Chapter 3

Biological Resources Impacts Assessment

3. Biological Resources Impacts Assessment

This chapter analyzes effects of the WHCP 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 WHCP 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 the DBW will undertake to avoid, or minimize, potential environmental impacts. The DBW has undergone, and will continue to undergo, consultation with various State and federal agencies, including USFWS, CDFG, NOAA-Fisheries, and CVRWQCB regarding impacts and mitigation measures. Many of the mitigation measures result from the biological consultation process with USFWS and NOAA-Fisheries. Proposed mitigation measures may be revised, and/or additional mitigation measures incorporated, as a result of this ongoing consultation process with environmental regulatory agencies.

A. Environmental Setting

Exhibit 2-1 illustrates the WHCP program area. The WHCP 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, California Department of Fish and Game, U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service, and NOAA-Fisheries. 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 from the Sacramento River to south Delta.

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 WHCP is a minor element of this complex dynamic Delta environment. The WHCP seeks to control only one of the hundreds of invasive species in the Delta. The WHCP 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 WHCP is to control the growth of water hyacinth within this highly modified Delta environment. Water hyacinth, left to grow unchecked, has significant negative environmental impacts. At the same time, the WHCP also must minimize potential negative impacts of water hyacinth treatment.

1. Regulatory Settings

There are several Federal and State laws relevant to biological resources that are applicable in the WHCP 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 (NOAA-Fisheries 2008). The law is implemented by USFWS and NOAA-Fisheries. 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 WHCP has obtained ESA Section 7 Biological Opinions from USFWS and NOAA-Fisheries through the consultation process. The federal nexus for this process is USDA-ARS. The biological opinions specify requirements that the DBW must follow to minimize the potential for take of endangered of threatened species.

California Endangered Species Act

The California Endangered Species Act (CESA) is administered by CDFG Habitat Conservation Planning Branch. The California Endangered Species Act protects wildlife and plants listed as threatened or endangered by the California Fish and Game Commission (CDFG 2008). This law restricts "take" of listed species, and agencies must apply for an incidental take permit under CESA, similar to the process under ESA. CESA includes additional species that are not covered by the federal ESA, however implementation of CESA and ESA is typically closely coordinated between USFWS, NOAA-Fisheries, and CDFG.

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 WHCP 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 WHCP 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.

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 50,000 acres of water. 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 100°F, and drop to below freezing in the winter. Annual rainfall varies from approximately 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 WHCP.

3. Natural Community Conservation Plan (NCCP) 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 WHCP, we first describe the habitat types within the WHCP area. 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 CDFG's California Wildlife Habitat Relationships System.

CALFED's NCCP categories are more specific to the Delta region, and have been utilized in a number of recent Delta environmental documents. Those twelve NCCP habitats that are within the WHCP area are described below, including two fish groups. 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, NOAA-Fisheries, and CDFG 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. Water hyacinth is typically found in this habitat.

Additional TPA habitat aquatic plant species include 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 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. CALFED has an NCCP goal to restore 9,000 acres of tidal perennial aquatic habitat and minimize effects on tidal perennial aquatic habitat (USBR 2003, 5-4).

Tidal Freshwater Emergent

Tidal freshwater emergent (TFE) habitat 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 habitat occurs within the Delta along island levees, channel islands, and shorelines (USBR 2003, 5-11), including many sites with water hyacinth.

The dominant vegetation for tidal emergent wetland habitat includes bulrush, tules, cattails, and common reed. Several special status plant species potentially affected by the WHCP 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.

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).

Nontidal Freshwater Permanent Emergent

Nontidal freshwater permanent emergent (NFPE) 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 WHCP treatment area are within this classification.

Vegetation and wildlife for nontidal freshwater permanent emergent habitats are similar to tidal freshwater emergent 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 permanent emergent habitats is similar to that described for tidal freshwater emergent habitats

Valley Riverine Aquatic

Valley riverine aquatic habitat (VRA) includes the water column of flowing streams and rivers in low-gradient channel reaches below an elevation of approximately 300 feet that are not tidally influenced. Additionally, VRA includes associated shaded riverine aquatic pool, riffle, run, and unvegetated channel substrate habitat features, and sloughs, backwaters, overflow channels, and flood bypasses hydrologically connected to stream and river channels (CALFED July 2000). Delta waterways that are classified as VRA include the Sacramento, San Joaquin, Cosumnes, Mokelumne, and Calaveras rivers and other sloughs, streams, and ephemeral creeks (USBR 2003, 5-6), including many sites with water hyacinth.

Dominant vegetation of VRA habitat includes plankton, water moss, algae, and duckweed. One special status plant species potentially affected by the WHCP, eel-grass pondweed, is associated with this habitat (CALFED July 2000, C-2-1 to C-2-12). Aquatic species include riffle insects, pool insects, mollusks, crustaceans, diving beetles, and water boatmen. Avian species include waterfowl,

wading birds, shorebirds, and raptors. Mammal species include river otter, muskrat, and beaver.

Valley riverine aquatic habitat in the Central Valley has declined from over 900,000 acres, historically, to about 100,000 acres today. Much of the existing habitat is in a highly degraded condition. Degradation has occurred due to channel straightening; channel incising; channel dredging and clearing; instream gravel mining; riparian zone grazing; flow modifications; removal and fragmentation of shoreline riparian vegetation; and loss of sediment, bedload, and woody debris from watershed sources upstream of dams (USBR 2003, 5-5).

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 pond 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 WHCP 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).

Managed Seasonal 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 WHCP project area, including private lands managed primarily for waterfowl or state and federal wildlife areas/refuges (USBR 2003, 5-14). WHCP 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).

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). Water hyacinth 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 WHCP 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).

Montane Riverine Aquatic

Montane riverine aquatic (MRA) habitat includes the water column of flowing streams and rivers above an elevation of approximately 300 feet (USBR 2003). MRA includes associated pools, riffles, runs, unvegetated channels, sloughs, backwaters, and overflow channels connected to stream and river channels. Within the WHCP, this habitat exists on the Merced, San Joaquin, and Tuolumne Rivers. Dominant vegetation and wildlife are similar to VRA habitat species. Special status species in this habitat that may be impacted by the WHCP include western pond turtle, California red-legged frog, and eel-grass pondweed.

Upland Cropland

Upland cropland (UC) habitat includes agricultural lands farmed for grain, field, truck, and other crops for profit that are not seasonally flooded (USBR 2003, 5-15). The predominant land use category in the Delta is agricultural, including upland cropland, and seasonally flooded agriculture, described below. There are over 370,000 acres of harvested or grazed irrigated crops in the Delta (Rich 2006).

Upland cropland vegetation is dominated by cereal rye, barley, wheat, corn, dry beans, safflower, alfalfa, cotton, tomatoes, lettuce, Bermuda grass, ryegrass, tall fescue, almonds, walnuts, peaches, plums, pears, and grapes. Wildlife use of these areas varies throughout the growing season depending on crop type, level of disturbance, and available cover (USBR 2003, 5-17). Water hyacinth may be situated in waterways adjacent to upland cropland habitat.

Seasonally Flooded Agricultural Lands

Seasonally flooded agricultural lands (SFA) habitat includes agricultural lands farmed for grain, rice, field, truck, and other crops for profit that require seasonal flooding for at least one week at a time as a management practice, or are purposely flooded seasonally to enhance habitat values for specific wildlife species (e.g., ducks for duck clubs). Agricultural ditches and drains associated with maintaining seasonally flooded agricultural lands are included in this habitat type (CALFED July 2000). Agricultural lands throughout the Delta fall into this habitat category, and may be adjacent to waterways with water hyacinth.

Rice fields, a large component of this habitat category, provide important habitat cover for a variety of species. Many species forage on post-harvest grain waste, as well as duckweed, fish, and crayfish found in rice fields. Rice can provide resting and nesting habitat similar to natural wetlands, particularly for migrating waterfowl. Species dependent on rice fields for all or part of their lifecycle include the giant garter snake, various rodents, and various raptors. Irrigation ditches can contain wetland vegetation such as cattails, and provide habitat for rails, egrets, herons, bitterns, marsh wrens, sparrows, and common yellowthroats (USBR 2003, 5-19).

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 WHCP, 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 WHCP, and are discussed in this chapter.

4. Special Status Species

The WHCP occurs on waterways within portions of 11 counties: Alameda, Contra Costa, Fresno, Madera, Merced, Sacramento, San Joaquin, Solano, Stanislaus, Tuolumne, and Yolo. The 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 NOAA-Fisheries, through the Endangered Species Act (ESA). California threatened and endangered species are regulated by CDFG, through the California Endangered Species Act (CESA).

The 26 special status species that may occur in, or utilize, habitats potentially impacted by the WHCP are identified in **Table 3-1,** on the next page. There are eleven special status plants, one invertebrate, eight fish, one amphibian, two reptiles, three birds, and five critical habitats potentially impacted by WHCP activities.

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 five species that are potentially impacted by the WHCP, and for which critical habitat has been designated, are: (1) delta smelt, (2) Central Valley steelhead, (3) Central Valley spring-run Chinook salmon, (4) winter run Chinook salmon, Sacramento River, and (5) California red-legged frog. Parts of the critical habitat for the first four of these species occur within the WHCP, however none of the designated critical habitat for the California red-legged frog occurs within the WHCP area.

We describe the current status of each of these species below, and potential impacts of the WHCP 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 WHCP activities. This programmatic EIR does not consider these majority special status species.

Table 3-1
Special Status Species Potentially Impacted by the WHCP

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, FCHP, CSC
2. *Hypomesus transpacificus*	delta smelt	FT (considering FE)[1], **FCH,** CE
3. *Lampetra ayresi*	river lamprey	CSC
4. *Oncorhynchus mykiss*	Central Valley steelhead	FT, **FCH**
5. *Oncorhynchus tshawytscha*	Central Valley spring-run Chinook salmon	FT, **FCH,** CT
6. *Oncorhynchus tshawytscha*	winter-run Chinook salmon, Sacramento River	FE, **FCH,** CE
7. *Pogonichthys macrolepidotus*	Sacramento splittail	CSC
8. *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

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

Table 3-1
Special Status Species Potentially Impacted by the WHCP

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 five critical habitats identified in Table 3-1, four include areas within the WHCP, and could potentially be impacted by the WHCP. Critical habitat for the California red-legged frog does not occur within the WHCP 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.

Table 3-15, located on page 3-77 at the end of Chapter 3, identifies more than 250 species that we do not expect to be impacted by the WHCP, but that may occur within the 11 WHCP counties. Less than ten percent of all the special status species identified for the 11 WHCP counties could be potentially impacted by the WHCP.

No new primary data surveys were conducted specifically for this draft PEIR. However, data from previous DBW and prior relevant plant or wildlife surveys were included in this PEIR. The DBW has monitored and reviewed environmental impacts of the WHCP each year since 1983.

5. Invertebrates

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

Source: www.fws.gov.

Photo: Valley Elderberry Longhorn Beetle.

Valley Elderberry Longhorn Beetle

Valley elderberry longhorn beetle is classified as federally threatened. 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 WHCP 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 CDFG/ 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 3-2, 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 WHCP, 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.

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

Table 3-2
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.

