts on pump operating and maintenance costs.

Similarly, clogging of agricultural pumps by untreated spongeplant can result in inefficient pumping, increased pumping costs, and possible mechanical failure of pumps. Prior to the start of the WHCP, in a letter to the U.S. Army Corps of Engineers, the San Joaquin Farm Bureau Federation stated that growers were facing increased costs from efforts to open clogged channels where water hyacinth was decreasing the flow of water to pumps and clogging screens (U.S. Army Corps of Engineers 1985).

Impact W6 – Turbidity: SCP treatment may potentially result in changes to turbidity that cause nuisance or adversely affect beneficial uses, violating water quality standards or otherwise substantially degrading water quality

Operation of SCP vessels for treatment and monitoring may potentially result in changes in turbidity that violate water quality standards or otherwise substantially degrade water quality. Such turbidity increases could result in nuisance or adversely affect beneficial uses.

The SCP operates under the General NPDES permit CAG990005, and the Basin Plan objectives for turbidity. The Basin Plan turbidity objectives are as follows:

"Waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses. Increases in turbidity attributable to controllable water quality factors shall not exceed the following limits:

- *Where natural turbidity is between 0 and 5 Nephelometric Turbidity Units (NTUs), increases shall not exceed 1 NTU.*
- *Where natural turbidity is between 5 and 50 NTUs, increases shall not exceed 20 percent.*
- *Where natural turbidity is between 50 and 100 NTUs, increases shall not exceed 10 NTUs.*
- *Where natural turbidity is greater than 100 NTUs, increases shall not exceed 10 percent.*

In Delta waters, the general objectives for turbidity apply subject to the following: except for periods of storm runoff, the turbidity of Delta waters shall not exceed 50 NTUs in the waters of the Central

Delta and 150 NTUs in other Delta waters. Exceptions to the Delta specific objectives will be considered when dredging operations can cause an increase in turbidity. In this case, an allowable zone of dilution within which turbidity in excess of limits can be tolerated will be defined for the operation and prescribed in a discharge permit" (CVRWQB 2007).

DBW analyzed WHCP monitoring results from 2001 to 2005 to determine whether there were statistical differences between water quality parameters before, and after, water hyacinth treatment. In general, there was no statistical evidence that water quality degraded significantly as a result of aquatic herbicide treatments. Similar results are expected from the SCP, which will require substantially lower volumes of herbicide treatment than the WHCP.

DBW measured compliance with turbidity requirements by comparing pre-treatment turbidity levels with post-treatment turbidity levels measured at follow-up visits. For the 2001 to 2005 time period, DBW compared pre- and post-treatment turbidity for 352 pairs of samples. In all cases, the WHCP was in compliance with Basin Plan limits for changes in turbidity.

In 2009, 2010, 2011, and 2012, turbidity measurements were all within an acceptable range. However, the data was somewhat unreliable, as DBW experienced difficulties with the monitoring probes. DBW has been working with the manufacturer to address these problems. In 2006, 2007, and 2008, there were a total of 20 occasions and 10 sites for which turbidity levels exceeded basin plan limits. In all but three instances in each year, the exceedances were due to the sampling boat entering areas where it was very shallow, many submerged aquatic plants, agricultural discharges, inputs from more turbid tributaries, wading livestock, or instrument error. In the three other instances each year, there was no recorded explanation for the exceedance in the measured turbidity levels. In most cases, the exceedances occurred on the treatment day, and when the turbidity was measured on the follow-up sampling day, they were again within basin limits. In a few cases, the follow-up turbidity levels were still high. Therefore, if the WHCP was responsible for the turbidity violations, the effects were only temporary and most likely did not have any adverse effects on beneficial uses.

While exceedances in Basin Plan limits may occur within the Delta, it has been and will continue to be difficult to determine whether these exceedances were a result of the WHCP. However, any exceedances that are a result of future SCP activities are likely to be short-term. The SCP is not likely to result in increases in turbidity that create nuisance or adversely affect beneficial uses. As a result, **the impact of the SCP on turbidity is expected to be less than significant.** While no mitigation measures are required, DBW will implement the following mitigation measure to further reduce any potential impact level.

- **Mitigation Measure 5** – <u>Operate program vessels in a manner that causes the least amount of disturbance to the habitat</u>.

  Operational procedures for DBW vessels will minimize boat wakes and propeller wash. These procedures will be particularly important in shallow water, or in other sensitive habitats.

This section identified mitigation measures to address six potential impacts to hydrology and water quality. Many of these mitigation measures are intended to reduce more than one potential impact. **Exhibit 5-3,** on the next page, combines and summarizes the hydrology and water quality mitigation measures.

Exhibit 5-3
Summary of Potential Hydrology and Water Quality Impacts and Mitigation Measures

Mitigation Measure Summary[1]	Impacts Applied To
1. Avoid herbicide applications near special status species, and sensitive riparian and wetland habitat; and other biologically important resources	Impact W2: Pesticides Impact W3: Toxicity
3. Conduct herbicide treatment in order to minimize potential for drift	Impact W1: Chemical constituents Impact W2: Pesticides Impact W3: Toxicity
4. Conduct herbicide treatments using diquat only in emergency situations and for no more than 50 acres in total among DBW aquatic weed control programs	Impact W1: Chemical constituents Impact W2: Pesticides Impact W3: Toxicity
5. Operate program vessels in a manner that causes the least amount of disturbance to the habitat	Impact W2: Pesticides Impact W3: Toxicity Impact W6: Turbidity
7. Monitor herbicide and adjuvant levels to ensure that the SCP does not result in potentially toxic concentrations of chemicals in Delta waters	Impact W1: Chemical constituents Impact W2: Pesticides Impact W3: Toxicity
8. Implement an adaptive management approach to minimize the use of herbicides	Impact W1: Chemical constituents Impact W2: Pesticides Impact W3: Toxicity
10. Monitor dissolved oxygen (DO) levels pre- and post-treatment for all for all SCP treatments	Impact W4: Dissolved oxygen
11. Implement the Fish Passage Protocol to provide a zone of passage through areas of low dissolved oxygen	Impact W4: Dissolved oxygen
13. Collect plant fragments during and immediately following treatments	Impact W5: Floating material
20. Follow the protocol for herbicide applications within one mile of drinking water intake facilities	Impact W1: Chemical constituents Impact W2: Pesticides Impact W3: Toxicity Impact W5: Floating Material
21. Notify County Agricultural Commissioners about SCP activity	Impact W5: Floating material

[1] Please refer to the text for the complete mitigation measure description.

Section 6

Utilities and Service Systems and Agricultural Resources Impacts Assessments

6. Utilities and Service Systems and Agricultural Resources Impacts Assessment

This chapter analyzes effects of the SCP on utility and service systems, and agricultural resources. SCP effects on both of these resource areas are likely to be minimal. The chapter is organized as follows:

A. *Utility and Service Systems Impacts Assessment*
B. *Agricultural Resources Impacts Assessment.*

For each resource area, we first describe the environmental setting, and then provide an impact analysis and mitigation measures. The environmental setting sections describe the current status of utility and service systems, and agricultural resources, in the Delta. The discussions focus on water utility pumps and agricultural crops, which are areas of potential impact.

The impact analyses sections provide assessments of the specific environmental impacts potentially resulting from program operations. The discussion of impacts utilizes findings from DBW research projects, technical information from government reports, and program experience. The impact assessments are based on technical information.

For each of the potential SCP impacts to utility and service systems and agricultural resources, we provide a description of the impact, analyze the impact, classify the impact level, and identify mitigation measures to reduce the impact level.

The mitigation measures are specific actions that the DBW will undertake to avoid, or minimize, potential environmental impacts. The DBW has developed these actions based on over 30 years of program experience and discussions with local governments, water agencies, and County Agricultural Commissioners. The DBW maintains regular contact with these entities regarding potential impacts to pump systems and crops, and will respond to concerns expressed by these agencies to revise and/or add new mitigation measures, as necessary.

The SCP is a new aquatic weed control program for a new invasive species. At the time this PEIR is being prepared, the extent of the spongeplant invasion is small. In any given treatment season, the scope of the treatment approaches, and resulting impacts, will be scaled to the level of invasion. At the current low levels of spongeplant invasion, SCP approaches will consist of spot treatments with herbicides and hand removal with pool-skimmer nets. Only if spongeplant spreads extensively in the future will SCP utilize herding and/or mechanical removal methods. DBW and USDA-ARS are incorporating all potential treatment approaches into the proposed action because this PEIR covers future program years, and there is the potential for the extent of spongeplant in the Delta to increase significantly over time. Similarly, the potential impacts of the SCP will depend on the scale of the program.

A. Utilities and Service Systems Impacts Assessment

1. Environmental Setting

Water-Related Infrastructure

Water conveyance infrastructure consists of many agricultural, industrial, and municipal diversions for supplying water to the Delta itself and for export by the SWP and CVP. Diversions and conveyance require canals, waterways, levees, siphons, pumps, radial gates, and other miscellaneous infrastructure. We discuss agricultural diversions in Section B of this chapter.

Table 6-1
Delta Drinking Water Intakes

Intake Name	Jurisdiction	Waterbody
1. Barker Slough Intake	Department of Water Resources	Sacramento River and Deep Water Channel
2. Harvey O. Banks Pumping Plant	Department of Water Resources	Clifton Court Forebay
3. C.W. “Bill” Jones Pumping Plant	U.S. Bureau of Reclamation (USBR)	Delta-Mendota Canal
4. Rock Slough Intake	Contra Costa Water District	Rock Slough and Contra Costa Canal
5. Old River Intake	Contra Costa Water District	Old River
6. Mallard Slough Intake Pump Station	Contra Costa Water District and USBR	Mallard Slough and Suisun Bay
7. Victoria Canal Intake	Contra Costa Water District	Victoria Canal

Most water conveyance facilities in the Delta have been developed under the authority of the federal government’s Central Valley Project (CVP) and California’s State Water Project (SWP). As part of CVP development, exportation of water from the Delta began in 1940 with the completion of the Contra Costa Canal. Other major federal units were completed during the early 1950s, including the Delta-Mendota Canal and the Delta Cross Channel (DCC). The DCC transfers water across the Delta from the Sacramento River to the C.W. “Bill” Jones Pumping Plant (formerly the Tracy Pumping Plant), which serves the Delta-Mendota Canal. Numerous SWP facilities have been developed in the Delta, including the Harvey O. Banks Delta Pumping Plant, the California Aqueduct, and the North Bay Aqueduct (NBA). Combined, the CVP and SWP typically export approximately five (5) million acre feet of water annually for agricultural and urban use in Central and Southern California.

The Contra Costa Water District (CCWD) provides water to approximately 500,000 customers in central and eastern Contra Costa County. CCWD operates four intakes that divert drinking water from the Delta, located at Rock Slough, Old River, Victoria Canal, and Mallard Slough. There are power plants in the western Delta, at Antioch and Pittsburg, which utilize Delta waters for cooling. The East Bay Municipal Utility District operates the Mokelumne Aqueduct, providing water to 1.3 million people. Mokelumne Aqueduct pipelines cross through the southern portion of the Delta, but do not pump Delta waters.

