Appendices

Appendix A
WHCP Permits

Appendix A
WHCP Permits

Table of Contents

NPDES Statewide General Permit (CAG990005)

USFWS Biological Opinion (1-1-04-F-0149)

NOAA-Fisheries Biological Opinion (151422SWR2005SA00681:JSS)

[This page intentionally left blank.]

WHCP Permits

NPDES Statewide General Permit (CAG990005)

California Regional Water Quality Control Board

Central Valley Region

Robert Schneider, Chair

Alan C. Lloyd, Ph.D.
Agency Secretary

Sacramento Main Office
11020 Sun Center Drive #200, Rancho Cordova, California 95670-6114
Phone (916) 464-3291 • FAX (916) 464-4645
http://www.swrcb.ca.gov/rwqcb5

Arnold Schwarzenegger
Governor

20 March 2006

Adam Morrill
Department of Boating and Waterways
2000 Evergreen Street, Suite 100
Sacramento, CA 95815

NOTIFICATION OF RECEIPT OF NOTICE OF INTENT (NOI) TO COMPLY WITH THE TERMS OF THE STATEWIDE GENERAL NPDES PERMIT FOR THE DISCHARGE OF AQUATIC PESTICIDES FOR AQUATIC WEED CONTROL IN WATERS OF THE UNITED STATES -GENERAL PERMIT NO. CAG990005 (GENERAL PERMIT)

We have received your NOI to seek coverage under the General Permit. For your reference, your Waste Discharge Identification Number (WDID #) is 5B34AP00002. This number should be referenced in letters and reports submitted regarding this permit.

Under the terms of the permit, the operations described in the NOI may commence upon the submittal of the NOI and annual fee (if first time enrollee). All conditions of this General Permit must be complied with. Any act of noncompliance constitutes a violation of the Clean Water Act and the Porter-Cologne Water Quality Control Act and is grounds for enforcement action.

As part of your NOI packet, we have reviewed your Aquatic Pesticides Application Plan (APAP). Your APAP is complete. Please be aware of the permit conditions and the following important date:

1. The Annual Report [1] must be submitted to the Regional Board by **1 March** of each year.

Failure to submit the required report is subject to a minimum penalty of $3,000 for each 30-day period a report is not submitted. This penalty is mandatory per § 13385.1 of the California Water Code.

If you have any questions, I can be reached at (916) 464-4636 or at ealejandrino@waterboards.ca.gov

Emily Alejandrino

EMILY ALEJANDRINO
Environmental Scientist
Agriculture Unit

[1] Contents of Annual Report can be found on page 4 under Monitoring and Reporting Program in the General Permit.

STATE WATER RESOURCES CONTROL BOARD

FACT SHEET

WATER QUALITY ORDER NO. 2004-0009-DWQ

STATEWIDE GENERAL NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT FOR THE DISCHARGE OF AQUATIC PESTICIDES FOR AQUATIC WEED CONTROL IN WATERS OF THE UNITED STATES GENERAL PERMIT NO. CAG990005

BACKGROUND

On March 12, 2001, the Ninth Circuit Court of Appeals held that discharges of pollutants from the use of aquatic pesticides to waters of the United States require coverage under a National Pollutant Discharge Elimination System (NPDES) permit (Headwaters, Inc. v. Talent Irrigation District[1]). The Talent decision was issued just prior to the major season for applying aquatic pesticides. Because of the serious public health, safety, and economic implications of delaying applications of aquatic pesticides, the State Water Resources Control Board (State Water Board) adopted an interim NPDES permit, Water Quality Order (Order) No. 2001-12-DWQ on an emergency basis.

Order No. 2001-12-DWQ imposed requirements on any discharge of aquatic pesticides from public entities to waters of the United States in accordance with the State Water Board's *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California* (Policy). The Policy establishes procedures for implementing water quality standards for priority pollutants[2] in NPDES permits.

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

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

---

[1] Headwaters, Inc. v. Talent Irrigation District, (9th Cir. 2001) 243 F.3d 526.

[2] The water quality standards for priority pollutants are listed in 40 Code of Federal Regulations (CFR), § 131.38 (b)(1), and include acrolein and copper.

FACT SHEET
WATER QUALITY ORDER NO. 2004-0009-DWQ

ORDER NO. 2001-12-DWQ LAWSUIT

In August 2001, Waterkeepers Northern California (Waterkeepers) filed a lawsuit against the State Water Board challenging several aspects of Order No. 2001-12-DWQ. In a settlement agreement, the State Water Board agreed to fund a comprehensive aquatic pesticide monitoring program (APMP) that would assess pesticide alternatives, receiving water toxicity caused by residual aquatic pesticides, and other monitoring parameters. The State Water Board contracted with the San Francisco Estuary Institute (SFEI) to conduct the program. On February 5, 2004, SFEI provided the draft report to APMP's Steering Committee. On April 13, 2004, SFEI circulated the final report publicly. The report made the following conclusions:

1. **2,4-D**

   The study monitored the effects of 2,4-D D (in the 2,4-D dimethylamine salt formulation) and a nonylphenolethoxylate surfactant at the Stone Lake National Wildlife Refuge. No toxicity was observed at this sampling event.

2. **Acrolein**

   APMP work with acrolein this year focused on development of a field sampling method that would allow for accurate determination of concentrations in the environment. Toxicity testing is difficult for acrolein due to its rapid breakdown and volatilization. As acrolein is labeled as an aquatic pesticide, it is also functionally a biocide with very low Lowest Observed Effect Concentration (LOEC)/No Observed Effect Concentration (NOEC) values. Therefore, anywhere acrolein is found, it can be considered toxic. The most appropriate monitoring at this time would be chemical characterization only. The current U.S. Environmental Protection Agency (USEPA) method has an adequate Method Detection Limit (MDL); however, commonly used field sampling techniques are insufficient and will lead to erroneous results.

3. **Copper**

   Copper sulfate applications were monitored in two reservoirs. In one reservoir treatment area treated with dissolved copper sulfate, toxicity (in the form of mortality) was observed for at least 24 hours after application in juvenile trout. Lethal (mortality) and sublethal (reproduction) toxicity were observed in Ceriodaphnia (water flea) up to one week after application.

   In the reservoir treated with granular copper sulfate applications, significant mortality was observed in Ceriodaphnia and juvenile trout water toxicity tests immediately after application within the treatment area. Follow up water sampling was not conducted because the reservoir received only one application in 2003. Mortality and growth inhibition was also observed in a number of the sediment samples. Sediment copper concentrations exceeded National Oceanographic and Atmospheric Administration

(NOAA) Effect Ratio Low and Medium values. However, the limited toxicity observed in the sediments indicates that the majority of the copper is not bioavailable.
Chelated copper pesticides were monitored during applications in two irrigation canal systems. One system used a product of mixed copper ethanolamines and the other the same product of mixed copper ethanolamines in an emulsified formulation. Chelated copper formulations are likely to have distinct behavior from copper sulfate and each other in aquatic environments based on the chelating agent and other adjuvants.

In both systems where monitoring occurred, the water samples were almost uniformly toxic pre-application and post application. Therefore, no definitive conclusions can be drawn about the toxicity of mixed copper ethanolamines. Copper carbonate is the active ingredient in other chelated copper products and no monitoring of copper carbonate-based pesticides was conducted.

4. **Glyphosate**

Glyphosate was monitored at several locations. It was commonly used with a nonylphenolethoxylate surfactant. No toxicity was found to be associated with the glyphosate applications.

5. **Diquat Dibromide or Diquat**

Diquat was sampled at two locations (one small pond and one Delta slough). At both sites, 100 percent mortality was observed in the acute and chronic Ceriodaphnia toxicity tests one hour after application. Twenty four hours after application to the Delta slough, no toxicity was observed in the treatment area. Additional samples were not gathered from the pond site.

6. **Fluridone**

Fluridone was sampled at several locations. In Costa Ponds, the fluridone water concentration ranged from 0.05 µg/L before application to 7.2 µg/L one hour after application. The fluridone porewater concentration ranged from 0.08-1.24 µg/L. Toxicity was observed in all *Selenastrum* tests conducted, including the water collected before pre-application. This indicates that fluridone was not the only cause of toxicity. No toxicity was observed in the Ceriodaphnia or fathead minnow tests. Monitoring during an application of liquid fluridone, the pesticide was found to accumulate in the tissue of fish and crayfish two weeks after application. At four weeks after the cessation of treatment, tissue concentrations had returned to pre-application levels.

In Big Bear Lake, the fluridone sediment concentrations ranged from 5.88-300 µg/L. Toxicity in the Hyallela tests (10 and 28 day tests) was observed but bore no correlation to sediment fluridone concentration. The sediment fluridone concentration was also not correlated to the pore water fluridone concentration.

7. **Triclopyr**

Only one site treated with triclopyr (in the triclopyr, triethylamine salt formulation) was monitored in 2003. It was used with a nonylphenolethoxylate surfactant. No toxicity was observed.

8. **Nonionic Surfactants**

There is a wide range of surfactants available, but the most commonly used surfactants for aquatic pesticides applications are Target Prospreader Activator and R-11. Both are nonylphenolethoxylate surfactants. There are only limited data available on surfactants.

In summary, these results show that no toxicity was found with the use of 2,4-D, glyphosate and triclopyr. Toxicity testing is difficult for acrolein. Results were inconclusive for diquat and fluridone. Toxicity was conclusive only in copper-based applications. To confirm these results, additional monitoring will be conducted in 2004.

The APMP includes a section on Alternative or Non-Chemical Methods to Aquatic Pest Control. The report found that water quality impacts from alternative or non-chemical methods were temporary or not apparent. Turbidity increased, but usually returned to pre-project status within days. Shredding in stagnant water bodies indicated decreases in dissolved oxygen, increases in nutrients, and an increase in biochemical oxygen demand. Shredding is not selective in its impacts and will shred non-target species within the area being controlled. In water bodies where harvesting was conducted routinely, the effects on water quality appeared to be short-lived, and unlikely to adversely affect beneficial uses. Alum and gypsum may be a substitute for copper in controlling algae, but more research is needed to adequately produce useful results.

Data results indicated that the relative cost-effectiveness of conventional pesticides versus alternative non-chemical methods varied among different project scenarios, including water body and the particular weed being targeted. Using conventional pesticides for floating or submerged weeds in Delta water bodies proved most cost effective. A combination of chemical application and mechanical harvesting for milfoil in Big Bear Lake was most cost effective. Mowing was most effective for vegetation in wetlands. The use of alternative or non-chemical methods should be done at the appropriate time in the life cycle of the targeted weed and at the correct pesticide dilution to increase efficiency.

DISCHARGER MONITORING DATA REVIEW

State Water Board staff reviewed the 2003 annual monitoring reports from dischargers under Order No. 2001-12 DWQ and found that water quality in application areas return to background water quality levels when pesticides are applied with the proper label instructions. Results show that acrolein levels are not detectable after 24 hours. Generally, diquat and glyphosate returned to below water quality objective levels five days after application. Copper dissipated within two

weeks when applied in small amounts or percentages. If greater amounts of copper were used, it took up to four weeks for the water to return to levels observed before application.

AQUATIC PESTICIDE PROJECTS

The use of aquatic pesticides by Control Agencies[3] is necessary to manage resources and maintain beneficial uses, such as to ensure the proper operation of municipal and agricultural irrigation water distribution systems, maintain capacity in flood control channels, maintain boating access, and control invasive species. Weed control projects are undertakings necessary to control a specified type of weed to an acceptable level in the treatment area[4] that is being managed. The need for aquatic pesticide application events as part of a project can vary from week to week and from season to season due to such things as temperature and flow of the receiving water. It is a balancing act between managing resources and impairing resources. This General Permit and the other governmental regulatory programs described below provide different pieces to ensure this balancing act is successful.

RELATED AQUATIC PESTICIDE REGULATIONS

Pesticide formulations contain disclosed active ingredients that yield toxic effects on target organisms and may also have toxic effects on non-target organisms. They also contain inactive or inert ingredients, as well as adjuvants. Adjuvants are compounds chosen by the discharger and added to aquatic pesticides during an application event to increase the effectiveness of the aquatic pesticides on target organisms. Inactive ingredients and adjuvants are trade secrets and have not been publicly disclosed.

According to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), USEPA has sole jurisdiction of pesticide label language. Label language and any changes thereto must be approved by USEPA before the product can be sold in this country. As part of the labeling process, USEPA evaluates data submitted by registrants to ensure that a product used according to label instructions will cause no harm (or "adverse impact") on non-target organism that cannot be reduced (or "mitigated") with protective measures or use restrictions. Registrants are required to submit data on the effects of pesticides on target pests (efficacy) as well as effects on non-target pests. Data on non-target effects include plant effects (phytotoxicity), fish and wildlife hazards (ecotoxicity), impacts on endangered species, effects on the environment, environmental fate, breakdown products, leachability, and persistence; however, FIFRA is not necessarily as protective of water quality as the Clean Water Act (CWA).

---

[3] The Control Agency is the permitted discharger authorized by this General Permit. It is the agency responsible for controlling the weeds or pests. In some cases, such as irrigation districts, the Control Agency may own the conveyance system. In other cases, such as application to Delta waters, the Control Agency may not own the water body or conveyance system into which aquatic pesticides are applied. Additionally, the Control Agency may be the pesticide applicator, but it may also contract with a separate entity that does the actual pesticide application. In either case, however, the Control Agency must ensure that the discharge is in compliance with this General Permit.

[4] The treatment area is the area being treated by the aquatic pesticide to control weeds and therefore, the area being targeted to receive lethal doses of aquatic pesticides. It is the responsibility of the discharger to define the treatment area for each specific location that it discharges to.

Department of Pesticide Regulation (DPR) is responsible for reviewing the toxic effects of aquatic pesticide formulations and determining whether a pesticide is suitable for use in California's waters through a registration process. To do this, DPR also reviews data submitted by the registrants. While DPR cannot require manufacturers to make changes in labels, DPR can refuse to register products in California unless manufacturers address unmitigated hazards by amending the pesticide label. Consequently, requirements that are specific for use in California are included in many pesticide labels that are approved by USEPA.

DPR also licenses applicators of pesticides designated as a "restricted material"[5]. To legally apply these pesticides, the applicator must be a holder of a Qualified Applicator Certificate or work under the supervision of someone who is certified. For aquatic pesticides, the qualified Applicator Certificate must have the category "aquatic."

State regulations require that the County Agricultural Commissioners (CACs) determine if a substantial adverse environmental impact will result from the proposed use of a restricted material. The CAC implements this by issuing Use Permits for the application of pesticides considered as restricted materials. In evaluating local conditions, CACs may use information supplied by DPR, which suggests permit conditions that reflect minimum measures necessary to protect people and the environment. State regulations require that specific types of information be provided in an application to the CACs for a pesticide use permit. The CACs review the application to ensure that appropriate alternatives were considered and that any potential adverse effects are mitigated. The CACs also conduct pre-project inspections on at least five percent of projects.

ADDITION OF NEWLY REGISTERED AQUATIC PESTICIDES

Finding 31 of this Order states that it may be reopened to add coverage of aquatic pesticides that have been newly registered by DPR. On August 30, 2005, DPR registered imazapyr for aquatic application.

Imazapyr is a herbicide used to control floating and emergent aquatic vegetation, including shoreline grass, broadleaf weeds, brush species, and perennials. It does not control submerged or mostly submerged foliage. Imazapyr is a slow-acting amino acid synthesis inhibitor. It has an average water half-life of four days with photodegradation as the primary form of degradation in water.

Imazapyr acts quicker and is less toxic than other low-volume herbicides. According to the San Francisco Estuary Invasive Spartina Project's May 4, 2005 report titled *Use of Imazapyr Herbicide to Control Invasive Cordgrass (Spartina spp.) in the San Francisco Estuary*, imazapyr in water rapidly degrades via photolysis. The report further states that a number of field studies demonstrated that imazapyr rapidly dissipated from water within several days, no detectable residues of imazapyr were found

[5] DPR designates a pesticide as a restricted material in California if it poses hazards to public health, farm workers, domestic animals, honeybees, the environment, wildlife, or crops other than those being treated ("Regulating Pesticides: A Guide to Pesticide Regulation in California," October 2001, DPR).

in either water or sediment within two months; and in estuarine systems, dilution of imazapyr with the incoming tides contributes to its rapid dissipation suggesting that imazapyr is not environmentally persistent in the estuarine environment and does not result in significant impacts to water quality. The report concludes that imazapyr herbicides can be a safe, highly effective treatment for control and eradication of non-native *Spartina* species in the San Francisco Estuary and offers an improved risk scenario over the existing treatment regime with glyphosate herbicides.

PERMIT COVERAGE/NOTIFICATION REQUIREMENTS

This General Permit addresses the discharge of aquatic pesticides related to the application of 2,4-D, acrolein, copper, diquat, endothall, fluridone, glyphosate, imazapyr, and triclopyr-based aquatic pesticides to surface waters for the control of aquatic weeds. Aquatic pesticides that are applied to application areas[6] within waters of the United States in accordance with FIFRA label requirements and Use Permit restrictions are not considered pollutants. However, pollutants associated with aquatic pesticide application require coverage under this General Permit. These include over-applied or misdirected pesticide products and pesticide residues. Residues are any pesticide byproduct, or breakdown product, or pesticide product that is present after the use of the pesticide to kill or control the target weed.

This General Permit does not cover agricultural storm water discharges or return flows from irrigated agriculture because these discharges are not defined as "point sources" and do not require coverage under an NPDES permit. This General Permit also does not cover other indirect or nonpoint source discharges from applications of pesticides, including discharges of pesticides to land that may be conveyed in storm water or irrigation runoff. This General Permit does not cover the discharge of pollutants related to applications of pesticides other than 2,4-D, acrolein, copper, diquat, endothall, fluridone, glyphosate, imazapyr, and triclopyr based pesticides; however, this General Permit includes a re-opener statement specifying that the permit may be reopened for the specific purpose of modifying the list of pesticides whose associated discharge is authorized by this General Permit.

The basic requirements of this General Permit include:

1. The applicator must follow all pesticide label instructions and any Use Permits issued by a CAC;

2. The discharger must be licensed by DPR or work under the supervision of someone who is licensed if the aquatic pesticide is considered a restricted material;

3. The discharger must comply with effluent limitations including developing and implementing an Aquatic Pesticide Application Plan (APAP);

4. The discharger must comply with applicable receiving water limitations; and

[6] The application area is the area to which aquatic pesticides are directly applied.

5. The discharger must comply with monitoring and reporting requirements.

To obtain coverage under this General Permit, a discharger must submit a completed Notice of Intent to Comply with the Terms of this General Permit (Notice of Intent, NOI), a vicinity map, and the first annual fee to the appropriate Regional Water Quality Control Board (Regional Water Board). These items constitute a complete application package, the submittal of which authorizes the discharge of pollutants associated with the application of aquatic pesticides in compliance with this General Permit, unless the Regional Water Board requests additional information necessary to determine the applicability of the discharge to this General Permit.

Each enrollment will cover all discharges occurring within the boundaries of that Regional Water Board. Separate NOIs are required for discharges located within more than one Regional Water Board's boundary, as defined in section 13200 of the California Water Code (CWC). Only one annual fee is required for all applicable discharges from one entity.

Authorization to discharge under this General Permit is terminated upon receipt by the discharger, from the appropriate Regional Water Board(s), of a Notice of Exclusion (NOE),[7] or upon the adoption of either an individual or other general NPDES permit covering the discharge. Alternatively, the discharger may initiate termination under this General Permit by submitting a letter to the appropriate Regional Water Board explaining why coverage under the General Permit is no longer necessary.

WATERS OF THE UNITED STATES

This General Permit regulates the discharge of pollutants associated with the application of aquatic pesticides to waters of the United States. "Waters of the United States" include all waters currently used, used in the past, or susceptible to use in interstate commerce; all interstate waters; all other waters the use, degradation, or destruction of which would or could affect interstate or foreign commerce. Waters of the United States include waters used by interstate or foreign travelers for recreation, waters from which fish or shellfish are taken and sold in interstate or foreign commerce, impoundments[8] of and tributaries to waters of the United States, and wetlands adjacent to waters of the United States. Waters of the United States include, but are not limited to, irrigation and flood control channels that exchange water with waters of the United States.

WATER QUALITY STANDARDS

The CWA defines Water Quality Standards as "Provisions of state or federal law which consist of designated uses for the waters of the United States, water quality criteria for waters based

[7] An NOE is a one-page notice that indicates that the discharger or proposed discharger is not eligible for coverage under this General Permit and states the reason why. This justification can include, but is not limited to, necessity to comply with a total maximum daily load or to protect sensitive water bodies.
[8] Surface water impoundments include, but are not limited to, drinking water reservoirs, ornamental lakes and ponds, and impoundments used to store irrigation water.

upon such uses, and antidegradation policies. Water quality standards are to protect the public health or welfare, enhance the quality of water and serve the purposes of the Act." [40 Code of Federal Regulations (CFR) section 131.3(i)].

In California, *Water Quality Control Plans* designate the beneficial uses of waters of the State and water quality objectives (WQOs) to protect those uses. The *Water Quality Control Plans* are adopted by the State and Regional Water Boards through a formal administrative rulemaking process, and, upon approval by USEPA, the WQOs for waters of the United States (generally surface waters) become State water quality standards.

USEPA has established water quality criteria in California for priority pollutants in the National Toxics Rule and the California Toxics Rule (CTR). The CTR criteria are also water quality standards.

EFFLUENT LIMITATIONS

NPDES permits for discharges to surface waters must meet all applicable provisions of sections 301 and 402 of the CWA. These provisions require controls that utilize best available technology economically achievable (BAT), best conventional pollutant control technology (BCT), and any more stringent controls necessary to reduce pollutant discharge and meet water quality standards.

Title 40, CFR section 122.44 states that if a discharge causes, has the reasonable potential to cause, or contributes to an excursion (Reasonable Potential) of a numeric or narrative water quality criterion, the permitting authority must develop effluent limits as necessary to meet water quality standards. Title 40, CFR section 122.44(k)(3) allows these effluent limits to be requirements to implement BMPs if numeric effluent limits are infeasible. It is infeasible for the State Water Board to establish numeric effluent limitations in this General Permit because:

1. The application of aquatic pesticides is not necessarily considered a discharge of pollutants according to the Talent decision. The regulated discharge is the discharge of pollutants associated with the application of aquatic pesticides. These include over-applied and misdirected pesticide product and pesticide residue. At what point the pesticide becomes a residue is not precisely known and varies depending on such things as target weed, water chemistry, and flow. Therefore, in the application of aquatic pesticides, the exact effluent is unknown;

2. It would be impractical to treat the numerous short duration intermittent pesticide releases to surface waters from many different locations; and

3. Treatment, in many cases, may render the pesticide useless for aquatic weed control.

Therefore, the effluent limitations contained in this General Permit are narrative and include requirements to develop and implement an APAP that describes appropriate BMPs, including compliance with all pesticide label instructions, and to comply with receiving water limitations.

The BMPs required herein constitute BAT and BCT and will be implemented to minimize the area and duration of impacts caused by the discharge of aquatic pesticides in the treatment area and to allow for restoration of water quality and protection of beneficial uses of the receiving waters to pre-application quality following completion of a treatment event.

APAP

An APAP is a comprehensive plan developed by the discharger that describes the project, the need for the project, what will be done to reduce water quality impacts, and how those impacts will be monitored. Specifically, the APAP must contain the following elements:

1. Description of the water body(ies) or water body systems being controlled;
2. Description of what weed(s) are being controlled and why;
3. Discussion of control tolerances (i.e., how much growth can occur before action is necessary);
4. Discussion of the factors influencing the decision to use aquatic pesticides in regards to those tolerances (pros and cons);
5. Type(s) of aquatic pesticides used[9], the method in which they are applied, and the adjuvants used;
6. Description of the application area and the treatment area in the system;
7. Other control methods used (alternatives) and what their limitations are;
8. How much product is needed and how this is determined;
9. Monitoring plan (See Attachment C), including the location of representative site(s);
10. If applicable, list the gates or control structures and inspection schedule of those gates or control structures to ensure that they are not leaking;
11. If the Control Agency has been granted a section 5.3 exception, describe the exception period. If weeds are also controlled outside of this period, describe how is it ensured that receiving water criteria are not exceeded;
12. Description of the BMPs to be implemented; and
13. Evaluation of other available BMPs to determine feasible alternatives to the selected aquatic pesticide application project that could reduce potential water quality impacts.