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.

More recently, 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).

By early 2008, the POD working group refined their analysis, developing two conceptual modeling approaches for identifying causes of pelagic organism decline. The first model included four major components: (1) previous abundance levels; (2) habitat; (3) top-down effects; and (4) bottom-up effects (Baxter et al. 2008a). Previous abundance levels consider 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 will examine specific models for individual species.

The POD working group continues to refine the conceptual models in order to further evaluate causes of POD. The 2008 workplan identifies three types of work: (1) continuation of expanded monitoring, (2) 31 ongoing studies, and (3) 19 new studies (Baxter et al. 2008b). 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 for the SWP and CVP.

The USFWS issued a new biological opinion in December 2008. This new BO incorporated more restrictive water exports, as specified in the 2007 federal court decision. The San Luis and Delta-Mendota Water Authority and Westlands Water District moved for a preliminary injunction of the export restrictions. In a May 2009 decision, the federal court required USFWS to "explain why alternative, less restrictive flows would not adequately protect the delta smelt," but did not preclude the restrictive flows (U.S. District Court 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 NOAA-Fisheries 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.

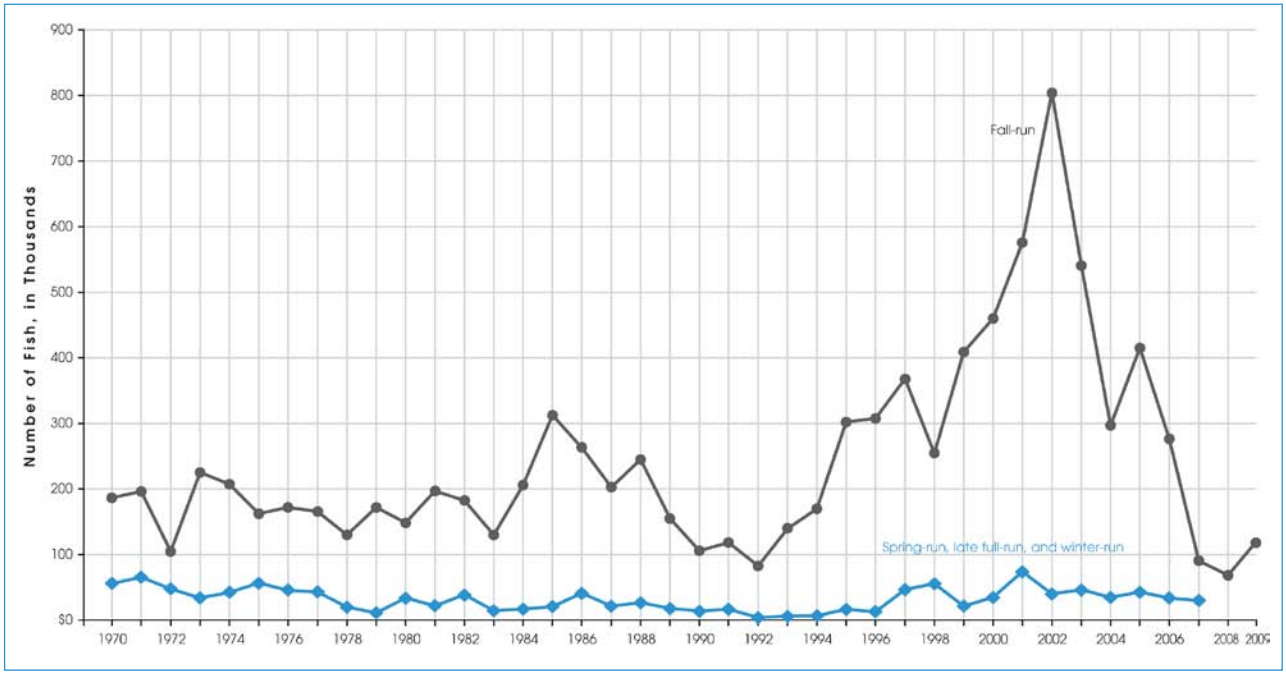
The causes of this unprecedented decline are unknown, but likely factors include ocean temperature changes, in-stream water withdrawals, habitat alternations, dam operations, construction, pollution, and changes in hatchery operations (PFMC 2008). A multi-agency task force will review 46 possible causes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

Responding to these low salmon counts, CDFG 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. CDFG will still allow 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. CDFG 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. **Exhibit 3-1,** on the next page, 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.

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



Source: PFMC, February 2008, February 2009.

Photo: Green Sturgeon.

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 NOAA-Fisheries in July 2006. This is a Distinct Population Segment (DPS), separate from green sturgeon found at the Eel River and north to British Columbia (NOAA-Fisheries February 2005). The green sturgeon is also listed as a California species of special concern by CDFG. In September 2008, NOAA-Fisheries proposed critical habitat for green sturgeon, including San Francisco Bay, the Delta, and the Sacramento River. In May 2009, NOAA-Fisheries issued proposed rules to establish take prohibitions for the southern green sturgeon population.

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 WHCP 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 CDFG Central Valley Bay-Delta Branch is conducting studies of both white and green sturgeon to increase understanding of these issues (CDFG 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 (NOAA-Fisheries 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 (NOAA-Fisheries February 2005, 13-14).

Source: www.fws.gov.

Photo: Delta Smelt.

Delta Smelt

The delta smelt *(Hypomesus transpacificus)* is State listed as endangered, and federally listed as threatened. The federal threatened status was maintained following the 5-Year Review (USFWS March 2004), however several groups recently petitioned the USFWS for emergency listing of the delta smelt as endangered (CBD 2006). In July 2008, the USFWS initiated a 60-day comment period to consider changing the listing of delta smelt from "threatened" to "endangered". In March 2009, the USFWS initiated a five-year review to assess the endangered status of delta smelt. A change in designation will not impact WHCP operations or biological opinions, as the species already is subject to an incidental take permit.

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 CDFG 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 CDFG, 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 CDFG'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. 2008b; 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 (CDFG 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.

Source: www.hoatzin.de.

Photo: River Lamprey.

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."

Source: www.fs.fed.us.

Photo: Central Valley Steelhead.

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 (NOAA-Fisheries 2005). NOAA-Fisheries 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 (NOAA-Fisheries 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 (NOAA-Fisheries 2007).

Source: www.fws.gov.

Photo: Chinook Salmon.

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. Two of these runs are special status species and will be discussed below: winter-run, and spring-run. NOAA-Fisheries is developing recovery plans for both species.

In 1989, the Sacramento River winter-run Chinook salmon was listed as threatened under the federal ESA by NOAA-Fisheries (54 FR 32085). NOAA-Fisheries reclassified the winter-run as endangered in 1994 (59 FR 440), and reaffirmed this classification in 2005 (NOAA-Fisheries 2005). Winter-run Chinook salmon were classified by the State as endangered in 1989. In 1993, NOAA-Fisheries 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 (NOAA-Fisheries 2005).

Central Valley fall-run and late fall-run Chinook salmon runs do not have any special State or federal status. 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 (CDFG 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 (NOAA-Fisheries 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 (NOAA-Fisheries 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 (NOAA-Fisheries 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 (CDFG 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 (CDFG 2005, 66). "Yearlings" remain in the stream until the following October, and emigrate starting in October through the following March (CDFG 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 (NOAA-Fisheries 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 (NOAA-Fisheries 2007).

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 (NOAA-Fisheries 2005, 153-155).

Source: www.fws.gov.

Photo: Sacramento Splittail.

Sacramento Splittail

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 (CDFG 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 (CDFG 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 (CDFG 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 (CDFG 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 (CDFG 2006a).

Source: swr.nmfs.noaa.gov.

Photo: Longfin Smelt.

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 (CDFG 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

Source: www.fws.gov.

Photo: California Red-Legged Frog.

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 WHCP 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

Source: www.californiaherps.com.

Photo: Giant Garter Snake.

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 rarely found away from 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 (CDFG 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 (CDFG 2005, 17).

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 (CDFG 2005, 18).

Source: www.fws.gov.

Photo: Western Pond Turtle.

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 CDFG. 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

Source: www.birdphotography.com.

Photo: California Black Rail.

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.

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).

Source: www.fws.gov.

Photo: Yellow-Headed Blackbird.

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.

Source: www.fws.gov.

Photo: Tricolored Blackbird.

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).

10. Plants

We identified eleven special status plant species potentially affected by the WHCP as those that are located, or potentially located, in those habitat types that will be directly impacted by water hyacinth 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 WHCP are identified in Table 3-1, and are described below.

In botanical surveys conducted by DBW in 2002 and 2003 at WHCP 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 3-3,** on the next page, identifies submergent and emergent plants found in DBW's botanical surveys.

Source: calphotos.berkeley.edu.

Photo: Bristly sedge.

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.

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 WHCP 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).

Table 3-3
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*	Native
5. fanwort	*Cabomba carolina*	Native
6. long-leaved pondweed	*Potamogeton nodus*	Native
7. southern naid	*Najas guadalupensis*	Native
8. sago pondweed	*Stuckenia pectinatus*	Native

Emergent

Common Name	Scientific Name	Native/Nonnative *(if specified)*
1. pennywort	*Hydrocotyl ranuculoides*	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.

Source: www.dbw.ca.gov.

Photo: Wooly Rose-Mallow.

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.

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 WHCP 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).

Source: www.dbw.ca.gov.

Photo: Delta Tule Pea.

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).

Delta tule pea has been identified in a number of topographic quads covering WHCP 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).

Source: calphotos.berkeley.edu.

Photo: Mason's Lilaeopsis.

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 (CDFG 2005, 444). Mason's lilaeopsis is found in topographic quads throughout WHCP 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 (CDFG 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 (CDFG 2005, 444).

Source: calphotos.berkeley.edu.

Photo: Delta Mudwort.

Delta Mudwort

Delta mudwort *(Limosela 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 WHCP 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).

Source: www.elacuarista.com.

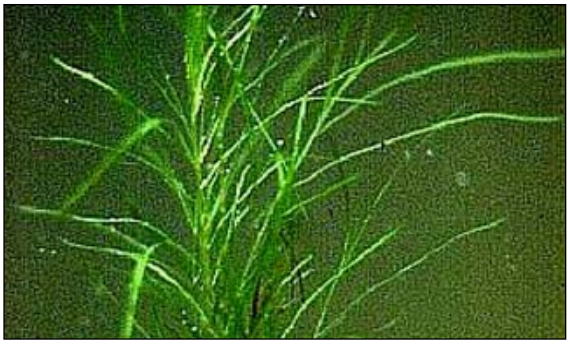


Photo: Eel-Grass Pondweed.

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.

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).

Source: calphotos.berkeley.edu.

Photo: Sanford's Arrowhead.

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.

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 WHCP 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).

Source: cricket.biol.sc.edu.

Photo: Marsh Skullcap.

Marsh Skullcap

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).

Source: www.globalherbalsupplies.com.

Photo: Side-Flowering Skullcap.

Side-Flowering Skullcap

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 WHCP 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).

Source: calphotos.berkeley.edu.

Photo: Suisun Marsh Aster.

Suisun Marsh Aster

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 WHCP 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).

Source: www.nativeplantproject.com.

Photo: Wright's Trichocoronis.