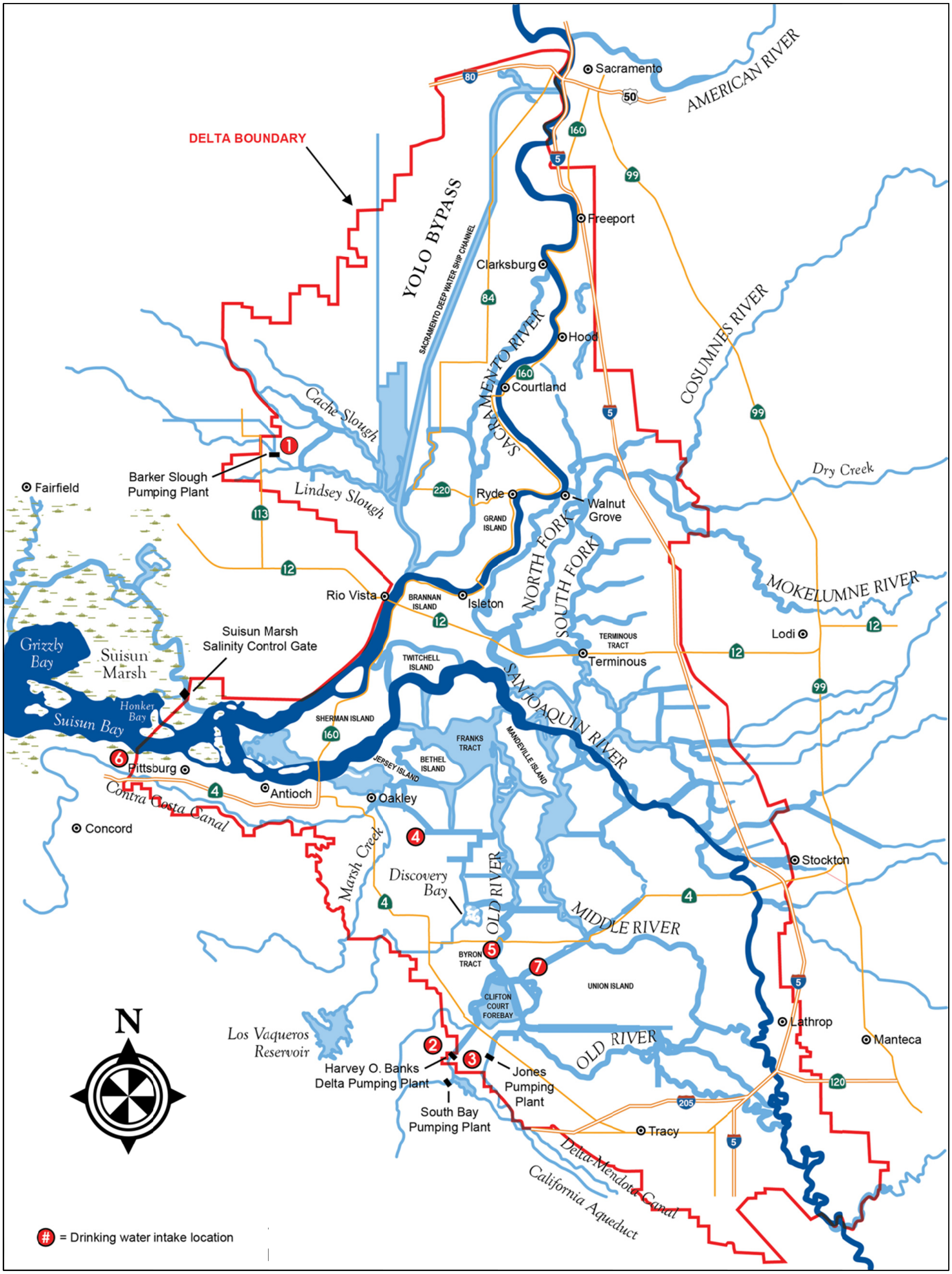
Exhibit 6-1, on the next page, and **Table 6-1,** above, identify seven major drinking water intake pumps in and near the SCP project area. The numbers in Table 6-1 refer to the locations on Exhibit 6-1.

Natural Gas Infrastructure

Natural gas was discovered in the Delta region in 1935 and has since been developed into a significant source and depot for underground storage. Gas fields, pipelines, underground storage areas, and related infrastructure are located in the Delta. Infrastructure consists mainly of pipelines and storage facilities owned by oil and gas companies, public utilities, and various independent leaseholders.

In 2013, there were approximately 233 operating natural gas wells in the Delta and Suisun Marsh (BDCP, Chapter 26 2013). There are more than twenty-five (25) underground natural gas storage areas located throughout the Delta and surrounding vicinity. Pacific Gas and Electric (PG&E) maintains a storage area under McDonald Island in the Central Delta that provides approximately 33 percent of the peak natural gas supply for the PG&E service area (URS Corporation 2007). In addition, fuel pipelines carry gasoline and aviation fuel from the Bay Area to the Central Valley through the Delta.

Exhibit 6-1
Drinking Water Intakes in the Sacramento-San Joaquin Delta



Public Services

Police protection is provided by various departments within the cities and counties of the Delta region. For example, the San Joaquin Sheriff's Department marine patrol division provides water patrol services to approximately 600 square miles of waterways in the Delta area. The Contra Costa County Sheriff's Department provides law enforcement services in the area. Fire protection service is provided by various departments in the Delta area, including the San Joaquin County Delta Fire Protection District and the Contra Costa Fire Protection District. Volunteer firefighters also respond to fire emergencies as needed. Fire suppression in areas not under the jurisdiction of a fire protection district is the responsibility of the landowners. Cities and counties in the region provide emergency services.

Solid Waste and Wastewater Treatment Services

There are over thirty solid waste facilities located in or adjacent to the Delta and Suisun Marsh (URS Corporation 2007). Most facilities are located at the periphery of the Delta. There are thirteen sewage treatment plants located in the Delta region, all located in the periphery, near developed areas (URS Corporation 2007).

Electric Utilities and Communication Infrastructure

Power transmission facilities have developed with the population growth of various communities surrounding the Delta. PG&E, Sacramento Municipal Utility District (SMUD), and the Western Area Power Administration have developed and oversee power transmission lines across the Delta islands and waterways. There are more than 500 miles of transmission lines and 60 substations within the Delta boundaries (URS Corporation 2007). Many of the transmission corridors are within the periphery of the Delta upland areas, including several natural gas-fired plants. Communication infrastructure in the region includes underground cable and fiber optic lines, and communication/transmission towers.

2. Impact Analysis and Mitigation Measures

For purposes of this analysis, we considered an impact to utilities and service systems to be significant and require mitigation if it would result in any of the following:

- Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board
- Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities
- Require or result in the construction of new storm water drainage facilities or expansion of existing facilities
- Require new or expanded entitlements for water supply
- Result in a determination by the wastewater treatment provider that it does not have adequate capacity to serve the project
- Exceed permitted landfill capacity
- Result in noncompliance with federal, state, or local statutes and regulations related to solid waste
- Result in problems for local or regional water utility intake pumps.

Exhibit 6-2, on page 6-6, provides a summary of the potential SCP impact for the one utility and service systems significance area which could potentially be affected. Exhibit 6-2 also explains those utility and service systems significance areas in which there will be no impacts. We discuss potential impacts of the SCP on water quality in Chapter 5.

<u>Impact U1 – Water utility intake pumps: effects of SCP treatments on water utility intake pumps</u>

Herbicide treatments, hand removal with nets, herding, and mechanical removal may break fragments of spongeplant loose into Delta waterways. These spongeplant fragments could increase debris loading at intake facilities. Fragments have the potential to clog water utility intake pumps, requiring additional pump maintenance for affected water agencies.

The potential for spongeplant fragments resulting from SCP treatments to cause adverse effects on water utility intake pumps is low. However, should spongeplant debris resulting from the SCP clog or damage water utility intake pumps, it would represent a significant impact. This impact would be an **avoidable significant impact, reduced to a less-than-significant level by implementing the following two mitigation measures.**

- **Mitigation Measure 13** – Collect plant fragments during and immediately following handpicking, herding, or herbicide treatments.

  To maximize containment of plant fragments, crews will collect spongeplant fragments. Crews will also be trained on the importance of minimizing fragment escape.

- **Mitigation Measure 20** – Follow the protocol for herbicide applications within one mile of drinking water intake facilities.

  In order to treat within one mile of a drinking water intake, DBW must notify the appropriate jurisdiction at least two weeks in advance, and make every reasonable attempt to schedule applications during periods when intakes are shut down for environmental or maintenance reasons, allowing at least two complete tidal cycles between application and restart. This measure is primarily aimed at reducing the potential for drinking water contamination from the SCP. DBW has a formal Memorandum of Understanding (MOU) regarding applications near drinking water intakes with the Contra Costa Water District (CCWD), but also follows the same protocol with other jurisdictions, such as the City of Stockton and the City of Antioch. In Contra Costa County, generally, no applications shall occur within Rock Slough, or within one mile of the confluence of Rock Slough and Old River, or within one mile of CCWD's Old River or Mallard Slough intake pumps without consensual agreement between CCWD and DBW. Herbicide applications within one mile of CCWD's water intakes may only occur with prior consent of CCWD.

* * * * *

The potential impact to water intake systems is likely to be outweighed by the benefits to water intake pump systems that result from removing spongeplant from Delta waterways. One concern resulting from water hyacinth's invasion in the Delta in the 1980s was plants blocking CVP and SWP pumps (U.S. Army Corps of Engineers 1985). In fact, the Bureau of Reclamation estimated that the WHCP saved the Bureau $400,000 per year in reduced operating and maintenance costs associated with removing water hyacinth from just the C.W. "Bill" Jones Pumping Plant (DBW 2001). While the spongeplant currently has a significantly smaller footprint in the Delta than the water hyacinth, its removal is similarly expected to have positive impacts on operating and maintenance costs.

B. Agricultural Resources Impacts Assessment

1. Environmental Setting

The Delta is an important agricultural area. Farming in the Delta region began in the 1850s, following passage of the Swamp and Overflow Act, and Reclamation District Act, which provided for the sale of swamp and overflow lands for reclamation (DPC January 2001). Early farmers built a system of levees and irrigation ditches, and began growing a variety of vegetables, fruits, and grains. Over time, most farms have shifted from growing diverse crops, to growing a few crops, which are rotated (DPC January 2001). Crops that have been important at various times in the Delta include potatoes, asparagus, pears, and sugar beets. Characteristics that make the Delta well-suited to agriculture include: rich soil, ample water, a long growing season, mild climate, and proximity to end markets (DPC May 2001).

California is the fifth largest agricultural economy in the world, producing over 400 plant and animal commodities worth nearly $43.5 billion in 2011 (CDFA 2013). There were over 25 million acres of agricultural land (including grazing land) in California in 2011 (CDFA 2013).