[9] List the types and the names of aquatic pesticides used or anticipated to be used. If additional or alternative pesticides are used during the year, amend the APAP and note this in the annual report.

The development of BMPs provides the flexibility necessary to establish controls to minimize the area and duration of impacts caused by the discharge of aquatic pesticides. This flexibility allows dischargers to implement different BMPs for different types of applications and different types of waters.

RECEIVING WATER LIMITATIONS

Once an aquatic pesticide has been applied to an application area, the pesticide product can actively treat the target species within the treatment area. During the treatment event, the aquatic pesticide is at a sufficient concentration to actively kill or control target weeds. When active ingredient concentrations are below this effective concentration, the aquatic pesticide becomes a residue. The minimum effective concentration, and the time required to reach it, vary due to site specific conditions, such as flow, target species, and water chemistry. The Receiving Water Limitations require that an application event does not result in an exceedance of water quality standards in the receiving water. The receiving water includes:

1. Anywhere outside of the treatment area at any time, and

2. Anywhere inside the treatment area after completion of the treatment event.

In recognition of the variability in the temporal extent of a treatment event, this General Permit does not require it to be discretely defined. Instead, post-event monitoring of the water is required no more than a week from the time of aquatic pesticide application.

For those dischargers that have been granted a section 5.3 exception, the event may result in "short -term or seasonal" exceedance of water quality standards for priority pollutants in the receiving water. Again, there is no discrete definition of short-term but the intent is to allow the exception to apply for some period of time, such as the summer months (June, July, and August) and in some years extending through September due to weather. The exception is not intended to apply all year.

The discharger may apply aquatic pesticides longer than would be considered short-term or seasonal. However, it must demonstrate that exceedances of priority pollutant standards occur only during the defined short-term or season. It is up to the discharger to make this demonstration. The justification must be incorporated into the APAP and it must be confirmed through monitoring, if necessary.

To protect all designated beneficial uses of the receiving water, the most protective (lowest) and appropriate (to implement the CTR criteria and WQOs in the *Water Quality Control Plans*) limit should be selected as the water quality limit for a particular water body and constituent. In many cases, water quality standards include narrative, rather than numerical, water quality objectives. In such cases, numeric water quality limits from the literature or publicly available information may be used to ascertain compliance with these standards.

For acrolein and copper, the freshwater aquatic life protection objective (in *Water Quality Control Plans*) and criterion (from CTR) are applicable. For 2,4-D, diquat, endothall, fluridone, and glyphosate, the most protective limits are those for the protection of the MUN beneficial use. The resulting numeric limits shall be used to assess impacts from pollutants associated with aquatic pesticide application on the quality of waters of the State and the beneficial uses that they are able to support. The absence of WARM or COLD criteria for a constituent does not mean that those beneficial uses or other beneficial uses are absent in the receiving water. It simply means that there are no State or USEPA-based numeric water quality objectives or criteria to implement those beneficial uses. This is the case for 2,4-D, diquat, fluridone, and glyphosate.

Below are brief descriptions of the active ingredients covered by this General Permit. The surfactant (a type of adjuvant) nonylphenol is also discussed.

2,4-D

Applications of 2,4-D-based aquatic pesticides are used to control broad-leaved aquatic weeds, as well as water hyacinth. It is applied using a spray nozzle.

The California Department of Health Services (DHS) and USEPA have promulgated a Primary Maximum Contaminant Level (MCL) of 70 µg/L for 2,4-D that is applicable for drinking water sources, or water bodies with a domestic or municipal supply (MUN) designation. This General Permit requires compliance with the Primary MCL for discharges to water bodies with MUN designation. The receiving water limitation for discharge of 2,4-D to water bodies with MUN designation is 70 µg/L.

Acrolein

Acrolein-based aquatic pesticides are used to control submerged and floating vegetation. Application is accomplished by directly injecting the acrolein-based pesticides into flowing water.

Acrolein is a priority pollutant, and its criteria are specified in Table (b)(1) of the CTR. Criteria are established for human consumption of water and organisms (320 µg/L)[10] and only organisms (780 µg/L).[11] The maximum recommended concentration of acrolein for the control of submerged or surface dwelling target species[12] is 15,000 µg/L.

[10] These criteria apply to waters of the Sacramento-San Joaquin Delta and other waters of the State defined as inland waters that include a municipal use (MUN) use designation.
[11] These criteria apply to waters of the State defined as bays and estuaries including San Francisco Bay upstream to and including Suisun Bay and the Sacramento-San Joaquin Delta; and waters of the State defined as inland waters without and MUN use designation.
[12] Acrolein safety manual.

Acrolein is recommended to be applied at a concentration that is greater than the CTR criteria or applicable WQOs[13]. Therefore, there would be a Reasonable Potential for aquatic pesticide applications to cause residue concentrations to exceed the CTR criteria or WQOs.

All Regional Water Board Basin Plans contain narrative criteria prohibiting discharges from causing toxicity in receiving waters. USEPA found acute and chronic toxic effects to freshwater organisms at 68 µg/L and 21 µg/L, respectively.[14] The Lowest Observed Effect Levels (LOELs) of 68 mg/L and 21 µg/L were determined from toxicity testing to freshwater organisms. Therefore, in order to protect freshwater aquatic life from toxic effects resulting from acrolein-based aquatic pesticide residue, this General Permit requires that receiving water residue of acrolein be less than the chronic 21 µg/L LOEL.

This General Permit requires that:

1. Acrolein residue, resulting from applications to inland surface waters, bays, and estuaries with uses of water that support warm and cold water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates (designation WARM and COLD), be less than 21 µg/L;

2. Acrolein residue, resulting from applications to inland surface waters, bays, and estuaries with a MUN designation, be less than 320 µg/L; and

3. Acrolein residue, resulting from applications to inland surface waters, bays, and estuaries without a MUN or warm and cold designation, be less than 780 µg/L.

Copper

Copper-based aquatic pesticides are used to control algal and aquatic plant growth. There are many different formulations, and application methods vary from pitching water-soluble tablets to direct injection of copper-based liquid products.

Copper-based aquatic pesticide labels recommend applications of copper can be up to 1,000 µg/L or more. Applicable water quality criteria for fresh and salt water, discussed below, are less than 1,000 µg/L. As described above for acrolein, limitations are required for discharges that have the Reasonable Potential to cause an exceedance of applicable criteria or WQOs.

Copper is a priority pollutant and the criteria for dissolved copper are specified in Table (b)(1) of the CTR. Criteria are established for maximum and continuous discharges in fresh and salt water. Conversion factors were also used to convert dissolved copper limitations to the total copper limitations assigned in this General Permit. The continuous or chronic criterion has been chosen in this case because it is the most protective considering that in many cases aquatic pesticides are applied several times per season and the limitation is for pesticide residue in receiving waters.

---

[13] Acrolein could be applied in concentrations much higher that CTR criteria or WQOs, which could in turn cause residue concentrations to exceed the criteria.
[14] USEPA Goldbook, 1986.

Freshwater copper criteria need to be adjusted for water hardness and may significantly differ from one irrigation system to another. Water hardness shall be determined by the calculation[7] or titration method. It is necessary to specify a range of total copper limitations in this General Permit because of the possible variations in freshwater hardness statewide. The total copper limitation will be calculated using the following equation:

$$\text{Maximum Residual Total Copper Concentration} = \exp[0.8545(\ln(hardness) - 1.702)]$$

For example, for application in water with a hardness of 325 mg/L, in order to be in compliance with this General Permit, the copper concentration in the receiving water must be less than 32.7 µg/L.

Diquat

Diquat-based aquatic pesticides are used to control aquatic weeds. Diquat is a quick-acting contact pesticide, causing injury only to the parts of the plant to which it is applied.

All Regional Water Board Basin Plans contain narrative criteria prohibiting discharges from causing toxicity in receiving waters. USEPA has established an MCL of 20 µg/L for diquat that is applicable for drinking water sources or water bodies with an MUN designation. Therefore, to prevent receiving waters with an MUN designation from toxicity due to the use of diquat-based aquatic pesticides, this General Permit requires compliance with USEPA's MCL of 20 µg/L. The receiving water limitation for discharges of diquat to water bodies with MUN designation is 20 µg/L.

Endothall

Endothall-based aquatic pesticides are used to control a variety of aquatic weeds. USEPA has promulgated a Primary MCL of 100 µg/L for endothall that is applicable for drinking water sources or water bodies with an MUN designation. This General Permit requires compliance with USEPA Primary MCLs for discharges to water bodies with MUN designation. Therefore, the receiving water limitation for discharge of endothall to water bodies with MUN designation is 100 µg/L.

Fluridone

Fluridone is a systemic herbicide that kills the entire plant and is generally non-selective, which means most submersed plants and some floating leaved plants will be killed by fluridone during the treatment. USEPA has a reference dose as a drinking water level of 560 µg/L. This General Permit requires compliance with USEPA's reference dose of 560 µg/L for discharges to water bodies with MUN designation. Therefore, the receiving water limitations for discharge of fluridone to water bodies with MUN designation is 560 µg/L.

---

[7] Hardness, mg equivalent $CaCO_3$ mg/L = 2.497[Ca, mg/L] + 4.118[Mg, mg/L].

Glyphosate

Glyphosate-based aquatic pesticides are used to control emergent foliage of aquatic weeds. Glyphosate-based aquatic pesticides are ineffective on submerged or mostly submerged foliage. USEPA has promulgated a Primary MCL of 700 µg/L for glyphosate that is applicable for drinking water sources or water bodies with an MUN designation. This General Permit requires compliance with USEPA Primary MCLs for discharges to water bodies with MUN designation. Therefore, the receiving water limitation for discharge of glyphosate to water bodies with MUN designation is 700 µg/L.

Imazapyr

Currently, there are no State or USEPA-based numeric objectives or criteria for imazapyr. Therefore, this General Permit does not have receiving water limitations for imazapyr. However, it requires dischargers who use imazapyr to monitor their applications.

Nonylphenol

Nonylphenol is soluble in water and moderately resistant to natural degradation in water. Because of its chemical properties and widespread use as a chemical intermediate (surfactant), concerns have been raised over the risks it poses to both freshwater and saltwater organisms. Currently, there are no State or USEPA-based numeric objectives or criteria for nonylphenol. However, this General Permit requires monitoring for nonylphenol when this type of adjuvant is used.

Triclopyr

Triclopyr is an herbicide used for the control of perennial broadleaf weeds. Triclopyr has little tendency to hydrolyze, and photolysis is the main degradation pathway in natural water. In river water, the half-life of triclopyr was determined to be 1.3 days in artificial and natural light. Currently, there are no State or USEPA-based numeric objectives or criteria for triclopyr. However, this General Permit requires dischargers who use triclopyr to monitor their applications.

CEQA EXEMPTION

Pursuant to CWC section 13389, Regional Water Boards are exempt from the requirement to comply with Chapter 3, Division 13 of the Public Resources Code (PRC) when adopting NPDES permits. While adoption of this General Permit is exempt from preparation of a CEQA document, public entities receiving exceptions pursuant to section 5.3 of the Policy were required to prepare a CEQA document, as discussed below.

POLICY EXCEPTION

The Policy contains implementation provisions for water quality standards. The Policy provides that categorical exceptions may be granted to allow short-term or seasonal exceptions from meeting the priority pollutant criteria/objectives if "necessary to implement control measures ... for resource or pest management... conducted by public entities to fulfill statutory requirements." The Policy specifically refers to vector or weed control, and pest and fishery management as bases for categorical exceptions. The exceptions are available only to public entities that have adequately provided the following, as listed in the Policy:

1. CEQA documentation including notifying potentially affected public and government agencies;

2. A detailed description of the proposed action which includes the proposed method of completing the action;

3. A time schedule;

4. A discharge and receiving water monitoring plan that specifies monitoring prior to application events, during application events, and after completion with the appropriate quality control procedures; and

5. Any necessary contingency plans.

The State Water Board requested in a letter dated August 6, 2003 that aquatic pesticide users who seek exceptions provide the above information. All the above information must have been submitted to the State Water Board prior to the adoption of this General Permit for public entities to obtain a section 5.3 exception.

The public entities listed in Attachment E have prepared Initial Studies, Negative Declarations (ND), and Notices of Determination or Mitigated Negative Declarations (MND) for the discharge of aquatic pesticides in accordance with CEQA (PRC §21000 et seq.) to comply with the exception requirements of section 5.3 of the Policy. The boards of each public entity, as the lead agencies under CEQA, approved the Final ND/MND and determined that the discharge of aquatic pesticides in their respective projects would not have significant effect on the environment. Those public entities have determined that the water quality or related water quality impacts identified in the environmental assessments of the ND/MND are less than significant. The boards of each public entity, as the lead agencies under CEQA, approved the Final ND/MND and are not required to meet priority pollutant criteria until after completion of the application event.

As required in section 15096 of the CEQA Guidelines, the State Water Board, as Responsible Agency under CEQA, considered the ND/MND approved by the board of each public entity and finds that the projects will have less than significant water quality impact if the waste discharge requirements in this General permit are followed. Accordingly, the public entities listed in Attachment E are hereby granted an exception pursuant to section 5.3 of the policy.
Aquatic pesticide users not listed in Attachment E are required to meet all applicable priority pollutant criteria in receiving waters, consistent with applicable federal and State regulations.

Several lawsuits have been filed which challenge the Negative Declarations adopted by various applicants for this General Permit. Pursuant to section 15233 of the CEQA Guidelines, the State Water Board must treat the Negative Declarations at issue as if they comply with CEQA and must continue to process the applications according to the time limits for responsible agency action contained in Government Code section 65952. Accordingly, the following applicants are granted a conditional exception under section 5.3 of the Policy: Merced Irrigation District, Modesto Irrigation District, Oakdale Irrigation District, South San Joaquin Irrigation District, and Turlock Irrigation District. The conditional exceptions granted by this General Permit only provide permission to proceed with the project at the applicant's risk. An applicant's conditional exception shall automatically be withdrawn in the event that a court enters a final decision finding that the applicant's Negative Declaration was inadequate.

The California Department of Food and Agriculture (CDFA) has determined that its ongoing projects to eradicate hydrilla are exempt from the requirements of CEQA because the activities are necessary to prevent or mitigate an emergency pursuant to PRC section 21080 (b)(4). The bases for this determination are that the CDFA Hydrilla Program is mandated under sections 403 and 6048 of the Food and Agriculture Code and the Governor and/or the CDFA Secretary has declared that an emergency situation existed as each eradication project began. Although CDFA has determined the CDFA Hydrilla Program is exempt form CEQA, CDFA will coordinate all eradication activities with federal, state and local regulatory agencies to ensure no long-term significant environmental impacts occur.
As required in section 15096 of the CEQA Guidelines, the State Water Board, as a Responsible Agency under CEQA, considered the exemption claimed by CDFA and finds that the projects will have less than significant water quality impact if the waste discharge requirements in this General Permit are followed. Accordingly, CDFA is hereby granted an exception pursuant to section 5.3 of the Policy, as long as the Governor or the CDFA Secretary has declared that an emergency situation exists prior to project implementation.

MONITORING REQUIREMENTS

This General Permit requires that dischargers comply with the Monitoring and Reporting Program (MRP), Attachment C of this General Permit. The goals of the MRP are to:

1. Determine compliance with the receiving water limitations and other requirements specified in this General Permit;

2. Measure and improve the effectiveness of the APAP;

3. Support the development, implementation, and effectiveness of BMPs;

4. Assess the chemical, physical, and biological impacts on receiving waters resulting from aquatic pesticide applications;

5. Assess the overall health and evaluate long-term trends in receiving water quality;

6. Demonstrate that water quality of the receiving waters following completion of resource or weed management projects are equivalent to pre-application conditions;

7. Identify and characterize aquatic pesticide application projects conducted by the discharger; and

8. Ensure that projects that are monitored are representative of all pesticides and application methods used by the discharger.

The MRP provided by this General Permit is considered baseline monitoring. Monitoring plans proposed by entities receiving a section 5.3. exception as a mitigation measure must also comply with that monitoring plan proposed in their CEQA document where the two plans differ.

The APMP, conducted by SFEI as an outcome of the settlement agreement, evaluated the toxicity of the 2,4-D, acrolein, copper, diquat, fluridone, glyphosate, and triclopyr. The APMP report states that no toxicity was found with the use of 2,4-D, glyphosate, and triclopyr; toxicity testing is difficult for acrolein due to its rapid breakdown and volatility; results were inconclusive for diquat and fluridone; and toxicity in copper-based applications was confirmed. Additionally, during the prior permit term, there were no incidents to suggest that toxicity testing is warranted.

The purpose of toxicity testing is to determine if the aquatic pesticide applications cause toxicity in the receiving water. Since the active ingredients, surfactants, and breakdown products used in these aquatic pesticides are known and have receiving water limitations and/or are analyzed for in the MRP, toxicity testing is not necessary. This General Permit specifies receiving water limitations for each active ingredient that has State or USEPA-based water quality objectives or criteria and when available for their breakdown products and surfactants. These limitations are adequate to protect the beneficial uses of the receiving waters.

In order to meet the MRP's monitoring goals, dischargers are required to provide for all application sites a map and information on surface area and/or volume of treatment area and any other information used to calculate dosage and quantity of each pesticide used. In addition, dischargers are required to conduct visual monitoring at all application sites during each application event. Furthermore, dischargers are also required to conduct water quality monitoring at 10 percent of all its application sites during each application event. Ten percent is used as a standard quality control protocol in sample analysis methodology to ensure that the process stays within acceptable criteria. The MRP requires sampling a minimum of two representative sites for a discharger with 20 application sites or less and 10 percent of all application sites for a discharger with more than 20 application sites. Sampling 10 percent of all the application sites is adequate to obtain information necessary to evaluate the effects of all the applications.

Additionally, specific monitoring and requirements are also provided for irrigation canals or similar systems that have reasonable control over treated water.

PERMIT RE-OPENERS

This General Permit contains a re-opener provision that allows the General Permit to be re-opened for the specific purpose of granting exceptions to agencies that have adequately met the section 5.3 exception criteria. Alternatively, dischargers may request an individual permit with the appropriate Regional Water Board.

The re-opener provision also allows for additional aquatic pesticides to be added to those authorized by this General Permit or to revise the monitoring and reporting program to allow for group or regional monitoring.

STATE WATER RESOURCES CONTROL BOARD

WASTE DISCHARGE REQUIREMENTS

WATER QUALITY ORDER NO. 2004-0009-DWQ

STATEWIDE GENERAL NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT FOR THE DISCHARGE OF AQUATIC PESTICIDES FOR AQUATIC WEED CONTROL IN WATERS OF THE UNITED STATES GENERAL PERMIT NO. CAG990005

The State Water Resources Control Board (hereafter State Water Board) finds that:

1. States may request authority to issue general National Pollutant Discharger Elimination System (NPDES) permits pursuant to Title 40, Code of Federal Regulations (CFR) section 122.28. On June 8, 1989, the State Water Board submitted an application to the U.S. Environmental Protection Agency (USEPA) requesting revisions to its NPDES program in accordance with 40 CFR sections 122.28, 123.62, and 403.10. The application included a request to add general permit authority to its approved NPDES program. On September 22, 1989, the USEPA, Region 9, approved the State Water Board's request and granted authorization for the State to issue general NPDES permits.

2. Federal regulation at 40 CFR section 122.28(a)(1) allows NPDES permits to be written to cover a category of discharges within State political boundaries.

3. According to section 301(a) of the federal Clean Water Act (CWA), discharges of pollutants from point sources to waters of the United States are prohibited unless they are in compliance with an NPDES permit.

4. In order to manage resources and protect beneficial uses, many agencies use aquatic pesticides to control aquatic weeds.

5. On March 12, 2001, the Ninth Circuit Court of Appeals held that discharges of pollutants from the use of aquatic pesticides in waters of the United States require coverage under an NPDES permit (Headwaters, Inc. v. Talent Irrigation District[1]).

6. Because of the serious public health, safety, and economic implications of delaying pesticide applications, in 2001 the State Water Board adopted Water Quality Order (Order) No. 2001-12-DWQ, Statewide General NPDES Permit for Discharges of Aquatic Pesticides to Waters of the United States, on an emergency basis to provide immediate NPDES permit coverage for broad categories of aquatic pesticide use in California.

7. In August 2001, Waterkeepers Northern California (Waterkeepers) filed a lawsuit against the State Water Board challenging several aspects of Order No. 2001-12-DWQ. Major aspects of the challenge included the emergency adoption of the Order without compliance with the

[1] Headwaters, Inc. v. Talent Irrigation District, (9th Cir. 2001) 243 F.3d 526.

California Environmental Quality Act (CEQA) and other exception requirements of the State Water Board's *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California* (Policy); failure to address cumulative impacts; and failure to comply with the California Toxics Rule (CTR).

8. In a settlement of the Waterkeepers' lawsuit, the State Water Board agreed to fund a comprehensive aquatic pesticide monitoring program (APMP) that would assess receiving water toxicity caused by aquatic pesticide residues. Available data from the APMP were used to develop the terms and conditions of this General Permit.

9. The results of the APMP show that no toxicity was found with the use of 2,4-D, glyphosate, and triclopyr; toxicity testing is difficult for acrolein due to its rapid breakdown and volatilization; toxicity effects were inconclusive for diquat and fluridone; and toxicity in copper-based applications was confirmed.

10. Pesticide formulations may include "active ingredients" [2] and "inert ingredients" [3]. Adjuvants[4] or surfactants may be added to the active ingredients in the application equipment that is used in the delivery of the pesticide.

11. Pollutants associated with aquatic pesticide application include over- applied and misdirected pesticide product and pesticide residues. Pesticide residues are pesticide byproducts, breakdown products, or pesticide products that are present after the use of the pesticide for controlling the target weed.

12. This General Permit is intended to cover the discharge of pollutants associated with the application of 2,4-D, acrolein, copper, diquat, endothall, fluridone, glyphosate, and triclopyr-based aquatic pesticides to surface waters associated with controlling aquatic weeds.

13. On August 30, 2005, the California Department of Pesticide Regulation (DPR) registered imazapyr for aquatic application. On September 7, 2005, this General Permit was modified to allow the discharge of pollutants associated with the application of imazapyr-based aquatic pesticides to surface waters for aquatic weed control.

14. The aquatic pesticides covered by this General Permit are applied directly into the water body and/or directly to organisms in the water or on the water surface with the intent of killing or controlling the target aquatic organisms. The impacts of these chemicals may not be limited to the target organisms–other plants and aquatic life in the treatment area[5] may be

---

[2] Active ingredients are manufacturer disclosed ingredients that yield toxic effects on target organisms.
[3] Inert ingredients are additional ingredients that are not toxic to target organisms. These ingredients are often trade secrets and therefore not always disclosed by the manufacturer.
[4] Adjuvants are ingredients that are added to aquatic pesticides during a treatment event. These ingredients are chosen by the discharger, based on site characteristics, and typically increase the effectiveness of aquatic pesticides on target organisms.
[5] The treatment area is the area that is treated by the aquatic pesticide to control weeds and therefore, the area being targeted to receive lethal doses of aquatic pesticides. It is the responsibility of the discharger to define the treatment area for each specific location that it discharges to.

impacted. Due to water movement at the treatment locations, residual pesticides can be carried to adjacent areas while concentrations in the water are still high enough to cause adverse impacts not only to aquatic organisms but also to other beneficial uses such as irrigation, municipal water supplies, and recreation (such as swimming).

15. As part of the pesticide registration process of pesticides for use in California, USEPA and the Department of Pesticide Regulation (DPR) evaluate data submitted by registrants to ensure that a product used according to label instructions will cause no harm or adverse impact on non-target organisms that cannot be reduced or mitigated with protective measures or use restrictions. While DPR conducts these tests it does not require or conduct Compliance Monitoring.

16. DPR and the County Agricultural Commissioners (CACs) regulate the sale and use of pesticides in California. The use of pesticides must be consistent with the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) pesticide label instructions. If applying a pesticide designated as a restricted material, applicators must either be licensed by DPR with a Qualified Applicator Certificate or work under the supervision of someone who is licensed and obtain Use Permits from CACs. For the use of aquatic pesticides, a Qualified Applicator Certificate with the category "aquatic" is required, and their use must be reported to the CACs where required by law or by agreement with DPR.