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

Source: www.afsc.noaa.gov.

Photo: Starry Flounder.

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 WHCP project area, or salvaged at the Skinner or Tracy fish facilities in the South Delta, indicating that starry flounder are found throughout the Delta.

Source: hmsc.oregonstate.edu.

Photo: English Sole.

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 25 ppt 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 WHCP. 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 WHCP 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 3-4,** on the next page. 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).

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 WHCP treatments. While there are a number of special status bird species that inhabit the eleven county WHCP region (see Table 3-15), only three of these species may be potentially impacted by the WHCP.

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 WHCP region (see Table 3-15), none of these species is likely to be impacted by the WHCP. 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 WHCP 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 WHCP research projects, technical information from scientific literature, and relevant information on public policies. 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 CDFG 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 CDFG or USFWS

Table 3-4
Major Wildlife and Habitat Areas in the Sacramento-San Joaquin Delta

Name	County	Owner/Manager	Acreage
1. Yolo Bypass Wildlife Area	Yolo County	CDFG	16,610
2. Lower Sherman Island Wildlife Area	Sacramento County	CDFG/Sacramento County	3,115
3. White Slough Wildlife Area	San Joaquin County	CDFG/DWR/San Joaquin County	800
4. Rhode Island Wildlife Area	Contra Costa County	CDFG/Contra Costa County	67
5. Miner Slough and Decker Island Wildlife Areas	Solano County	Solano County	50
6. Woodbridge Ecological Reserve	San Joaquin	CDFG	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
Total			68,776

- 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 (also designated with the letter 'B'). These include specific actions that DBW will undertake to avoid or minimize potential impacts. The DBW continues to undergo consultation with various State and federal agencies, including USFWS, CDFG, NOAA-Fisheries, 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 NOAA-Fisheries. Proposed mitigation measures may be revised and/or additional mitigation measures incorporated as a result of this ongoing consultation process with regulatory agencies.

Table 3-5, on the next page, provides a summary of potential WHCP impacts for each of the significance criteria areas. The remainder of this chapter analyzes eight specific impacts and associated mitigation measures.

Table 3-5
Crosswalk of Biological Resources Significance Criteria, Impacts, and Benefits of the WHCP

	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 CDFG or USFWS?						Removal of water hyacinth 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	**X**				X
Impact B2: Herbicide toxicity	1, 3, 5, 6, 7, 8	**X**				
Impact B3: Herbicide bioaccumulation				X		
Impact B4: Food web effects	1, 6, 7	**X**				X
Impact B5: Dissolved oxygen levels	9, 10, 11, 12		**X**			X
Impact B6: Treatment disturbances	1, 4		**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?						Removal of water hyacinth could improve riparian and sensitive habitat
Impact B1: Herbicide overspray	1, 2, 3, 4	**X**				X
Impact B5: Dissolved oxygen levels	9, 10, 11, 12		**X**			X
Impact B6: Treatment disturbances	1, 4		**X**			
Impact B7: Plant fragmentation	13, 14		**X**			
Impact B8: Disposal following handpicking	15, 16			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 water hyacinth could improve wetland habitat
Impact B1: Herbicide overspray	1, 2, 3, 4	**X**				X
Impact B5: Dissolved oxygen levels	9, 10, 11, 12		**X**			X
Impact B6: Treatment disturbances	1, 4		**X**			
Impact B7: Plant fragmentation	13, 14		**X**			
Impact B8: Disposal following handpicking	15, 16			X		

Table 3-5
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 water hyacinth could improve navigation channels for migrating species and movement of resident species
Impact B2: Herbicide toxicity	1, 3, 5, 6, 7	**X**				
Impact B4: Food web effects	1, 6, 7	**X**				X
Impact B5: Dissolved oxygen levels	9, 10, 11, 12		**X**			X
Impact B6: Treatment disturbances	1, 4		**X**			
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?				WHCP has no known significant conflicts with local policies or ordinances protecting biological resources		Removal of water hyacinth 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?					WHCP has no known conflicts with various conservation plans, programs, or other initiatives in the Delta. WHCP's reduction in an invasive species is supportive of these conservation efforts	Removal of water hyacinth is consistent with conservation planning efforts to reduce invasive species in the Delta

For each of the eight potential WHCP 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.

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

The primary treatment of the WHCP is chemical. The program utilizes two herbicides, 2,4-D and glyphosate.

Weedar® 64 (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, water hyacinth shows 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 WHCP treatment sites also include other potentially impacted broadleaf plants.

AquaMaster™ (glyphosate) is a broad spectrum, non-selective, systemic herbicide. (DBW has also used Rodeo®, a similar glyphosate 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 plant species and habitat impacts.

The DBW also utilizes adjuvants to increase absorption and translocation of the herbicide. Currently, DBW utilizes the paraffin-based non-ionic surfactant, Agridex®. The DBW continues to evaluate other adjuvants, such as 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.

The concentration of active ingredient (2,4-D or glyphosate) leaving the spray nozzle is high enough (ranging from 600 ppm to 4,800 ppm) to cause adverse effects. Thus, there is the potential that uncontrolled herbicide overspray could affect nearby nontarget vegetation.

Treatment of water hyacinth could result in 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 splittail and delta smelt.

Loss of cover, rearing, and forage area of special status species could constitute a significant impact under certain conditions. However, dense canopies of water hyacinth 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 water hyacinth 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. 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.

The 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 four mitigation measures.

- **Mitigation Measure B1a** – 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, the 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 opinions; incidental take procedures; and that unlawful take of an animal or destruction of its habitat is a violation of the Endangered Species Act.

  The DBW also 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 for each site to document the presence or absence of special status species. If any special status species or sensitive habits are present at the site, the field crew will not perform any treatment.

- **Mitigation Measure B1b** – Provide a 250 foot buffer between treatment sites and shoreline elderberry shrubs (*Sambucus* ssp.), host plant for the valley elderberry longhorn beetle *(Desmocerus californicus dimorphus)*.

  The 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 3-2,** on the next page, provides a map identifying locations of elderberry shrubs and giant garter snake sitings within the WHCP treatment area.

  DBW crews will maintain the 250 buffer zone when elderberry shrubs are present. Crews will also conduct treatments downwind of elderberry shrubs.

  In addition, DBW's Environmental Scientists will survey a sample of elderberry shrubs which could be potentially impacted by WHCP 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 B1c** – 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.

Exhibit 3-2a

Valley Elderberry Shrub Locations and Giant Garter Snake Habitat Valuation – Northern Sites

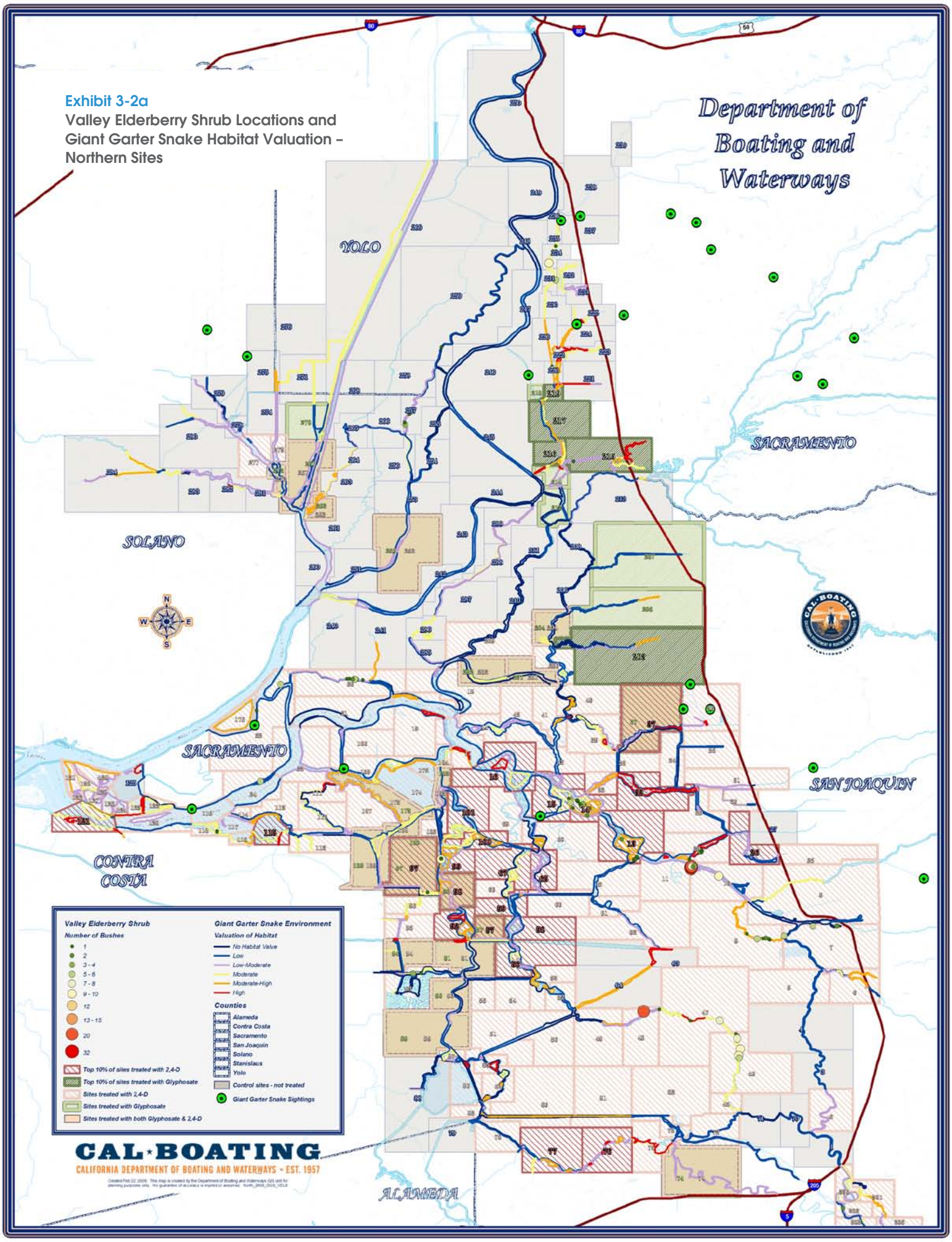
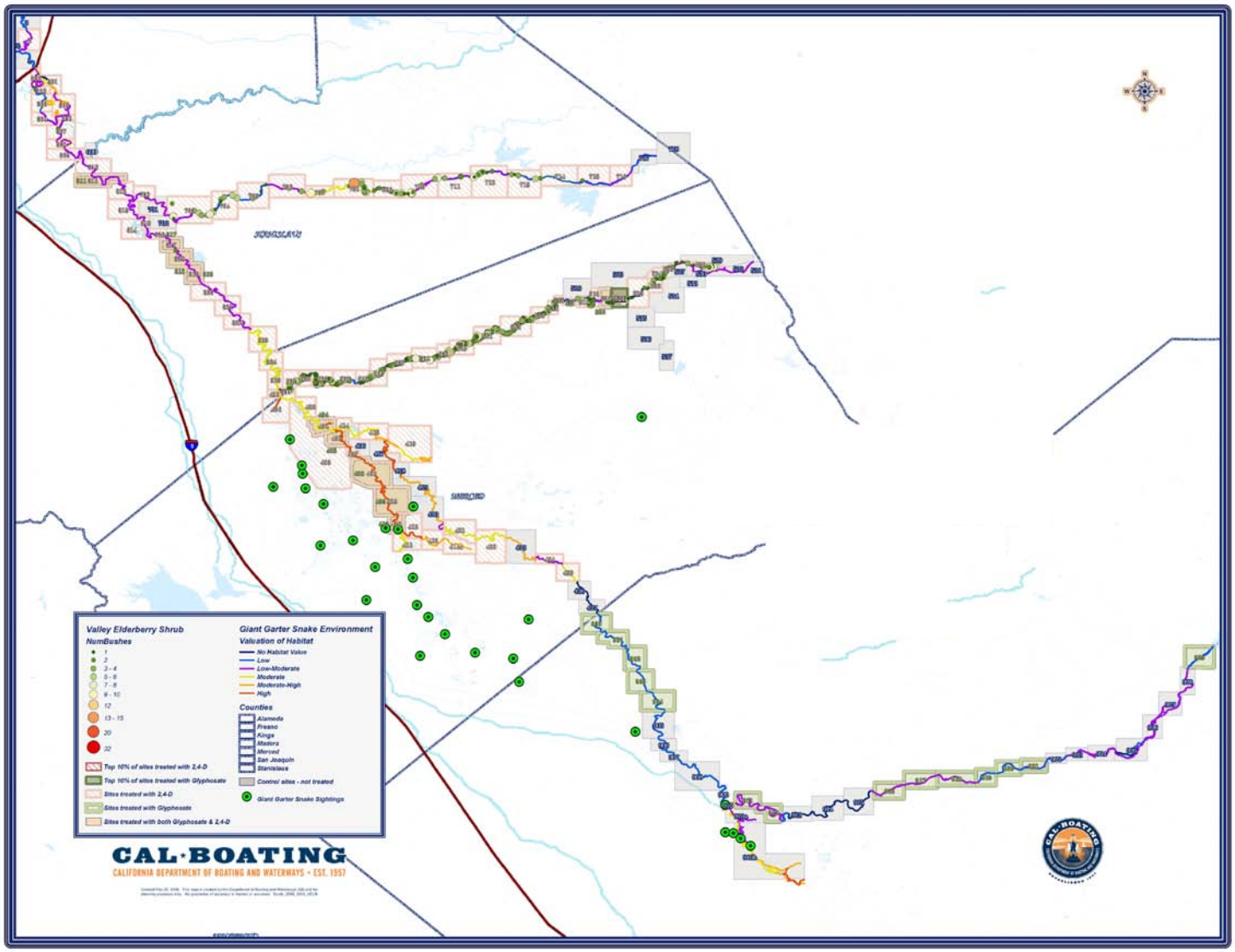