Exhibit 6-2
Crosswalk of Utility and Service Systems Significance Criteria, Impacts, and Benefits of the SCP

	Mitigation Measures	Unavoidable or Potentially Unavoidable Significant Impact	Avoidable Significant Impact	Less than Significant Impact	No Impact	Beneficial Impact
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?					SCP will have no wastewater treatment impacts	
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?					SCP will not require construction or expansion of water or wastewater treatment facilities	
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?					SCP will not require construction or expansion of storm water drainage facilities	
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?					SCP will have no impact on water supplies	
e) Result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?					SCP will have no impact on wastewater treatment capacity	
f) Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?					SCP will have no impact on landfill capacity. A small amount of handpicked spongeplant will be placed on levee banks and allowed to naturally desiccate and disperse	
g) Comply with federal, state, and local statutes and regulations related to solid waste?					SCP will comply with federal, state, and local statues and regulations related to solid waste	
h) Result in problems for local or regional water utility intake pumps?						Removal of spongeplant from Delta waterways could reduce clogging of water utility intake pumps
Impact U1: Water utility intake pumps	13, 20		X			X

Table 6-2
Total and Agricultural Acres in Delta Counties

County	Total County Acres	Total County Agricultural Acres (2010)	Approximate County Delta Acres	Delta Total Agricultural Delta Acres (in production) (2010)
1. San Joaquin	912,602	737,503	317,778	214,053
2. Yolo	653,452	479,858	91,861	54,986
3. Sacramento	636,083	328,593	118,717	66,428
4. Solano	582,373	358,225	88,071	72,499
5. Contra Costa	514,019	146,933	104,751	48,062
6. Alameda	525,338	204,233	6,422	5,352
Total	3,823,867	2,255,345	727,600	461,380

Sources: USDA Census of Agriculture (www.agcensus.usda.gov); DOC, http://www.consrv.ca.gov; Delta Protection Commission 2011. DBW.

The six counties with land area in the legal Delta (Alameda, Contra Costa, Sacramento, San Joaquin, Solano, and Yolo) produced over $3.6 billion in agricultural products in 2011 (USDA 2012). The additional SCP counties (Fresno, Stanislaus, Madera, Tuolumne, Merced) produced a combined $14.8 billion in agricultural output. The SCP project area in these counties is limited to the treatment sites on the San Joaquin, Merced, and Tuolumne Rivers. Among the six counties with land area in the legal Delta, San Joaquin County has the greatest agricultural output. San Joaquin County produced the seventh highest value of agricultural products statewide, at $2.2 billion in 2011.

In 2010, the Delta region had about 500,000 acres available for agriculture, with 461,000 acres in use (DPC 2011), just over 2 percent of the total agricultural acreage statewide, and approximately 67 percent of Delta land acreage. Of the Delta's 500,000 agricultural acres, approximately 80 percent is classified as prime farmland (DPC 2011).The average annual gross value of the agricultural output of the Delta is typically about two percent of the statewide agricultural output, and was $800 million in 2009. **Table 6-2,** above, summarizes total and Delta agricultural land use in the six Delta counties.

Tables 6-3 and **6-4,** on the next page, identify the top ten Delta agricultural crops in 2009, based on annual average gross value, and acreage. These tables illustrate the diversity of agriculture in the Delta, with no single product dominating either acreage or economic output.

2. Impact Analysis and Mitigation Measures

For purposes of this analysis, we considered an impact to agricultural resources to be significant and require mitigation if it would result in any of the following:

- Conflict with existing zoning for agricultural use, or a Williamson Act contract
- Involve other changes in the existing environment which, due to their location or nature, could result in conversion of farmland to non-agricultural use
- Adversely impact agricultural crops or agricultural operations.

Table 6-5, on the next page, provides a summary of the potential SCP impacts for the one agricultural resources significance area which could potentially be affected. Table 6-5 also explains those agricultural resource significance areas in which there will be no impacts.

Table 6-3
Top Ten Delta Agricultural Crops, Based on 2009 Value

Agricultural Product	Annual Gross Value (in millions of dollars)
1. Processing tomatoes	$117.2
2. Wine grapes	105.0
3. Corn	93.0
4. Alfalfa	66.0
5. Asparagus	50.1
6. Pears	36.7
7. Turf	31.6
8. Potato	28.6
9. Almond	8.8
10. Watermelon	8.0

Source: Delta Protection Commission 2011

Table 6-4
Top Ten Delta Agricultural Products, Based on 2009 Acreage

Agricultural Product	Delta Irrigated Acres
1. Corn	105,362
2. Alfalfa	91,978
3. Processing tomatoes	38,123
4. Wheat	34,151
5. Wine grapes	30,148
6. Oats	15,847
7. Safflower	8,874
8. Asparagus	7,217
9. Pear	5,912
10. Bean, dried	5,493

Source: Delta Protection Commission 2011

Table 6-5
Crosswalk of Agricultural Resources Significance Criteria, Impacts, and Benefits of the SCP

	Mitigation Measures	Unavoidable or Potentially Unavoidable Significant Impact	Avoidable Significant Impact	Less than Significant Impact	No Impact	Beneficial Impact
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?					SCP will not convert prime farmland, unique farmland, or farmland of statewide importance to non-agricultural use	
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?					SCP will not conflict with existing zoning from agricultural use, or a Williamson Act contract	
c) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use?					SCP will not involve other changes in the existing environment which would result in conversion of farmland to non-agricultural uses	
d) Adversely impact agricultural crops or agricultural operations, such as irrigation?						Removal of spongeplant from Delta waterways could reduce clogging of agricultural pumps
Impact A1: Agricultural crops	3, 21		X			
Impact A2: Irrigation pumps	13, 21		X			X

Impact A1 – Agricultural crops: effects of SCP herbicide treatments on agricultural crops

There are approximately 1,800 agricultural diversions in the Delta. During the peak summer irrigation season, diversions from these facilities collectively exceed 5,000 cubic feet per second (URS Corporation May 2007). The SCP could adversely impact agricultural crops, since treatments would occur during the irrigation season.

SCP herbicide treatments occurring adjacent to agricultural diversions could result in adverse impacts to nearby agricultural crops, since irrigation with herbicide-treated water may injure irrigated vegetation. All five SCP herbicides could potentially reduce growth or possibly kill crops they contact.

SCP herbicide treatments occurring adjacent to agricultural crops could also result in adverse impacts due to herbicide drift. As discussed in Chapter 3 (Impact 1), 2,4-D is a systemic herbicide specific to broadleaf plants. Exposure of broadleaf crops to 2,4-D could result in damage to crops. Glyphosate is a broad spectrum, non-selective, systemic herbicide. Penoxsulam and imazamox are also broad spectrum systemic herbicides. Exposure of any non-target crops to glyphosate, penoxsulam, or imazamox could result in damage to crops. Diquat is a contact herbicides. Any leaves subject to diquat overspray would be damaged.

The 2,4-D label specifies that the herbicide not be used adjacent to sensitive broadleaf crops, in particular grapes, tomatoes, and cotton. Grapes and tomatoes are grown throughout the Delta. DBW does not utilize 2,4-D north of Highway 12 in order to avoid areas with grape crops. The DBW will utilize glyphosate, penoxsulam or imazamox, rather than 2,4-D, when treating sites adjacent to sensitive broadleaf crops. The 2,4-D label also requires a delay in the use of treated waters for irrigation for three weeks after treatment, unless an approved assay shows that water does not contain more than 0.1 ppm 2,4-D. As discussed in Chapter 3, typical post-treatment 2,4-D levels are far below this threshold, even immediately post-treatment. The glyphosate label does not specify any restrictions for use of treated water for irrigation. The penoxsulam label specifies that waters treated with penoxsulam shall not be used for irrigation until concentrations are determined to be equal to, or less than, 1 ppb. DBW will monitor penoxsulam concentrations to ensure compliance with this requirement. The imazamox label does not specific restrictions related to irrigation when imazamox is applied to flowing waters at rates of less than or equal to 126 ounces per acre. The diquat label specifies wait times for various uses, including a two to five day wait time when treated waters are used for spray tank applications for irrigation. The SCP will follow all label requirements related to irrigation following treatment.

While there is a potential risk to agricultural crops due to herbicide overspray, the likelihood of such effects is low. Herbicide application will be focused directly on target plants to decrease the possibility that concentrated herbicides would come in contact with agricultural crops. The DBW will follow herbicide label instructions that reduce herbicide drift. These steps include using the largest spray droplets, and lowest spray pressure, that will provide sufficient coverage and control. Furthermore, DBW will not treat at a particular site if the wind is greater than 10 mph (or 7 mph in Contra Costa County).

While there is also a potential risk to agricultural crops due to irrigating with water following SCP herbicide treatments, the likelihood of such effects is similarly low. WHCP environmental monitoring has shown consistently low herbicide levels immediately following WHCP treatments. We would expect similar low herbicide levels following SCP treatments. Tidal movement and water flow in the Delta promote dilution of SCP herbicides.

Should agricultural crops adjacent to SCP treatment sites be adversely affected by herbicide drift or irrigation waters containing SCP herbicides, it would represent a significant impact. This impact would be an **avoidable significant impact, reduced to a less-than-significant level by implementing the following two mitigation measures.**

- **Mitigation Measure 3** – Conduct herbicide treatments in order to minimize potential for drift.

  In addition to the label requirements noted above, DBW will, to the degree possible, schedule herbicide applications to occur at high tide, or at a point in the tidal cycle determined by the field supervisor to provide the least non-target impact at a particular site. In general, treatment at high tide will allow for better spray accuracy and access and will provide for greater dilution volume of herbicides. DBW crews will change nozzle type and spray pressures whenever conditions warrant, limiting the amount of herbicide which may inadvertently contact agricultural crops.

- **Mitigation Measure 21** – <u>Notify County Agricultural Commissioners about SCP activities</u>.

  Before an application may occur, DBW shall file Pesticide Use Recommendations (PUR) and a Notice of Intent (NOI) with the appropriate County Agricultural Commissioner (CAC) office. Each NOI will include the site number, spray dates, locations, and herbicides and adjuvants to be used. NOIs will be submitted before the upcoming treatment week. Based on information in the NOIs, CAC's could inform land owners of particular periods of time during which irrigation should not occur. If necessary, DBW shall also obtain a Restricted Use Permit (RUP) from all appropriate CACs.

<u>Impact A2 – Irrigation pumps: effects of SCP treatments on agricultural irrigation</u>

Herbicide treatments, hand removal with nets, herding, or mechanical treatment may break fragments of spongeplant lose into Delta waterways. These spongeplant fragments would increase debris loading at the 1,800 agricultural irrigation intakes located throughout the Delta. Fragments have the potential to clog water agricultural irrigation intakes, requiring additional intake maintenance for affected farmers.

The potential for fragments of spongeplant from herbicide treatment, hand removal with nets, herding, or mechanical removal to cause adverse effects to agricultural irrigation intakes is low. However, should spongeplant fragments resulting from the SCP clog or damage agricultural irrigation intakes, it would represent a significant impact. This impact would be an **avoidable significant impact, reduced to a less-than-significant level by implementing the following two mitigation measures.**

- **Mitigation Measure 13** – <u>Collect plant fragments during and immediately following treatments</u>.

  To maximize containment of plant fragments, crews will collect spongeplant fragments. Crews will also be trained on the importance of minimizing fragment escape.

- **Mitigation Measure 20** – <u>Follow the protocol for herbicide applications within one mile of drinking water intake facilities</u>.