17. DPR regulates the use of pesticide-treated commodities and sites where needed to ensure that pesticide residues do not pose a hazard to human health or the environment. DPR also regulates the use of pesticides to reduce the release of residues from treated sites. This includes regulation of wastes generated by applications not in accordance with all laws and regulations, including drift from applications.

18. Under this General Permit, aquatic pesticide discharges require minimal or no treatment systems to meet limits and pose no significant threat to water quality. As such, they are eligible for Category 3 in section 2200(b)(9) of Title 23, California Code of Regulations (CCR). This category is appropriate because aquatic pesticide applications incorporate best management practices (BMPs) to control potential impacts to beneficial uses, and this General Permit prohibits pollutant discharge associated with aquatic pesticide application from causing exceedance of CTR criteria or water quality objectives. The annual fee associated with this rating can be found in section 2200(b)(9) of Title 23, CCR.

19. Section 122.44(k)(3) of 40 CFR allows effluent limits to be in the form of BMP requirements, if numeric effluent limits are infeasible. Numeric effluent limits for pollutant discharges associated with the application of aquatic pesticides are infeasible. Therefore, this General Permit requires the implementation of BMPs. The BMPs are identified in the discharger's Aquatic Pesticides Application Plan (APAP) to control and abate the discharge of pollutants associated with aquatic pesticide applications. In addition, where State or USEPA-based water quality objectives or criteria are available, this General Permit includes numeric receiving water limitations.

20. This General Permit requires submittal of a Notice of Intent to Comply with the Terms of this General Permit (NOI) to obtain permit coverage.

21. If the area of aquatic pesticide application extends beyond a Regional Water Quality Control Board (Regional Water Board) boundary, discharges in each Regional Water Board shall be covered by a separate NOI under this General Permit. Only one annual fee must be submitted to the State Water Board.

22. Although a discharge may be eligible for coverage under this General Permit, the appropriate Regional Water Board may determine that the discharge must be regulated under an individual permit or a different general NPDES permit. If an individual or another general NPDES permit is issued for a discharge, then the applicability of this General Permit to the discharge is immediately terminated on the effective date of the other permit.

23. The State Water Board has considered antidegradation pursuant to 40 CFR section 131.12 and State Water Board Resolution No. 68-16. Discharges must be consistent with both State and federal antidegradation policies. The conditions of this General Permit require aquatic pesticide discharges to meet applicable water quality objectives. Waters of exceptional quality may be degraded due to the application of aquatic pesticides, however, it would only be temporary and in the best interest of the people of the State. The nature of aquatic pesticides is to be toxic in order to protect beneficial uses such as municipal and agricultural supply, recreation, and human health (preventing floods by maintaining capacity in flood control channels). However, compliance with receiving water limitations must be maintained. Therefore, this General Permit is consistent with State and federal antidegradation policies.

24. There may be other non-toxic or less toxic control measures available to minimize the discharge of wastes to waters of the United States. This General Permit requires dischargers to evaluate BMPs that may include alternative control options, procedures to determine that water quality impacts have been minimized, and a determination that there are no feasible alternatives to the selected resource or weed management measures.

25. The State Water Board, in establishing the requirements contained herein, considered factors including, but not limited to, the following:

    a. Beneficial uses to be protected and the water quality objectives reasonably required for that purpose;
    b. Other waste discharges;
    c. Past, present, and probable future beneficial uses of the waters under consideration;
    d. Environmental characteristics of the waters under consideration;
    e. Economic considerations;
    f. The need to maintain conveyance facilities to provide water supplies for municipal, irrigation, and industrial purposes; and
    g. Seasonal and weather conditions that require timely implementation of control measures.

26. The designated beneficial uses of surface waters throughout the State may include domestic or municipal, industrial, and agricultural supply; water contact and non-contact recreation; navigation; ground water recharge; fresh water replenishment; hydropower generation; wildlife habitat; cold freshwater and warm freshwater habitat; fish migration and fish spawning; marine habitat; estuarine habitat; shellfish harvesting; ocean commercial and sport fishing; preservation of areas of special biological significance; and preservation of rare and endangered species. To the extent that the applicable State or Regional Water Board *Water Quality Control Plan* designates additional or different beneficial uses, the *Water Quality Control Plan* shall govern.

27. USEPA establishes water quality criteria for priority pollutants in the National Toxics Rule and the CTR, and water quality objectives are established in *Water Quality Control Plans*. The State Water Board's Policy went into effect on May 22, 2000 and generally requires limitations for all constituents that will cause, have the reasonable potential to cause, or contribute to toxicity in receiving waters.

28. Section 5.3 of the Policy provides that the State Water Board may allow short-term or seasonal categorical exceptions from meeting the priority pollutant criteria/objectives if it is determined to be necessary to implement control measures for resource or pest management conducted by public entities to fulfill statutory requirements, including, but not limited to, those in the California Fish and Game, Food and Agriculture, Health and Safety, and Harbors and Navigation codes. Section 5.3 requires that the provisions of CEQA are satisfied and, dischargers provide specific discharge information before an exception may be granted.

29. Because of the emergency nature of Order No. 2001-12-DWQ, many of the actions that would normally occur prior to issuance of a permit granting a section 5.3 categorical exception to priority pollutant objectives/criteria had not yet occurred. Therefore, Order No. 2001-12-DWQ was issued as a limited-term permit, which expired on January 31, 2004. During the term of the Order No. 2001-12-DWQ, the public entities seeking an exception to the CTR during the term of this General Permit were directed to complete necessary CEQA documents and prepare other submittals to satisfy the criteria for the categorical exception.

30. The State Water Board has received CEQA documentation and all other information required for a section 5.3 exception from public entities listed in Attachment E to this General Permit. This General Permit grants the public entities listed in Attachment E a section 5.3 categorical exception from meeting priority pollutant criteria for short-term or seasonal time frames. This General Permit does not grant remaining enrollees a section 5.3 exception of the Policy.

31. Several lawsuits have been filed which challenge the Negative Declarations adopted by various applicants for this General Permit. Pursuant to section 15233 of the CEQA Guidelines, the State Water Board must treat the Negative Declarations at issue as if they comply with CEQA and must continue to process the applications according to the time limits for responsible agency action contained in Government Code section 65952. Accordingly, the following applicants are granted a conditional exception under section 5.3 of the Policy: Merced Irrigation District, Modesto Irrigation District, Oakdale Irrigation District, South San Joaquin Irrigation District, and Turlock Irrigation District. The

conditional exceptions granted by this General Permit only provide permission to proceed with the project at the applicant's risk. An applicant's conditional exception shall automatically be withdrawn in the event that a court enters a final decision finding that the applicant's Negative Declaration was inadequate.

32. This General Permit may be re-opened to modify Attachment E if additional entities qualify for a section 5.3 exception. This General Permit may also be re-opened if additional aquatic pesticides are registered by DPR or to revise the monitoring and reporting program to allow for group or regional monitoring.

33. This General Permit does not authorize any take of endangered species. The discharge is prohibited from adversely impacting biologically sensitive or critical habitats, including, but not limited to, habitat of species listed under federal or State endangered species laws. To ensure that endangered species issues are raised to the responsible agencies, the State Water Board has notified the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and the California Department of Fish and Game of this General Permit.

34. The action to adopt an NPDES permit is exempt from the provisions of Chapter 3 of CEQA (Public Resources Code section 21100, et seq.), in accordance with section 13389 of the California Water Code (CWC).

35. The State Water Board has notified interested agencies and persons of its intent to prescribe waste discharge requirements in this General Permit and has provided them with an opportunity to submit comments.

36. The State Water Board, in a public hearing, heard and considered all comments pertaining to the discharges to be regulated by this General Permit.

37. This Order shall serve as an NPDES permit pursuant to section 402 of the Clean Water Act and amendments thereto and shall take effect upon the date of adoption.

IT IS HEREBY ORDERED that all dischargers subject to this General Permit shall comply with the following:

A. Application Requirements:

In order to obtain coverage, the discharger must submit the following to the appropriate Regional Water Board(s)[6]. Dischargers that apply 2,4-D, acrolein, copper, diquat, endothall, fluridone, glyphosate, imazapyr, and triclopyr -based aquatic pesticides to waters of the United States are eligible for coverage under this General Permit provided:

1. An NOI (Attachment A) signed in accordance with the signatory requirements of Standard Provision B;

[6] The discharger must submit an NOI to each applicable Regional Water Board it discharges within. However, only one application fee is required for each discharger, regardless of the number of NOIs submitted.

2. A vicinity map; and
3. An annual fee (for first-time enrollees).

Regional Water Boards may require additional information in order to determine whether a discharge is appropriately covered by this General Permit. Additionally, the Regional Water Board may issue a Notice of Exclusion, which either terminates permit coverage or requires submittal of an application for an individual permit or alternative general permit.

B. Effluent Limitations:

1. The discharge of wastes other than as described in this General Permit is prohibited, unless authorized by a separate NPDES permit.

2. The discharge of wastes shall not cause or contribute to conditions of nuisance or pollution.

3. The discharge shall not cause or contribute to long-term adverse impacts on beneficial uses of waters of the United States.

4. The discharger shall apply pesticides in accordance with the developed APAP, as described in section D.4.

C. Receiving Water Limitations:

1. Discharges shall not cause or contribute to an exceedence of the following in the receiving water.

Constituent/ Parameter	BENEFICIAL USE			
	MUN	WARM or COLD	Other than MUN, WARM, or COLD	All Designations
2,4-D	70 µg/L			
Acrolein[7]	320 µg/L	21 µg/L	780 µg/L	
Copper[8]				Maximum Copper Concentration = exp[0.8545 (ln(hardness))-1.702]
Diquat	20 µg/L			
Endothall	100 µg/L			
Fluridone	560 µg/L			
Glyphosate	700 µg/L			
Toxicity				Applications shall not cause or contribute to toxicity

[7] Public entities listed in Attachment E are not required to meet this limitation in receiving waters during the Exception period, as described in the APAP in accordance with Aquatic Pesticide Requirement D.5.k.
[8] Public entities listed in Attachment E are not required to meet this limitation in receiving waters during the Exception period, as described in the APAP in accordance with Aquatic Pesticide Requirement D.5.k.

The most restrictive (smallest) receiving water limit shall apply when discharges are to water bodies that have multiple limits listed above.

2. Discharges shall not cause or contribute to an exceedance of any CTR criteria or applicable water quality objective in a State or Regional Water Board *Water Quality Control Plan* in the receiving water.

D. Aquatic Pesticide Use Requirements:

1. **License Requirements.** Dischargers must be licensed by DPR if such licensing is required for the aquatic pesticide application project.[9]

2. **Application Requirements.** The pesticide use must be consistent with FIFRA pesticide label instructions and any Use Permits issued by CACs.

3. **Application Schedule.** When requested, the discharger shall provide a phone number to persons who request the discharger's application schedule. The discharger shall provide the requester with the most current application schedule and inform the requester if the schedule is subject to change. Information may be made available by electronic means.

4. **Public Notice Requirements.** Every calendar year, prior to the first application of aquatic pesticides, the discharger shall notify potentially affected governmental agencies. The notification shall include the following information:

    a. A statement of the discharger's intent to apply aquatic pesticide(s);
    b. Name of pesticide(s);
    c. Purpose of use;
    d. General time period and locations of expected use;
    e. Any water use restrictions or precautions during treatment; and
    f. A phone number that interested persons may call to obtain additional information from the discharger.

5. **Aquatic Pesticides Application Plan (APAP).** The discharger shall develop an APAP that contains the following elements:

    a. Description of the water system to which aquatic pesticides are being applied;

    b. Description of what weed(s) are being controlled and why;

    c. Discussion of control tolerances (i.e., how much growth can occur before action is necessary);

[9] A license is required for application of restricted material, as defined by DPR.

d. Discussion of the factors influencing the decision to use aquatic pesticides in regards to those tolerances (pros and cons);

e. Type(s) of aquatic pesticides used[10], the method in which they are applied, and the adjuvants used;

f. Description of the application area and the treatment area in the system;

g. Other control methods used (alternatives) and what their limitations are;

h. How much product is needed and how this is determined;

i. Monitoring plan (see Attachment C), including the location of representative site(s);

j. If applicable, list the gates or control structures and provide an inspection schedule of those gates or control structures to ensure they are not leaking;

k. If the Control Agency has been granted an exception, describe the exception period. If weeds are also controlled outside of this period, how is it ensured that receiving water criteria are not exceeded;

l. Evaluation of other available BMPs to determine if there are feasible alternatives to the selected aquatic pesticide application project that could reduce potential water quality impacts; and

m. Description of the BMPs to be implemented.

6. **Pesticide Application Log.** The discharger shall maintain a log for each aquatic pesticide application. The application log shall contain, at a minimum, the following information:

a. Date of application;
b. Location of application;
c. Name of applicator;
d. List of gates or control structures in the treatment area that may discharge to surface waters, if applicable;
e. Time of gate or control structure closure and reopening, include any calculations used to determine closure and reopening times, if applicable;
f. Application details, such as water temperature, flow or level of water body, time application started and stopped, and aquatic pesticide application rate and concentration;
g. Visual monitoring assessment; and

[10] List the types and the names of the aquatic pesticides most often used or anticipated to be used. If additional or alternative pesticides are used during the year, amend the APAP and note this in the annual report.

h. Certification that applicator(s) followed the APAP.

E. Provisions:

1. **Permit Compliance.** The discharger must comply with all conditions of this General Permit including timely submittal of technical and monitoring reports as directed by the appropriate Regional Water Board' s Executive Officer.

2. **Alternatives.** In accordance with APAP D.5.m, the discharger shall implement the identified alternative measures to the selected aquatic pesticide application project that could reduce potential water quality impacts.

3. **Monitoring and Reporting.** The discharger shall comply with the provisions of the attached Monitoring and Reporting Program (MRP) contained in Attachment C to this General Permit and any revision thereto.

4. **Standard Provisions.** The discharger shall comply with all the applicable items of the Standard Provisions and Reporting for Waste Discharge Requirements (Standard Provisions), which are part of this General Permit (Attachment D).

5. **General Permit Reference.** A copy of this General Permit shall be kept where key operating personnel can refer to the document. Key operating and site management personnel shall be familiar with its contents.

6. **Monitoring Reports to USEPA.** When requested by USEPA, the discharger shall also submit Discharge Monitoring Reports to USEPA.

7. **Change of Control Agency.** In the event of any change in the Control Agency that sought coverage under this Genera Permit, the original Control Agency shall notify the succeeding Control Agency of the existence of this General Permit by letter, a copy of which shall be immediately forwarded to the appropriate Regional Water Board. Upon receipt of the letter, Regional Water Board staff shall terminate coverage of the original Control Agency under this General Permit. The new Control Agency shall complete and submit to the Regional Water Board a revised NOI form (Attachment A) in accordance with Application A.1.

8. **Qualified Biologist Certification Following Project Completion.** Upon completion of an aquatic pesticide project, public entities listed in Attachment E to this General Permit shall provide certification by a qualified biologist that beneficial uses of receiving waters accepting aquatic pesticides have been restored.

9. **Submittal of APAP.** Dischargers that apply for this General Permit before August 1, 2004 shall submit their APAP to the appropriate Regional Water Board by August 1, 2004; those dischargers that apply for this General Permit after August 1, 2004 shall submit their APAP to the appropriate Regional Water Board with their NOI application.

WASTE DISCHARGE REQUIREMENTS
WATER QUALITY ORDER NO. 2004-0009-DWQ

CERTIFICATION

The undersigned, Clerk to the Board, does hereby certify that the foregoing is a full, true, and correct copy of an order duly and regularly adopted at a meeting of the State Water Resources Control Board held on May 20, 2004.

AYE:	Arthur G. Baggett, Jr. Peter S. Silva Richard Katz Gary M. Carlton Nancy H. Sutley
NO:	None
ABSENT:	None
ABSTAIN:	None

Original signed by _____
Debbie Irvin
Clerk to the Board

Alan C. Lloyd, Ph.D.
Agency Secretary

State Water Resources Control Board

Division of Water Quality
1001 I Street • Sacramento, California 95814 • (916) 341-5455
Mailing Address: P.O. Box 100 • Sacramento, California • 95812-0100
FAX (916) 341-5463 • Internet Address: http://www.waterboards.ca.gov

Arnold Schwarzenegger
Governor

ATTACHMENT A

NOTICE OF INTENT

TO COMPLY WITH THE TERMS OF WATER QUALITY ORDER NO. 2004-0009-DWQ STATEWIDE GENERAL NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT FOR THE DISCHARGE OF AQUATIC PESTICIDES FOR AQUATIC WEED CONTROL IN WATERS OF THE UNITED STATES GENERAL PERMIT NO. CAG990005

I. NOTICE OF INTENT STATUS (see instructions)

MARK ONLY ONE ITEM	A. ☐	New Applicator	B. ☐	Change of Information for WDID#

II. CONTROL AGENCY INFORMATION

A. Name			
B. Mailing Address			
C. City	D. County	E. State	F. Zip
G. Contact Person	H. Title		I. Phone

III. RECEIVING WATER INFORMATION

A. Do wastes and pesticide residues discharge to (check all that apply):

1. ☐ Canals, ditches, or other constructed conveyance facilities owned and controlled by Control Agency?
   Name of the conveyance system: _____

2. ☐ Canals, ditches, or other constructed conveyance facilities owned and controlled by an entity other than the Control Agency
   Owner's name: _____
   Name of the conveyance system: _____

3. ☐ Directly to river, lake, creek, stream, bay, ocean, etc.?
   Name of water body: _____

B. Regional Water Quality Control Board(s) where application sites are located (REGION 1, 2, 3, 4, 5, 6, 7, 8, or 9):
REGION _____
(List all regions where pesticide application is proposed.)

NOTICE OF INTENT
WATER QUALITY ORDER NO. 2004-0009-DWQ

IV. PESTICIDE APPLICATION INFORMATION

A. Target Organism: ____Algae _____Aquatic Weeds (surface) _____Aquatic Weeds (submerged)

____OTHER (identify): _____

B. Aquatic Pesticides Used: List Name and Active ingredients

_____

C. Period of Application: Start Date _____ End Date_____

D. Types of Adjuvants Used:

V. AQUATIC PESTICIDES APPLICATION PLAN

Has Aquatic Pesticides Application Plan been prepared and is the applicator familiar with its contents? Yes ☐ No ☐
If not, when will it be prepared? _____

VI. NOTIFICATION

Have potentially affected public and governmental agencies been notified? Yes ☐ No ☐

VII. VICINITY MAP AND FEE

A. Have you included vicinity map(s) with this submittal? ..... YES ☐ NO ☐
Separate vicinity maps must be submitted for each Region where a proposed discharge will occur.

B. Have you included payment of the filing fee (for first-time enrollees only) with this submittal? ... YES ☐ NO ☐ NA ☐

VIII. CERTIFICATION

"I certify under penalty of law that this document and all attachments were prepared under my direction and supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine or imprisonment. Additionally, I certify that the provisions of the permit, including developing and implementing a monitoring program, will be complied with."

A. Printed Name:_____

B. Signature: _____ **Date:** _____

C. Title:_____

INSTRUCTIONS
FOR COMPLETING THE NOI

WATER QUALITY ORDER NO. 2004-0009-DWQ
STATEWIDE GENERAL NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT FOR DISCHARGE OF AQUATIC PESTICIDES FOR AQUATIC WEED CONTROL IN WATERS OF THE UNITED STATES
GENERAL PERMIT NO. CAG990005

These instructions are intended to help you, the discharger, complete the Notice of Intent (NOI) form for the general National Pollutant Discharge Elimination System (NPDES) permit. **Please type or print clearly when completing the NOI form and vicinity map(s).**

Send the completed and signed form along with the filing fee, supporting documentation, and vicinity map(s) to the appropriate Regional Water Board. One NOI should be submitted by appropriate discharger to cover all proposed discharges within the boundaries of each Regional Water Quality Control Board (Regional Water Board). If proposed discharges will occur in more than one Region, submit extra copies of the NOI and maps for each Region where a discharge will occur. Only one annual fee is required for each discharger.

Section I – Notice of Intent Status

Please mark whether this is the first time coverage under this General Permit is being requested or if this is a change of information for a discharge already covered under this General Permit. If this is a change of information, please supply the eleven-digit Waste Discharge Identification (WDID) number for the discharge.

Section II – Control Agency Information

A. Enter the name of the Control Agency.
B. Enter the street number and street name where mail and correspondence should be sent (P.O. Box is acceptable).
C. Enter the city that applies to the mailing address given.
D. Enter the county that applies to the mailing address given.
E. Enter the state that applies to the mailing address given.
F. Enter the zip code that applies to the mailing address given.
G. Enter the name (first and last) of the contact person for the Control Agency listed above.
H. Enter the contact person's title.
I. Enter the contact person's daytime telephone number.

Section III – Receiving Water Information

A. Check all boxes that apply. At least one box must be checked.

1. Check this box if the application site is a canal, ditch, or other constructed conveyance system owned and controlled by the Control Agency. Print the name of the conveyance system.
2. Check this box if the application site is a canal, ditch, or other constructed conveyance system owned and controlled by a different person or entity other than the Control Agency. Clearly print the name and the owner of the conveyance system.

3. Check this box if the application site is not a constructed conveyance system (including application to river, lake, creek, stream, bay, ocean) and enter the name of the water body.

B. List all Region numbers where pesticide application is proposed. Regional Water Board boundaries are defined in section 13200 of the California Water Code. The numbers for each Region are given below and a map is attached.

1- North Coast
2- San Francisco Bay
3- Central Coast
4- Los Angeles
5- Central Valley (Sacramento, Fresno, Redding)
6- Lahontan (South Lake Tahoe, Victorville)
7- Colorado River Basin
8- Santa Ana
9- San Diego

Section IV – Pesticide Application Information

A. Check the appropriate target organism. If the target organism is not listed, check OTHER, and list the name or type of target organism in the space provided.
B. List the name and active ingredients of each pesticide to be used.
C. List the start and end date of proposed pesticide application season.
D. List the name(s) and type(s) of adjuvants that will be used.

Section V – Aquatic Pesticides Application Plan (APAP)

An APAP must be prepared and the applicator familiar with its contents before aquatic pesticide application is authorized under this General Permit. If an APAP is not complete at the time of application, enter the date by which it will be completed.

Section VI – Notification

Have you notified potentially affected governmental agencies, as required by Provision D.4 of the General Permit?

Section VII – Vicinity Map and Fee

A. If you have included vicinity map(s) with your Form A submittal, check the YES box if you have not included the vicinity map(s), check the NO box. **NOTE:** Vicinity map(s) of the proposed pesticide application site must be received before you can be covered by this General Permit. You must submit separate vicinity map(s) for each Regional Water Board service area where a discharge is proposed. If applying for coverage under Region 5, please send in two additional copies of the required map, if applying for coverage under Region 6, please send in one additional copy of the required map.

B. Check the YES box if you have included payment of the annual fee for a Category 3 discharge specified in Title 23, California Code of Regulations, section 2200(b)(9) with your submittal. Check the NO box if you have not included this payment.

NOTICE OF INTENT INSTRUCTIONS
WATER QUALITY ORDER NO. 2004-0009-DWQ

NOTES:

1. Payment of this fee is not necessary if you have paid an annual fee within the last year for coverage under the previous order, Order No. 2001-12-DWQ.
2. You will be billed annually and payment is required to continue coverage.

Section VIII

A. Print the name of the appropriate official. For a municipality, State, federal, or other public agency, this would be a principal executive officer, ranking elected official, or duly authorized representative. The principal executive officer of a federal agency includes the chief executive officer of the agency or the senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency (e.g., Regional Administrator of USEPA).