Exhibit 3-2b
Valley Elderberry Shrub Locations and Giant Garter Snake Habitat Valuation – Southern Sites



- **Mitigation Measure B1d** – 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.

* * * * *

There also are potential positive impacts to special status plants, sensitive habitats, and wetlands from the WHCP. Water hyacinth clogs waterways and reduces overall habitat for native plants (CALFED 2000). Dense patches of water hyacinth shade out habitat and outcompete native aquatic vegetation, including Mason's lilaeopsis (CALFED 2000).

Control of water hyacinth in Delta waterways expands habitat suitable for native species. Thus, long-term impacts of water hyacinth 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 water hyacinth. During 2008, 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 WHCP 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 and glyphosate on various animal species over the last 30 years. In addition, the WHCP has conducted a number of toxicity tests using surrogate species and water samples obtained from WHCP treatment sites.

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

Herbicide Concentrations in Delta Waters Immediately Following WHCP 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.

Table 3-6
Calculated Maximum Concentrations of 2,4-D, Glyphosate, and Agridex® Immediately Following WHCP Treatment

Concentration of:	2,4-D *(active ingredient)*	Glyphosate *(active ingredient)*	Agridex® *(total adjuvant)*
1. Chemical directly out of spray nozzle	2,500 ppm	4,000 ppm	5,000 ppm
2. Chemical in 1 acre-ft, @ 100% water contact	3.1 ppm	2.3 ppm	1.5 ppm
3. Chemical in 10 acre-ft, @ 100% water contact	0.31 ppm	0.23 ppm	0.15 ppm
4. Chemical in 1 acre-ft, @ 10 to 20% water contact	0.31 ppm to 0.62 ppm	0.23 ppm to 0.46 ppm	0.15 ppm to 0.30 ppm
5. Chemical in 10 acre-ft, @ 10 to 20% water contact	0.031 ppm to 0.062 ppm	0.023 ppm to 0.046 ppm	0.015 ppm to 0.030 ppm

The WHCP utilizes pump-driven hand-held spray nozzles to treat water hyacinth. The pump mixes calibrated amounts of herbicide (either 2,4-D or glyphosate), adjuvant, and water. The DBW applies the chemicals at the herbicide label-specified rates.

Table 3-6, above, summarizes expected instantaneous concentrations of active ingredients at the spray nozzle, and in the water. Table 3-6 provides conservative estimates assuming that 100 percent of the herbicide reaches the water, and a more realistic estimate assuming 10 to 20 percent of the herbicide reaches the water. The latter range 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.

The calculated maximum concentrations in Table 3-6 reflect potential chemical concentrations immediately after (or during) spraying. However, herbicides dissipate over time, as most of the Delta is subject to tidal action and/or water flow. Thus, the concentration of chemicals will be further diluted as water moves within the Delta.

In 1982, prior to the start of the WHCP, USDA-ARS (Anderson 1982) conducted field tests of 2,4-D levels following herbicide applications at Coney Island, in the Delta. Anderson applied the herbicide at a rate that was 25 percent higher than the labeled maximum. Anderson collected samples in float samplers (open-top vessels 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. **Table 3-7,** on the next page, provides the range and average for test measurements.

WHCP environmental monitoring results provide additional data on actual herbicide residue levels following treatments. Between 2001 and 2005, DBW obtained chemical residue tests on 110 water samples collected 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 37 2,4-D sites ranged from non-detectable (ND), to 390 ppb. The average concentration at each of the 14 glyphosate sites ranged from non-detectable to 158 ppb. **Exhibit 3-3,** on page 3-52, summarizes herbicide concentrations of the in-treatment-site samples for 2001 to 2005.

Table 3-7
Results of Delta Coney Island Field Test, Concentrations of 2,4-D Following 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

Over three years of environmental monitoring (2006 to 2008), DBW has monitored receiving waters directly downstream of the treatment sites, immediately 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 three year period, DBW conducted 36 sampling events for 2,4-D, and 21 sampling events for glyphosate. DBW also monitored Agridex® at all the 57 sampling events. In every case, Agridex® concentrations were non-detectable.

Exhibit 3-4, on page 3-52, illustrates the 2006 to 2008 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 Exhibit 3-3. 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.

Seven of the 2006 to 2008 post-treatment receiving water 2,4-D samples (12 percent), were at non-detectable levels. In a few cases, 2,4-D levels were slightly higher in follow-up sampling (a maximum of 16.3 ppb at one site), although generally 2,4-D levels declined to even lower levels in the follow-up visit.

Glyphosate was tested fewer times, because the herbicide was used less frequently during the 2006 to 2008 treatment seasons. Of the 21 glyphosate receiving water sample events during 2006 to 2008, 15 resulted in non-detectable levels. All but one of the remaining glyphosate samples were at extremely low levels, ranging from 0.3 ppb to 1.9 ppb with one 2008 sample at 21 ppb. 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 2,4-D, glyphosate, and adjuvant levels in the Delta following herbicide treatment are low. Maximum 2,4-D levels immediately after spraying within a treatment site may reach levels as high as 400 ppb (0.4 ppm), although this was uncommon. Maximum 2,4-D levels immediately downstream of the site are likely to be less than 10 ppb. 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).

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

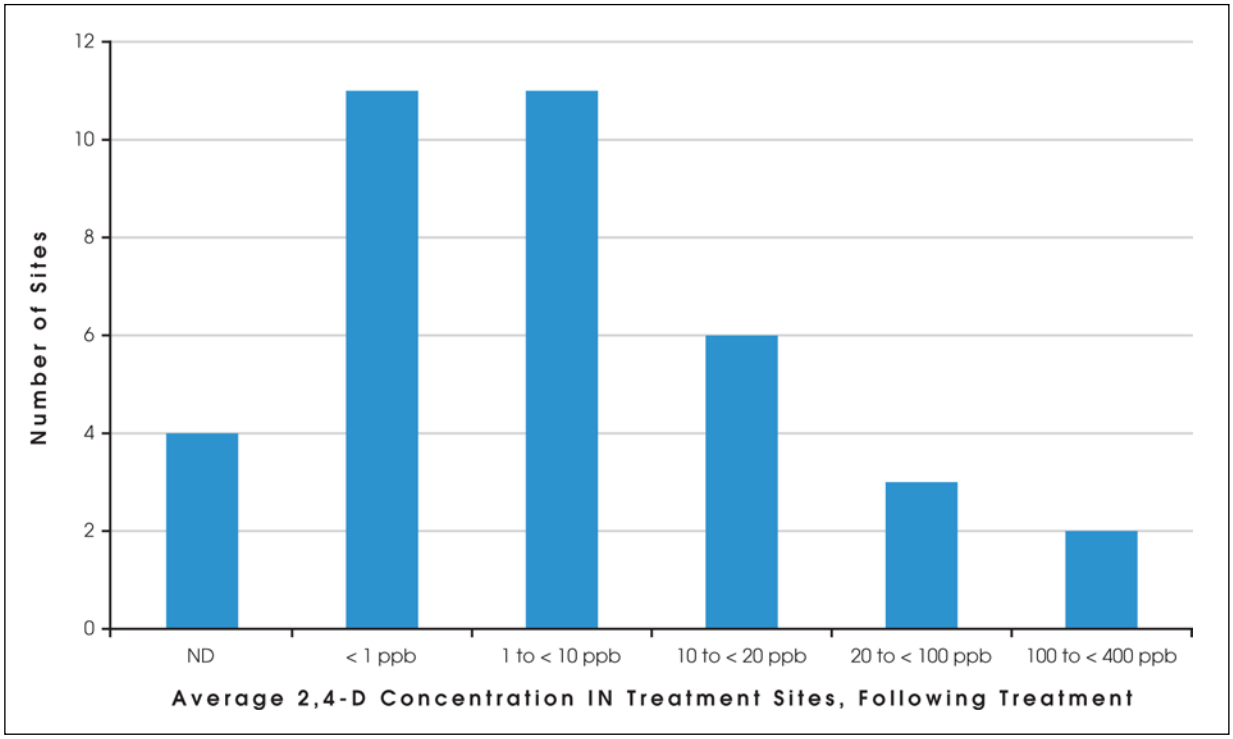


Exhibit 3-3b
Number of Sites at Various Glyphosate Concentrations (IN Treatment Site) (2001 to 2005)