  In order to treat within one mile of a drinking water intake, DBW must notify the appropriate jurisdiction at least two weeks in advance, and make every reasonable attempt to schedule applications during periods when intakes are shut down for environmental or maintenance reasons, allowing at least two complete tidal cycles between application and restart. This measure is primarily aimed at reducing the potential for drinking water contamination from the SCP. DBW has a formal Memorandum of Understanding (MOU) regarding applications near drinking water intakes with the Contra Costa Water District (CCWD), but also follows the same protocol with other jurisdictions, such as the City of Stockton and the City of Antioch. In Contra Costa County, generally, no applications shall occur within Rock Slough, or within one mile of the confluence of Rock Slough and Old River, or within one mile of CCWD's Old River or Mallard Slough intake pumps without consensual agreement between CCWD and DBW. Herbicide applications within one mile of CCWD's water intakes may only occur with prior consent of CCWD.

* * * * *

Table 6-6
Summary of Potential Utility and Service Systems and Agricultural Resources Impacts and Mitigation Measures

Mitigation Measure Summary[1]	Impacts Applied To
3. Conduct herbicide treatment in order to minimize potential for drift	Impact A1: Agricultural crops
13. Collect plant fragments during and immediately following treatments	Impact U1: Water utility intake pumps Impact A2: Irrigation pumps
20. Follow the protocol for herbicide applications within one mile of drinking water intake facilities	Impact U1: Water utility intake pumps
21. Notify County Agricultural Commissioners about SCP activity	Impact A1: Agricultural crops Impact A2: Irrigation pumps

[1] Please refer to the text for the complete mitigation measure description.

There are also potential benefits to agricultural resources resulting from the SCP. Left untreated, spongeplant can potentially interfere with pumping at the 1,800 agricultural irrigation intakes throughout the Delta. Clogging by spongeplant may result in inefficient pumping, increasing pumping costs, and possible mechanical failure of pumps. Prior to the start of the WHCP, in a letter to the U.S. Army Corps of Engineers, the San Joaquin Farm Bureau Federation stated that growers were facing increased costs from efforts to open clogged channels where water hyacinth was decreasing the flow of water to pumps and clogging screens (U.S. Army Corps of Engineers 1985). While the spongeplant currently has a significantly smaller footprint in the Delta than the water hyacinth, spongeplant could potentially result in similar negative impacts to irrigation intakes.

This section identified six mitigation measures to address three potential impacts to utility and service systems and agricultural resources. Two mitigation measures are duplicative, as they each apply to two impacts. **Table 6-6,** above, combines and summarizes the utility and service systems and agricultural resources mitigation measures.

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Section 7

Cumulative Impacts Assessment

7. Cumulative Impacts Assessment

This chapter of the Final PEIR provides an assessment of the SCP's potential to contribute to cumulative impacts in the Delta region. Section 15130 of the CEQA guidelines require that an EIR discuss the cumulative impacts of a project when the project's incremental effect is cumulatively considerable.

Section 15355 of the CEQA guidelines defines cumulative impacts as follows: "Cumulative impacts refer to two or more individual effects which, when considered together, are considerable or which compound or increase other environmental impacts. The individual effects may be changes resulting from a single project or number of separate projects. The cumulative impact from several projects is the change in the environment which results from the incremental impact of the project when added to other closely related past, present, and reasonably foreseeable probable future projects. Cumulative impacts can result from individually minor but collectively significant projects taking place over a period of time."

There are two possible approaches to discussing significant cumulative impacts. The first approach, utilized in this Final PEIR, is to use a list of past, present, and probable future projects producing related or cumulative impacts. The second approach is to utilize projections in an adopted general plan or planning document. Within the first approach, factors to consider when determining whether or not to assess a related project include: the nature of each environmental resource being examined, location of the project, and type of project.

This chapter identifies related projects, and provides a discussion of potential cumulative impacts. The chapter is organized as follows:

A. *Related Project Summaries*
B. *Assessment of Cumulative Impacts.*

A. Related Project Summaries

There are numerous large and small-scale projects in the Delta related to resource conservation, endangered species, restoration, water conveyance, water quality, and water use. Many of these projects have been in operation for several years, while others are in the early stages of planning and environmental permitting. In developing this summary of past, current, and future projects, we primarily utilized the July 2009, Delta-Mendota Canal/California Aqueduct Intertie EIS, the August 2008, Biological Assessment on the Continued Long-Term Operations of the Central Valley Project and the State Water Project, the Bay Delta Conservation Plan EIR/EIS, the 2013 California Water Plan Update, and other environmental documentation and project summaries.

Most Delta-wide projects are of far greater scope than the SCP. For example, several of the projects described in this chapter involve significant Delta-wide operations that will influence Delta hydraulics and fisheries. None of the prior Delta EIRs or EISs reviewed for this PEIR (with the exception of the WHCP and EDCP EIRs and the Bay Delta Conservation Plan PEIR/EIS) even considered the SCP, WHCP or EDCP in their cumulative impacts assessment. This suggests to DBW that as compared to other Delta projects, the environmental impacts of the SCP are immaterial.

Below, we describe 24 present and future projects (not including the SCP) with which the SCP may potentially contribute to cumulative impacts. We categorize these projects based on their implementation time period: (1) Existing Delta Projects, (2) Near Future Delta Projects, and (3) Longer-Term Future Delta Projects. Near future Delta projects are in construction or planning phases, with significant probable action expected in the next few years. Longer-term future Delta projects are earlier in the planning phases.

Figure 7-1
Summary of WHCP Prior Activities

- Program Initiated: **1983**
- Annual Budget: **$5.3 to $6.0 million** (for WHCP and EDCP) (2010 to 2011)
- Total Staffing: **19** (for WHCP and EDCP, includes DBW and USDA-ARS) (2012)
- Monitoring Crews/Boats: **one to two 2-person crews** (for WHCP and EDCP) (2012)
- Average* Annual WHCP Sites Treated: **160** (range = 104 to 211 sites)
- Average* Annual WHCP Acres Treated: **1,016** (range = 421 to 2,185 acres)
- Average* Annual WHCP Treatments: **538** (range = 330 to 941 treatments)
- Average* Annual WHCP Acres per Treatment: **1.89** (range = 0.01 to 4.28 average annual acres per treatment)

* 2007 to 2013 averages and ranges per WHCP daily logs.

1. Existing Delta Projects

a. Water Hyacinth Control Program (WHCP)

The WHCP is an aquatic weed program designed to control the growth and spread of water hyacinth in the Delta and its tributaries. In 1982, in response to concerns about water hyacinth in the Delta, the California Legislature passed Senate Bill 1344 (Garamendi, Chapter 263, Statutes of 1982), designating DBW as the lead agency for controlling water hyacinth in the Delta, its tributaries, and Suisun Marsh, the same area as the SCP and EDCP. The USDA-ARS has served as the federal nexus for WHCP for the last fifteen (15) years, providing research and scientific expertise, and has provided technical and programmatic advice to WHCP for over 30 years, since the program's inception.

The WHCP has been an adaptive integrated pest management program (IPM). WHCP activities have emphasized chemical treatment, supported by limited handpicking, herding, mechanical removal, and evaluation of biological controls.

Figure 7-1, above, provides a summary of WHCP historical characteristics. The WHCP has been (and will continue to be) a relatively small aquatic weed control program concerned with managing the invasive, and non-native, water hyacinth in a large and complex Delta water environment.

Selected primary program herbicides are 2,4-Dichlorophenoxyacetic acid, dimethylamine (DMA) salt, or 2,4-D) and glyphosate. Beginning in 2014, WHCP will 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.

DBW applies herbicides with an adjuvant to increase adhesion to water hyacinth leaves. WHCP utilizes the adjuvant Agridex and the vegetable oil-based adjuvant, Competitor.

Historical treatment data provides an order of magnitude indication of likely chemical treatment levels in future years. **Table 7-1,** on the next page, summarizes the treatment types, number of sites, gallons used, pounds active ingredient, and acres treated from 2007 to 2013. A primary and unpredictable factor influencing treatment acres in any given year is the extent of water hyacinth infestation. In addition, as compared to the 2007 through 2013 data, future chemical use could decrease due to use of the new lower volume herbicides. Future chemical use could also be reduced by treating water hyacinth early in the treatment season. Future treatment acres and chemical use could increase as a result of higher infestation levels and deployment of increased staff resources and/or improved staff utilization.

Table 7-1
Summary Data for WHCP – 2007 to 2013

Year	Number of Sites	Number of Treatments	Gallons				Acres		
			2,4-D	Glyphosate	Total Herbicide	Agridex	2,4-D	Glyphosate	Total Acres
1. 2007	211	941	938	149	1,087	441	938	199	1,137
2. 2008	146	439	336	64	400	163	336	85	421
3. 2009	177	492	619	64	683	266	619	86	705
4. 2010	199	719	879	109	988	372	879	145	1,024
5. 2011	104	330	449	253	702	286	449	338	787
6. 2012	151	337	82	577	659	234	82	769	851
7. 2013	130	510	0	1,889	1,889	777	0	2,185	2,185
Total	1,118	3,768	3,303	3,105	6,408	2,539	3,303	3,807	7,110
Average	160	538	472	444	915	363	472	544	1,016

Year	Averages			Pounds Active Herbicide Ingredient		
	Average Acres/Treatment	Average Herbicide Gallons/Site	Average Pounds/Site	2,4-D	Glyphosate	Total
1. 2007	1.21	5.15	19.90	3,752	447	4,199
2. 2008	0.96	2.74	10.52	1,344	192	1,536
3. 2009	1.43	3.86	15.07	2,476	192	2,668
4. 2010	1.42	4.96	19.31	3,516	327	3,843
5. 2011	2.38	6.75	24.57	1,796	759	2,555
6. 2012	2.53	4.36	13.64	328	1,731	2,059
7. 2013	4.28	14.53	58.12	0	7,556	7,556
Average	1.89	5.73	21.84	1,887	1,601	3,488

In addition to herbicide treatments, the WHCP utilizes handpicking, herding, and mechanical removal. These approaches can help reduce the need for herbicides. Handpicking is primarily utilized to reduce plant biomass in nursery areas. Herding is used in order to push water hyacinth mats (1) into main channels where it flows naturally out of the Delta and dies in the more saline water of San Francisco Bay; or (2) toward mechanical removal sites.

The WHCP utilizes 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, DBW, and their partners will continue to evaluate the use of biological controls to reduce the spread of water hyacinth.

USDA-ARS and DBW implement a growth-based start-date approach for WHCP chemical treatments. This approach is intended to minimize potential for impacts on fisheries and maximize treatment efficacy. This approach will be dependent on fish survey data and field surveys for water hyacinth, within calendar-date windows. Chemical treatments will likely begin by early-March in selected areas. Chemical treatments in some regions of the Delta will continue through the end of November.

Treatment sites will be prioritized so that nursery areas, and areas where water hyacinth causes negative navigational, agricultural, public safety, environmental, or industrial impacts, are treated first. The WHCP will also consider logistical and operational factors such as prevailing winds, travel time, and weather conditions when selecting treatment locations.

The WHCP follows an Operations Management Plan that specifies a pre-application planning protocol; an Application/ Monitoring Coordination Protocol; "Best Maintenance Practices" for Handling Herbicides; Spray Equipment Maintenance and Calibration; and an Herbicide Spill Contingency Plan. The Operations Management Plan includes requirements related to avoiding threatened or endangered species, conducing habitat evaluation, dissolved oxygen measurement, a fish passage protocol, and other program monitoring requirements.