B. The person whose name is printed above must sign and date the NOI.

C. Enter the title of the person signing the NOI.

ATTACHMENT B
WATER QUALITY ORDER NO. 2004-0009-DWQ
STATE WATER RESOURCES CONTROL BOARD

Division of Water Quality
P.O. Box 100
Sacramento, CA 95812-0100
Web Page: http://www.waterboards.ca.gov

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARDS

NORTH COAST REGION (1)
5550 Skylane Blvd, Ste. A
Santa Rose, CA 95403
(707) 576-2220 FAX: (707)523-0135
Web Page:
http://www.waterboards.ca.gov/northcoast/

SAN FRANCISCO BAY REGION (2)
1515 Clay Street, Ste. 1400
Oakland, CA 94612
(510) 622-2300 FAX: (510) 622-2640
Web Page:
http://www.waterboards.ca.gov/sanfranciscobay/

CENTRAL COAST REGION (3)
895 Aerovista Place, Ste 101
San Luis Obispo, CA 93401
(805) 549-3147 FAX: (805) 543-0397
Web Page:
http://www.waterboards.ca.gov/centralcoast/

LOS ANGELES REGION (4)
320 W. 4th Street, Ste. 200
Los Angeles, CA 90013
(213) 576-6600 FAX: (213) 576-6640
Web Page:
http://www.waterboards.ca.gov/losangeles/

CENTRAL VALLEY REGION (5S)
11020 Sun Center Dr., #200
Rancho Cordova, CA 95670-6114
(916) 464-3291 FAX: (916) 464-4645
Web Page:
http:www.waterboards.ca.gov/centralvalley/

FRESNO BRANCH OFFICE (5F)
1685 E St.
Fresno, CA 93706
(559) 445-5116 FAX: (559) 445-5910
Web Page:
http://www.waterboards.ca.gov/centralvalley/

REDDING BRANCH OFFICE (5R)
415 Knollcrest Drive, Ste. 100
Redding, CA 96002
(530) 224-4845 FAX: (530) 224-4857
Web Page:
http://www.waterboards.ca.gov/centralvalley/

LAHONTAN REGION (6 SLT)
2501 Lake Tahoe Blvd.
South Lake Tahoe, CA 96150
(530) 542-5400 FAX: (530) 544-2271
Web Page:
http://www.waterboards.ca.gov/lahontan/

VICTORVILLE OFFICE (6V)
14440 Civic Drive, Suite 200
Victorville, CA 92392-2383
(760) 241-6583 FAX: (760) 241-7308
Web Page:
http://www.waterboards.ca.gov/lahontan/

COLORADO RIVER BASIN REGION (7)
73-720 Fred Waring Dr., Ste. 100
Palm Desert, CA 92260
(760) 346-7491 FAX: (760) 341-6820
Web Page:
http://www.waterboards.ca.gov/coloradoriver/

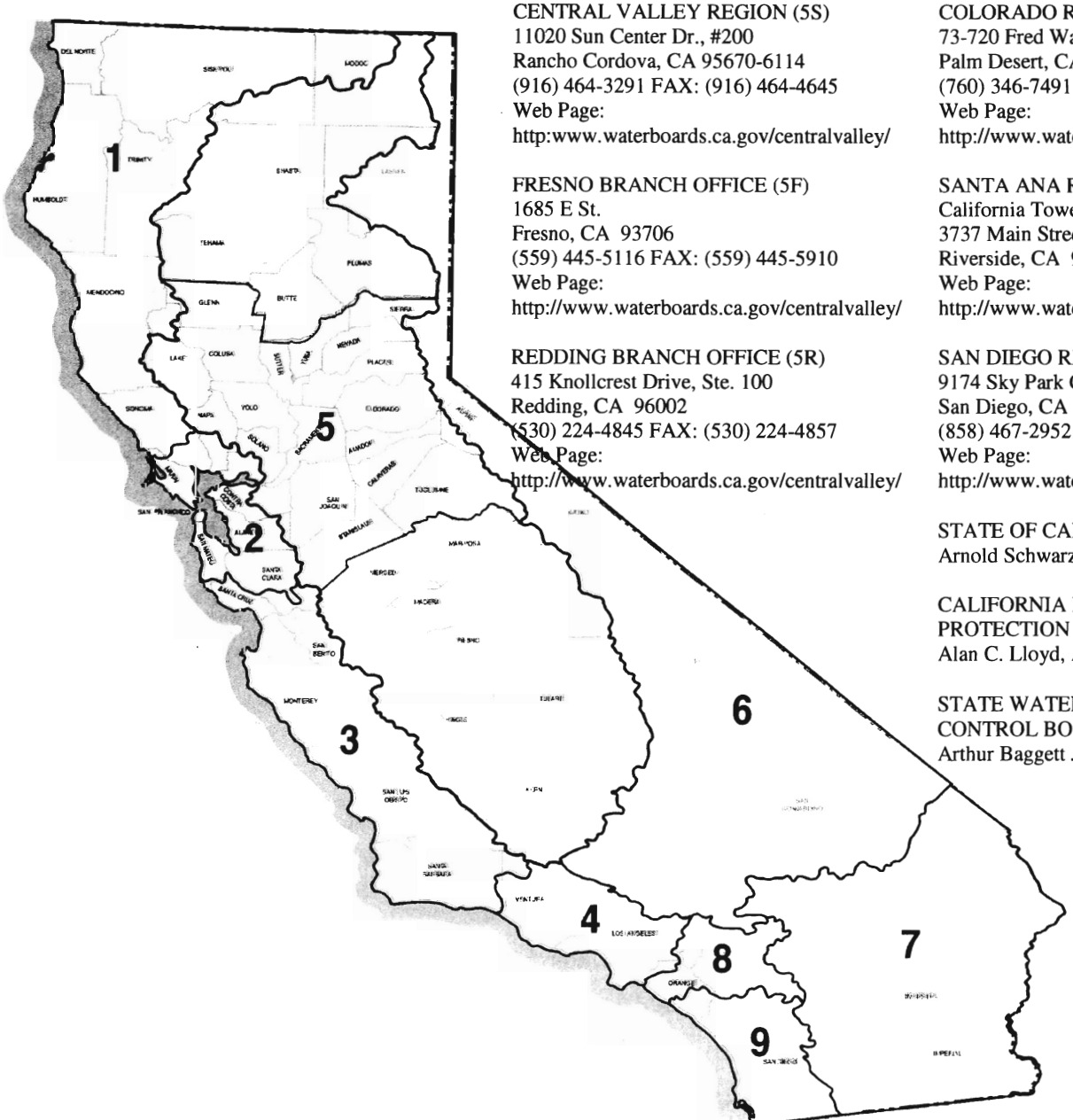
SANTA ANA REGION (8)
California Tower
3737 Main Street, Ste. 500
Riverside, CA 92501-3339
Web Page:
http://www.waterboards.ca.gov/santaana/

SAN DIEGO REGION (9)
9174 Sky Park Court, Ste. 100
San Diego, CA 92123-4340
(858) 467-2952 FAX: (858) 571-6972
Web Page:
http://www.waterboards.ca.gov/sandiego/

STATE OF CALIFORNIA
Arnold Schwarzenegger, Governor

CALIFORNIA ENVIRONMENTAL
PROTECTION AGENCY
Alan C. Lloyd, Agency Secretary

STATE WATER RESOURCES
CONTROL BOARD
Arthur Baggett Jr., Chairman



ATTACHMENT C

STATE WATER RESOURCES CONTROL BOARD
MONITORING AND REPORTING PROGRAM (MRP)

WATER QUALITY ORDER NO. 2004-0009-DWQ
STATEWIDE GENERAL NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT FOR DISCHARGE OF AQUATIC PESTICIDES FOR AQUATIC WEED CONTROL IN WATERS OF THE UNITED STATES
GENERAL PERMIT NO. CAG990005

A. MONITORING PROVISIONS

1. **Sampling Analysis.** All laboratory analyses shall be conducted at a laboratory certified for such analyses by the California Department of Health Services. All analyses shall be conducted in accordance with the latest edition of "Guidelines Establishing Test Procedures for Analysis of Pollutants" (Guidelines), promulgated by the U.S. Environmental Protection Agency (USEPA) (Title 40 Code of Federal Regulations part 136), except nonylphenol analysis. Nonylphenol shall be analyzed using USEPA Method 3535/Ligquid Chromatograph-Fluorescence. Hardness shall be determined by the calculation[1] or titration method.

2. **Sampling Procedures.** Samples shall be collected using sampling procedures, which minimize loss of monitored constituents during sample collection and analysis and maintain sample integrity.

3. **Monitoring Frequency.** If the discharger monitors any constituent required to be monitored under this General Permit more frequently than specified, the monitoring results shall be submitted to the appropriate Regional Water Board.

4. **Retention of Records.** The discharger shall retain records of all monitoring information including all calibration and maintenance records, copies of all reports required by this General Permit, and records of all data used to complete the application for this General Permit. Records shall be maintained for a minimum of three years from the date of the sampling, measurement, or report. This period may be extended during the course of any unresolved litigation regarding this discharge or when requested by the appropriate Regional Water Board Executive Officer.

5. **Monitoring Records.** Records of monitoring information shall include the following:

   a. The date, exact place, and time of sampling or measurements;

   b. The individuals who performed the sampling or measurements;

   c. The dates analyses were performed;

   d. The individuals who performed the analyses;

---

[1] Hardness, mg equivalent $CaCO_3$ mg/L = 2.497[Ca, mg/L] + 4.118[Mg, mg/L]

e. The analytical techniques or method used; and

f. The results of such analyses.

6. **Device Calibration and Maintenance.** All monitoring instruments and devices that are used by the discharger to fulfill the prescribed monitoring program shall be properly maintained and calibrated as necessary to ensure their continued accuracy.

B. RECEIVING WATER MONITORING

1. For each application at each site, the discharger shall prepare a map with a convenient scale showing the application area, treatment area, immediately adjacent untreated areas (if entire water body is not treated), and water bodies receiving treated water. The discharger shall also provide information on surface area and/or volume of application area and treatment area and any other information used to calculate dosage and quantity of each pesticide used at each application site. For acrolein applications, the map shall also show the acrolein injection points and locations of major canals, spillways, or gates that may flow to natural waters.

   Discharger shall also identify sampling locations described in B.3 through B.5 below and provide global positioning systems (GPS) coordinates for each sampling site.

2. Dischargers who operate canals, ditches, ponds, or other systems that allow dischargers reasonable control over their treated water through gates, weirs, locks, etc. shall inspect the integrity of their systems prior to every application within the system to ascertain that treated water does not unintentionally get discharged to streams, rivers, lakes, or other natural waterways.

3. The dischargers shall collect samples at 10 percent of all application sites for each type of aquatic pesticide used for each type of site. The 10 percent sampling sites shall be representative sites.

4. A discharger with 20 application sites or less shall collect samples at a minimum of two sites[2]. A discharger with greater than 20 sites shall collect samples at 10 percent of all the sites. The number of representative sites shall be rounded to the nearest whole number using scientific number protocol. For example, if the number of sites is 25, the discharger must sample three representative sites.

5. The following monitoring is required for each sampling:

   a. **Background Monitoring**
   Background samples shall be collected upstream at the time of the application event, or they may be collected at the treatment area, just prior (up to 24-hours in advance of application) to the application event.

[2] If the discharger only applies aquatic pesticides at one site, samples are required from that site only.

b. **Event Monitoring**
Event monitoring samples shall be collected immediately downstream of the treatment area in flowing waters or adjacent to the treatment area in non-flowing waters, immediately after the application event or shortly after application, but after sufficient time has elapsed such that treated water will have entered the adjacent or downstream area.

c. **Post-Event Monitoring**
Post-event samples shall be collected within the treatment area and immediately downstream of the treatment area in flowing waters or adjacent to the treatment area in non-flowing waters within one-week after the application event.

6. The following parameters shall be analyzed for:

TABLE 1 - MONITORING PARAMETERS

SAMPLE TYPE	CONSTITUENT/ PARAMETER	SAMPLE METHOD	LABORATORY METHOD	FREQUENCY
Visual	1. Site description (pond, lake, open waterway, channel, estimate of percent covered by vegetation, etc.) 2. Appearance of waterway (sheen, color, clarity, etc.) 3. Weather conditions (fog, rain, wind, etc.)	Visual Observation	Not Applicable	All applications at all sites
Physical	1. Temperature[3] 2. Turbidity[4] 3. Electrical conductivity/salinity[4]	Grab[5]	See USEPA Guidelines	All applications at 10 percent of all sites
Chemical	1. Active Ingredient 2. Nonylphenol[6] 3. pH[4] 4. Dissolved Oxygen[4] 5. Hardness ($CaCO_3$)[7]	Grab[5]	See USEPA Guidelines	All applications at 10 percent of all sites

C. ADDITIONAL MONITORING

Dischargers that propose monitoring as part of their CEQA compliance must also comply with that monitoring plan where the two plans differ.

[3] Field testing.
[4] Field or laboratory testing.
[5] Samples shall be collected at three feet below the surface, or mid-depth if water body is less than six feet deep.
[6] Required when nonylphenol is used.
[7] Required for copper applications only.

D. REPORTING

1. All reports shall be submitted to the appropriate Regional Water Board. All reports submitted in response to this Order must comply with the provisions stated in "Standard Provisions and Reporting for Waste Discharge Requirements (NPDES)" (Attachment D), section B, Monitoring and Reporting Requirements.

2. Annual reports shall contain the following information:

   a. An Executive Summary discussing General Permit compliance or violation and the effectiveness of the APAP to reduce or prevent the discharge of pollutants associated with aquatic pesticide applications;

   b. A summary of monitoring data, including the identification of water quality improvements or degradation, and recommendations for improvements to the APAP (including proposed BMPs) based on the monitoring results. All receiving water monitoring data shall be compared to applicable water quality standards;

   c. Identification of BMPs and a discussion of their effectiveness in meeting this General Permit requirements;

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

   e. A map showing the location of each application and treatment area;

   f. Types and amounts of aquatic pesticides used at each application event during each application;

   g. Information on surface area and/or volume of treatment area and any other information used to calculate dosage and quantity of each pesticide used;

   h. List of gates in the treatment area that may discharge to surface waters; time of gate closure and reopening, include any calculations used to determine closure and reopening times, if applicable;

   i. Sampling results for all required monitoring under section B of this MRP and any additional sampling conducted in compliance with section A.3 of this MRP. Sampling results shall indicate the name of the sampling agency or organization, detailed sampling location information (including latitude and longitude or township/range/section if available), detailed map or description of each sampling site (i.e., address, cross roads, etc.), collection date, name of constituent/parameter and its concentration detected, minimum levels, method detection limits for each constituent analysis, name or description of water body sampled, and a comparison with applicable water quality standards, description of analytical QA/quality control plan. Sampling results shall be tabulated so that they are readily discernible;

j. Recommendations to improve the monitoring program, BMPs, and APAP to ascertain compliance with this General Permit; and

k. Proposed changes to the APAP and monitoring program.

E. REPORT SCHEDULE

Monitoring reports shall be submitted to the Regional Water Board Executive Officer in accordance with the following schedule:

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

ATTACHMENT D

STATE WATER RESOURCES CONTROL BOARD

STANDARD PROVISIONS AND REPORTING FOR WASTE DISCHARGE REQUIREMENTS

WATER QUALITY ORDER NO. 2004-0009-DWQ
STATEWIDE GENERAL NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT FOR THE DISCHARGE OF AQUATIC PESTICIDES FOR AQUATIC WEED CONTROL IN WATERS OF THE UNITED STATES
GENERAL PERMIT NO. CAG 990005

A. General Provisions

1. **Duty to Comply** [Title 40, Code of Federal Regulations (CFR) 122.41(a)][California Water Code (CWC) 133811]

   a. The Discharger must comply with all of the conditions of this General Permit. Any General Permit noncompliance constitutes a violation of the Clean Water Act and the Porter-Cologne Water Quality Control Act and is grounds for enforcement action, for permit termination, revocation and reissuance or modification, or for denial of a permit renewal application.

   b. The Discharger shall comply with effluent standards or prohibitions established under section 307(a) of the Clean Water Act for toxic pollutants and with standards for sewage sludge use or disposal established under section 405(d) of the Clean Water Act within the time provided in the regulations that establish these standards or prohibitions, even if this General Permit has not been modified to incorporate the requirement.

2. **Duty to Mitigate** [40 CFR 122.41(d)]

   The Discharger shall take all reasonable steps to minimize or prevent any discharge in violation of this General Permit, which has a reasonable likelihood of adversely affecting human health or the environment.

3. **Proper Operation and Maintenance** [40 CFR 122.41(e)],

   The Discharger shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) that are installed or used by the Discharger to achieve compliance with this General Permit. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. This provision requires the operation of backup or auxiliary facilities or similar systems, which are installed by a Discharger only when necessary to achieve compliance with the conditions of this General Permit.

4. **Permit Actions** [40 CFR 122.41(f)][CWC 13263(e)][40 CFR 122.44(b)(1)]

   a. This General Permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by the Discharger for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not stay any permit condition.

   b. If any toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is promulgated under section 307(a) of the Clean Water Act for a toxic pollutant which is present in the discharge, and that standard or prohibition is more stringent than any limitation on the pollutant in this General Permit, this General Permit shall be modified or revoked and reissued to conform to the toxic effluent standard or prohibition and the Discharger so notified.

5. **Property Rights** [40 CFR 122.41(g)][CWC 13263(g)]

   a. This General Permit does not convey any property rights of any sort, or any exclusive privileges.

   b. All discharges of waste into water of the State are privileges, not rights.

6. **Duty to Provide Information** [40 CFR 122.41(h)]

   The Discharger shall furnish the Regional Water Quality Control Board (Regional Water Board), the State Water Resources Control Board (State Water Board), or the U.S. Environmental Protection Agency (USEPA), within a reasonable time, any information which the Regional Water Board, State Water Board, or USEPA may request to determine compliance with this General Permit. Upon request, the Discharger shall also furnish to the Regional Water Board, State Water Board, or USEPA copies of records required by this General Permit to be kept.

7. **Inspection and Entry** [40 CFR 122.41(h)]

   The Discharger shall allow the Regional Water Board, State Water Board, USEPA, and/or their authorized representatives (including an authorized contractor acting as their representative), upon the presentation of credentials and other documents as may be required by law, to:

   a. Enter upon the Discharger' s premises where a regulated facility or activity is located or conducted, or where records are kept under the conditions of this General Permit; and

   b. Inspect and photograph, at reasonable times, any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this General Permit; and

   c. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this General Permit; and

d. Sample or monitor, at reasonable times, for the purposes of ensuring permit compliance or as otherwise authorized by the Clean Water Act or the Porter-Cologne Water Quality Control Act, any substances or parameters at any location.

8. **Bypass and Upset** [40 CFR 122.41(m)] [40 CFR 122.41(n)]

a. Definitions.

(1) "Bypass" means the intentional diversion of waste streams from any portion of a treatment facility.

(2) "Severe property damage" means substantial physical damage to property, damage to the treatment facilities that causes them to become inoperable, or substantial and permanent loss of natural resources that can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

(3) "Upset" means an exceptional incident in which there is unintentional and temporary noncompliance with technology-based permit effluent limitations because of factors beyond the reasonable control of the Discharger. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation.

b. Prohibition of Bypass.

(1) Bypass is prohibited, and the Regional Water Board may take enforcement action against a permittee for bypass, unless:

(a) Bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;

(b) There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgement to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance; and

(c) The permittee submitted notices as required under 40 CFR 122.41(m)(3).

c. Conditions necessary for a demonstration of upset.

A permittee who wishes to establish the affirmative defense of upset shall demonstrate, through properly signed, contemporaneous operating logs, or other relevant evidence that:

(1) An upset occurred and that the permittee can identify the cause(s) of the upset;

(2) The permitted facility was at the time being properly operated;

(3) The permittee submitted notice of the upset as required in 24-Hour Reporting; and

(4) The permittee complied with any remedial measures required under 40 CFR 122.41(d).

d. Burden of proof.

In any enforcement proceeding, the permittee seeking to establish the occurrence of an upset has the burden of proof.

9. **Transfers** [40 CFR 122.41(L)(3)] [CWC 133771] [40 CFR 122.61(a)(b)]

This General Permit is not transferable to any person except after notice to the Regional Water Board. The Regional Water Board may require modification or reissuance of the permit conditions to change the name of the Discharger and incorporate such other requirements as may be necessary under the Clean Water Act and the Porter-Cologne Water Quality Control Act.

10. **Severability**

The provisions of this General Permit are severable and, if any provision of this General Permit or the application of any of its provisions to any circumstance is held invalid, the application of such provision to other circumstances and the remainder of this General Permit shall not be affected thereby.

11. **Pollution, Contamination, or Nuisance** [CWC 13050]

Neither the treatment nor the discharge shall create a condition of pollution, contamination, or nuisance.

B. Monitoring and Reporting Requirements

1. **Signatory Requirements** [40 CFR 122-41(k)] [40 CFR 122.221]

a. All permit applications or Notices of Intent (NOIs) submitted to the Regional Water Board, State Water Board, or USEPA shall be signed as follows:

(1) For a corporation: by a responsible corporate officer. For the purpose of this provision, a responsible corporate officer means: a president, secretary, treasurer, or vice president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision-making functions for the corporation, or the manager of one or more manufacturing, production, or operating facilities employing more than 250 persons or having gross annual sales or expenditures exceeding $25 million (in second quarter 1980 dollars), if authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures.

(2) For a partnership or sole proprietorship: by a general partner or the proprietor, respectively; or

(3) For a municipality, State, federal, or other public agency: by either a principal executive officer or ranking elected official. For purposes of this provision, a principal executive officer of a federal agency includes: the chief executive officer having responsibility for the overall operations of a principal geographic unit of the agency (e.g., Regional Administrators of USEPA).

b. All reports required by this General Permit and other information requested by the Regional Water Board, State Water Board, or USEPA shall be signed by a person described in paragraph (a) of this provision or by a duly authorized representative of that person. A person is a duly authorized representative only if:

(1) The authorization is made in writing by a person described in paragraph (a) of this provision;

(2) The authorization specified either an individual or a position having responsibility for the overall operation of the regulated facility or activity such as the position of plant manager, operator of a well or a well field, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters for the company (a duly authorized representative may thus be either a named individual or any individual occupying a named position); and

(3) The written authorization is submitted to the Regional Water Board, State Water Board, or USEPA.

c. If an authorization under paragraph (b) of this provision is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of paragraph (b) of this provision must be submitted to the Regional Water Board, State Water Board, or USEPA together with any reports, information, applications, or NOIs to be signed by an authorized representative.

d. Any person signing a document under paragraphs (a) or (b) of this provision shall make the following certification:

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

2. **Monitoring Reports** [40 CFR 122.41(l) (4)]

   a. Monitoring results shall be reported at the intervals specified in this General Permit.
   b. Monitoring results must be reported on a Discharge Monitoring Report (DMR) form or forms approved by the Regional Water Board or State Water Board for reporting results of monitoring of pollutants and sludge use or disposal practices.

   c. Calculations for all limitations, which require averaging of measurements, shall utilize an arithmetic mean unless otherwise specified in this General Permit.

3. **Compliance Schedules** [40 CFR 122.41(l) (5)]

   Reports of compliance or noncompliance with interim and final requirements contained in any compliance schedule of this General Permit shall be submitted no later than 14 days following each schedule date.

4. **Twenty-Four Hour Reporting** [40 CFR 122.41(l) (6)]

   a. The Discharger shall report any noncompliance that may endanger health or the environment. Any information shall be provided orally within 24 hours from the time the Discharger becomes aware of the circumstances. A written submission shall also be provided within five days of the time the Discharger becomes aware of the circumstances. The written submission shall contain a description of the noncompliance and its cause, the period of noncompliance, including exact dates and times and, if the noncompliance has not been corrected, the anticipated time it is expected to continue, and steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance.

   b. The following shall be included as information that must be reported within 24 hours under this paragraph:

      (1) Any bypass which exceeds any effluent limitation in this General Permit.

      (2) Any upset which exceeds any effluent limitation in this General Permit.

      (3) Violation of a maximum daily discharge limitation for any of the pollutants listed in this General Permit is to be reported within 24 hours. The Regional Water Board may waive the above required written report under this provision on a case-by-case basis if an oral report has been received within 24 hours.

5. **Other Noncompliance** [40 CFR 122.41(1)(7)]

   The Discharger shall report all instances of noncompliance not reported under Provisions (B.3) and (B.4) at the time monitoring reports are submitted. The reports shall contain the information listed in Provision (B.4).