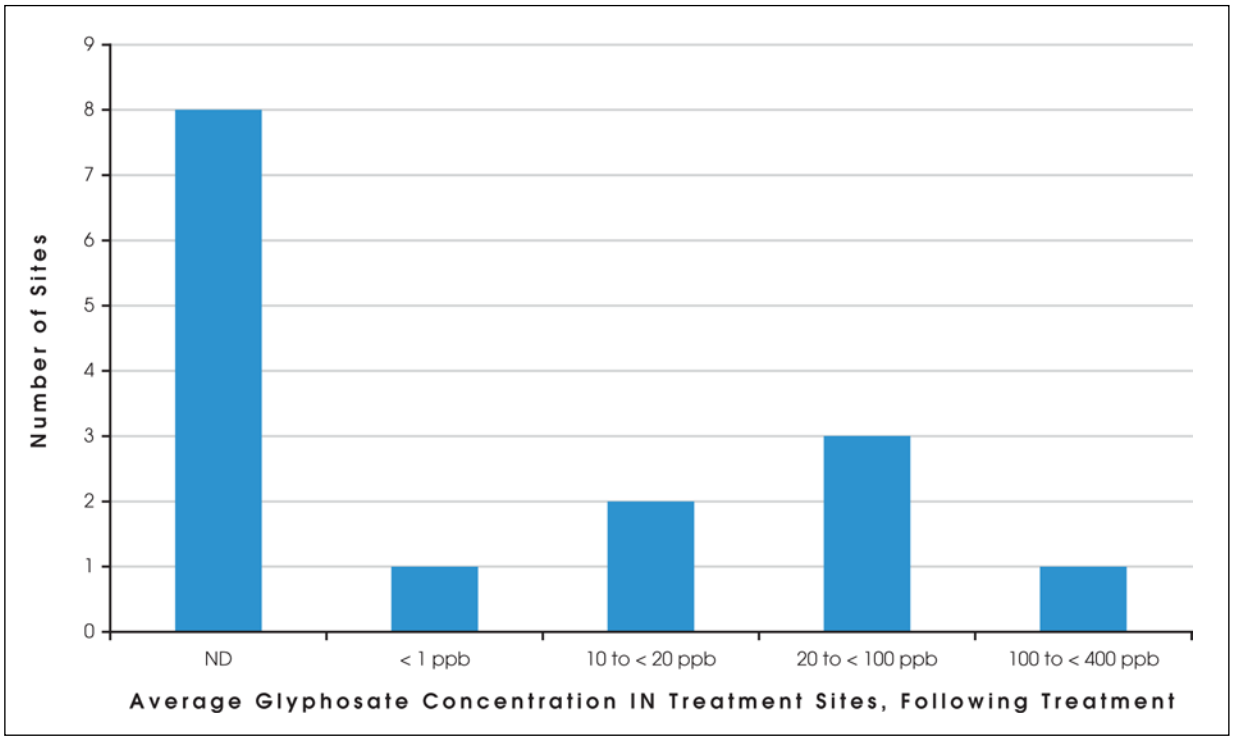


Exhibit 3-4a

Number of Sites at Various 2,4-D Concentrations (Downstream, IN Receiving Waters) (2006 to 2008)

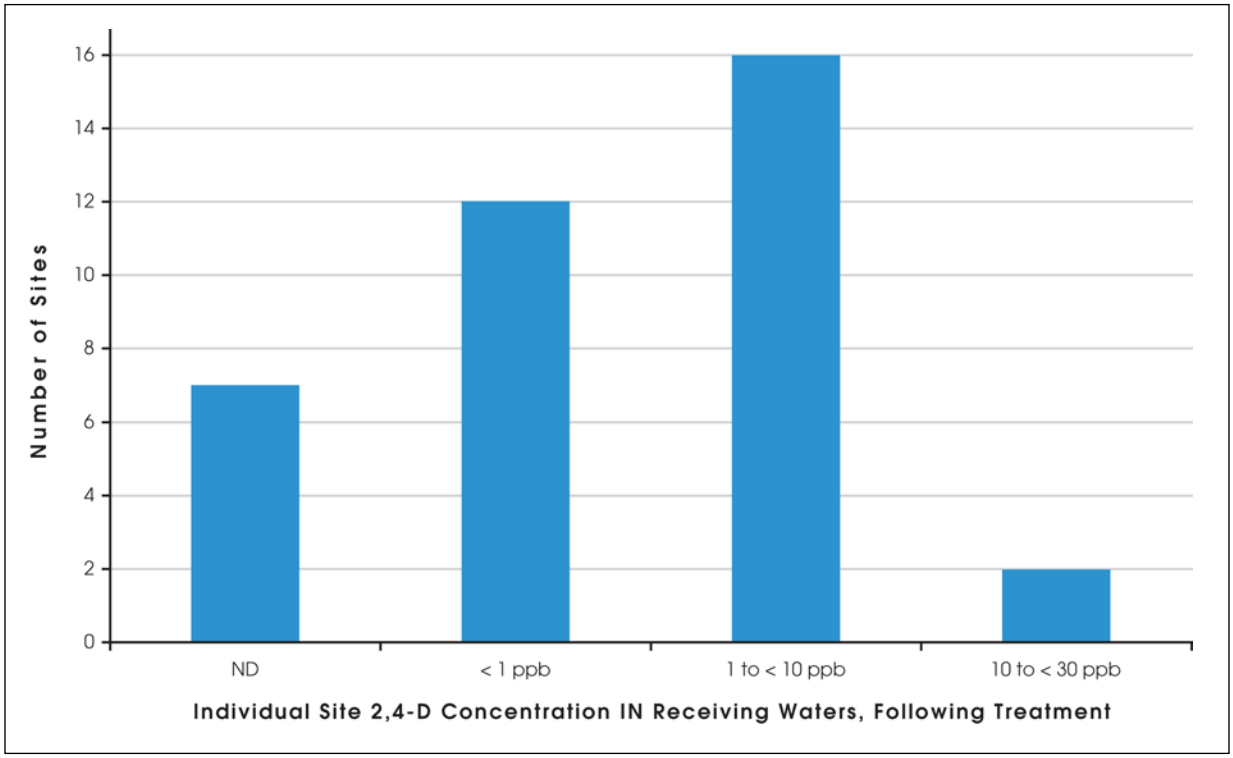
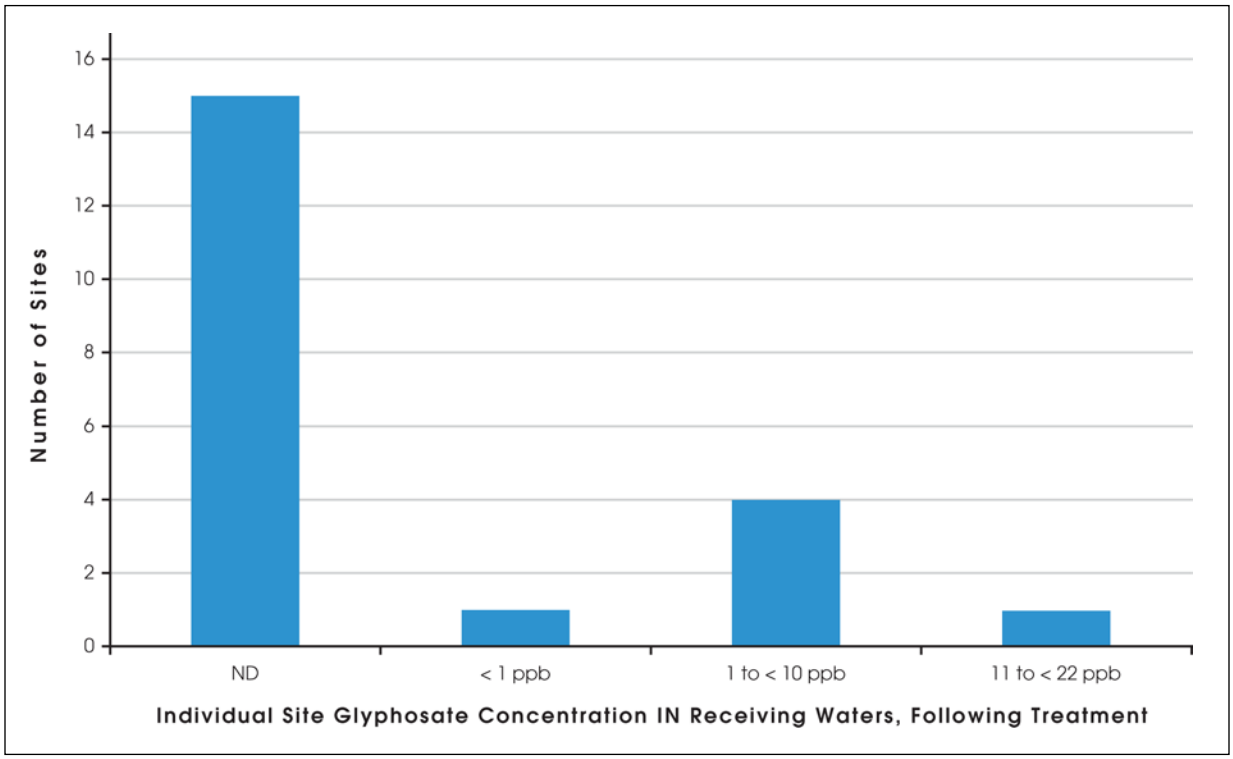


Exhibit 3-4b

Number of Sites at Various Glyphosate Concentrations (Downstream, IN Receiving Waters) (2006 to 2008)



Fate of WHCP Herbicides in Water

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 WHCP occurs within a highly dynamic, and vast, Delta. There are approximately 50,000 surface acres of waterways in the Delta. Annual treatment acreage ranges from 200 to 2,500 acres, thus each year the WHCP treats between 0.002 percent and five percent of the Delta waters. As most WHCP treatment locations are classified either tidal, or fast- or slow-moving riverine (see Table 2-2), herbicide concentrations will not remain at their immediate post-treatment levels. Thus, any potential impacts resulting from WHCP 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. 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. 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.

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). 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).

Potential for Toxic Effects of WHCP Herbicides on Fish

The levels of herbicide and adjuvant utilized by the WHCP are unlikely to result in acute toxic effects to special status or other fish, including

impacting movement of native resident or migratory fish. **Table 3-8**, on the next page, provides LC50 values for WHCP chemicals for a variety of fish species. These levels are significantly higher than the maximum concentrations of 2,4-D, glyphosate, or adjuvants in or immediately downstream of treatment sites.

There has been relatively little research on the toxic effects of adjuvants. Nonylphenol ethoxylate (NPE) surfactants are more toxic to aquatic species that most aquatic pesticides, and may also cause endocrine disruption. NPE adjuvants such as R-11® have been eliminated from the WHCP as a result.

The non-ionic adjuvant Agridex®, which replaced R-11®, has significantly lower toxicity, with LC50 levels greater than 1,000 mg/l (ppm). The DBW may consider use of another adjuvant, Competitor®. This adjuvant, which has not been utilized by the WHCP to-date, appears to have higher acute toxicity than Agridex®, but it is still far above WHCP exposure levels (see Table 3-6). Competitor® would be used at the same concentration as Agridex®.