Based on NPDES permit requirements, DBW follows an Annual Monitoring Protocol; this protocol is identical to that for the SCP and EDCP. This protocol fulfills monitoring requirements of the Central Valley Regional Water Quality Control Board, NMFS, and USFWS. The State Water Quality Control Board (SWRCB) updated the NPDES General Permit, effective December 2013. DBW revised their monitoring protocol to reflect the new conditions in the final General Permit.

In DBW's November 2009, *Programmatic Environmental Impact Report: Volume I – Chapters 1 to 7*, identified potentially affected environmental factors for the WHCP. All of the potentially affected environmental factors are the same potentially affected environmental factors for the SCP. The environmental resource areas with potentially significant impacts resulting from the WHCP include:

- **Agricultural Resources** – avoidable significant impacts to agricultural crops or agricultural operations, such as irrigation.
- **Biological Resources** – unavoidable or potentially unavoidable significant impacts to special status species, riparian habitat, wetlands, and movement of native species; avoidable significant impacts to riparian or sensitive natural communities.
- **Hazards and Hazardous Materials** – avoidable significant impacts due to routine transport, use, or disposal; or accidental spill, of hazardous materials.
- **Hydrology and Water Quality** – unavoidable or potentially unavoidable significant impacts due to violation of water quality standards, waste discharge requirements, or otherwise degrading water quality; avoidable significant impacts due to potentially degrading drinking water quality.
- **Utilities and Service Systems** – avoidable significant impacts due to plant fragments blocking water utility intake pumps.

b. *Egeria densa* Control Program (EDCP)

DBW, in collaboration with the USDA-ARS, implements the EDCP. The EDCP is an aquatic weed control program designed to minimize the extent of *Egeria densa* in the Delta. The USDA-ARS acts as the nexus for federal regulatory processes, as well as providing research, expertise, and decision-making input for EDCP planning. In 1996, in response to growing concerns about the spread of an aquatic invasive weed, *Egeria densa*, the California Legislature passed Assembly Bill (AB) 2193, authorizing DBW to develop a control program for this invasive species. The DBW began treating *Egeria densa* in the Delta in 2001, in collaboration with USDA-ARS, after completing an Environmental Impact Report (EIR) and obtaining the required NPDES permit and NMFS and USFWS biological opinions.

Figure 7-2, on the next page, provides a summary of EDCP historical characteristics. The EDCP has been (and will continue to be) a relatively small aquatic weed control program concerned with managing the invasive, and non-native, *Egeria densa* in a large and complex Delta water environment.

Egeria densa (Brazilian Elodea) is a submerged non-native aquatic plant, introduced into the Delta approximately fifty 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 (USFWS 2008). *Egeria densa* infests almost twenty percent of the Delta's 61,618 surface acres (67,778 acres including tributaries in the project area), and is spreading at approximately 100 acres per year.

The EDCP operates under three CEQA environmental documents: (1) 2001 EDCP Environmental Impact Report, (2) 2003 First Addendum to EDCP EIR, and (3) 2006 Second Addendum to EDCP EIR (with five year program review and future program operations plan). The Second Addendum, and the regulatory agency documents have guided the EDCP over the last seven years (2007 through 2013). DBW is preparing a Third Addendum for 2014 and beyond.

Prior to 2006, the EDCP operated under the original, and somewhat more restrictive, NPDES permit and Biological Opinions. These more recent documents reflect the lower level of environmental impact demonstrated during the first five years of the EDCP. On July 2, 2012, the USDA-ARS and the DBW received a letter of concurrence from NMFS agreeing with the USDA-ARS and the DBW's determination that the proposed use of fluridone-based herbicide products for the 2012 treatment season is not likely to adversely affect federally listed salmonids, green sturgeon, or critical habitat.

The EDCP generally utilizes trained two-person teams to conduct treatments in the Delta between approximately March 1st to November 30th. Start dates have been limited by the terms of the Biological Opinions. In most of the last seven seasons, the DBW has conducted the majority of EDCP treatments in the first several months of the season (April through July). These same trained crews also implement WHCP and SCP.

The EDCP is permitted to utilize four aquatic herbicides, Reward (diquat)[1] and Sonar (fluridone) for control of *Egeria densa*. Over the last five years, the DBW has not utilized Reward, but has utilized several formulations of fluridone. DBW is incorporating imazamox and penoxsulam into the EDCP. Treatment crews use injection hoses to apply aqueous herbicide into treatment areas, and a broadcast method to apply pellets or granules.

Fluridone is a selective systemic herbicide. Fluridone inhibits formation of carotene, resulting in the degradation of chlorophyll when exposed to sunlight. Because carotene is formed primarily during new growth, fluridone is most effective when the plant is growing rapidly (i.e. in spring, and sometimes in fall during a final growth spurt). This plant growth stage is why the DBW focuses treatments in the early part of the season, with some follow-up at the end of the season. Exposure to sunlight breaks fluridone down into naturally occurring elements in the environment.

As a condition of its permits, the EDCP also conducts an extensive monitoring program to measure herbicide residue and water quality parameters. The DBW is required to conduct both site-specific and daily monitoring. DBW environmental scientists take water samples immediately pre-application, and post-application, at specified time intervals. This monitoring occurs at a specified percentage of total treatment sites. In addition, treatment crews conduct daily monitoring, reporting dissolved oxygen, wind speed, temperature, acres treated, quantity of herbicide, presence of species of concern, and coordinates of the treatment location.

Figure 7-2
Summary of EDCP

- Program Initiated: **2001**
- Annual Budget: **$5.3 to $6.0 million** (for WHCP and EDCP) (2010 to 2012)
- Total Staffing: **19** (for WHCP and EDCP, includes DBW and USDA-ARS) (2012)
- Monitoring Crews/Boats: **one to two 2-person crews** (for WHCP and EDCP) (2012)
- Average* Annual EDCP Sites Treated: **7** (range = 3 to 19)
- Average* Annual EDCP Acres Treated: **1,870** (range = 228 to 3,195)
- Average* Annual EDCP Treatments: **114** (range = 43 to 207)

* 2007 to 2013 averages and ranges per EDCP daily logs.

[1] Diquat has higher toxicity, and thus may only be used between August 1st and November 30th, under emergency conditions (similar to the SCP).

At the completion of each treatment season, the DBW and the USDA-ARS report program results to USFWS, NMFS, and CVRWQB. The DBW conducted toxicity testing in the first several years of operation, but the regulatory agencies eliminated this requirement when test results were negative.

For the first five (5) years of the EDCP (2001 to 2005), the DBW treated 19 different sites within the Delta, covering between 268 and 622 acres per year. A study of the first five-years of operation found that the EDCP was likely restraining *Egeria densa* from spreading even more than it already had, but that the EDCP was "not keeping up" with the Delta-wide *Egeria densa* infestation. Following this initial five-year program evaluation in 2006, the DBW implemented a new, more focused, approach.

In 2007, renewal of the NMFS and the USFWS Biological Opinions allowed an early April 1st start date and a new treatment regime. In 2007 and 2008, the DBW focused all EDCP treatments within three treatment sites in Franks Tract, a known *Egeria densa* nursery area. This focused treatment approach was highly effective, and after two years of treatment, boats could navigate within Franks Tract.

DBW measures reductions in bio-volume and bio-cover of *Egeria densa* to determine efficacy of EDCP treatments. The current treatment protocols have been effective, as compared to untreated control sites. For example, in October 2011, following the 2011 treatment season, between zero and 16 percent of treated sites had a mean bio-volume of over 50 percent, while 65 to 94 percent of untreated sites had a mean bio-volume of over 50 percent. This reduction in *Egeria densa* bio-volume helps reduce the negative impact of *Egeria* on the Delta ecosystem.

Due to the success of the Franks Tract treatment regime, the DBW continued the focused treatment approach, expanding to new areas in 2009, 2010, and 2011. **Table 7-2,** on the next page, identifies EDCP treatment areas, net acreage treated, and pounds of active ingredient (fluridone) for the last seven years of operation. In 2013, under the letter of concurrence, the DBW started EDCP treatments on June 3, 2013. The DBW treated nineteen different sites and a total of 1,218 acres in 2013. During the last seven years of EDCP operation, there was no known take or harassment of federally endangered or threatened species. To minimize the occurrence of take, the DBW checked Interagency Ecological Program (IEP) surveys, as well as California Department of Fish and Wildlife trawls, prior to, and during, the treatment season to monitor the presence of Chinook salmon, steelhead trout, and delta smelt during early treatment season months when these species may be present in treatment areas. Treatment crews also conducted surveys to evaluate the presence of valley elderberry longhorn beetle and giant garter snake habitats throughout each treatment season.

The DBW's December 2006, *Second Addendum to 2001 Environmental Impact Report with Five-Year Program Review and Future Operations Plan* identified potentially affected environmental factors for the EDCP. Many of the potentially affected environmental factors are the same potentially affected environmental factors as described for the SCP. The environmental resource areas with potentially significant impacts resulting from the EDCP include:

- **Agricultural Resources** – avoidable significant impacts to agricultural crops or agricultural operations, such as irrigation.
- **Biological Resources** – unavoidable or potentially unavoidable significant impacts to special status species, wetlands, and movement of native species; avoidable significant impacts to riparian or sensitive natural communities.
- **Hazards and Hazardous Materials** – avoidable significant impacts due to routine transport, use, or disposal; or accidental spill, of hazardous materials.
- **Hydrology and Water Quality** – unavoidable or potentially unavoidable significant impacts due to violation of water quality standards, waste discharge requirements, or otherwise degrading water quality; avoidable significant impacts due to potentially degrading drinking water quality.
- **Utilities and Service Systems** – avoidable significant impacts due to plant fragments blocking water utility intake pumps.

Table 7-2
EDCP Areas Treated (by Site Name), Net Acres, and Pounds Herbicide Active Ingredient (Fluridone)

Site Name	2007	2008	2009	2010	2011	2012	2013
1. Franks Tract	✓	✓		✓	✓	✓	
2. White Slough			✓	✓		✓	✓
3. Disappointment Slough			✓	✓		✓	✓
4. Fourteen Mile Slough			✓			✓	
5. Pipers Slough					✓	✓	
6. Taylor Slough					✓	✓	✓
7. Sandmound Slough					✓	✓	✓
8. Discovery Bay					✓	✓	✓
9. Steamboat Slough						✓	
10. Sycamore Slough						✓	
11. Whiskey Slough						✓	
12. Honker Cut						✓	✓
13. Bishop Cut						✓	✓
14. Hogback Launch							✓
15. The Meadows							✓
16. Buckley Cove							✓
17. Oxbow Marina							✓
18. Dutch/Sandmound							✓
19. Dutch Slough							✓
20. Rivers End Marina						✓	✓
21. Cruiser's Haven							✓
22. Snug Harbor							✓
23. Korth's Pirates Lair							✓
24. Willow Berm Marina							✓
25. Delta Yacht Club							✓
Net Acres	2,571	2,571	228	641	3,195	2,663	1,218
Pounds Active Ingredient	7,479	4,977	562	1,974	8,113	7,357	3,550

c. Central Valley Project (CVP) and State Water Project (SWP)

All activities within the Delta occur within the context of the CVP and SWP. The CVP and SWP are two major inter-basin water storage and delivery systems that divert and re-divert water from the southern portion of the Delta. Both the CVP and SWP include major reservoirs upstream of the Delta, and transport water via natural watercourses and canal systems to areas south and west of the Delta.