6. **Other Information** [40 CFR 122.41(l) (8)]

When the Discharger becomes aware that it failed to submit any relevant facts in a permit application or NOI, or submitted incorrect information in a permit application, NOI or in any report to the Regional Water Board, State Water Board, or USEPA, the Discharger shall promptly submit such facts or information.

7. **Planned Changes** [40 CFR 122 41(l)(1)]

The Discharger shall give notice to the Regional Water Board as soon as possible of any planned physical alterations or additions to the permitted facility. Notice is required under this provision only when:

a. The alteration or addition to a permitted facility may meet one of the criteria for determining whether a facility is a new source in 40 CFR Part 122.29(b); or

b. The alteration or addition could significantly change the nature or increase the quantity of pollutants discharged. This notification applies to pollutants which are subject neither to effluent limitations in the General Permit nor to notification requirements under 40 CFR Part 122.42 (a) (1); or

c. The alteration or addition results in a significant change in the Discharger' s sludge use or disposal practices, and such alteration, addition, or change may justify the application of permit conditions that are different from or absent in the existing permit, including notification of additional use or disposal sites not reported during the permit application/NOI process or not reported pursuant to an approved land application plan.

8. **Anticipated Noncompliance** [40 CFR 122.41(l)(2)]

The Discharger shall give advance notice to the Regional Water Board or State Water Board of any planned changes in the permitted facility or activity, which may result in noncompliance with permit requirements.

9. **Discharge Monitoring Quality Assurance (DMQA) Program** [State Water Board/USEPA 106 Partnership Agreement]

The Discharger shall conduct appropriate analyses on any sample provided by USEPA as part of the DMQA program. The results of such analyses shall be submitted to USEPA' s DMQA manager.

C. Enforcement Provisions

1. The Clean Water Act provides that any person who violates a permit condition implementing sections 301, 302, 306, 307, 308, 318, or 405 of the Clean Water Act is subject to a civil penalty not to exceed $25,000 per day of violation. Any person who negligently violates permit conditions implementing sections 301, 302, 306, 307, 308, 318, or 405 of the Clean Water Act is subject to a fine of not less than $2,500 or more than $25,000 per day for each violation, or by imprisonment of not more than one year, or both. Higher penalties may be imposed for knowing violations and for repeat offenders. The Porter-Cologne Water Quality

Control Act provides for civil and criminal penalties comparable to and in some cases greater than those provided under the Clean Water Act. [40 CFR 122.41(a)(2)][CWC sections 13385 and 13387].

2. The Clean Water Act provides that any person who knowingly makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this General Permit including monitoring reports or reports of compliance or noncompliance shall be punished upon conviction by a fine of not more than $10,000 per violation or by imprisonment for not more than six months per violation, or by both. [40 CFR 122-41(k)(2)].

3. The Clean Water Act provides that any person who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required to be maintained under this General Permit shall, upon conviction, be punished by a fine of not more than $10,000 or by imprisonment for not more than two years, or both. Higher penalties may be imposed for repeat offenders. [40 CFR 122.41(j)(5)].

ATTACHMENT E
WATER QUALITY ORDER NO. 2004-0009-DWQ

STATE WATER RESOURCES CONTROL BOARD

LIST OF PUBLIC ENTITIES GRANTED AN EXCEPTION PURSUANT TO STATE WATER RESOURCES CONTROL BOARD POLICY FOR IMPLEMENTATION OF TOXICS STANDARDS FOR INLAND SURFACE WATERS, ENCLOSED BAYS, AND ESTUARIES OF CALIFORNIA (POLICY)

WATER QUALITY ORDER NO. 2004-0009-DWQ
STATEWIDE GENERAL NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT FOR THE DISCHARGE OF AQUATIC PESTICIDES FOR AQUATIC WEED CONTROL IN WATERS OF THE UNITED STATES
GENERAL PERMIT NO. CAG990005

The public entities listed herein have prepared Initial Studies, Negative Declarations (ND), and Notices of Determination or Mitigated Negative Declarations (MND) for the discharge of aquatic pesticides in accordance with the California Environmental Quality Act [CEQA (Public Resources Code Section 21000 et seq.)] to comply with the exception requirements of section 5.3 of the Policy. The boards of each public entity, as the lead agencies under CEQA, approved the Final ND/MND and determined that the discharge of aquatic pesticides in their respective projects would not have a significant effect on the environment. These public entities have determined that the water quality or related water quality impacts identified in the environmental assessments of the ND/MND are less than significant. In addition to submitting the CEQA documentation, these public entities have also complied with the other exception requirements of section 5.3 of the Policy.

As required in Section 15096 of the CEQA Guidelines, the State Water Resources Control Board (State Water Board), as a Responsible Agency under CEQA, considered the ND/MND approved by the board of each public entity and finds that the projects will have less than significant water quality impact if the waste discharge requirements in this General Permit are followed. Accordingly, the public entities listed herein are hereby granted an exception pursuant to section 5.3 of the Policy.

The California Department of Food and Agriculture (CDFA) has determined that its ongoing projects to eradicate hydrilla are exempt from the requirements of CEQA because the activities are necessary to prevent or mitigate an emergency pursuant to Public Resources Code Section 21080 (b)(4). The bases for this determination are that the CDFA Hydrilla Program is mandated under sections 403 and 6048 of the Food and Agriculture Code and the Governor of California and/or the CDFA Secretary has declared that an emergency situation existed as each eradication project began. Although CDFA has determined the CDFA Hydrilla Program is exempt form CEQA, CDFA will coordinate all eradication activities with federal, state and local regulatory agencies to ensure no long-term significant environmental impacts occur.

As required in Section 15096 of the CEQA Guidelines, the State Water Board, as a Responsible Agency under CEQA, considered the exemption claimed by CDFA and finds that the projects will have less than significant water quality impact if the waste discharge requirements in this General Permit are followed. Accordingly, CDFA is hereby granted an exception pursuant to section 5.3 of the Policy, as long as the Governor or the CDFA Secretary has declared that an emergency situation exists prior to project implementation.

ATTACHMENT E
WATER QUALITY ORDER NO. 2004-0009-DWQ

Public Entities with Policy Section 5.3 Exception

1. Byron-Bethany Irrigation District
2. City of Antioch Department of Public Works
3. Contra Costa Water District
4. Contra Costa County Flood Control and Water Conservation District
5. Department of Food and Agriculture
6. Department of Water Resources
7. Friant Water Users Authority
8. Maine Prairie Water District
9. Marin Municipal Water District
10. Metropolitan Water District of Southern California
11. Modesto Irrigation District
12. Nevada Irrigation District
13. North Marin Water District
14. Oakdale Irrigation District
15. Placer County Water Agency
16. Princeton-Cordora-Glenn Irrigation District
17. Provident Irrigation District
18. Reclamation District 1004
19. Santa Cruz Water Department
20. Solano Irrigation District
21. South Feather Water and Power Agency
22. South Sutter Water District
23. Tehama Colusa Canal Authority
24. Woodbridge Irrigation District
25. Yolo County Flood Control and Water Conservation District

ATTACHMENT F
WATER QUALITY ORDER NO. 2004-0009-DWQ

Definition of Terms

1. **Application Area** – The application area is the area to which aquatic pesticides are directly applied. (See Figure 1.)

2. **Application Event** – The application event is the time that introduction of the aquatic pesticide to the application area takes place. The application event is the time that the product is applied, not the length of time that it releases pesticide to the environment.

3. **Control Agency** - The Control Agency is the permitted discharger authorized by this General Permit. It is the agency responsible for controlling weeds. In some cases, such as irrigation districts, the Control Agency may own the conveyance system. In other cases, such as application to Delta waters, the Control Agency may not own the water body or conveyance system into which aquatic pesticides are applied. Additionally, the Control Agency may be the pesticide applicator, but it may also contract with a separate entity that does the actual pesticide application. In either case, however, the Control Agency must ensure that the discharge is in compliance with this General Permit.

4. **Pollutants Associated with Aquatic Pesticide Application** – Pollutants associated with aquatic pesticide application are the pollutants being regulated by this General Permit. They include aquatic pesticide residue, as well as misdirected and over-applied aquatic pesticides.

5. **Policy** – Policy is an abbreviation for the State Water Board's *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California*. It establishes procedures for implementing water quality standards for priority pollutants.

6. **Priority Pollutants** - Priority pollutants are listed in 40 Code of Federal Regulations, section 131.38(b)(1), and include acrolein and copper. Limits are set for priority pollutants in the California Toxics Rule.

7. **Project** –Projects are undertakings necessary to control a specified type of weed to an acceptable level in the treatment area that is being managed.

8. **Representative Site** – A site within and near the treatment area that is typical of the hydrologic and vegetative conditions present at the treatment area.

9. **Residues** – Residues are any pesticide byproduct, or breakdown product, or pesticide product that is present after the use of the pesticide to kill or control the target weed.

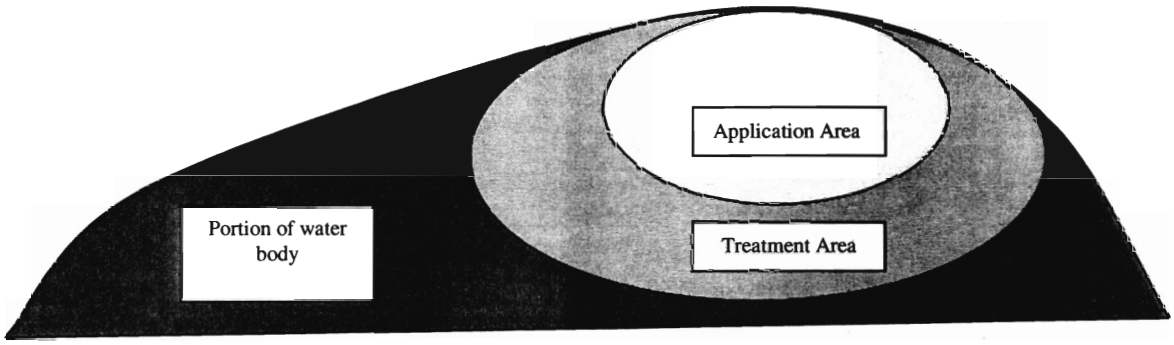
10. **Section 5.3 Exception** – Section 5.3 exception refers to a variance that dischargers may be granted, in accordance with section 5.3 of the *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California*. The variance allows dischargers to exceed water quality criteria for priority pollutants, as set by the California Toxics Rule.

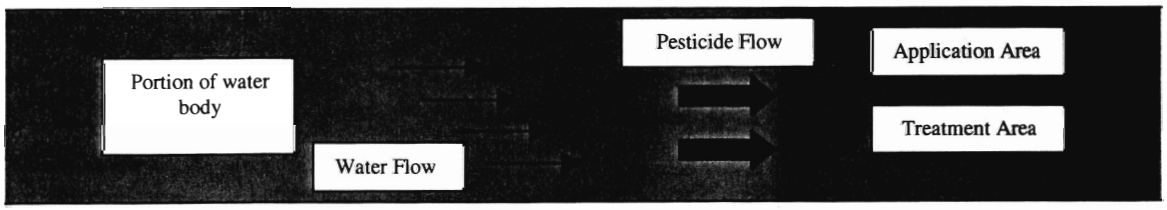
11. **Treatment Area** – The treatment area is the area that is treated by the aquatic pesticide to control weeds. It is the responsibility of the Control Agency to define the treatment area. (See Figure 1.)

12. **Treatment Event** – The treatment event is the period during which the aquatic application is actively killing or controlling weeds within the treatment area. It starts upon initiation of the application event and proceeds until the concentration of the aquatic pesticide is below that which can kill the target weed.

ATTACHMENT F
WATER QUALITY ORDER NO. 2004-0009-DWQ

Figure 1





WHCP Permits

USFWS Biological Opinion (1-1-04-F-0149)

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W-2605
Sacramento, California 95825-1846

IN REPLY REFER TO:
1-1-04-F-0149

MAY 2 1 2004

Dr. Lars W. J. Anderson
Lead Scientist
United States Department of Agriculture
Agricultural Research Service
Weed Science Program
University of California
One Shields Avenue
Davis, California 95616

Subject: Reinitiation of Formal Endangered Species Consultation on the Proposed Water Hyacinth Control Program in the Sacramento-San Joaquin Delta in Nine Counties, California

Dear Dr. Anderson:

This is in response to the U.S. Department of Agriculture's (USDA) February 20, 2004, request for reinitiation of formal consultation with the U.S. Fish and Wildlife Service (Service) on the proposed State of California Department of Boating and Waterways (DBW) Water Hyacinth Control Program (WHCP) and chemical control of *Eichhornia crassipes* (Water Hyacinth) in the Sacramento-San Joaquin Delta and its tributaries. Your request was received in our office on February 23, 2004.

On June 1, 2001, the Service issued a biological opinion for the WHCP (Service file No. 1-1-01-F-0050). This biological opinion was subsequently amended three times (Service file No.'s 1-1-02-F-0157, 1-1-03-F-0114, and 1-1-04-F-0113). Your letter stated that the toxicology studies required by the Service's June 1, 2001, biological opinion, as amended, have been completed. You requested that the Service's June 1, 2001, biological opinion, as amended, be modified to reflect the new information on the toxicity of the herbicides and adjuvants used in the WHCP.

The new information on the toxicology of the herbicides and adjuvants used in the WHCP constitutes a substantial change to the project description and effects sections of the Service's June 1, 2001, biological opinion, as amended. In addition, the Sacramento splittail (*Pogonichthys macrolepidotus*) is no longer listed under the Act. Therefore, the Service has determined that a new biological opinion is required to fully account for all of these changes.

TAKE PRIDE IN AMERICA

This document hereby represents the Service's biological opinion on the effects of the State of California Department of Boating and Waterways (DBW) Water Hyacinth Control Program (WHCP) and chemical control of *Eichhornia crassipes* (Water Hyacinth) in the Sacramento-San Joaquin Delta and its tributaries on the federally threatened delta smelt (*Hypomesus transpacificus*) and its critical habitat, giant garter snake (*Thamnophis gigas*), and valley elderberry longhorn beetle *(Desmocerus californicus dimorphus*) in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act). This biological opinion supersedes the Service's June 1, 2001, biological opinion (Service file No. 1-1-01-F-0050) and its amendments (Service file No.'s 1-1-02-F-0157, 1-1-03-F-0114, and 1-1-04-F-0113).

This biological opinion is based on the following information: 1) the Service's June 1, 2001, biological opinion (Service file No. 1-1-01-F-0050) and its amendments (Service file No.'s 1-1-02-F-0157, 1-1-03-F-0114, and 1-1-04-F-0113); 2) The DBW's WHCP 2003 Annual Report, dated January 2004; 3) the USDA's letter reinitiation of formal consultation, dated February 20, 2004; 4) the summary of aquatic acute toxicity data for five spray adjuvants, dated February 4, 2004; 5) the California Department of Fish and Game's (DFG's) study "Acute Oral and Dermal Toxicology of Aquatic Herbicides and a Surfacant to Garter Snakes," dated February 23, 2004; 6) the DFG's draft study "Acute Toxicities of Herbicides Used to Control Water Hyacinth and Brazilian Elodea on Larval Delta Smelt and Sacramento Spilttail," received on April 30, 2004; 7) numerous electronic mails, phone conversations, and meetings between the DBW, USDA and Mike Nepstad of the Service. A complete administrative record of this consultation is on file at the Sacramento Fish and Wildlife Office.

CONSULTATION HISTORY

On February 20, 2004, USDA requested reinitiation of formal consultation.

BIOLOGICAL OPINION

Description of the proposed Action

The DBW, with the assistance of USDA, works to control the non-native Water Hyacinth through the use of herbicides within the waterways of the Delta and its upland tributaries (see Attachment A, project area). The WHCP, approved by the Services June 1, 2001, biological opinion, is an on-going program that intends to control the growth and spread of Water Hyacinth through the use of chemical control methods. The WHCP treats Water Hyacinth using three different herbicides (Weedar ®64, Reward®, and Rodeo®) and three different adjuvants (Placement®, R-11®, and Agri-dex®). The majority of herbicide application would continue to be done from boats using a hand held spray gun; however some application would be done by land in locations not accessible by boat.

The purpose of the WHCP is to control and limit growth and spread of Water Hyacinth in the Delta and its tributaries, improve boat and vessel navigation in the Delta, and improve shallow-water habitat and water quality for native species. The WHCP proposes to use the most efficacious methods available with the least environmental impacts, employ a combination of control methods to allow for maximum flexibility, monitor results to fully understand impacts on the environment, reduce control efforts as efficacy of Water Hyacinth treatment is realized, and minimize use of methods that may cause adverse environmental impacts.

WHCP activities affect waterways, channels, and channel banks in the Delta and its tributaries. The environment affected by the WHCP and associated with the Delta and its tributaries includes three types of waterways: tidal delta, riverine, and dead-end slough. The habitats types include emergent herbaceous wetland vegetation (cattail, bulrush, pennywort), and riparian woodland vegetation (oaks, sycamore, willow, cottonwood, elderberry) associated with the waterways and levee banks of the Delta and tributaries. The majority of the waterways in the Delta have been channelized, are rip-rapped and constrained by levees.

The WHCP has divided the project area into numbered treatment sites varying in size between one and two miles in length depending on the amount of Water Hyacinth infestation, location, and waterbody type (*e.g.* tidal delta, riverine, dead-end slough). Treatment sites vary in size from year to year depending on Water Hyacinth distribution. Not all sites are treated each year. The WHCP is an adaptative program with control methods, treatment sites, and amount of herbicides used being reduced as the Water Hyacinth is effectively reduced. Should the treatment sites or methods need to change than the DBW and USDA have proposed to re-initiate consultation under the Act.

The protocols for the WHCP use five two-person crews each assigned to specific sites within the project area. The sites are prioritized as to greatest impact to navigation, Water Hyacinth nursery areas, and sites close to pumps or other structures. Typically, the five crews will spray about one to three sites each day, totaling 25 acres per day for the group. The maximum amount treated may be as high as 50 acres/day in summer when crews work overtime and weather conditions are conducive to treatment. The majority of the herbicide will be applied from boats with a smaller percentage being applied from land in areas where water access is impractical. Staging areas for the WHCP will be at developed launch sites. Access to sites from land would require disturbance of vegetation along waterways and levee banks. Staging areas would be limited to developed roadways for land operations.

The have maximum effectiveness, the WHCP needs to begin spraying as soon as possible in the spring, when the water hyacinth is small and rapidly growing. The crews check each site in their region throughout the season to evaluate the success of previous treatments and to inspect for any new plant growth.

The WHCP includes a water quality monitoring program. The monitoring program includes sampling for pre-treatment and post-treatment of dissolved oxygen and chemical residues and other monitoring parameters outlined below.

The WHCP assists in the implementation of several recovery actions outlined in the "Recovery Plan for the Sacramento/San Joaquin Delta Native Fishes" (Delta Recovery Plan) (Service 1996) and the "Draft Recovery Plan for the Giant Garter Snake" (GGS Recovery Plan) (Service 1999a). The WHCP also assists in implementing Delta Recovery Plan recovery action #1121 (Develop Delta habitat and vegetation zones), Delta Recovery Plan recovery action #132 (eliminate loss of shallow water habitat) by removing the competition from the non-native macrophytes. The monitoring plan assists in implementing Delta Recovery Plan recovery action #53 (conduct toxicological investigations), and the GGS Recovery Plan recovery task #4.7 (study the effects of contaminants on giant garter snake).

Background

Water Hyacinth (*Eichhornia crassipes*) is a member of the pickerelweed family (Pontederiaceae). Water Hyacinth originated in tropical South America, but has become naturalized in many warm areas of the world including North America (California and southern states), Central America, Africa, India, Asia, Australia, and New Zealand. The plants vary in size from a few centimeters to over a meter in height. The glossy green, leathery leaf blades are up to 20 cm long and 5-15 cm wide and are attached to petioles that are spongy, inflated, and bulb-like. Numerous dark, branched, fibrous roots dangle in the water from the underside of the plant. The inflorescence is a loose terminal spike with showy light-blue to violet flowers (flowers occasionally white). The fruit is a three-celled capsule containing many minute, ribbed seeds.

Water Hyacinth has rapidly spread throughout inland and coastal freshwater bays, lakes, and marshes in the United States and in other countries. New plant populations often form from rooted parent plants and wind movements and currents help contribute to their wide distribution. Linked plants form dense rafts in the water and mud.

The typical Water Hyacinth life cycle in the United States begins when the spring overwintering plants (old stem bases) initiate growth by producing daughter plants. These plants slowly increase in number and size during the spring and summer until the maximum biomass is reached in the late summer. Water Hyacinths are in full bloom in late summer and early fall. Seeds form in the submerged, withered flower. By late fall some of the old leaves start dying and by January most plants have gone into senescence. Colonization of a new site begins with small plants at low plant densities. These plants increase in number and density without increasing in size until they produce a new mat. As a mature dense mat is formed, individual plant size continues to increase, but density decreases as the result of intraspecific competition. Water Hyacinth reproduces sexually by seeds and vegetatively by budding and stolen production. Daughter plants sprout from the stolons and doubling times have been reported of 6-18 days. The seeds can germinate in a few days or remain dormant for 15-20 years. They usually sink and remain dormant until periods of stress (droughts). Upon reflooding, the seeds often germinate and renew the growth cycle.

Aquatic plants often play a beneficial role in the function and "health" of waterbodies in a variety of ways such as: producing dissolved oxygen (DO), cycling nutrients, driving the food chain, dampening wave action and currents, lowering water turbidity, and providing habitat for fish and

wildlife. However, the excessive growth of aquatic vegetation (from exotic weed species such as Eurasian water milfoil, Brazilian Elodea (*Egeria densa*), Hydrilla, and Water Hyacinth, etc.) can result in undesirable impacts to aquatic ecosystems. For instance, the normal nighttime respiration of an overabundance of submersed vegetation can severely deplete DO levels, particularly during summer months or other periods of elevated water temperatures. In addition, thick plant stands reduce light penetration and restrict water circulation patterns to the point of producing extreme temperature, pH and nutrient stratification in the affected water column. These major and other more subtle consequences of excessive plants can have deleterious effects on the full range of aquatic organisms - fish, invertebrates, plants, *etc.* The result is often a reduction in the biodiversity of waterbodies (U.S. Army Corps of Engineers, 1998).

Water Hyacinth forms dense mats that interfere with navigation, recreation, irrigation, power generation, and native aquatic flora and fauna. These mats competitively exclude native submersed and floating-leaved plants which are part of the habitat used by listed species and their forage base. Low oxygen conditions develop beneath Water Hyacinth mats and the dense floating mats impede water flow and create good breeding conditions for mosquitoes (CALFED, ERP Vol. 1, 2000).

Water Hyacinth has also been shown to alter population dynamics and community structure of native ecosystems. As compared to native pennywort (*Hydrocotyle umbellata*), an aquatic plant found in the Delta, Water Hyacinth mats had lesser densities of marcoinvertibrates. Pennywort also attracted greater concentrations of the native amphipod *Hyalella azteca*, which is heavily preyed upon by fish.

Biological Control Methods

This biological opinion does not include the biological control of Water Hyacinth.

Mechanical Control Methods

Herding and handpicking of water hyacinth is used in sensitive areas and/or during time periods where herbicide applications are restricted or impractical, such as Site 20 in Jackson Slough, where there is dense population of elderberry shrubs (*Sambucus* sp.). This biological opinion does not cover the use of mechanical shredders.

Chemical Control Methods

The WHCP proposes to treat Water Hyacinth using three different herbicides, Weedar ®64, Reward®, and Rodeo®, and three adjuvants, Placement®, R-11®, and Agri-dex®. Adjuvants (also called surfactants) help effectiveness of herbicides in a number of manners. The WHCP uses adjuvants to reduce drift, spread the herbicides evenly on to the plants, and facilitate plant uptake. All three herbicides and adjuvants have been approved by EPA and Pesticide Regulators for use in aquatic systems in California. Other chemicals with the same active ingredients may be substituted for the above name-brand chemicals in the WHCP by the DBW.