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. These studies are indicative of actual environmental impacts, as they reflect Delta conditions, and/or laboratory results specifically related to the WHCP. 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 and glyphosate on larval delta smelt, larval Sacramento splittail, and larval fathead minnows. The results of these studies are provided in **Table 3-9,** on page 3-57. The study concluded that 2,4-D and 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 (2004) conducted 96 hour and seven day toxicity screening of WHCP 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 were orders of magnitude higher than concentrations resulting from the WHCP
- 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 the WHCP
- The 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 Game laboratories to conduct five different toxicology tests. Based on an examination of toxicology test results from post-treatment water samples, it appears that the WHCP did not have a significant or consistent adverse affect on test organisms used by the laboratories (including fathead minnow)
- In the DBW analysis, there were 20 samples which exceeded previous NPDES permit levels (20 ppb) for 2,4-D (NPDES permit levels are now 70 ppb 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. While none of the glyphosate samples exceeded NPDES permit criteria (700 ppb), the CDFG

Table 3-8
Response of Various Fish Species to WHCP Chemicals, 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
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
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
Rainbow trout	Agridex®	>1,000 ppm	96 hr	WSDA 2005
Rainbow trout	Competitor®	95 ppm	96 hr	WSDA 2005

Table 3-9
CDFG Study Results, Acute Toxicities of 2,4-D and Glyphosate on Three Larval Fish Species, 96 Hour LC50 Values (in ppm)

Fish Species	2,4-D LC50	Glyphosate LC50
Larval delta smelt	149 ppm	270 ppm
Larval Sacramento splittail	446 ppm	1,132 ppm
Larval flathead minnow	216 ppm	1,154 ppm

Table 3-10
Aquatic Animal and Plant Levels of Concern

Risk Presumption	Risk Quotient	Level of Concern
Acute High Risk	EC/LC50 or EC50	0.5
Acute Restricted Use	EC/LC50 or EC50	0.1
Acute Endangered Species	EC/LC50 or EC50	0.05
Chronic Risk	EC/MATC or NOEC	1

Sources: Siemering et al. February 2005; Siemering et al. 2008

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 had an adverse effect on fathead minnow growth. (It is worth noting that 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 WHCP treatments (and/or simply from ambient Delta waters) on larval fish 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.

SFEI prioritized aquatic pesticides for further study, analyzed three years of monitoring data, and conducted several special studies of high priority pesticides. Both 2,4-D and glyphosate were among the herbicides evaluated by SFEI. Using an U.S. EPA methodology, SFEI calculated risk quotients (RQ) for each pesticide. The RQ was equal to the water chemical concentration divided by an acute or chronic toxicity value: RQ = Exposure/Toxicity. SFEI utilized the lowest available toxicity values in the scientific literature in order to ensure that RQ values were conservative.

SFEI compared the RQ values to a Level of Concern (LOC). LOC's are unit-less values determined by the U.S. EPA Office of Pesticide Programs. When the RQ is higher than the specified LOC, it is an indication of the need for further investigation of that particular chemical application. **Table 3-10**, above, provides the USEPA's LOCs.

Siemering et al., (February 2005) also provide USEPA's interpretations of the LOC risks:

- Acute high risk: potential for acute risk is high; regulatory action may be warranted in addition to restricted use classification
- Acute restricted use: the potential for acute risk is high, but this may be mitigated through restricted use classification
- Acute endangered species: the potential for acute risk to endangered species is high, but this may be mitigated through restricted use classification
- Chronic risk: the potential for chronic risk is high; regulatory action may be warranted.

For 2,4-D, the RQ values for Chinook salmon LC50, *Pimephales promelas* (fathead minnow) LC50, and delta smelt NOEC were all well below the 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). In similar analyses for glyphosate, there were also no LOC exceedances. Of the eight aquatic pesticides evaluated, SFEI ranked glyphosate as the lowest risk (Siemering et al. 2008).

SFEI did identify LOC exceedances for the surfactant R-11®. As a result of these concerns, DBW eliminated R-11® from the WHCP at the end of the 2003 treatment season.

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. 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." For 472 RQ values calculated for Agridex® in 2004 and 2005, SFEI also found no LOC exceedances.

While the risk of acute toxicity to special status or other fish resulting from the WHCP is extremely low, there is concern about chronic/sublethal toxicity impacts from both 2,4-D and glyphosate. 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) was 0.164 mg/l (or 164 ppb). There was no observed effect at the lowest two exposure concentrations.

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.

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.

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 the WHCP. Similarly, WHCP exposure levels of glyphosate are significantly lower than the long-term exposure levels tested by Li and Kole.

In addition, special status and native fish species may not commonly be present near water hyacinth, further reducing risk of exposure to WHCP chemicals. Toft et al., (2003) sampled fish adjacent to water hyacinth, and found that most of the fish were juveniles, and non-indigenous to the Delta. Three native species, Sacramento splittail, tule perch, and prickly sculpin accounted for only 8.2 percent of the fish captured at one Delta site (Toft 2003).

Potential for Toxic Effects of WHCP Herbicides on Amphibians and Reptiles

As compared to fish, there is significantly less information related to the toxic effects of WHCP herbicides and adjuvants to amphibians and reptiles. However, the limited information that is available indicates that toxic impacts to amphibians and reptiles resulting from the WHCP are highly unlikely.

Generally, 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.

Because of the scarcity of reptile studies, one of the conditions of the WHCP's initial USFWS Biological Opinion was to conduct snake toxicity testing of WHCP herbicides. The DBW provided funding to the CDFG to conduct acute oral and dermal toxicity studies on garter snakes (Hosea et al. 2004). CDFG 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 the WHCP 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 3-11
Concentrations of Test Solutions and Calculated Exposure Ranges for Herbicides, Surfactants, and Mixtures from CDFG 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

Table 3-11, above, provides the concentrations of test solutions and actual exposure range (in mg/kg body weight). CDFG 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. CDFG 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).

Much of the amphibian toxicity data in the literature for glyphosate was based on the herbicide Roundup®, and is not relevant for the WHCP. 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®. Rodeo® was previously utilized by the WHCP, and is essentially the same formulation as AquaMaster™, the current WHCP glyphosate herbicide.

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).

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 *Xenopus* 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 WHCP 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).

Perkins et al., (2000) examined the effect of various glyphosate herbicides, including Rodeo®, on *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).

In early WHCP documentation, the USFWS considered the potential impact of WHCP treatments on special status reptiles:

> *"The concentration of Weedar® or Rodeo® [equivalent to AquaMaster™] used on water hyacinth is not known to be toxic to reptiles (Van Way 1995), and direct exposure of giant garter snakes to these herbicides is unlikely. Giant garter snakes bask on grassy banks and on branches over the water's edge where herbicide applications will not occur. The giant garter snake is extremely shy and snakes in the water or on top of water hyacinth mats would probably move out of the area as the boat crews approach in motor driven boats. Emergent vegetation is used by adults for escape cover and for foraging habitat, and young use dense emergent vegetation for cover while absorbing their yolk sacks. Water hyacinth herbicides are applied only to water hyacinth and will not affect emergent vegetation or snakes utilizing emergent vegetation. The small potential adverse effect herbicide application could have on any giant garter snakes present is likely to be greatly outweighed by the benefit of water hyacinth removal on the species' habitat. Open water surface is a habitat requisite for this species (USFWS 1993). Water hyacinth infestations inhibit giant garter snakes from foraging and are reducing the numbers of prey species.*
>
> *It is unlikely that northwestern pond turtles would be directly exposed to the herbicides applied on the water hyacinth. Pond turtles are wary, and will quickly leave basking sites when approached. Water hyacinth control would benefit northwestern pond turtles on the Refuge by increasing food availability. Removal of water hyacinth mats would lead to an increase in the abundance and diversity of macroinvertebrates, tadpoles, small fish, and both submergent and floating native plant species"* (USFWS 1995, 5-6).

Potential for Toxic Effects of WHCP Herbicides on Birds

Birds 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.

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. **Table 3-12,** on the next page, summarizes the toxicity data for birds. These concentrations are significantly higher than potential exposures to 2,4-D from the WHCP, either indirectly through contaminated food, or directly through spray from herbicide drift or contact with water.

Table 3-12
Response of Various Bird Species to WHCP Chemicals, as LC50 or LD50 Values

Species	Chemical	LC50 or LD50	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
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

Glyphosate is practically nontoxic to birds. Toxicity studies for glyphosate are also summarized in Table 3-12. 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 WHCP, either indirectly through contaminated food sources or directly through spray from herbicide drift or contact with water. Thus, toxic impacts to bird species from the WHCP 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 WHCP exposures. In addition, it is not clear whether impacts resulted from glyphosate or POEA exposure.

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 WHCP herbicides are minimal.

WHCP 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.

* * * * *

It is extremely unlikely that there would be acute toxic impacts from WHCP herbicide or adjuvants to special status fish, amphibians, reptiles, or birds, or that WHCP 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 six mitigation measures.

- **Mitigation Measure B2a** – 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 specific locations and times are specified in the WHCP NOAA-Fisheries Biological Opinion (NOAA-Fisheries 2006), pages 9 and 10, and in maps provided to WHCP treatment crews. The Biological Opinion is provided in Appendix B of this Draft PEIR.

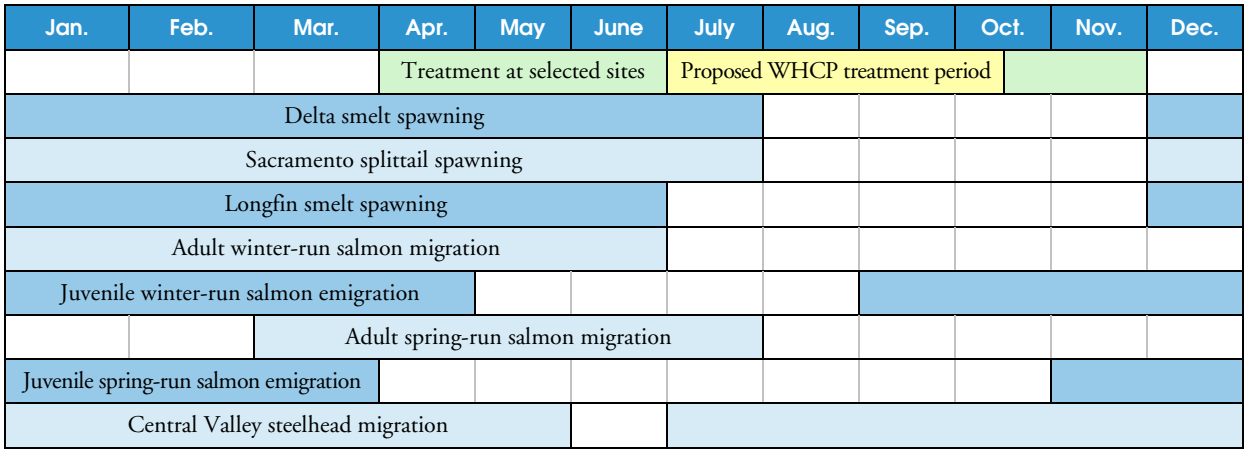
  Between July 1st and October 15th, there are no restrictions for areas to be sprayed within the project area. No earlier than April 1st, and prior to July 1st, only certain areas where migratory fish are not likely to be present may be treated. Certain sites, including the San Joaquin River upstream of the confluence of the Merced River, may be treated as late as November 30th. No sites may be treated between November 30th and April 1st.