The USBR and DWR operate the CVP and SWP to divert, store, and convey water consistent with applicable law and contractual obligations. The Coordinated Operations Agreement (COA) defines the project facilities and their water supplies, sets forth procedures for coordination of operations, identifies formulas for sharing joint responsibilities for meeting Delta standards, identifies how unstored flow will be shared, sets up a framework for exchange of water and services, and provides for periodic review of the agreement (USBR August 2008). The Operations Criteria and Plan (OCAP) defines the ongoing operations of the CVP and SWP. The USBR prepared a biological assessment for the OCAP in August 2008. In June 2009, NMFS delivered its biological opinion and conference opinion on the proposed long-term operations on the CVP and SWP, concluding that the proposed action would likely jeopardize the continued existence of several threatened and endangered species.

d. Environmental Water Account

The Environmental Water Account (EWA) is a two-part cooperative management program to assist in protecting and restoring native fish species, and to increase water supply reliability for CVP and SWP water deliveries (USBR 2003; USBR 2008). The EWA curtails pumping at CVP and SWP facilities to protect fish, and then purchases water from willing sellers to replace contract water supplies. The EWA was proposed in the CALFED 2000 Record of Decision (ROD), and an EIR/EIS was completed in 2004. The program was originally scheduled to run through 2007.

The Bureau of Reclamation, USFWS, and NMFS received congressional authorization to participate in the EWA through September 30, 2010, including an emphasis to support the Vernalis Adaptive Management Plan (VAMP). Following the decision by the California state legislature to transition responsibilities from the CALFED Bay-Delta Program to the Delta Stewardship Council, the program has continued to operate on a diminished scale as part of a long-term transfer of water from Yuba County (Hanak and Stryjewski, 2012).

e. Temporary Barriers Project

The DWR has installed temporary barriers in the South Delta in the spring and/or fall for most years since 1991 (DWR 2008). After the 1991 test project proved successful, the DWR has continued to extend the project. The project consists of four rock barriers across South Delta channels. The barriers serve as “fish barriers”, to benefit migrating salmon, or “agricultural barriers”, to increase water levels, water quality, and circulation patterns for agricultural users. The barriers are located at the Head of Old River, Old River near Tracy, Grantline Canal, and Middle River.

A study published in 2011 found the barriers were not associated with decreases in the survival of route-specific or total Delta Chinook salmon or steelhead; in fact, two barriers were associated with an increase in route-specific and overall survival rates (Pope et al. 2011).

f. USFWS BO – Reasonable and Prudent Alternative

The USFWS determined in December 2008 that a Reasonable and Prudent Alternative (RPA) is necessary for the protection of delta smelt (USBR July 2009). The RPA includes measures to: (1) prevent/reduce entrainment of delta smelt at Jones and Banks Pumping Plants; (2) provide adequate habitat conditions that will allow the adult delta smelt to successfully migrate and spawn in the Bay-Delta; (3) provide adequate habitat conditions that will allow larvae and juvenile delta smelt to rear in the Bay-Delta; (4) provide suitable habitat conditions that will allow successful recruitment of juvenile delta smelt to adulthood; and (5) monitor delta smelt abundance and distribution by continued sampling programs through the IEP. The RPA is comprised of the following actions:

- **Action 1:** To protect pre-spawning adults, exports would be limited starting as early as December 1st (depending on monitoring triggers) so that the average daily Old and Middle River (OMR) flows is no more negative than -2,000 cfs for a total duration of 14 days.
- **Action 2:** To further protect pre-spawning adults, the range of net daily OMR flows will be no more negative than -1,250 to -5,000 cfs (as recommended by smelt working group) beginning immediately after Action 1 is needed.
- **Action 3:** To protect larvae and small juveniles, the net daily OMR flows will be no more negative than -1,250 to -5,000 cfs (as recommended by smelt working group) for a period that depends on monitoring triggers (generally March through June 30th).

- **Action 4:** To protect fall habitat conditions, sufficient Delta outflow will be provided to maintain an average X2 for September and October no greater (more eastward) than 74 km (Chipps Island) in the fall following wet years and 81 km (Collinsville) in the fall following above normal years.
- **Action 5:** The head of Old River barrier will not be installed if delta smelt entrainment is a concern. If installation of the head of Old River barrier is not allowed, the agricultural barriers would be installed as described in the Project Description (of the OCAP BA).
- **Action 6:** A program to create or restore a minimum of 8,000 acres of intertidal and associated subtidal habitat in the Delta and Suisun Marsh will be implemented within 10 years. A monitoring program will be developed to focus on the effectiveness of the restoration program (USBR July 2009, 6-4).

g. NMFS BO – Reasonable and Prudent Alternative

The National Marine Fisheries Service (NMFS) determined (June 2009) that an RPA was necessary for the protection of salmon, steelhead, and green sturgeon (USBR July 2009). The RPA includes measures to improve habitat, reduce entrainment, and improve salvage, through both operational and physical changes in the system. Additionally, the RPA includes development of new monitoring and reporting groups to assist in water operations through the CVP and SWP systems and a requirement to study passage and other migratory conditions. The more substantial actions of the RPA include:

- Providing fish passage at Shasta, Nimbus, and Folsom Dams
- Providing adequate rearing habitat on the lower Sacramento River and Yolo Bypass through alternation of operations, weirs, and restoration projects
- Engineering projects to further reduce hydrologic effects and indirect loss of juveniles in the interior Delta
- Technological modifications to improve temperature management in Folsom Reservoir.

Overall the RPA is intended to avoid jeopardizing listed species or adversely modifying their critical habitat, but not necessarily achieve recovery. Nonetheless, the RPA would result in benefits to salmon, steelhead, green sturgeon and other fish and species that use the same habitats (USBR July 2009, 6-5).

Since the issuance of the initial RPA, NMFS has convened independent review panels to present and discuss technical reports, develop lessons learned, incorporate new science, and make appropriate adjustments to the 2009 RPA. The fourth annual review was held in November 2013.

h. Levee System Integrity Program

The goal of the Levee System Integrity Program is to reduce the risk of catastrophic breaching of Delta levees, which can disrupt land use and associated economic activities, water supply, agricultural and residential use, infrastructure, and the ecosystem (DWR, 2014). Since 2000, the program has led to the improvement of 700 miles of Delta levees and the ongoing maintenance of an additional 600 miles of Delta levees. In addition, the program has facilitated native vegetation growth and restoration projects, and the development of approximately 50 acres of riparian and wetland habitat and 3,000 linear feet of shaded riverine aquatic habitat. The levees program continues to implement levee improvements throughout the Delta, including the south Delta area (USBR July 2009, 6-14).

i. Ecosystem Restoration Program

The Ecosystem Restoration Program (ERP) is a multiagency effort aimed at improving and increasing aquatic and terrestrial habitats and ecological function in the Delta and its tributaries. The CDFW, USFWS and NFMS are collectively known as the ERP Implementing Agencies. As the state implementing agency, CDFW funds and manages grant projects to achieve the objectives of the ERP. The ERP has the following six strategic goals: 1) recover endangered and other at-risk species and native biotic communities; 2) rehabilitate ecological processes; 3) maintain or enhance harvested species populations; 4) protect and restore habitats; 5) prevent the establishment of and reduce impacts from non-native invasive species; and 6) improve or maintain water and sediment quality (CDFW, 2014).

Since implementation through June 2012, the ERP grants program has funded 527 projects with a total budget of over $700 million. The vast majority of these projects focus on fish passage issues, species assessment, sedimentation, ecosystem water quality or habitat restoration.

j. Delta Stewardship Council Delta Plan

In November 2009, the California legislature enacted the Sacramento-San Joaquin Delta Reform Act of 2009 as part of SBX71. This act established the Delta Stewardship Council, which was tasked with developing and implementing a legally enforceable, long-term management plan for the Delta. In 2012, the Delta Stewardship Council released the Delta Plan which includes 87 policies and recommendations aimed at achieving the State’s coequal goals. The Council unanimously adopted the plan in May 2013, and the legally enforceable regulations became effective on September 1, 2013.

k. Sacramento-San Joaquin Delta Conservancy Strategic Plan

The Delta Conservancy was created as a primary state agency to implement ecosystem restoration in the Delta and to support efforts that advance environmental protection and the economic well-being of Delta residents. In June 2012 the Delta Conservancy approved its Delta Conservancy Strategic Plan, which outlines the organization’s goals, objectives, and strategies for the next five years. The plan includes four funding and planning scenarios and identifies the following primary roles for the organization: 1) advocate for the Delta; 2) bring additional funds to the Delta; 3) support local collaboration and capacity building; and 3) lead efforts to address issues at the regional and local levels.

l. Central Valley Flood Protection Plan

The Central Valley Flood Protection Act of 2008 directed DWR to prepare the Central Valley Flood Protection Plan (CVFPP). The CVFPP is a flood management planning effort that addresses flood risks and ecosystem restoration opportunities in an integrated manner while concurrently improving ecosystem functions, operations and maintenance practices, and institutional support for flood management. It proposes a systemwide approach to flood management for the areas currently protected by facilities of the State Plan of Flood Control (SPFC). Under this approach, California will prioritize investments in flood risk reduction projects and programs that incorporate ecosystem restoration and multi-benefit projects. The CVFPP was adopted by the Central Valley Flood Control Board on June 29, 2012. It is expected that the CVFPP will be updated every 5 years thereafter.

The CVFPP proposes a systemwide approach to address, among others the following issues: 1) physical improvements in the Sacramento and San Joaquin River basins; 2) urban flood protection; 3) small community flood protection; 4) rural/Agricultural area flood protection; and 5) ecosystem restoration opportunities (DWR, 2013).

m. Stockton Deep Water Ship Channel Dissolved Oxygen Aeration Facility

The Stockton Deep Water Ship Channel Demonstration Dissolved Oxygen Aeration Facility Project was a multi-year study of the effectiveness of elevating dissolved oxygen (DO) concentrations in the channel. DO concentrations drop as low as 2 to 3 milligrams per liter (mg/L) during warmer and lower water flow periods in the San Joaquin River. The low DO levels can adversely affect aquatic life including the health and migration behavior of anadromous fish (e.g., salmon).

The objective of the study was to maintain DO levels above the minimum recommended levels specified in the State of California Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River basins. The aeration system is designed to be operated only when channel DO levels are below the Basin Plan DO water quality objectives (approximately 100 days per year) (DWR, 2014).

2. Near Future Delta Projects

n. Bay Delta Conservation Plan (BDCP)

This major collaborative planning effort is led by the California Department of Water Resources (DWR), California Department of Fish and Wildlife (CDFW), State Water Resources Control Board (SWB), U.S. Bureau of Reclamation (UBR), U.S. Fish and Wildlife Services (USFWS), and National Marine Fisheries Service (NMFS) (BDCP, 2013). Several water agencies, environmental organizations, and other organizations are also involved. The "purpose of the BDCP is to help recover endangered and sensitive species and their habitats in the Delta in a way that also will provide for sufficient and reliable water supplies."

The effort was initiated by Governor Schwarzenegger when he requested that the DWR evaluate at least four alternative Delta conveyance strategies in coordination with BDCP efforts to better protect at-risk fish species. The BDCP effort will meet ESA and Natural Community Conservation Planning requirements, and will also include development of an EIR/EIS.