Herbicides Used in the WHCP

Weedar ®64 (the active ingredient is 2,4-D Dimethylene Salt):
Weedar ®64 is a systemic herbicide specific to broadleaf plants. The active ingredient in this phenoxy herbicide is 2, 4-Dichlorophenoxyacetic acid dimethylamine salt (2, 4-D). Weedar ®64 is soluble in water and chemically stable. Weedar ®64 is absorbed through the leaves and takes approximately four to six hours to enter the phloem of the plant where is mimics plant regulating hormones leading to abnormal growth patterns and death of the plant. 2, 4-D has a relatively short half-life and is rather immobile in the soil. In 35 recent studies across the U.S., the average lowest depth detected ranged from 6 to 12 inches in soils of the southern United States to 16 to 24 inches in low organic soils. Soils were sampled to a depth of 48 inches. Its average half-life in soils ranged from 6.4 days in southern soils to 8.3 days in high organic matter soils. The average half-life in grass was 6.1 days and 6.9 days in thatch. The half-life in natural water was two to four weeks, although in areas such as a treated rice paddy, the half-life was as short as one day. The acid form of 2, 4-D, as well as the amine and ester chemical groups, metabolized to compounds of non-toxicological significance, and ultimately to forms of carbon. Thus, 2, 4-D is considered a biodegradable compound. Under normal conditions, 2, 4-D residues are not persistent in soil, water, or vegetation.

Breakdown in soil and groundwater: 2, 4-D has low soil persistence. The half-life in soil is less than 7 days (Wauchope *et al.* 1992). Soil microbes are primarily responsible for its disappearance (Howard 1991). Despite its short half-life in soil and in aquatic environments, the compound has been detected in groundwater supplies in at least five States and in Canada (Howard 1991). Very low concentrations have also been detected in surface waters throughout the U.S. (EPA 1992a).

Breakdown in water: In aquatic environments, microorganisms readily degrade 2, 4-D. Rates of breakdown increase with increased nutrients, sediment load, and dissolved organic carbon. Under oxygenated conditions the half-life is 1 week to several weeks (Howard 1991).

The effects of 2, 4-D on aquatic organisms: Some formulations of 2, 4-D are highly toxic to fish while others are less so. For example, the LC50 ranges between 1.0 and 100 mg/L in cutthroat trout, depending on the formulation used. Channel catfish had less than 10% mortality when exposed to 10 mg/L for 48 hours (Stevens and Sumner 1991 and EPA 1992b). Green sunfish, when exposed to 110 mg/L for 41 hours, showed no effect on swimming response. Limited studies indicate a half-life of less than 2 days in fish and oysters (National Research Council Canada 1978). Concentrations of 10 mg/L for 85 days did not adversely affect the survival of adult Dungeness crabs. For immature crabs, the 96-hour LC50 is greater than 10 mg/L, indicating that 2, 4-D is only slightly toxic. Brown shrimp showed a small increase in mortality at exposures of 2 mg/L for 48 hours (U.S. National Library of Medicine 1995 and Howard 1991).

The effects of 2, 4-D on delta smelt: To determine if exposure to aquatic herbicides (Reward®, Rodeo®, Weedar®64) and/or adjuvant (R-11®) used by the WHCP posed an acute threat to the delta smelt, acute toxicity tests were conducted by the DFG-Aquatic Toxicology Laboratory

(2004) on larval delta smelt. The adjuvant R-11® was more toxic than the herbicides, and Reward® was the most toxic herbicide. Exposure levels of the herbicides and adjuvant in the Sacramento-San Joaquin Delta are several orders of magnitude less than the 96-hour LC50 values with the exception of Reward®. Therefore, they determined that Weedar®64 is not causing toxicity at its application rates.

The effects of 2, 4-D on garter snakes: To determine if exposure to aquatic herbicides (Reward®, Rodeo®, Weedar®64) and/or adjuvant (R-11®) used by the WHCP posed an acute threat to the giant garter snake, toxicity tests were conducted by the DFG-Pesticide Investigations Unit (2004) with two sympatric, closely related species of garter snakes. Common garter snakes (*Thamnophis sirtalis*) and western terrestrial garter snakes (*Thamnophis elegans*) were orally and dermally dosed with solutions of the herbicides, adjuvant, and herbicide/adjuvant mixtures. Tank mix concentrations of WHCP herbicides and adjuvant were tested. No acute adverse effects were observed.

The maximum concentrations of 2, 4-D used by the WHCP would be approximately 1.5 to 3.1 mg/L with lesser concentrations reaching the water column. This herbicide can be used without an adjuvant, but often more than one treatment is needed to have the same effect.

Reward® (the active ingredient is Diquat):

Reward®, a non-selective contact herbicide, needs direct contact with the plant tissue to effectively control the plant's growth. Diquat dibromide, which is the active ingredient in Reward®, kills the plant tissue by destroying the plant's membranes. Diquat is fast acting and quickly absorbed into the plant tissue. However, diquat easily binds with organic particles and therefore its effectiveness is diminished in turbid waters. Because it quickly binds to particles and becomes biologically unavailable, its persistence in the waters of the Delta is limited. Reward® was used as the primary herbicide for the WHCP 2002-2003 spraying season.

Diquat dibromide is a non-selective, quick-acting herbicide and plant growth regulator, causing injury only to the parts of the plant to which it is applied. Diquat dibromide is referred to as a desiccant because it causes a leaf or an entire plant to dry out quickly. It is used to desiccate potato vines and seed crops, to control flowering of sugarcane, and for industrial and aquatic weed control. It is not residual; that is, it does not leave any trace of herbicide on or in plants, soil, or water.

Breakdown in soil and groundwater: Diquat dibromide is highly persistent, with reported field half-lives of greater than 1000 days (Wauchope *et al.* 1992). It is very well absorbed by soil organic matter and clay (Wauchope *et al.* 1992). Although it is water soluble (Wauchope *et al.* 1992), its capacity for strong adsorption to soil particles suggest that it will not easily leach through the soil, be taken up by plants or soil microbes, or broken down by sunlight (photochemical degradation). Field and laboratory tests show that diquat usually remains in the top inch of soil for long periods of time after it is applied (Tucker 1980).

Breakdown in water: Studies on the erosion of diquat-treated soils near bodies of water indicate

that diquat dibromide stays bound to soil particles, remaining biologically inactive in surface waters, such as lakes, rivers, and ponds (Gillett 1970). When diquat dibromide is applied to open water, it disappears rapidly because it binds to suspended particles in the water (Gillett 1970). Diquat dibromide's half-life is less than 48 hours in the water column, and may be on the order of 160 days in sediments due to its low bioavailability (Tucker 1980 and Gillett 1970). Microbial degradation and sunlight play roles in the breakdown of the compound (Gillett 1970). At 22 days after a weed infested artificial lake was treated, only 1% of the applied diquat dibromide remained in the water and 19% was adsorbed to sediments (Howard 1991).

Breakdown in vegetation: Diquat dibromide is rapidly absorbed into the leaves of plants, but usually kills the plant tissues necessary for translocation too quickly to allow movement to other parts of the plant. The herbicide interferes with cell respiration, the process by which plants produce energy. Diquat dibromide is broken down on the plant surface by photochemical degradation (Weed Science Society 1994). It is rapidly absorbed by aquatic weeds from the surrounding water and concentrated in the plant tissue (U.S. National Library of Medicine 1995). Thus, even low concentrations of the herbicide can control aquatic weeds (U.S. National Library of Medicine 1995).

The effects of diquat on aquatic organisms: Diquat dibromide is moderately to practically nontoxic to fish and aquatic invertebrates. The 8-hour LC50 for diquat dibromide is 12.3 mg/L in rainbow trout and 28.5 mg/L in Chinook salmon (Pimentel 1971). The 96-hour LC50 is 16 mg/L in northern pike, 20.4 mg/L in fingerling trout, 245 mg/L in bluegill, 60 mg/L in yellow perch, and 170 mg/L in black bullhead (Johnson and Finley 1980 and Simonin and Skea 1977). Research indicates that yellow perch suffer significant respiratory stress when herbicide concentrations in the water are similar to those normally present during aquatic vegetation control programs (Bimber 1976). There is little or no bioconcentration of diquat dibromide in fish (U.S. National Library of Medicine 1995).

The effects of 2, 4-D on delta smelt: To determine if exposure to aquatic herbicides (Reward®, Rodeo®, Weedar®) and/or adjuvant (R-11®) used by the WHCP posed an acute threat to the delta smelt, acute toxicity tests were conducted by the DFG-Aquatic Toxicology Laboratory (2004) on larval delta smelt. The adjuvant R-11® was more toxic than the herbicides, and Reward® was the most toxic herbicide. Exposure levels of the herbicides and adjuvant in the Sacramento-San Joaquin Delta are several orders of magnitude less than the 96-hour LC50 values with the exception of Reward®. Therefore, they determined that Reward® is causing toxicity at its application rates, and cannot be used without killing larval fish, if present in the application area.

The effects of diquat on garter snakes: To determine if exposure to aquatic herbicides (Reward®, Rodeo®, Weedar®) and/or adjuvant (R-11®) used by the WHCP posed an acute threat to the giant garter snake, toxicity tests were conducted by the DFG-Pesticide Investigations Unit (2004) with two sympatric, closely related species of garter snakes. Common garter snakes (*Thamnophis sirtalis*) and western terrestrial garter snakes (*Thamnophis elegans*) were orally and dermally dosed with solutions of the herbicides, adjuvant, and herbicide/adjuvant mixtures.

Tank mix concentrations of WHCP herbicides and adjuvant were tested. No acute adverse effects were observed.

The maximum concentrations of diquat used by the WHCP would be approximately 0.37mg/L, with lesser concentrations reaching the water column

Rodeo® (the active ingredient is Glyphosate):

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

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

Breakdown in water: In water, glyphosate is strongly adsorbed to suspended organic and mineral matter and is broken down primarily by microorganisms (USDA 1984). Its half-life in pond water ranges from 12 days to 10 weeks (EPA 1992a).

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

The effects of Glyphosate on aquatic organisms: Technical glyphosate acid is practically nontoxic to fish and may be slightly toxic to aquatic invertebrates. The 96-hour LC50 (dose required to kill 50% of a given test population) is 120 mg/L in bluegill sunfish, 168 mg/L in harlequin, and 86 mg/L in rainbow trout (Weed Science Society 1994). The reported 96-hour LC50 values for other aquatic species include greater than 10 mg/L in Atlantic oysters, 934 mg/L in fiddler crab, and 281 mg/L in shrimp (Weed Science Society 1994). The 48-hour LC50 for glyphosate in Daphnia (water flea), an important food source for freshwater fish, is 780 mg/L (Weed Science Society 1994). Some formulations of glyphosate may be more toxic to fish and aquatic species due to differences in toxicity between the salts and the parent acid or to surfactants used in the formulation (Weed Science Society 1994). There is a very low potential for the compound to build up in the tissues of aquatic invertebrates or other aquatic organisms

(Monsanto 1985).

The effects of 2, 4-D on delta smelt: To determine if exposure to aquatic herbicides (Reward®, Rodeo®, Weedar®) and/or adjuvant (R-11®) used by the WHCP posed an acute threat to the delta smelt, acute toxicity tests were conducted by the DFG-Aquatic Toxicology Laboratory (2004) on larval delta smelt. The adjuvant R-11® was more toxic than the herbicides, and Reward® was the most toxic herbicide. Exposure levels of the herbicides and adjuvant in the Sacramento-San Joaquin Delta are several orders of magnitude less than the 96-hour LC50 values with the exception of Reward®. Therefore, they determined that Rodeo® is not causing toxicity at its application rates.

The effects of Glyphosate on garter snakes: To determine if exposure to aquatic herbicides (Reward®, Rodeo®, Weedar®) and/or adjuvant (R-11®) used by the WHCP posed an acute threat to the giant garter snake, toxicity tests were conducted by the DFG-Pesticide Investigations Unit (2004) with two sympatric, closely related species of garter snakes. Common garter snakes (*Thamnophis sirtalis*) and western terrestrial garter snakes (*Thamnophis elegans*) were orally and dermally dosed with solutions of the herbicides, adjuvant, and herbicide/adjuvant mixtures. Tank mix concentrations of WHCP herbicides and adjuvant were tested. No acute adverse effects were observed.

The maximum concentrations of glyphosate used by the WHCP would be approximately 2.3 to 3.1 mg/L with lesser concentrations reaching the water column. This herbicide can only be used with an adjuvant.

Adjuvants used in the WHCP

Placement® (the active ingredients are Amine Salts, Aromatic Acid, and Petroleum Distillates):

Placement® is a deposition and retention agent that reduces evaporation and drift of chemicals while increasing coverage and adherence on the target area. The active ingredients are Amine Salts of Organic Acids, Aromatic Acid, and Aromatic and Aliphatic Petroleum Distillates. Placement® is used as a surfactant with all three herbicides at a rate of one part placement to four parts herbicide.

The effects of Placement® on aquatic organisms and garter snakes has not been studied in depth, however, preliminary lab work conducted by the DFG-Aquatic Toxicology Lab showed Placement® to be the most toxic of the three adjuvants in the WHCP. Based on this information, DBW ceased the use of Placement® for the WHCP.

R-11® (the active ingredients are Alkyl Aryl Polyethoxylates/Compounded Silicone/Linear Alcohol):

The R-11® adjuvant is a combined spreader-activator for increasing the efficiency of agricultural chemicals. R-11® is used where quick wetting and uniform coverage of herbicide is required.

R-11® increases absorption and translocation, as well as inhibits rust and corrosion in equipment. It will be used with all three herbicides at a rate of 2 quarts per 100 gallons of spray solution. R-11® was used as the adjuvant for the WHCP 2002-2003 spraying season.

The effects of R-11® on aquatic organisms: Researchers have published new data on R-11® indicating that it may be an endrocrine disruptor. In August 2003, NOAA Fisheries directed DBW to discontinue the use of R-11® and to use only Agri-dex® for the WHCP.

The effects of 2, 4-D on delta smelt: To determine if exposure to aquatic herbicides (Reward®, Rodeo®, Weedar®) and/or adjuvant (R-11®) used by the WHCP posed an acute threat to the delta smelt, acute toxicity tests were conducted by the DFG-Aquatic Toxicology Laboratory (2004) on larval delta smelt. The adjuvant R-11® was more toxic than the herbicides, and Reward® was the most toxic herbicide. Exposure levels of the herbicides and adjuvant in the Sacramento-San Joaquin Delta are several orders of magnitude less than the 96-hour LC50 values with the exception of Reward®. Therefore, they determined that R-11® could cause toxicity at its application rates, but that this could be avoided by ensuring that the spray is applied to the water hyacinth and not in the water column.

The effects of R-11® on garter snakes: To determine if exposure to aquatic herbicides (Reward®, Rodeo®, Weedar®) and/or adjuvant (R-11®) used by the WHCP posed an acute threat to the giant garter snake, toxicity tests were conducted by the DFG-Pesticide Investigations Unit (2004) with two sympatric, closely related species of garter snakes. Common garter snakes (*Thamnophis sirtalis*) and western terrestrial garter snakes (*Thamnophis elegans*) were orally and dermally dosed with solutions of the herbicides, adjuvant, and herbicide/adjuvant mixtures. Tank mix concentrations of WHCP herbicides and adjuvant were tested. No acute adverse effects were observed.

Agri-dex® (the active ingredients are Paraffin Base Petroleum Oil/Polyoxyethylate Polyol Fatty Acid Esters):

Agri-Dex® is a nonionic blend of surfactants and spray oil that is designed for use with a broad range of pesticides where oil concentrate adjuvant is recommended. Agri-Dex® improves pesticide application by modifying the wetting and deposition characteristics of the spray solution, resulting in a more even and uniform spray deposit. It will be used with all three herbicides at a rate of approximately one to four pints per 100 gallons.

The effects of Agri-Dex® on aquatic organisms and garter snakes has not been studied in depth, however, aquatic acute toxicity studies by the Washington State University have indicated that Agri-Dex® is practically non-toxic and is less toxic to fish and aquatic invertebrates than R-11®. Agri-Dex® was also shown to be less toxic to fish and aquatic invertebrates than R-11® in some preliminary lab work conducted by the DFG-Aquatic Toxicology Lab.

<u>WHCP Monitoring Program</u>

The DBW, with assistance from USDA and CDFA , has been monitoring pre-treatment and post-treatment levels of 2,4-D, Diquat, and Glyphosate since the inception of the WHCP. Historic sampling by DBW, USDA, and CDFA, since 1983, have shown levels of 2,4-D well below allowable State criteria. There have been no recorded fish kills resulting from activities associated with the WHCP since the start of the program. The DBW has been monitoring three fixed locations along with random site location sampling since initiating the WHCP.

The DBW will continue to implement a representative monitoring program for the WHCP. The monitoring program would include monitoring preselected locations where herbicide applications traditionally occur on an annual basis. These sites have associated with them representative samples of delta smelt, giant garter snake, and valley elderberry longhorn beetle habitats. Monitoring sites will include samples from each of the three water types in the WHCP (tidal delta, riverine, and dead-end slough). The monitoring program includes at a minimum of two (2) locations for each species. In years where herbicide application does not occur on the designated sites additional back-up sites will be evaluated so the minimum number of sites are monitored each year. Each site will be monitored a minimum of three times per year.

Chemical Residue Monitoring

The monitoring program includes a daily log with site specifics (*e.g.* location, wind, chemicals used, location of listed species/species habitat), dissolved oxygen levels (DO), pH, and pre-treatment and post-treatment levels of chemical residues.

NPDES Permit Monitoring Requirements

The DBW will follow an approved Central Valley Regional Water Quality Control Board water quality monitoring plan. The DBW will provide copies of the monitoring reports to the Service.

Elderberry Monitoring

The DBW monitors the effects of the WHCP herbicide application on elderberry shrubs which are adjacent (within levee banks or 250 feet which ever is less) to waterways being treated as described in their protocols and standards for elderberry shrub monitoring. Elderberry shrubs will be identified and shrubs health status documented pre-treatment and post-treatment of herbicides following Service guidelines. Any loss of elderberry shrubs with stems greater than 1" attributed to the WHCP shall be compensated for using approved compensation guidelines (U.S. Fish and Wildlife 1999b).

Intertidal Vegetation Monitoring

The DBW monitors the loss of intertidal vegetation as described in their protocols and standards for intertidal vegetation monitoring and will review treatment protocol should significant loss occur.

Dissolved Oxygen Monitoring

The DBW monitors the dissolved oxygen concentration of the treatment areas and would avoid treatment should dissolved oxygen levels fall below certain predetermined levels. Areas which are infested by Water Hyacinth (especially in areas of little water movement) tend to have DO levels which are unsuitable for aquatic life. A review committee comprised of the DBW, USDA, Service, NOAA Fisheries, and DFG will be established to review the ongoing DO monitoring and propose ways to further minimize impacts should monitoring indicate problems.

Treatment Schedule and Data Reporting

DBW submits to the Service an annual treatment schedule and herbicide use report by January 31st of each year. In addition a progress report would be submitted by June 1st of each year detailing the expected amount and area of chemical application for the WHCP. The Service shall review the reports and any available data regarding the monitoring of the WHCP and notify the DBW of any concerns about the WHCP.

WHCP Treatment Restrictions

The DBW has incorporated several treatment restriction on use of chemical herbicides. They are as follows:

1) The maximum size for any treatment site would be no more than 3 contiguous acres. A buffer zone will be created around all treatment sites to ensure that impacts will be spread out and not segregated to one larger area. This will help maintain higher DO levels and provide refugia for smaller fish and invertebrates. The DBW will treat no more than 3 contiguous acres, after which at least one adjacent site will be skipped to create a buffer zone between treatment areas. Buffer zones will be at least equal size of the previously treated site. Crews will not treat skipped sites until two tidal changes have occurred, or in non-tidal areas, until 24 hours after treatment.

2) For completely infested dead-end sloughs greater than one acre, no more than ½ the area at one time would be treated to allow for fish passage.

3) No treatment if winds are greater than 10 MPH.

4) The DBW shall use drift control agents as recommended by chemical label, and change nozzle type and spray pressures whenever conditions warrant, limiting the amount of herbicide which may inadvertently contact non-target plant species.

5) No treatment will occur within 250 feet of elderberry shrubs known to be inhabited by the valley elderberry longhorn beetle.

6) The WHCP will operate from July 1st through November 30th. The WHCP will operate

earlier only if the Service determines that one or more of their herbicides and adjuvants are non-toxic and therefore acceptable for earlier usage.

Action Area

The action area of the WHCP covers a nine-county region encompassing much of the Sacramento-San Joaquin Delta and several of its tributaries, including the San Joaquin River, the Merced River, and the Tuolumne River. The nine counties are: Contra Costa, Merced, Solano, Fresno, Sacramento, Stanislaus, Madera, San Joaquin, and Yolo. The WHCP action area is considered to be the waterways of the Delta and upland tributaries, within the following general geographic boundaries:

1) West up to and including Sherman Island, near the confluence of the Sacramento and San Joaquin Rivers.

2) West up to the Sacramento Northern Railroad to include water bodies north of the southern confluence of the Sacramento River and Sacramento River Deep Water Ship Channel.

3) North to the northern confluence of the Sacramento River and Sacramento River Deep Water Ship Channel , plus waters within Lake Natoma.

4) South along the San Joaquin River and Kings River to Mendota, just east of the City of Fresno.

5) East along the San Joaquin River to Friant Dam on Millerton Lake.

6) East along the Tuolumne River to La Grange Reservoir, below Don Pedro Reservoir.

7) East along the Merced River to Merced Falls, below Lake McClure.

All of the WHCP treatment sites are within the range of the giant garter snake and valley elderberry longhorn beetle. WHCP treatment sites 1-132, 173-176, 241-289, 300-309, and 600 are within the range of the delta smelt and are within its designated critical habitat. WHCP treatment sites 200-239 occur in the Stone Lakes Basin, which is outside the range of the delta smelt but is within its designated critical habitat. WHCP treatment sites 310-325, 401-427, 500-537, 700-718, and 900-929 are outside of the range of the delta smelt and are outside of its designated critical habitat. None of the WHCP treatment sites are within the valley elderberry longhorn beetle's designated critical habitat.

Status of the Species

Delta smelt

Delta smelt was federally listed as a threatened species on March 5, 1993, (58 **FR** 12854) (Service 1993). Critical habitat for delta smelt was designated on December 19, 1994 (59 FR 65256) (Service 1994a). The Sacramento-San Joaquin Delta Native Fishes Recovery Plan was completed in 1996 (Service 1996). The Five Year Status Review for the delta smelt was completed on March 31, 2004 (Service 2004).

Description: Delta smelt are slender-bodied fish that typically reach 60-70 mm standard length (measured from tip of the snout to origin of the caudal fin), although a few may reach 120 mm standard length. The mouth is small, with a maxilla that does not extend past the midpoint of the eye. The eyes are relatively large, with the orbit width contained approximately 3.5-4 times in the head length. Small, pointed teeth are present on the upper and lower jaws. The first gill arch has 27-33 gill rakers and there are 7 branchiostegal rays (paired structures on either side and below the jaw that protect the gills). Counts of branchiostegal rays are used by taxonomists to identify fish. The pectoral fins reach less than two-thirds of the way to the bases of the pelvic fins. There are 9-10 dorsal fin rays, 8 pelvic fin rays, 10-12 pectoral fin rays, and 15-17 anal fin rays. The lateral line is incomplete and has 53-60 scales along it. There are 4-5 pyloric caeca. Live fish are nearly translucent and have a steely-blue sheen to their sides. Occasionally there may be one chromatophore (cellular organelle containing pigment) between the mandibles, but usually there is none. Delta smelt belong to the family Osmeridae, a more ancestral member of the order Salmoniformes which also includes the family Salmonidae (salmon, trout, whitefish, and graylings) (Molye and Cech 1988).

Distribution: Delta smelt are endemic to the upper Sacramento-San Joaquin estuary. They occur in the Delta primarily below Isleton on the Sacramento River, below Mossdale on the San Joaquin River, and in Suisun Bay. They move into freshwater when spawning (ranging from January to July) and can occur in: (1) the Sacramento River as high as Sacramento, (2) the Mokelumne River system, (3) the Cache Slough region, (4) the Delta, and, (5) Montezuma Slough, (6) Suisun Bay, (7) Suisun Marsh, (8) Carquinez Strait, (9) Napa River, and (10) San Pablo Bay. It is not known if delta smelt in San Pablo Bay are a permanent population or if they are washed into the Bay during high outflow periods. Since 1982, the center of delta smelt abundance has been the northwestern Delta in the channel of the Sacramento River. In any month, two or more life stages (adult, larvae, and juveniles) of delta smelt have the potential to be present in Suisun Bay (Department of Water Resources (DWR) and the Bureau of Reclamation (Reclamation) 1994; Molye 1976; and Wang 1991). Delta smelt are also captured seasonally in Suisun Marsh.