  These treatment time restrictions minimize potential exposure of migratory salmonids and sensitive juvenile fish to WHCP herbicides. **Exhibit 3-5,** on the next page, illustrates spawning and migration times for several special status fish, in relation to WHCP treatment times.

- **Mitigation Measure B2b** – Monitor herbicide and adjuvant levels to ensure that the WHCP does not result in potentially toxic concentrations of chemicals in Delta waters.

  The DBW will conduct comprehensive monitoring. This monitoring is in compliance with the general NPDES permit, and NOAA-Fisheries and USFWS Biological Opinions. The 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 ten (10) percent of the sites it treats for each pesticide, per water body type. Water samples will be submitted to a certified analytical laboratory to measure 2,4-D, glyphosate, and adjuvant levels. Should these levels exceed allowable limits, DBW will take immediate measures to reduce chemical levels at future treatment sites.

Exhibit 3-5
Proposed Period of WHCP Treatments; Periods of Spawning in the Delta; and Migration and Emigration of Special Status Fish Species through the Sacramento-San Joaquin River System



Source: DBW 2001.

- **Mitigation Measure B2c** – 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 WHCP 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 water hyacinth to be treated each year, until treatment acreage reaches a minimal level. This will reduce the volume of herbicide utilized by the WHCP.

- **Mitigation Measure B2d (same as Mitigation Measure B1a)** – 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 training on special status species and sensitive habitats. 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 opinions; incidental take procedures; and that unlawful take of an animal or destruction of its habitat is a violation of the Endangered Species Act.

  The DBW also 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 fish, amphibians, reptiles, or birds are present. Crews will complete an Environmental Observations Checklist for each site to document the presence or absence of special status species. If any special status species are present at the site, the field crew will not perform any treatment.

- **Mitigation Measure B2e** – Provide treatment crews with electronic mapping that identifies previously surveyed areas for giant garter snake habitat (see hard copy example in Exhibit 3-2).

  Application crews will use this map as a tool for performing pre-application visual inspections for the presence of giant garter snakes. If giant garter snakes are present, treatment crews will not treat at that location.

- **Mitigation Measure B2f (same as Mitigation Measure B1c)** – Conduct herbicide treatments in order to minimize potential for drift.

  In addition to complying with application 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. The DBW crews will change nozzle type and spray pressures whenever conditions warrant, limiting the amount of herbicide which may inadvertently contact non-target species.

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

The WHCP is not likely to result in significant adverse 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.

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).

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). Wang et al., (2004) also 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 neither glyphosate or 2,4-D bioaccumulates 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.

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).

In an AquaMaster™ fact sheet, Monsanto (2002) states that "in laboratory studies conducted with glyphosate, biocentration 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 include marine mollusks and crustaceans, also showed low potential for bioaccumulation."

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).

Based on existing evidence, neither 2,4-D, glyphosate, or the adjuvant Agridex® are 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 WHCP 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 WHCP, 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.

The 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. Generally, 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. Generally, Toft et al., found the two plants to be not functionally equivalent, with the native pennywort providing better habitat and food sources for native invertebrates and fish species. This would indicate that if there was loss of invertebrates due to WHCP treatments, the impact on the food web would likely not be significant.

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). 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).
- 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).

When Weedar® 64 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 the WHCP. LC50 values for most zooplankton were over 100 ppm 2,4-D, while two species had LC50 values ranging from 1 to 10 ppm 2,4-D (Halter 1980). LC50 values for 2,4-D for benthic invertebrates were found to be generally over 1,000 ppm and over 10 ppm in life-cycle invertebrate tests using eggs and early life stages (Halter 1980). **Table 3-13**, on the next page, summarizes toxicity data for invertebrate species at various life stages for 2,4-D, glyphosate, and two adjuvants.

When glyphosate is applied at labeled rates, the herbicide is not likely to have a negative impact on aquatic invertebrates. Invertebrates appear to be 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.

Chronic toxicity tests using WHCP chemicals also found impact levels several orders of magnitude greater than likely exposure levels. The California Department of Fish and Game, Aquatic Toxicology Laboratory, conducted seven day chronic toxicity tests on the water flea neonates, *Ceriodaphnia dubia* (CDFG 2003). The seven day LC50 for Weedar® 64 was 97 ppm. The seven day LOEC for Weedar® was 40.5 ppm. CDFG used the glyphosate herbicide Rodeo® for toxicity testing. The seven day LOEC for Rodeo® was 104 ppm.

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

In the DBW analysis, there were 20 samples which exceeded 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.

While none of the glyphosate samples exceeded NPDES permit criteria (700 ppb), the CDFG 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 2,4-D or glyphosate, it is not possible to attribute the small number of cases with adverse effects on exposure to 2,4-D or glyphosate.

The US EPA presumes that a pesticide poses a risk to nontarget aquatic biota when the ratio of the acute LC50 to the environmental concentration is less than or equal to 10 (Henry 1994). When glyphosate or 2,4-D are applied at labeled rates, assuming that 10 to 20 percent of the chemical reaches the water, the concentration of herbicide active ingredient in one acre-foot of water is between 0.2 ppm to 0.6 ppm. Thus, LC50 values of 2 ppm to 6 ppm, much lower than most of the values in Table 3-13, might be expected to pose risk to aquatic invertebrates.

Table 3-13
Response of Various Invertebrate Species to WHCP Chemicals, at LC50 Values

Species	Chemical	LC50	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	CDFG 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	48hr	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	CDFG 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	96hr	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
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	Agridex®	>1,000 ppm	48 hr	WSDA 2005
Daphnia	Competitor®	>100 ppm	48 hr	WSDA 2005

It is unlikely that there would be significant adverse effects to special status, resident native, or migratory fish from WHCP impacts on the Delta food web. Given the low levels of herbicides utilized, and the limited treatment acreage, the potential for food web effects to impact special status fish, resident native or migratory fish, is likewise low. However, should such 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 three mitigation measures.

- **Mitigation Measure B4a (same as Mitigation Measure B2b) –** Monitor herbicide and adjuvant levels to ensure that the WHCP does not result in potentially toxic concentrations of chemicals in Delta waters.

  The DBW will conduct comprehensive monitoring. This monitoring is in compliance with the general NPDES permit, and NOAA-Fisheries and USFWS Biological Opinions. The 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 ten (10) percent of the sites it treats for each pesticide, per water body type. Water samples will be submitted to a certified analytical laboratory to measure 2,4-D, glyphosate, and adjuvant levels. Should these levels exceed allowable limits, DBW will take immediate measures to reduce chemical levels at future treatment sites.

- **Mitigation Measure B4b (same as Mitigation Measure B2c) –** 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 WHCP and alternative control methodologies; report findings to regulatory agencies; and adjust program actions, as necessary, in response to recommendations and evaluations by DBW, 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 water hyacinth to be treated each year, until treatment acreage reaches a minimal level. This will reduce the volume of herbicide utilized by the WHCP.

- **Mitigation Measure B4c (same as Mitigation Measure B1a and B2d) –** Avoid herbicide application near special status species, and sensitive riparian and wetland habitat; and other biologically important resources.

  Each year, prior to the start of the treatment season, DBW will conduct field crew training on special status species and sensitive habitats. 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 opinions; incidental take procedures; and that unlawful take of an animal or destruction of its habitat is a violation of the Endangered Species Act.

  The DBW also 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 species are present. Crews will complete an Environmental Observations Checklist for each site to document the presence or absence of special

status species. If any special status species are present at the site, the field crew will not perform any treatment.

* * * * *

There also are potential positive impacts to the Delta food web resulting from the WHCP. Rapid growth and invasion of water hyacinth reduces open water habitat and impairs wetlands and sensitive riparian habitats, altering the natural food web. Toft et al. (2003) found that removal of water hyacinth also resulted in loss of the non-native amphipod *Crangonyx floridanus*, a species which was not prevalent in fish diets. Toft suggested that once an invasive species such as water hyacinth is removed from the system, "aspects of the community can return to a more natural pre-invasion state" (Toft et al. 2003).

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 WHCP 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 water hyacinth, other aquatic macrophytes, and algae following herbicide application. Decomposition of vegetative material may create an organic carbon slug, 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. Generally, 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 water hyacinth 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 generally impair sensitive riparian or wetland habitats.

The label for Weedar 64® (2,4-D) notes that decaying weeds use up oxygen, and recommends treating only one-half of a lake or pond to avoid fish kill. In larger bodies of weed infested waters, the label recommends leaving 100-foot wide buffer strips untreated, and delaying treatment of these strips for four to five weeks, until the treated dead vegetation has decomposed. The label for AquaMaster™ (glyphosate) recommends treating an area in strips when there is full coverage of the weed in impounded areas to avoid oxygen depletion. The DBW follows these label recommendations in their operations, to avoid reductions in DO.

Dissolved oxygen levels under water hyacinth are already low. 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 mats with low dissolved oxygen, even prior to treatment (NOAA-Fisheries 2006).

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 WHCP 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 four mitigation measures. These mitigation measures are also included within DBW's Fish Passage Protocol for the WHCP.

- **Mitigation Measure B5a** – Monitor dissolved oxygen levels pre- and post-treatment for all WHCP 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, WHCP 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 B5b** – Treat no more than three contiguous acres at any treatment site.

  Crews will create a buffer zone around all treatment sites to ensure that impacts will be spread out and not segregated to one larger area. Buffer zones will be at least equal in size to the previously treated site. After treating three maximum acres, crews will then skip at least one adjacent site before treating another site. The DBW crews will not treat skipped sites until two tidal changes have occurred or, in nontidal areas, until 24 hours after treatment.

- **Mitigation Measure B5c** – Treat no more than one-half of the area at one time of completely infested dead-end sloughs to allow for fish passage.

  The DBW will return to treat the remaining half according to label instructions and permit conditions. The remaining area may be treated after four to five weeks, or when the dead vegetation has decomposed.

- **Mitigation Measure B5d** – Treat no more than one-half of completely infested moving waterways at one time to allow for fish passage.

  The DBW will not treat the remaining area until the treated water hyacinth is decomposed or until a passage has opened up in the waterway.

* * * * *

There also are positive impacts related to dissolved oxygen that will result from the WHCP. Dissolved oxygen levels at treatment sites will increase, improving fish habitat, once dead water hyacinth have decayed or floated away. Removing large patches of water hyacinth 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 WHCP herbicide treatments, handpicking, or herding, 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 water hyacinth and other vegetation management activities using boats have been conducted for over 25 years. Thus, fish are likely habituated to a substantial degree of boat-related noise. The WHCP 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.

Airboat noise and related disturbances during WHCP 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 WHCP treatment has the potential to result in noise-related disturbances to waterfowl. Two special status bird species, yellow-headed blackbird *(Xanthocephalus xanthocephalus)* and tricolored blackbird *(Agelaius tricolor)*, could nest adjacent to WHCP treatment locations during summer treatment months. There is the potential that

these species would be disturbed by WHCP vessels. This disturbance would be temporary, and would occur at most one to two times per treated site. However, this disturbance would represent **an avoidable significant impact that would be reduced to a less-than-significant level** by implementation of the following two mitigation measures.