As outlined in the Notice of Preparation, the BCDP is ultimately intended to "secure authorizations that would allow the conservation of covered species, the restoration and protection of water supply reliability, protection of certain drinking water quality parameters, and the restoration of ecosystem health to proceed within a stable regulatory framework." Activities under the BDCP will include habitat development, water supply and power generation, facility maintenance, and improvements.

One of the goals of the project is to reexamine the conveyance alternatives that were analyzed in the CALFED August 2000 documents, based on recent declines in pelagic organisms, particularly delta smelt, increased concern about higher risks from Delta levees due to earthquakes, and potential impacts of climate change. The BDCP stems in part from the Delta Vision's recommendation that the State should consider different approaches to conveying water through the Delta than the current through-Delta alternative that was approved by the CALFED Record of Decision. In developing the Draft EIR/EIS, the BDCP steering committee considered four conservation strategy options:

- Existing through Delta conveyance with physical habitat restoration
- Improved through Delta conveyance with physical habitat restoration
- Dual conveyance, including improved through Delta conveyance and isolated conveyance from the Sacramento River to the south Delta, with physical habitat restoration
- Isolated conveyance from the Sacramento River to south Delta, with physical habitat restoration.

A series of deliberations has led to the creation of 15 action alternatives which are considered in the EIR/EIS. Among these 15 alternatives, one adopts an improved through Delta conveyance strategy, 11 adopt the dual conveyance strategy, and three adopt the isolated conveyance strategy. The CEQA (or state) preferred approach, known as Alternative 4, recommends four new on-bank intake facilities on the Sacramento River, two or four 16-foot diameter conduits used as conveyance pipelines, and three tunnels. The system is estimated to have a North Delta diversion capacity of 9,000 cfs (BDCP, 2013).

In addition, the BDCP's action plan centers around a set of 22 "conservation measures." These measures are as follows:

Water Facilities and Operation

- CM1: Water Facilities and Operation

Natural Community Protection and Restoration

- CM2: Yolo Bypass Fisheries Enhancement
- CM3: Natural Communities Protection and Restoration
- CM4: Tidal Natural Communities Restoration
- CM5: Seasonally Inundated Floodplain Restoration

- CM6: Channel Margin Enhancement
- CM7: Riparian Natural Community Restoration
- CM8: Grassland Natural Community Restoration
- CM9: Vernal Pool and Alkali Seasonal Wetland Complex Restoration
- CM10: Nontidal Marsh Restoration
- CM11: Natural Communities Enhancement and Management
- CM12: Methylmercury Management
- CM22: Avoidance and Minimization Measures

Other Stressors Conservation

- CM13: Invasive Aquatic Vegetation Control
- CM14: Stockton Deep Water Ship Channel Dissolved Oxygen Levels
- CM15: Localized Reduction of Predatory Fishes
- CM16: Nonphysical Fish Barriers
- CM17: Illegal Harvest Reduction
- CM18: Conservation Hatcheries
- CM19: Urban Stormwater Treatment
- CM20: Recreational Users Invasive Species Program
- CM21: Nonproject Diversions

The draft EIR/EIS was made available for public review and comment from December 2013 to June 2014, after which the lead agencies began preparing the final EIR/EIS.

o. Sacramento River and Stockton Deep Water Ship Channels

The Sacramento River Deep Water Ship Channel provides a deep-draft channel from Suisun Bay to an inland harbor at Washington Lake, west of the Sacramento River in the City of West Sacramento. The Stockton Deep Water Ship Channel extends from Suisun Bay into the San Joaquin River and ends at the turning basin in the City of Stockton, a distance of 43 miles. The John F. Baldwin Ship Channel extends from the Golden Gate to Chipps Island (in Suisun Bay).

The U.S. Army Corps of Engineers solicits bids annually for maintenance dredging in the Sacramento River and Stockton Deep Water Ship Channels. The U.S. Army Corps of Engineers is also preparing a feasibility study and EIS/EIR for deepening the existing 35-foot channel from the San Francisco Bay to the Port of Stockton to between 40 and 45 feet (U.S. Army Corps of Engineers, 2014).

p. Delta Wetlands Project

The Delta Wetlands Project is a private water development project that would divert and store up to 210,000 acre-feet on two islands in the Delta and dedicate two other islands for wetland and wildlife habitat improvements (USBR July 2009). As part of the Delta Wetlands Project, Webb Tract and Bacon Island would be converted to reservoirs, and Bouldin Island and Holland Tract would be used as wetland and wildlife habitat per DFG habitat management plans (USBR July 2009, 6-7).

The Semitropic Water Storage District, the CEQA lead agency for the Delta Wetlands Project EIR, published a Notice of Preparation in November 2008 (Delta Wetlands Project 2009) and a final Place of Use EIR in 2011 (ESA, 2011). The project has been postponed due to litigation that was ultimately settled in 2013.

q. San Joaquin River Restoration Program (SJRRP)

The SJRRP will implement the San Joaquin River litigation settlement involving the Natural Resources Defense Council (NRDC), Friant Water Users Authority, the Department of Interior, and NMFS (SJRRP 2007). The program is being implemented by the Bureau of Reclamation, USFWS, NMFS, DWR, and DFG. The goals of the program are to restore and maintain fish populations in "good condition" on the main stem of the San Joaquin River below Friant Dam, and to the confluence of the Merced River, and to reduce or avoid adverse water supply impacts to Friant Division long-term contractors that may result from the Interim Flows and Restoration Flows provided for in the settlement.

Federal legislation to fund the SJRRP was signed in March 2009, and the final Programmatic Environmental Impact Statement/Report was issued in July 2012. The settlement involves operation and maintenance of an interim hatchery facility, adjacent to the San Joaquin River Fish Hatchery, by the CDFW. The program will include developing and maintaining a genetically diverse brood stock of spring-run and, potentially, fall-run Chinook salmon through specified releases from Friant Dam to support migration and emigration. Interim flows began in fall 2009. The project also includes structural and channel improvements. Total costs are expected to range from $250 million to $800 million. The project area falls within potential SCP treatment sites currently managed by Merced and Fresno Counties.

r. Franks Tract Project

The DWR and Bureau of Reclamation propose to implement the Franks Tract Project to improve water quality and fisheries conditions in the Delta (USBR July 2009). DWR and Reclamation are evaluating installing operable gates to control the flow of water at key locations (Threemile Slough and/or West False River) to reduce sea water intrusion, and to positively influence movement of listed fish species to areas that provide favorable habitat conditions. By protecting fish resources, this project also would improve operational reliability of the SWP and CVP because curtailments in water exports (pumping restrictions) are likely to be less frequent. The overall purpose of the Franks Tract Project is to modify hydrodynamic conditions to protect and improve water quality in the central and south Delta, protect and enhance conditions for fish species of concern in the western and central Delta, and achieve greater operational flexibility for pump operations in the south Delta (USBR July 2009, 6-12).

s. Suisun Marsh Habitat Management, Preservation, and Restoration Plan

A charter group consisting of members from the Bureau of Reclamation, USFWS, CDFW, DWR, the California Bay-Delta Authority, and the Suisun Resource Conservation District are developing a management plan to restore 5,000 to 7,000 acres of tidal wetlands and enhance existing seasonal wetlands in Suisun Marsh (USBR July 2009). The plan would be implemented over 30 years and is expected to contribute to the recovery of many terrestrial and aquatic species. The Final EIS/EIR for the plan, issued in December 2011, evaluated the 30-year plan to address use of resources within the approximately 52,000 acres of wetland and upland habitats in Suisun Marsh. The plan's objective is to achieve a multi-stakeholder approach to the restoration of tidal wetlands and the enhancement of managed wetlands and their functions (DWR, 2014).

t. Fish Restoration Program Agreement

The Fish Restoration Program Agreement (FRPA), was signed between the CDFW and DWR in 2010 in order to address specific habitat restoration requirements of the USFWS and the NMFS Biological Opinions for SWP and CVP operations (DWR, 2014). FRPA is also intended to address the habitat requirements of the CDFW Longfin Smelt Incidental Take Permit (ITP) for SWP Delta operations.

The primary objective of the FRPA program is to implement the fish habitat restoration requirements and related actions of the Biological Opinions and the ITP in the Delta, Suisun Marsh, and Yolo Bypass and is focused on 8,000 acres of intertidal and associated subtidal habitat to benefit delta smelt, including 800 acres of mesohaline habitat to benefit longfin smelt, and a number of related actions for salmonids. The USFWS Biological Opinion allows DWR 10 years to implement the restoration of the required 8,000 acres.

u. Bay-Delta Water Quality Control Plan Update

The State Water Resources Control Board's (State Water Board) Bay-Delta Water Quality Control Plan (aka Bay-Delta Plan) identifies beneficial uses of the Bay Delta, water quality objectives for the reasonable protection of those beneficial uses, and a program of implementation for achieving the water quality objectives including control of salinity caused by saltwater intrusion, municipal discharges, and agricultural drainage, and water projects operations.

The State Water Board is currently undergoing a four phase process to update and implement the Bay-Delta Plan, last published in 2006, and revise flow objectives for key tributaries to the Delta. As part of Phase 1 of the process, the State Water Board released a draft Substitute Environmental Document (SED) in December 2012. The SED outlines a set of alternative Lower San Joaquin River and southern Delta water quality objectives for protection of fish and wildlife beneficial uses, salinity, and other objectives for protection of agricultural beneficial uses. It also includes a program of implementation, monitoring, and special studies. The State Water Board received public comments on this document during a March 2013 workshop, and is currently preparing a revised draft.

v. Sacramento Area Flood Control Agency (SAFCA) Flood Management Program

The Sacramento Area Flood Control Agency (SAFCA) Flood Management Program includes studies, designs, and construction of flood control improvements. In the South Sacramento area, SAFCA projects include the South Sacramento Streams Project and the Sacramento River Bank Protection Project.

The South Sacramento Streams Project consists of levee, floodwall, and channel improvements starting south of the town of Freeport along the Sacramento River to protect the City of Sacramento from flooding associated with Morrison, Florin, Elder, and Unionhouse creeks.

The Sacramento River Bank Protection Project, which is implemented and funded primarily through the U.S. Army Corps of Engineers, addresses long-term erosion protection along the Sacramento River and its tributaries. Bank protection measures typically consist of large angular rock placed to protect the bank, with a layer of soil/rock material to allow bank re-vegetation.

3. Longer-Term Future Delta Projects

w. Upper San Joaquin River Basin Storage Investigation

The Upper San Joaquin River Basin Storage Investigation is a feasibility study by the U.S. Bureau of Reclamation and DWR (USBR July 2009). The purpose of the investigation is to determine the type and extent of federal, State, and regional interests in a potential project in the upper San Joaquin River watershed to expand water storage capacity; improve water supply reliability and flexibility of the water management system for agricultural, urban, and environmental uses; and enhance San Joaquin River water temperature and flow conditions to support anadromous fish restoration efforts.

Progress and results of the investigation have been documented in a Draft Feasibility Report released in 2014. A Draft EIS/EIR is in progress and the USBR is planning to complete the Final Feasibility Report and EIS/R in 2015, with a Record of Decision planned by 2016 (USBR, 2013).

x. Tracy (Jones) Pumping Plant Mitigation Program

The Tracy (Jones) Pumping Plant Mitigation Program was established in 1992 under the 1992 Central Valley Project Improvement (CVPIA) Act. The goal of this program is to mitigate the impacts associated with operations at the Tracy Pumping Plant through actions such as improved fish screens, fish recovery facilities, and improved practices at the Tracy Pumping Plant.