Habitat Requirements: Delta smelt are euryhaline (a species that tolerates a wide range of salinities) fish that generally occur in water with less than 10-12 parts per thousand (ppt) salinity. However, delta smelt have been collected in the Carquinez Strait at 13.8 ppt and in San Pablo Bay at 18.5 ppt (DFG 2000). In recent history, they have been most abundant in shallow areas

where early spring salinities are around 2 ppt. However, prior to the 1800's before the construction of levees that created the Delta Islands, a vast fluvial marsh existed in the Delta and the delta smelt probably reared in these upstream areas. During the recent drought (1987-92), delta smelt were concentrated in deep areas in the lower Sacramento River near Emmaton, where average salinity ranged from 0.36 to 3.6 ppt for much of the year (DWR and Reclamation 1994). During years with wet springs (such as 1993), delta smelt may continue to be abundant in Suisun Bay during summer even after the 2 ppt isohaline (an artificial line denoting changes in salinity in a body of water) has retreated upstream (Sweetnam and Stevens 1993). Fall abundance of delta smelt is generally highest in years when salinities of 2 ppt are in the shallows of Suisun Bay during the preceding spring ($p < 0.05$, $r = 0.50$) (Herbold 1994) (p is a statistical abbreviation for the probability of an analysis showing differences between variables, r is a statistical abbreviation for the correlation coefficient, a measure of the linear relationship of two variables). Herbold (1994) found a significant relationship between number of days when 2 parts per thousand was in Suisun Bay during April with subsequent delta smelt abundance ($p < 0.05$, $r = 0.49$) (Figure 2.2), but noted that autocorrelations (interactions among measurements that make relationships between measurements difficult to understand) in time and space reduce the reliability of any analysis that compares parts of years or small geographical areas. It should also be noted that the point in the estuary where the 2 ppt isohaline is located (X2) does not necessarily regulate delta smelt distribution in all years. In wet years, when abundance levels are high, their distribution is normally very broad. In late 1993 and early 1994, delta smelt were found in Suisun Bay region despite the fact that X2 was located far upstream. In this case, food availability may have influenced delta smelt distribution, as evidenced by the *Eurytemora* found in this area by DFG. In Suisun Marsh, delta smelt larvae occur in both large sloughs and small dead end sloughs. New studies are under way to test the hypothesis that adult fall abundance is dependent upon geographic distribution of juvenile delta smelt.

Life History: Wang (1986) reported spawning taking place in fresh water at temperatures of about 7º-15º Celsius (C). However, ripe delta smelt and recently hatched larvae have been collected in recent years at temperatures of 15º-22º C, so it is likely that spawning can take place over the entire 7º-22º C range. Temperatures that are optimal for survival of embryos and larvae have not yet been determined, although R. Mager, UCD, (unpublished data) found low hatching success and embryo survival from spawns of captive fish collected at higher temperatures. Delta smelt of all sizes are found in the main channels of the Delta and Suisun Marsh and the open waters of Suisun Bay where the waters are well oxygenated and temperatures relatively cool, usually less than 20º-22º C in summer. When not spawning, they tend to be concentrated near the zone where incoming salt water and out flowing freshwater mix (mixing zone). This area has the highest primary productivity and is where zooplankton populations (on which delta smelt feed) are usually most dense (Knutson and Orsi 1983; Orsi and Mecum 1986). At all life stages delta smelt are found in greatest abundance in the top 2 m of the water column and usually not in close association with the shoreline.

Delta smelt inhabit open, surface waters of the Delta and Suisun Bay, where they presumably school. In most years, spawning occurs in shallow water habitats in the Delta. Shortly before spawning, adult smelt migrate upstream from the brackish-water habitat associated with the mixing zone to disperse widely into river channels and tidally-influenced backwater sloughs

(Radtke 1966, Moyle 1976, Wang 1991). Migrating adults with nearly mature eggs were taken at the Central Valley Projects's (CVP) Tracy Pumping Plant, located in the south Delta, from late December 1990 to April 1991 (Wang 1991). In February 2000, gravid adults were found at both CVP and the State Water Projects' (SWP) fish facilities in the south Delta. Spawning locations appear to vary widely from year to year (DWR and Reclamation 1993). Sampling of larval smelt in the Delta suggests spawning has occurred in the Sacramento River, Barker, Lindsey, Cache, Georgiana, Prospect, Beaver, Hog, and Sycamore sloughs, in the San Joaquin River off Bradford Island including Fisherman's Cut, False River along the shore zone between Frank's and Webb tracts, and possibly other areas (Wang 1991). In years of moderate to high Delta outflow, smelt larvae are often most abundant in Suisun Bay and sloughs of Suisun Marsh, but it is not clear the degree to which these larvae are produced by locally spawning fish and the degree to which they originate upstream and are transported by river currents to the bay and marsh. Some spawning probably occurs in shallow water habitats in Suisun Bay and Suisun Marsh during wetter years (Sweetnam 1999 and Wang 1991). Spawning has also been recorded in Montezuma Slough near Suisun Bay (Wang 1986) and also may occur in Suisun Slough in Suisun Marsh (P. Moyle, UCD, unpublished data).

The spawning season varies from year to year, and may occur from late winter (December) to early summer (July). Pre-spawning adults are found in Suisun Bay and the western delta as early as September (DWR and Reclamation 1994). Moyle (1976) collected gravid adults from December to April, although ripe delta smelt were common in February and March. In 1989 and 1990, Wang (1991) estimated that spawning had taken place from mid-February to late June or early July, with peak spawning occurring in late April and early May. A recent study of delta smelt eggs and larvae (Wang and Brown 1993 as cited in Water Resources and Reclamation 1994) confirmed that spawning may occur from February through June, with a peak in April and May. Spawning has been reported to occur at water temperatures of about 7° to 15° C. Results from a University of California at Davis (UCD) study (Swanson and Cech 1995) indicate that although delta smelt tolerate a wide range of temperatures ($<8^{\circ}$ C to $>25^{\circ}$ C), warmer water temperatures restrict their distribution more than colder water temperatures.

Delta smelt spawn in shallow, fresh, or slightly brackish water upstream of the mixing zone (Wang 1991). Most spawning occurs in tidally-influenced backwater sloughs and channel edgewaters (Moyle 1976; Wang 1986, 1991; Moyle *et al.* 1992). Although delta smelt spawning behavior has not been observed in the wild (Moyle *et al.* 1992), some researchers believe the adhesive, demersal eggs attach to substrates such as cattails, tules, tree roots, and submerged branches in shallow waters (Moyle 1976, Wang 1991).

Laboratory observations have indicated that delta smelt are broadcast spawners (DWR and Reclamation 1994) and eggs are demersal (sinks to the bottom) and adhesive, sticking to hard substrates such as: rock, gravel, tree roots or submerged branches, and submerged vegetation (Moyle 1976; Wang 1986). At 14°-16° C, embryonic development to hatching takes 9 -14 days and feeding begins 4-5 days later (R. Mager, UCD, unpublished data). Newly hatched delta smelt have a large oil globule that makes them semi-buoyant, allowing them to maintain themselves just off the bottom (R. Mager, UCD, unpublished data), where they feed on rotifers (microscopic crustaceans used by fish for food) and other microscopic prey. Once the

swimbladder (a gas-filled organ that allows fish to maintain neutral buoyancy) develops, larvae become more buoyant and rise up higher into the water column. At this stage, 16-18 mm total length, most are presumably washed downstream until they reach the mixing zone or the area immediately upstream of it. Growth is rapid and juvenile fish are 40-50 mm long by early August (Erkkila *et al.* 1950; Ganssle 1966; Radtke 1966). By this time, young-of-year fish dominate trawl catches of delta smelt, and adults become rare. Delta smelt reach 55-70 mm standard length in 7-9 months (Moyle 1976). Growth during the next 3 months slows down considerably (only 3-9 mm total), presumably because most of the energy ingested is being directed towards gonadal development (Erkkila *et al.* 1950; Radtke 1966). There is no correlation between size and fecundity, and females between 59-70 mm standard lengths lay 1,200 to 2,600 eggs (Moyle *et al.* 1992). The abrupt change from a single-age, adult cohort during spawning in spring to a population dominated by juveniles in summer suggests strongly that most adults die after they spawn (Radtke 1966 and Moyle 1976). However, in El Nino years when temperatures rise above 18º C before all adults have spawned, some fraction of the unspawned population may also hold over as two-year-old fish and spawn in the subsequent year. These two-year-old adults may enhance reproductive success in years following El Nino events.

In a near-annual fish like delta smelt, a strong relationship would be expected between number of spawners present in one year and number of recruits to the population the following year. Instead, the stock-recruit relationship for delta smelt is weak, accounting for about a quarter of the variability in recruitment (Sweetnam and Stevens 1993). This relationship does indicate, however, that factors affecting numbers of spawning adults (*e.g.*, entrainment, toxics, and predation) can have an effect on delta smelt numbers the following year.

Delta smelt feed primarily on (1) planktonic copepods (small crustaceans used by fish for food), (2) cladocerans (small crustaceans used by fish for food), (3) amphipods (small crustaceans used by fish for food) and, to a lesser extent, (4) on insect larvae. Larger fish may also feed on the opossum shrimp, *Neomysis mercedis*. The most important food organism for all sizes seems to be the euryhaline copepod, *Eurytemora affinis*, although in recent years the exotic species, *Pseudodiaptomus forbesi*, has become a major part of the diet (Moyle *et al.* 1992). Delta smelt are a minor prey item of juvenile and subadult striped bass, *Morone saxatilis*, in the Sacramento-San Joaquin Delta (Stevens 1966). They also have been reported from the stomach contents of white catfish, *Ameiurus catus*, (Turner 1966 *in* Turner and Kelley (eds) 1966) and black crappie, *Pomoxis nigromaculatus*, (Turner 1966 *in* Turner and Kelley 1966) in the Delta.

Abundance: The smelt is endemic to Suisun Bay upstream of San Francisco Bay and throughout the Delta, in Contra Costa, Sacramento, San Joaquin, Solano and Yolo counties, California. Historically, the smelt is thought to have occurred from Suisun Bay and Montezuma Slough, upstream to at least Verona on the Sacramento River, and Mossdale on the San Joaquin River (Moyle *et al.* 1992, Sweetnam and Stevens 1993).

Since the 1850s, however, the amount and extent of suitable habitat for the delta smelt has declined dramatically. The advent in 1853 of hydraulic mining in the Sacramento and San Joaquin rivers led to an increase in siltation and the alteration of the circulation patterns of the Estuary (Nichols *et al.* 1986, Monroe and Kelly 1992). The reclamation of Merritt Island for

agricultural purposes, in the same year, marked the beginning of the present-day cumulative loss of 94% of the Estuary's tidal marshes (Nichols *et al.* 1986, Monroe and Kelly 1992). The extensive levee system in the Delta has led to a loss of seasonally flooded habitat and significantly changed the hydrology of the Delta ecosystem, restricting the ability of suitable habitat substrates to re-vegetate.

Delta smelt were once one of the most common pelagic (living in open water away from the bottom) fish in the upper Sacramento-San Joaquin estuary, as indicated by its abundance in DFG trawl catches (Erkkila *et al.* 1950; Radtke 1966; Stevens and Miller 1983). Delta smelt abundance from year to year has fluctuated greatly in the past, but between 1982 and 1992 their population was consistently low. The decline became precipitous in 1982 and 1983 due to extremely high outflows and continued through the drought years 1987-1992 (Moyle *et al.* 1992). In 1993, numbers increased considerably, apparently in response to a wet winter and spring. During the period 1982-1992, most of the population was confined to the Sacramento River channel between Collinsville and Rio Vista (D. Sweetnam, DFG unpublished data). This was still an area of high abundance in 1993, but delta smelt were also abundant in Suisun Bay. The actual size of the delta smelt population is not known. However, the pelagic life style of delta smelt, short life span, spawning habits, and relatively low fecundity indicate that a fairly substantial population probably is necessary to keep the species from becoming extinct.

Recreation in the Delta has resulted in the presence and propagation of predatory non-native fish such as striped bass (*Morone saxatilis*). Additionally, recreational boat traffic has led to a loss of habitat from the building of docks and an increase in the rate of erosion resulting from boat wakes. In addition to the loss of habitat, erosion reduces the water quality and retards the production of phytoplankton in the Delta.

In addition to the degradation and loss of estuarine habitat, delta smelt have been increasingly subject to entrainment, upstream or reverse flows of waters in the Delta and San Joaquin River, and constriction of low salinity habitat to deep-water river channels of the interior Delta (Moyle *et al.* 1992). These adverse conditions are primarily a result of the steadily increasing proportion of river flow being diverted from the Delta by the Projects, and occasional droughts (Monroe and Kelly 1992).

Reduced water quality from agricultural runoff, effluent discharge and boat effluent has the potential to harm the pelagic larvae and reduce the availability of the planktonic food source. When the mixing zone is located in Suisun Bay where there is extensive shallow water habitat within the euphotic zone (depths less than four meters), high densities of phytoplankton and zooplankton may accumulate (Arthur and Ball 1978, 1979, 1980). The introduction of the Asian clam (*Potamocorbula amurensis)*, a highly efficient filter feeder, presently reduces the concentration of phytoplankton in this area.

According to seven abundance indices which provide information on the status of the delta smelt, this species was consistently at low population levels through the 1980's (Stevens *et al.* 1990). These same indices also showed a pronounced decline from historical levels of abundance (Stevens *et al.* 1990).

For a large part of its annual life span, this species is associated with the freshwater edge of the mixing zone, where the salinity is approximately 2 ppt. (Ganssle 1966, Moyle *et al.* 1992, Sweetnam and Stevens 1993). The relationship between the portion of the smelt population west of the Delta as sampled in the summer townet survey and the natural logarithm of Delta outflow from 1959 to 1988, indicates the summer townet index increased dramatically when outflow was between 34,000 and 48,000 cubic feet per second, placing X2 between Chipps and Roe islands (DWR and Reclamation 1994).

Specifically, the summer townet abundance index constitutes one of the more representative indices because the data have been collected over a wide geographic area (from San Pablo Bay upstream through most of the Delta) for the longest period of time (since 1959) (DFG 2001). The summer townet abundance index measures the abundance and distribution of juvenile delta smelt and provides data on the recruitment potential of the species (DFG 2001). Since 1983, (except for 1986, 1993, and 1994), this index has remained at consistently lower levels than previously found (DFG 2001). These consistently lower levels correlate with the 1983 to 1992 mean location of X2 upstream of the confluence (DFG 2001).

The final summer townet index for 2000 was 8.0, a decline from the 11.9 index for the 1999 summer townet (DFG 2001). Both of these indices represent an increase from the 1998 index of 3.3. However, both 1999 and 2000 indices are still below the pre-decline average of 20.4 (1959-1981, no sampling in 1966-1968) (DFG 2001).

The second longest running survey (since 1967), the fall midwater trawl survey (FMWT), measures the abundance and distribution of late juveniles and adult delta smelt in a large geographic area from San Pablo Bay upstream to Rio Vista on the Sacramento River and Stockton on the San Joaquin River (Stevens *et al.* 1990, DFG 1999). The FMWT indicates the abundance of the adult population just prior to upstream spawning migration (DFG 1999). The index calculated from the FMWT uses numbers of sampled fish multiplied by a factor related to the volume of the area sampled (DFG 1999). Until recently, except for 1991, this index has declined irregularly over the past 20 years (DFG 1999). Since 1983, the delta smelt population has exhibited more low FMWT abundance indices, for more consecutive years, than previously recorded (DFG 1999). The 1994 FMWT index of 101.2 was a continuation of this trend (DFG 1999). This occurred despite the high 1994 summer townet index for reasons unknown (DFG 1999). The low 1995 summer townet index value of 3.3 was followed by a high FMWT index of 839 reflecting the benefits of higher flows due to an extremely wet year (DFG 1999, 2001).

The 1999 FMWT index of 717, which is an increase from 1998's index (417.6), is the third highest since the start of decline of delta smelt abundance in 1982 (DFG 1999). The FMWT abundance index (127) for 1996 represented the fourth lowest on record (DFG 1999). The 1997 abundance index (360.8) almost tripled since the 1996 survey, despite the low summer townet index (4.0) (DFG 1999, 2001).

Both 2001 TNS and FMWT abundance indices for delta smelt decreased from 2000 (Souza and Bryant 2002, DFG 1999 and 2001). The 2001 TNS delta smelt index (3.5) is less than 1999 (11.9) and 2000 (8.0) but comparable to recent years (1995, 1997, and 1998) when the index

ranged from 3.2 to 4.0 (Souza and Bryant 2002, DFG 2001). The 2001 FMWT delta smelt index (603) decreased by 20% from 2000 (756) (Souza and Bryant 2002, DFG 2001). Both surveys exhibited an overall trend of decline in the last three years, but this decline seems more pronounced in the TNS where the 2001 delta smelt index is 95% lower than the greatest index of record (62.5) in 1978 (Souza and Bryant 2002, DFG 2001).

Swimming Behavior: Observations of delta smelt swimming in a swimming flume and in a large tank show that these fish are unsteady, intermittent, slow speed swimmers (Swanson and Cech 1995). At low velocities in the swimming flume (<3 body lengths per second), and during spontaneous, unrestricted swimming in a 1 m tank, smelt consistently swam with a "stroke and glide" behavior. This type of swimming is very efficient; Weihs (1974) predicted energy savings of about 50% for "stroke and glide" swimming compared to steady swimming. However, the maximum speed smelt are able to achieve using this mode of swimming is less than 3 body lengths per second, and the fish did not readily or spontaneously swim at this or higher speeds (Swanson and Cech 1995). Although juvenile delta smelt appear to be stronger swimmers than adults, forced swimming at 3 body lengths per second in a swimming flume was apparently stressful; the smelt were prone to swimming failure and extremely vulnerable to impingement (Swanson and Cech 1995). Delta smelt swimming performance was limited by behavioral rather than physiological or metabolic constraints (Brett 1976).

Summary of the Five Year Review: In summary, the threats of the destruction, modification, or curtailment of its habitat or range resulting from extreme outflow conditions, the operations of the State and Federal water projects, and other water diversions as described in the original listing remain. The only new information concerning the delta smelt's population size and extinction probability indicates that the population is at risk of falling below an effective population size and therefore in danger of becoming extinct. Although VAMP and Environmental Water Account have helped to ameliorate these threats, it is unclear how effective these will continue to be over time based on available funding and future demands for water. In addition, there are increased water demands outside the CVP and the SWP, which could also impact delta smelt. The increases in water demands are likely to result in less suitable rearing conditions for delta smelt in Suisun Marsh, increased vulnerability to entrainment, and less water available for maintaining the position of X2. The importance of exposure to toxic chemicals on the population of delta smelt is highly uncertain. Therefore, a recommendation to delist the delta smelt is inappropriate.

In addition, many potential threats have not been sufficiently studied to determine their effects, such as predation, disease, competition, and hybridization. Therefore, a recommendation of a change in classification to endangered is premature.

In his August 24, 2003, letter, the foremost delta smelt expert, Dr. Peter B. Moyle, stated that the delta smelt should continue to be listed as a threatened species (Moyle 2003). In addition, in their January 23, 2004, letter, DFG fully supported that the delta smelt should retain its threatened status under the Act (DFG 2004).

Delta Smelt Critical Habitat

In determining which areas to designate as critical habitat, the Service considers those physical and biological features that are essential to a species' conservation and that may require special management considerations or protection (50 CFR §424.12(b)).

The Service is required to list the known primary constituent elements together with the critical habitat description. Such physical and biological features include, but are not limited to, the following:

1. space for individual and population growth, and for normal behavior;

2. food, water, air, light, minerals, or other nutritional or physiological requirements;

3. cover or shelter;

4. sites for breeding, reproduction, rearing of offspring, germination, or seed dispersal; and

5. generally, habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species.

In designating critical habitat for the delta smelt, the Service identified the following primary constituent elements essential to the conservation of the species: physical habitat, water, river flow, and salinity concentrations required to maintain delta smelt habitat for spawning, larval and juvenile transport, rearing, and adult migration. Specific areas that have been identified as important delta smelt spawning habitat include Barker, Lindsey, Cache, Prospect, Georgiana, Beaver, Hog, and Sycamore sloughs and the Sacramento River in the Delta, and tributaries of northern Suisun Bay.

Larval and juvenile transport. Adequate river flow is necessary to transport larvae from upstream spawning areas to rearing habitat in Suisun Bay and to ensure that rearing habitat is maintained in Suisun Bay. To ensure this, X2 must be located westward of the confluence of the Sacramento-San Joaquin Rivers, located near Collinsville (Confluence), during the period when larvae or juveniles are being transported, according to historical salinity conditions. X2 is important because the "entrapment zone" or zone where particles, nutrients, and plankton are "trapped," leading to an area of high productivity, is associated with its location. Habitat conditions suitable for transport of larvae and juveniles may be needed by the species as early as February 1 and as late as August 31, because the spawning season varies from year to year and may start as early as December and extend until July.

Rearing habitat. An area extending eastward from Carquinez Strait, including Suisun, Grizzly, and Honker bays, Montezuma Slough and its tributary sloughs, up the Sacramento River to its confluence with Three Mile Slough, and south along the San Joaquin River including Big Break, defines the specific geographic area critical to the maintenance of suitable rearing habitat. Three

Mile Slough represents the approximate location of the most upstream extent of historical tidal incursion. Rearing habitat is vulnerable to impacts of export pumping and salinity intrusion from the beginning of February to the end of August.

Adult migration. Adequate flow and suitable water quality is needed to attract migrating adults in the Sacramento and San Joaquin river channels and their associated tributaries, including Cache and Montezuma sloughs and their tributaries. These areas are vulnerable to physical disturbance and flow disruption during migratory periods.

The Service's 1994 and 1995 biological opinions on the operations of the CVP and SWP provided for adequate larval and juvenile transport flows, rearing habitat, and protection from entrainment for upstream migrating adults (Service 1994b, 1995). Please refer to 59 FR 65255 for additional information on delta smelt critical habitat.

Giant Garter Snake

The giant garter snake was listed as a threatened species on October 20, 1993 (58 FR 54053) (Service 1993b). A draft recovery plan for the giant garter snake was completed in 1999 (Service 1999a).

Description - The giant garter snake is one of the largest garter snakes and may reach a total length of at least 64 inches (160 centimeters). Females tend to be slightly longer and proportionately heavier than males. The weight of adult female giant garter snakes is typically 1.1-1.5 pounds (500-700 grams). Dorsal background coloration varies from brownish to olive with a checkered pattern of black spots, separated by a yellow dorsal stripe and two light colored lateral stripes. Background coloration and prominence of black checkered pattern and the three yellow stripes are geographically and individually variable (Hansen 1980). The ventral surface is cream to olive or brown and sometimes infused with orange, especially in northern populations.

Historical and current range - Fitch (1941) described the historical range of the species as extending from the vicinity of Sacramento and Contra Costa Counties southward to Buena Vista Lake, near Bakersfield, in Kern County. Prior to 1970, the giant garter snake was recorded historically from 17 localities (Hansen and Brode 1980). Five of these localities were clustered in and around Los Banos, Merced County. The paucity of information makes it difficult to determine precisely the species' former range. Nonetheless, these records coincide with the historical distribution of large flood basins, fresh water marshes, and tributary streams. Reclamation of wetlands for agriculture and other purposes apparently extirpated the species from the southern one-third of its range by the 1940s -1950s, including the former Buena Vista Lake and Kern Lake in Kern County, and the historic Tulare Lake and other wetlands in Kings and Tulare Counties (Hansen and Brode 1980, Hansen 1980). Surveys over the last two decades have located the giant garter snake as far north as the Butte Basin in the Sacramento Valley.