- **Mitigation Measure B6a (same as Mitigation Measure B1a, B2d, and B4c)** – Avoid herbicide application near special status species, and sensitive riparian and wetland habitat; and other biologically important resources.

  In particular, avoid treatments near special status bird species nesting sites. Each year, prior to start of the treatment season, DBW will conduct field crew training on special status species. 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 opinions; incidental take procedures; and that unlawful take of an animal or destruction of its habitat is a violation of the Endangered Species Act. This training will also include discussion of tricolored blackbird and yellow-headed blackbird nesting patterns and site identification.

  The DBW also will examine CNDDB records to determine if special status bird species have been sited within WHCP treatment locations, and prepare a map for field crews identifying such sites. Prior to treating a site, crews will conduct a visual survey 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 any nesting sites for yellow-headed blackbird or tricolored blackbird are present at the site, the field crew will not perform any treatment.

- **Mitigation Measure B6b (same as Mitigation Measure B1d)** – 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.

Impact B7 – Plant fragmentation: effects of plant fragmentation on sensitive habitat and wetlands

There is the potential for plant fragmentation resulting from WHCP activities to impact sensitive habitats and wetlands. Handpicking water hyacinth in nursery and sensitive areas will occur from November through February. Two-person field crews will utilize boats, 30-gallon barrels, and lawn-grooming rakes for handpicking. Each crew consists of one person driving the boat, and one person handpicking water hyacinth. The crew member will use the lawn-groom rake to collect water hyacinth and place it in 30-gallon barrels.

Herding in the western portion of the Delta near Antioch may occur from November through February. Herding will be planned based on tides, storm events, and dam releases. Herding will be conducted by field crews using spray boats fitted with a rebar and wire U-shaped "cage" mounted to the front of the boats. The boats will approach the water hyacinth and push the mat or a section of the mat toward the main channel, where it will be pushed out of the Delta into saline waters. Water hyacinth cannot survive in waters greater than 2 ppt saline. This method is not anticipated to be used as frequently as handpicking.

With handpicking, there is a possibility that some fragments of water hyacinth will float away from the boat before the crew can rake-up the plants. With herding, there is a possibility that some plants will escape the "cage", and not be pushed out of the Delta. The likelihood of either of these events

occurring is low, as both handpicking and herding will take place under slow and deliberate conditions.

Water hyacinth has been shown to successfully propagate from fragments (Spencer et al. 2006). Thus, to the extent that plants or fragments "escape" the handpicking or herding processes, they may propagate into new water hyacinth plants, and establish new water hyacinth colonies. This would potentially impair sensitive habitats and wetlands in the Delta.

Further spread of water hyacinth 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 B7a** – Collect plant fragments during and immediately following treatments.

  To maximize containment of plant fragments, crews will collect water hyacinth fragments. Crews will also be trained on the importance of minimizing fragment escape.

- **Mitigation Measure B7b** – Conduct handpicking and herding only as required.

  The DBW will limit handpicking and herding activities, primarily to winter months, when water hyacinth is dormant. In the unlikely event that water hyacinth fragments escape the raking and/or nets, the dormant plants are more likely to be washed out of the Delta, and less likely to become established, than if they had escaped during the growing season.

Impact B8 – Disposal following handpicking: effects of disposal following handpicking on sensitive habitat and wetlands

Disposal of handpicked water hyacinth, if not properly managed, could impair sensitive habitats and wetlands. To prevent such impacts, disposal of handpicked water hyacinth will occur on levees or other previously surveyed areas with low habitat value. Crews will leave water hyacinth in these dispersal areas to desiccate naturally, and will periodically monitor the areas to observe and record the fate of the water hyacinth and any effects of dispersal activities. Due to high cost and labor requirements of handpicking, the amount of handpicked water hyacinth disposed in this way will be minimal. 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 B8a** – Identify and utilize disposal areas that have no and/or low habitat value for the federal and State listed giant garter snake (*Thamnophis gigas*).

  The 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 B8b** – 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 23 mitigation measures (of which 16 are unique measures) to address the eight (8) potential impacts to biological resources. Several mitigation measures are duplicative, as they apply to more than one impact. For example, Mitigation Measure B1c and Mitigation Measure B2f are identical, addressing the need to conduct herbicide treatments in order to minimize potential for drift. **Table 3-14**, on the next page, combines and summarizes these biological resource mitigation measures.

Table 3-14
Summary of Potential Biological Resource Impacts and Mitigation Measures

	Mitigation Measure Summary[1]	Mitigation Measure Number	Impacts Applied To
1.	Avoid herbicide application near special status species, and sensitive riparian and wetland habitat; and other biologically important resources	Mitigation Measure B1a Mitigation Measure B2d Mitigation Measure B4c Mitigation Measure B6a[2]	Impact B1: Herbicide overspray Impact B2: Herbicide toxicity Impact B4: Food web effects Impact B6: Treatment disturbances
2.	Provide a 250 foot buffer between treatment sites and shoreline elderberry shrubs *(Sambucus* ssp.), host plant for the Valley elderberry longhorn beetle *(Desmocerus californicus dimorphus)*	Mitigation Measure B1b	Impact B1: Herbicide overspray
3.	Conduct herbicide treatments in order to minimize potential for drift	Mitigation Measure B1c Mitigation Measure B2f	Impact B1: Herbicide overspray Impact B2: Herbicide toxicity
4.	Operate program vessels in a manner that causes the least amount of disturbance to the habitat	Mitigation Measure B1d Mitigation Measure B6b	Impact B1: Herbicide overspray Impact B6: Treatment disturbances
5.	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	Mitigation Measure B2a	Impact B2: Herbicide toxicity
6.	Monitor herbicide and adjuvant levels to ensure that the WHCP does not result in potentially toxic concentrations of chemicals in Delta waters	Mitigation Measure B2b Mitigation Measure B4a	Impact B2: Herbicide toxicity Impact B4: Food web effects
7.	Implement an adaptive management approach to minimize the use of herbicides	Mitigation Measure B2c Mitigation Measure B4b	Impact B2: Herbicide toxicity Impact B4: Food web effects
8.	Provide treatment crews with electronic mapping that identifies previously surveyed areas for giant garter snake habitat	Mitigation Measure B2e	Impact B2: Herbicide toxicity
9.	Monitor dissolved oxygen levels pre- and post-treatment for all WHCP treatments	Mitigation Measure B5a	Impact B5: Dissolved oxygen levels
10.	Treat no more than three contiguous acres at any treatment site	Mitigation Measure B5b	Impact B5: Dissolved oxygen levels
11.	Treat no more than one-half of the area at one time of completely infested dead-end sloughs to allow for fish passage	Mitigation Measure B5c	Impact B5: Dissolved oxygen levels
12.	Treat no more than one-half of completely infested moving waterways at one time to allow for fish passage	Mitigation Measure B5d	Impact B5: Dissolved oxygen levels
13.	Collect plant fragments during and immediately following treatments	Mitigation Measure B7a	Impact B7: Plant fragmentation
14.	Conduct handpicking and herding only as required	Mitigation Measure B7b	Impact B7: Plant fragmentation
15.	Identify and utilize disposal areas that have no and/or low habitat value for the federal and State listed giant garter snake *(Thamnophis gigas)*	Mitigation Measure B8a	Impact B8: Disposal following handpicking
16.	Identify and utilize disposal areas that are at least 100 feet away from elderberry shrubs *(Sambucus* ssp.)	Mitigation Measure B8b	Impact B8: Disposal following handpicking

[1] Please refer to the text for the complete mitigation measure description.
[2] Mitigation Measure 6a includes additional provisions specific to special status nesting birds.

Table 3-15

Special Status Species in the Eleven (11) Counties within WHCP Area, Not Likely to be Impacted by the WHCP *Page 1 of 11*

Invertebrates		
Scientific Name	**Common Name**	**Status***
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

Table 3-15
Special Status Species in the Eleven (11) Counties within WHCP Area, Not Likely to be Impacted by the WHCP *(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. *Buteo swainsoni*	Swainson's hawk	CT
7. *Charadrius alexandrinus nivosus*	western snowy plover	FT, CSC
8. *Charadrius montanus*	mountain plover	CSC
9. *Circus cyaneus*	northern harrier	CSC
10. *Coccyzus americanus occidentalis*	western yellow-billed cuckoo	FC, CE
11. *Coturnicops noveboracensis*	yellow rail	CSC
12. *Dendroica petechia brewsteri*	yellow warbler	CSC
13. *Empidonax traillii*	willow flycatcher	CE
14. *Falco peregrinus anatum*	American peregrine falcon	CE
15. *Geothlypis trichas sinuosa*	saltmarsh common yellowthroat	CSC
16. *Grus Canadensis Canadensis*	lesser sandhill crane	CSC
17. *Gymnogyps californianus*	California condor	FE
18. *Haliaeetus leucocephalus*	bald eagle	CE
19. *Icteria virens*	yellow-breasted chat	CSC
20. *Lanius ludovicianus*	loggerhead shrike	CSC
21. *Melospiza melodia maxillaris*	Suisun song sparrow	CSC
22. *Melospiza melodia pusillula*	Alameda song sparrow	CSC
23. *Melospiza melodia samuelis*	San Pablo song sparrow	CSC
24. *Pelecanus occidentalis californicus*	California brown pelican	FE
25. *Progne subis*	purple martin	CSC
26. *Rallus longirostris obsoletus*	California clapper rail	FE, CE
27. *Riparia riparia*	bank swallow	CT
28. *Rynchops niger*	black skimmer	CSC
29. *Sternula antillarum (=Sterna, =albifrons) browni*	California least tern	FE, CE
30. *Strix nebulosa*	great grey owl	CE
31. *Strix occidentalis caurina*	northern spotted owl	FT
32. *Toxostoma lecontei*	Le Conte's thrasher	CSC

Table 3-15

Special Status Species in the Eleven (11) Counties within WHCP Area, Not Likely to be Impacted by the WHCP *(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

Table 3-15
Special Status Species in the Eleven (11) Counties within WHCP Area, Not Likely to be Impacted by the WHCP *(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

Table 3-15

Special Status Species in the Eleven (11) Counties within WHCP Area, Not Likely to be Impacted by the WHCP *(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

Table 3-15
Special Status Species in the Eleven (11) Counties within WHCP Area, Not Likely to be Impacted by the WHCP *(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

Table 3-15
Special Status Species in the Eleven (11) Counties within WHCP Area, Not Likely to be Impacted by the WHCP *(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

Table 3-15
Special Status Species in the Eleven (11) Counties within WHCP Area, Not Likely to be Impacted by the WHCP *(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

Table 3-15
Special Status Species in the Eleven (11) Counties within WHCP Area, Not Likely to be Impacted by the WHCP *(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

Table 3-15
Special Status Species in the Eleven (11) Counties within WHCP Area, Not Likely to be Impacted by the WHCP *(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

Table 3-15
Special Status Species in the Eleven (11) Counties within WHCP Area, Not Likely to be Impacted by the WHCP *(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

[This page intentionally left blank.]