The initial focus of the program was the Tracy Fish Test Facility (TFTF), to be constructed near Byron, California, and intended to develop and implement new fish collection, holding, transport, and release technology to significantly improve fish protection at the major water diversions in the south Delta (USBR July 2009). The DWR and USBR were to use results of the TFTF to design the potential Clifton Court Forebay Fish Facility, and improve fish protection at the Jones Pumping Plant facility.

Due primarily to high construction costs the CALFED South Delta Fish Facilities Forum (SDFF) recommended that the TFTF not proceed. Instead, the SDFF recommended focusing on fixing and improving the existing fish collection facilities located at the South Delta's export pumps. The SDFF also recommended improvements in debris and predation management, replacement of a new secondary screening system, and continued research activities (USBR, 2013).

USBR and related agencies have identified 28 actions for the existing Tracy Fish Collection Facility. Implementation of these actions has been ongoing since 1992 and full implementation is expected in 2016 at the earliest.

B. Assessment of Cumulative Impacts

There is widespread acknowledgement among California policymakers that the Delta is in crisis. As the Governor's Delta Vision Blue Ribbon Task Force stated, "ecosystems have eroded, levees have deteriorated, fish populations have collapsed, and our system of delivering water has become ever more precarious" (Isenberg et al. 2008). There are numerous efforts, at the federal, State, and local level, to improve conditions in the Delta. The SCP operates within this context of a deteriorated Delta environment, and an active array of public programs seeking to reverse this deterioration.

Exhibit 7-1, starting on page 7-17, compares the environmental resource areas for which the SCP has potentially significant impacts, with those of 24 other Delta projects and programs. All of the identified programs are intended to improve conditions in the Delta, for sensitive species and habitats, agriculture, or water quality, or some combination of these areas. However, in creating these improved conditions, each program also has the potential to result in significant environmental impacts, at least temporarily. Most of these 24 other Delta programs identified in this Section have significantly greater scope, and scale, than the SCP. The SCP affects only a relatively small percentage of the total Delta, while many of these programs have, or will have, Delta-wide affects. Currently, several of these programs are still in the planning and permitting phases. Only the EDCP and WHCP are of a similar small scale to the SCP.

The two environmental resource areas that are most likely to be affected by cumulative impacts of the SCP, combined with these other Delta projects and programs, are biological resources, and hydrology and water quality. Several projects and programs identified in Exhibit 7-1 are in the planning phase, and have not completed environmental impact reports. However, given the scope of these project efforts, it is reasonable to assume that impacts to biological resources are likely.

To the extent that any of these Delta projects create stress (of any kind) on special status species and habitats, this stress could be compounded by the combined impacts of each program. For example, while the potential impacts of the SCP on special status fish may be limited, if special status fish are already impacted by other Delta projects, the cumulative impact on special status fish may be significant.

The SCP will implement mitigation measures, as described in Chapter 3, to minimize SCP impacts to biological resources. In addition, as these other projects and programs are implemented, they will also implement mitigation measures to minimize impacts on biological resources.

The potential for cumulative impacts to hydrology and water quality are similar to those of biological resources. The SCP will potentially result in unavoidable, potentially unavoidable, or avoidable impacts to water quality. Several of these other Delta programs may also result in at least temporary impacts to water quality, that when combined with the SCP impacts, would be cumulatively considerable. SCP mitigation measures, as described in Chapter 5, will minimize the SCP's contribution to water quality degradation in the Delta. These other Delta projects will also implement mitigation measures to minimize impacts to hydrology and water quality.

For projects with construction-related impacts to biological resources, hydrology and water quality, or hazards and hazardous materials, the DBW will coordinate with the respective implementing agencies to avoid conducting SCP treatments in locations where construction is taking place. This simple action will reduce or eliminate the potential for cumulative impacts during the construction phase of any Delta project.

The programs with the greatest potential to result in cumulative impacts with the SCP are the WHCP and EDCP, due to the similar nature of these programs, and the similar nature of their potential impacts. However, the EDCP, SCP, and WHCP utilize different herbicides, and do not conduct treatments in the same areas of the Delta during the same time periods. As a result, the likelihood of significant cumulative impacts is low. In addition, all three programs implement mitigation measures to reduce their respective impacts.

Exhibit 7-2, following Exhibit 7-1, provides a summary of the potential cumulative impacts resulting from the SCP. It is likely that these cumulative impacts, should they occur, will be reduced, to some extent, by mitigation measures implemented by the SCP, and the other programs.

Exhibit 7-1
Comparison of Potential Impacts of the SCP and Projects in the Delta

Page 1 of 2

Project	Objective	Environmental Resource Area – Potential Cumulative Impacts					Potential for Benefits	Status (as of April 2014)
		Agriculture	Biological Resources	Hydrology and Water Quality	Hazards and Hazardous Materials	Utilities and Service Systems		
Spongeplant Control Program	Controlling growth and spread of spongeplant in the Delta	X	X	X	X	X	Yes	Existing
a. Water Hyacinth Control Program	Controlling growth and spread of water hyacinth in the Delta	X	X	X	X	X	Yes	Existing
b. *Egeria densa* Control Program	Controlling growth and spread of *Egeria densa* in the Delta	X	X	X	X	X	Yes	Existing
c. Central Valley Project and State Water Project	Water storage and delivery		X	X			Yes	Existing
d. Environmental Water Account	Protect fish; increase water supply reliability		X	X			Yes	Existing
e. Temporary Barriers Project	Benefit migrating salmon and benefit agricultural water users		X	X			Yes	Existing
f. USFWS BO – Reasonable and Prudent Alternative	Protection of delta smelt		X				Yes	Existing
g. NMFS BO – Reasonable and Prudent Alternative	Protection of salmon, steelhead, and green sturgeon		X				Yes	Existing
h. Levees System Integrity Program	Improve Delta levees		X	X			Yes	Existing
i. Ecosystem Restoration Program	Refine and develop new ecosystem restoration projects		X				Yes	Existing
j. Delta Stewardship Council Delta Plan	Achieve coequal Delta goals		X	X			Yes	Existing
k. Sacramento-San Joaquin Delta Conservancy Strategic Plan	Implement ecosystem restoration in the Delta		X	X			Yes	Existing
l. Central Valley Flood Protection Plan	Address flood risks and ecosystem restoration opportunities		X	X			Yes	Existing
m. Stockton Deep Water Ship Channel Dissolved Oxygen Aeration Facility	Raise DO levels to support aquatic life		X	X			Yes	Existing
n. Bay Delta Conservation Plan	Recover sensitive species and habitats while maintaining water supplies		X	X			Yes	Near Future

Exhibit 7-1
Comparison of Potential Impacts of the SCP and Projects in the Delta *(continued)*

Project	Objective	Environmental Resource Area – Potential Cumulative Impacts					Potential for Benefits	Status (as of July 2009)
		Agriculture	Biological Resources	Hydrology and Water Quality	Hazards and Hazardous Materials	Utilities and Service Systems		
o. Sacramento River and Stockton Deep Water Ship Channels	Maintenance dredging and long-term channel improvements		X	X			Yes	Near Future
p. Delta Wetlands Project	Divert and store Delta water and wetlands and wildlife habitat improvements		X	X			Yes	Near Future
q. San Joaquin River Restoration Program	Restore fish, maintain water supplies		X				Yes	Near Future
r. Franks Tract Project	Improve water quality and fisheries conditions in the Delta		X	X			Yes	Near Future
s. Suisun Marsh Habitat Management, Preservation, and Restoration Plan	Restore and enhance tidal wetlands		X	X			Yes	Near Future
t. Fish Restoration Program Agreement	Implement fish habitat restoration requirements		X	X			Yes	Near Future
u. Bay-Delta Water Quality Control Plan Update	Achieve water quality objectives		X	X	X	X	Yes	Near Future
v. Sacramento Area Flood Control Agency (SAFCA) Flood Management Program	Study, design, and construct flood control improvements		X	X			Yes	Near Future
w. Upper San Joaquin River Basin Storage Investigation	Determine interest in projects to expand water storage capacity and reliability		X	X		X	Yes	Longer-Term Future
x. Tracy (Jones) Pumping Plant Mitigation Program	Develop and implement new procedures to improve fish protection at major water diversions		X			X	Yes	Longer-Term Future

Exhibit 7-2
Summary of Potential Cumulative Impacts Resulting from the SCP

Resource Area and Potential Impact	Cumulative Impact	Description
II. Agricultural Resources		
d) Adversely impact agricultural crops or agricultural operations, such as irrigation	[X]	The SCP may result in adverse impacts to agricultural crops through herbicide overspray or herbicide toxicity. The SCP may also result in clogging of irrigation pumps from plant fragments. The WHCP and EDCP have the potential to result in the same adverse impacts to agricultural crops and irrigation pumps
IV. Biological Resources		
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the CDFG or USFWS	[X]	The SCP may result in adverse impacts to special status species present in treatment areas through herbicide overspray, herbicide toxicity, food web effects, dissolved oxygen levels, and/or treatment disturbances. There is a potential for these listed projects to result in temporary or permanent adverse effects to special status species
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the CDFG or USFWS	[X]	The SCP may result in adverse impacts to riparian or other sensitive habitats due to herbicide overspray, dissolved oxygen levels, treatment disturbances, and/or plant fragmentation. There is a potential for these listed projects to result in temporary or permanent adverse effects to riparian or other sensitive habitats
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means	[X]	The SCP may result in adverse impacts to wetlands through herbicide overspray, dissolved oxygen levels, treatment disturbances, and/or plant fragmentation. There is a potential for these listed projects to result in temporary or permanent adverse effects to wetlands
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites	[X]	The SCP may result in adverse impacts to migratory fish through herbicide toxicity, food web effects, dissolved oxygen levels, and/or treatment disturbances. There is a potential for these listed projects to result in temporary or permanent adverse effects to migratory fish
VII. Hazards and Hazardous Materials		
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials in the environment	[X]	The SCP may result in exposure to hazardous materials due to accidental spills of herbicide.
VIII. Hydrology and Water Quality		
a) Violate any water quality standards or waste discharge requirements	[X]	The SCP may result in violations of water quality standards due to chemical constituents, pesticides, toxicity, dissolved oxygen levels, floating material, and/or turbidity. There is a potential for these listed projects to result in temporary or permanent violations of water quality standards
f) Otherwise substantially degrade water quality	[X]	The SCP may degrade water quality due to chemical constituents, pesticides, toxicity, dissolved oxygen levels, floating material, and/or turbidity. There is a potential of these listed projects to result in temporary or permanent degradation of water quality
g) Otherwise substantially degrade drinking water quality	[X]	The SCP may result in degradation of drinking water quality through chemical constituents, pesticides, and/or toxicity. There is potential for these listed projects to result in temporary or permanent degradation of drinking water quality
XVI. Utilities and Service Systems		
h) Result in problems for local or regional water utility intake pumps	[X]	The SCP may result in adverse impacts to utility service intake pumps from plant fragments. The WHCP and EDCP have the same potential to result in adverse impacts to utility service intake pumps

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