As recently as the 1970s, the range of the giant garter snake extended from near Burrel, Fresno County (Hansen and Brode 1980), northward to the vicinity of Chico, Butte County (Rossman and Stewart 1987). DFG studies (Hansen 1988) indicate that giant garter snake populations

currently are distributed in portions of the rice production zones of Sacramento, Sutter, Butte, Colusa, and Glenn Counties; along the western border of the Yolo Bypass in Yolo County; and along the eastern fringes of the Sacramento-San Joaquin River delta from the Laguna Creek-Elk Grove region of central Sacramento County southward to the Stockton area of San Joaquin County. This distribution largely corresponds with agricultural land uses throughout the Central Valley.

Essential habitat components - Endemic to wetlands in the Sacramento and San Joaquin valleys, the giant garter snake inhabits marshes, sloughs, ponds, small lakes, low gradient streams, and other waterways and agricultural wetlands, such as irrigation and drainage canals and rice fields, and the adjacent uplands. Giant garter snakes feed on small fishes, tadpoles, and frogs (Fitch 1941, Hansen 1980, Hansen 1988). Essential habitat components consist of: (1) adequate water during the snake's active season (early-spring through mid-fall) to provide food and cover; (2) emergent, herbaceous wetland vegetation, such as cattails and bulrushes, for escape cover and foraging habitat during the active season; (3) upland habitat with grassy banks and openings in waterside vegetation for basking; and (4) higher elevation uplands for cover and refuge from flood waters during the snake's dormant season in the winter (Hansen 1980).

Foraging ecology - Giant garter snakes are extremely aquatic, are rarely found away from water, forage in the water for food, and will retreat to water to escape predators and disturbance. This species occupies a niche similar to some eastern water snakes (*Nerodia* spp). Giant garter snakes are active foragers, feeding primarily on aquatic prey such as fish and amphibians. Historically, prey likely consisted of Sacramento blackfish (*Orthodon microlepidotus*), thick-tailed chub (*Gila crassicauda*), and red-legged frog (*Rana aurora*). Because these species are no longer available (chub extinct, red-legged frog extirpated from the Central Valley, blackfish declining/in low numbers), the predominant food items are now introduced species such as carp (*Cyprinus carpio*), mosquito-fish (*Gambusia affinis*), bullfrogs (*Rana catesbiana*), and Pacific chorus frog (*Pseudacris regilla*) (Fitch 1941, Rossman *et al*, 1996).

Reproductive ecology - The breeding season extends through March and April, and females give birth to live young from late July through early September (Hansen and Hansen 1990). Brood size is variable, ranging from 10 to 46 young, with a mean of 23 (Hansen and Hansen 1990). At birth young average about 20.6 cm snout-vent length and 3-5 g. Young immediately scatter into dense cover and absorb their yolk sacs, after which they begin feeding on their own. Although growth rates are variable, young typically more than double in size by one year of age (Service 1999a). Sexual maturity averages three years in males and 5 years for females (Service 1999a).

Movements and habitat use - The giant garter snake typically inhabits small mammal burrows and other soil crevices throughout its winter dormancy period (*i.e.*, November to mid-March). Although these areas are generally thought to be above prevailing flood elevations, snakes may not always utilize high ground during their winter dormancy period. The Biological Resources Division (BRD) has documented giant garter snakes at the Colusa National Wildlife Refuge overwintering in areas with few high ground retreat sites (Wylie et al. 1997). Giant garter snakes in another study population at Gilsizer Slough overwintered in a low elevation wetland area, even though higher ground was present nearby. Both of these populations survived flooding and were

not displaced from the area. Giant garter snakes also use burrows as refuge from extreme heat during their active period. The BRD (Wylie *et al.* 1997) has documented giant garter snakes using burrows in the summer as much as 165 feet (50 meters) away from the marsh edge. Overwintering giant garter snakes have been documented using burrows as far as 820 feet (250 meters) from the edge of marsh habitat.

During radio-telemetry studies conducted by the BRD giant garter snakes typically moved little from day to day. However, total activity varied widely between individuals. Snakes have been documented moving up to 5 miles (8 kilometers) over the period of a few days (Wylie *et al.* 1997). In agricultural areas, giant garter snakes were documented using rice fields in 19-20 percent of the observations, marsh habitat in 20-23 percent of observations, and canal and agricultural waterway habitats in 50-56 percent of the observations (Wylie *et al.* 1997).

The current distribution and abundance of the giant garter snake is much reduced from former times. Agricultural and flood control activities have extirpated the giant garter snake from the southern one third of its range in former wetlands associated with the historic Buena Vista, Tulare, and Kern lakebeds. These lakebeds once supported vast expanses of ideal giant garter snake habitat, consisting of cattail and bulrush dominated marshes. Vast expanses of bulrush and cattail floodplain habitat also typified much of the Sacramento Valley historically (Hinds 1952). Prior to reclamation activities beginning in the mid to late 1800s, about 60 percent of the Sacramento Valley was subject to seasonal overflow flooding in broad, shallow flood basins that provided expansive areas of giant garter snake habitat (Hinds 1952). Valley floor wetlands are subject to the cumulative effects of upstream watershed modifications, water storage and diversion projects, as well as urban and agricultural development; all natural habitats have been lost and an unquantifiably small percentage of seminatural wetlands remain extant. Only a small percentage of extant wetlands currently provides habitat suitable for the giant garter snake.

The giant garter snake currently is only known from a small number of populations. The status of these populations and the threats to these snakes and their habitats are detailed in the final rule that listed the giant garter snake as threatened (58 FR 54053). A number of land use practices and other human activities currently threaten the survival of the giant garter snake throughout the remainder of its range. Although some giant garter snake populations have persisted at low levels in artificial wetlands associated with agricultural and flood control activities, many of these altered wetlands are now threatened with urban development. Cities within the current range of the giant garter snake that are rapidly expanding include: (1) Chico, (2) Yuba City, (3) Sacramento, (4) Galt, (5) Stockton, (6) Gustine, and (7) Los Banos. Ongoing maintenance of aquatic habitats for flood control and agricultural purposes eliminate or prevent the establishment of habitat characteristics required by giant garter snakes and can fragment and isolate available habitat, prevent dispersal of snakes among habitat units, and adversely affect the availability of the garter snake's food items (Hansen 1988, Brode and Hansen 1992). Livestock grazing along the edges of water sources degrades habitat quality in a number of ways: (1) eating and trampling aquatic and riparian vegetation needed for cover from predators, (2) changes in plant species composition, (3) trampling snakes, (4) water pollution, (5) and reducing or eliminating fish and amphibian prey populations. Overall, grazing has contributed to the elimination and reduction of the quality of available habitat at four known locations (Hansen 1980, 1988).

In many areas, the restriction of suitable habitat to water canals bordered by roadways and levee tops renders giant garter snakes vulnerable to vehicular mortality. Fluctuation in rice and agricultural production affects stability and availability of habitat. Recreational activities, such as fishing, may disturb snakes and disrupt basking and foraging activities. Non-native predators, including introduced predatory gamefish, bullfrogs, and domestic cats also threaten giant garter snake populations. While large areas of seemingly suitable giant garter snake habitat exist in the form of duck clubs and waterfowl management areas, water management of these areas typically does not provide summer water needed by giant garter snakes.

Although giant garter snakes on national wildlife refuges are relatively protected from many of the threats to the species, degraded water quality continues to be a threat to the species both on and off refuges.

Valley Elderberry Longhorn Beetle

The valley elderberry longhorn beetle is dependent on its host plant, elderberry, which is a locally common component of the remaining riparian forests and savannah areas and, to a lesser extent, the mixed chaparral-foothill woodlands of the Central Valley. Use of the elderberry shrubs by the animal, a wood borer, is rarely apparent. Frequently, the only exterior evidence of the shrub's use by the beetle is an exit hole created by the larva just prior to the pupal stage. Observations made within elderberry shrubs along the Consumes River and in the Folsom Lake area indicate that larval galleries can be found in elderberry stems with no evidence of exit holes; the larvae either succumb prior to constructing an exit hole or are not far enough along in the developmental process to construct an exit hole. Larvae appear to be distributed in stems which are 1.0 inch or greater in diameter at ground level. The *Valley Elderberry Longhorn Beetle Recovery Plan* (Service 1984) and Barr (1991) contain further details on the beetle's life history.

Population densities of the beetle are probably naturally low (Service 1984); and it has been suggested, based on the spatial distribution of occupied shrubs (Barr 1991), that the beetle is a poor disperser. Low density and limited dispersal capability cause the beetle to be vulnerable to the negative effects of the isolation of small subpopulations due to habitat fragmentation.

When the beetle was listed, the species was known from less than 10 localities along the American River, the Merced River, and Putah Creek. By the time the *Valley Elderberry Longhorn Beetle Recovery Plan* was prepared in 1984, additional species localities had been found along the American River and Putah Creek. As of 1998, the California Natural Diversity Database (CNDDB) included 181 occurrences for this species in 44 drainages throughout the Central Valley, from a location along the Sacramento River in Shasta County, southward to an area along Caliente Creek in Kern County (CNDDB 1998). The beetle continues to be threatened by habitat loss and fragmentation, invasion by Argentine ants (*Linepithema humile*), and possibly other factors such as pesticide drift, exotic plant invasion, and grazing.

The following paragraphs analyze the effects of past and ongoing factors leading to the current status of the species, its habitat and ecosystem, throughout the species' range. It includes an analysis of impacts from projects that have received incidental take authorization for the beetle

since the species was listed, and an evaluation of conservation efforts aimed at minimizing these impacts, based on the best available information. The purpose of this analysis is to provide a baseline with which to compare in determining whether implementation of the programmatic conservation strategy would jeopardize the continued existence of the species, and whether the strategy would provide for the species' long-term survivability.

Habitat loss has been ranked as the single greatest threat to biodiversity in the United States (Wilcove *et al.* 1998). In the 1980 final rule to list the beetle as threatened, habitat destruction was cited as the primary factor contributing to the need to federally list the species (Service 1980). As stated in the final rule, by the time the species was listed its habitat had largely disappeared throughout much of its former range due to agricultural conversion, levee construction, and stream channelization. The 1984 recovery plan reiterated that the primary threat to the beetle was loss and alteration of habitat by agricultural conversion, grazing, levee construction, stream and river channelization, removal of riparian vegetation, riprapping of shoreline, plus recreational, industrial and urban development (Service 1984).

Riparian forests, the primary habitat for the beetle, have been severely depleted throughout the Central Valley over the last two centuries as a result of expansive agricultural and urban development (Katibah 1984, Thompson 1961, Roberts *et al.* 1977). Since colonization, these forests have been "...modified with a rapidity and completeness matched in few parts of the United States" (Thompson 1961). As of 1849, the rivers and larger streams of the Central Valley were largely undisturbed. They supported continuous bands of riparian woodland four to five miles in width along some major drainages such as the lower Sacramento River, and generally about two miles wide along the lesser streams (Thompson 1961). Most of the riverine floodplains supported riparian vegetation to about the 100-year flood line (Katibah 1984). A large human population influx occurred after 1849, however, and much of the Central Valley riparian habitat was rapidly converted to agriculture and used as a source of wood for fuel and construction to serve a wide area (Thompson 1961). By as early as 1868, riparian woodland had been severely impacted in the Central Valley, as evidenced by the following excerpt:

> This fine growth of timber which once graced our river [Sacramento], tempered the atmosphere, and gave protection to the adjoining plains from the sweeping winds, has entirely disappeared - the woodchopper's axe has stripped the river farms of nearly all the hard wood timber, and the owners are now obliged to rely upon the growth of willows for firewood. (Cronise 1868, *in* Thompson 1961).

The clearing of riparian forests for fuel and construction made this land available for agriculture (Thompson 1977). Natural levees bordering the rivers, once supporting vast tracts of riparian habitat, became prime agricultural land (Thompson 1961, 1977). As agriculture expanded in the Central Valley, needs for increased water supply and flood protection spurred water development and reclamation projects. Artificial levees, river channelization, dam building, water diversion, and heavy groundwater pumping further reduced riparian habitat to small, isolated fragments (Katibah 1984). In recent decades, these riparian areas have continued to decline as a result of ongoing agricultural conversion as well and urban development and stream channelization. As of 1989, there were over 100 dams within the Central Valley drainage basin, as well as thousands

of miles of water delivery canals and streambank flood control projects for irrigation, municipal and industrial water supplies, hydroelectric power, flood control, navigation, and recreation (Frayer *et al.* 1989). Riparian forests in the Central Valley have dwindled to discontinuous strips of widths currently measurable in yards rather than miles.

Some accounts state that the Sacramento Valley supported approximately 775,000 to 800,000 acres of riparian forest as of approximately 1848, just prior to statehood (Smith 1977, Katibah 1984). No comparable estimates are available for the San Joaquin Valley. Based on early soil maps, however, more than 921,000 acres of riparian habitat are believed to have been present throughout the Central Valley under pre-settlement conditions (Katibah 1984). Another source estimates that of approximately five million acres of wetlands in the Central Valley in the 1850s, approximately 1,600,000 acres were riparian wetlands (Warner *et al.* 1985, Frayer *et al.* 1989).

Based on a DFG riparian vegetation distribution map, there were approximately 102,000 acres of riparian vegetation remaining in the Central Valley by 1979. This represents a decline in acreage of approximately 89% as of 1979 (Katibah 1984). More extreme figures were given by Frayer *et al.* (1989), who reported that woody riparian forests in the Central Valley had declined to 34,600 acres by the mid-1980s (from 65,400 acres in 1939). Although these studies have differing findings in terms of the number of acres lost (most likely explained by differing methodologies), they attest to a dramatic historic loss of riparian habitat in the Central Valley. As there is no reason to believe that riparian habitat suitable to the beetle (*i.e.* occupied by elderberry shrubs) would be destroyed at a different rate than other riparian habitat, we can assume that the rate of loss for beetle habitat in riparian areas has been equally dramatic.

A number of studies have focused on riparian loss along the Sacramento River, which supports some of the densest known populations of the beetle. Approximately 98% of the middle Sacramento River's historic riparian vegetation was believed to have been extirpated by 1977 (DWR 1979). The State Department of Water Resources estimated that native riparian habitat along the Sacramento River from Redding to Colusa decreased from 27,720 acres to 18,360 acres (34%) between 1952 and 1972 (McGill 1975, Conrad *et al.* 1977). The average rate of riparian loss on the middle Sacramento River was 430 acres per year from 1952 to 1972, and 410 acres per year from 1972 to 1977. In 1987, riparian areas as large as 180 acres were observed converted to orchards along this river (McCarten and Patterson 1987).

Barr (1991) examined 79 sites in the Central Valley supporting beetle habitat. When 72 of these sites were re-examined by researchers in 1997, seven no longer supported beetle habitat. This represents a decrease in the number of sites with beetle habitat by approximately nine percent in six years.

There is no comparable information on the historic loss of non-riparian beetle habitat such as elderberry savanna and other vegetation communities where elderberry occurs (oak or mixed chaparral-woodland, or grasslands adjacent to riparian habitat). However, all natural habitats throughout the Central Valley have been heavily impacted within the last 200 years (Thompson 1961), and we can therefore assume that non-riparian beetle habitat also has suffered a widespread decline. This analysis focuses on loss of riparian habitat because the beetle is

primarily dependent upon riparian habitat. Adjacent upland areas are also likely to be important for the species (Huxel pers. comm. 2000), but this upland habitat typically consist of oak woodland or elderberry savanna bordering willow riparian habitat (Barr 1991). The riparian acreage figures given by Frayer *et al.* (1989) and Katibah (1984) included the oak woodlands concentrated along major drainages in the Central Valley, and therefore probably included lands we would classify as upland habitat for the beetle adjacent to riparian drainages.

Between 1980 and 1995, the human population in the Central Valley grew by 50%, while the rest of California grew by 37%. The Central Valley's population was 4.7 million by 1999, and it is expected to more than double by 2040. The American Farmland Trust estimates that by 2040 more than 1 million cultivated acres will be lost and 2.5 million more put at risk (Ritter 2000). With this growing population in the Central Valley, increased development pressure is likely to result in continuing loss of riparian habitat.

While habitat loss is clearly a large factor leading to the species' decline, other factors are likely to pose significant threats to the long term survival of the beetle. Only approximately 20% of riparian sites with elderberry observed by Barr (1991) and Collinge *et al.* (2001) support beetle populations (Barr 1991, Collinge *et al.* 2001). Jones and Stokes (1988) found 65% of 4,800 riparian acres on the Sacramento River to have evidence of beetle presence. The fact that a large percentage of apparently suitable habitat is unoccupied suggests that the valley elderberry longhorn beetle is limited by factors other than habitat availability, such as habitat quality or limited dispersal ability.

Destruction of riparian habitat in central California has resulted not only in a loss of acreage, but also in habitat fragmentation. Fahrig (1997) states that habitat fragmentation is only important for habitats that have suffered greater than 80% loss. Riparian habitat in the Central Valley, which has experienced greater than 90% loss by most estimates, would meet this criterion as habitat vulnerable to effects of fragmentation. Existing data suggests that beetle populations, specifically, are affected by habitat fragmentation. Barr (1991) found that small, isolated habitat remnants were less likely to be occupied by beetles than larger patches, indicating that beetle subpopulations are extirpated from small habitat fragments. Barr (1991) and Collinge *et al.* (2001) consistently found beetle exit holes occurring in clumps of elderberry bushes rather than isolated bushes, suggesting that isolated shrubs do not typically provide long-term viable habitat for this species. Local populations of organisms often undergo periodic colonization and extinction, while the metapopulation (set of spatially separated groups of a species) may persist (Collinge 1996).

Habitat fragmentation can be an important factor contributing to species declines because (1) it divides a large population into two or more small populations that become more vulnerable to direct loss, inbreeding depression, genetic drift, and other problems associated with small populations, (2) it limits a species' potential for dispersal and colonization, and (3) it makes habitat more vulnerable to outside influences by increasing the edge:interior ratio (Primack 1998). These factors, as they relate to the beetle, are discussed below.

Small, isolated subpopulations are susceptible to extirpation from random demographic, environmental, and/or genetic events (Shaffer 1981, Lande 1988, Primack 1998). While a large area may support a single large population, the smaller subpopulations that result from habitat fragmentation may not be large enough to persist over a long time period. As a population becomes smaller, it tends to lose genetic variability through genetic drift, leading to inbreeding depression and a lack of adaptive flexibility. Smaller populations also become more vulnerable to random fluctuations in reproductive and mortality rates, and are more likely to be extirpated by random environmental factors.

Species that characteristically have small population sizes, such as large predators or habitat specialists, are more likely to become extinct than species that typically have large populations (Primack 1998). Also, a species with low population density (few individuals per unit area) tends to have only small populations remaining if its habitat is fragmented. Populations of species that naturally occur at lower density become extinct more rapidly than do those of more abundant species (Bolger *et al.* 1991). The species may be unable to persist within each fragment, and gradually die out across the landscape.

The valley elderberry longhorn beetle, a specialist on elderberry plants, tends to have small population sizes, and to occur in low densities (Barr 1991, Collinge *et al.* 2001). Collinge *et al.* (2001) compared resource use and density of exit holes between the valley elderberry longhorn beetle and a related subspecies, the California elderberry longhorn beetle (*Desmocerus californicus californicus*). The valley elderberry longhorn beetle tended to occur in areas with higher elderberry densities, but had lower exit hole densities than the California elderberry longhorn beetle. With extensive riparian habitat loss and fragmentation, these naturally small populations are broken into even smaller, isolated populations. Once a small population has been extirpated from an isolated habitat patch, the species may be unable to re-colonize this patch if it is unable to disperse from nearby occupied habitat. Insects with limited dispersal and colonization abilities may persist better in large habitat patches than small patches because small fragments may be insufficient to maintain viable populations and the insects may be unable to disperse to more suitable habitat (Collinge 1996).

Studies suggest that the beetle is unable to re-colonize drainages where the species has been extirpated, because of its limited dispersal ability (Huxel 2000, Barr 1991; Collinge *et al.* 2001). Huxel (2000) used computer simulations of colonization and extinction patterns for the beetle based on differing dispersal distances, and found that the short dispersal simulations best matched the 1997 census data in terms of site occupancy. This suggests that in the natural system dispersal and thus colonization is limited to nearby sites. At spatial scales greater than 10 kilometers (km.), such as across drainages, beetle occupancy appears to be strongly influenced by regional extinction and colonization processes, and colonization is constrained by limited dispersal (Collinge *et al.* 2001). Except for one occasion, drainages examined by Barr that were occupied in 1991 remained occupied in 1997 (Collinge *et al.* 2001). The one exception was Stoney Creek, which was occupied in 1991 but not in 1997. All drainages found by Barr (1991) to be unoccupied in 1991 were also unoccupied in 1997. This data suggests that drainages unoccupied by the beetle remain so and that colonizing is slow.

Habitat fragmentation not only isolates small populations, but also increases the interface between habitat and urban or agricultural land, increasing negative edge effects such as the invasion of non-native species (Huxel 2000, Soule 1990) and pesticide contamination (Barr 1991). There are several edge effect-related factors that may be related to the decline of the beetle.

Recent evidence indicates that the invasive Argentine ant poses a risk to the long-term survival of the beetle. Surveys along Putah Creek found beetle presence where Argentine ants were not present or had recently colonized, and beetle absence from otherwise suitable sites where Argentine ants had become established (Huxel 2000). The Argentine ant has negatively impacted populations of other native arthropod species (Holway 1998; Ward 1987). Predation on eggs, larvae, and pupae are the most likely impacts these ants have on the beetle. In Portugal, Argentine ants have been found to be significant egg predators on the eucalyptus borer (*Phorocantha semipunctata*), a cerambycid like the valley elderberry longhorn beetle. Egg predation on the beetle could lead to local extirpations, as indicated by a population viability study suggesting that egg and juvenile mortality are significant factors affecting probability of extinction for the beetle (Huxel and Collinge, in prep.). The Argentine ant has been expanding its range throughout California since its introduction around 1907, especially in riparian woodlands associated with perennial streams (Holway 1998, Ward 1987). Huxel (2000) states that, given the potential for Argentine ants to spread with the aid of human activities such as movement of plant nursery stock and agricultural products, this species may come to infest most drainages in the Central Valley along the valley floor, where the beetle is found.

Direct spraying and drift of pesticide, including herbicides and/or insecticides, in or near riparian areas (which is done to control mosquitos, crop diseases, invasive and/or undesirable plants, or other pests) is likely to adversely affect the beetle and its habitat. Although there have been no studies specifically focusing on the effects of pesticides on the beetle, evidence suggests that the species is likely to be affected by pesticides. As of 1980, the prevalent land use adjacent to riparian habitat in the Sacramento Valley was agriculture, even in regions where agriculture was not generally the most common land use (Katibah 1984), therefore the species is likely vulnerable to pesticide contamination from adjacent agricultural practices. Recent studies of major rivers and streams documented that 96% of all fish, 100% of all surface water samples and 33% of major aquifers contained one or more pesticides at detectable levels (Gilliom 1999). Pesticides were identified as one of the 15 leading causes of impairment for streams included on the Federal Water Pollution Control Act, as amended (Clean Water Act), section 303(d) lists of impaired waters. As the beetle occurs primarily in riparian habitat, the contamination of rivers and streams affects this species and its habitat. Pesticides have been identified as one of a number of potential causes of pollinator species' declines and declines of other insects beneficial to agriculture (Ingraham *et al.* 1996), therefore it is likely that the beetle, typically occurring adjacent to agricultural lands, has suffered a decline due to pesticides.

Grazing by livestock damages or destroys elderberry plants and inhibits regeneration of seedlings. Cattle readily forage on new growth of elderberry, which may explain the absence of beetles at manicured elderberry stands (Service 1984). Habitat fragmentation exacerbates problems related to exotic species invasion and cattle grazing by increasing the edge to interior ratio of habitat patches, facilitating the penetration of these influences.

Environmental Baseline

Delta Smelt

Adult delta smelt spawn in central Delta sloughs from February through August in shallow water areas having submersed aquatic plants and other suitable substrates and refugia. These shallow water areas have been identified in the Delta Native Fishes Recovery Plan (Recovery Plan) (Service 1996) as essential to the long-term survival and recovery of delta smelt and other resident fish. A no net loss strategy of delta smelt population and habitat is proposed in this Recovery Plan.

The delta smelt is adapted to living in the highly productive Estuary where salinity varies spatially and temporally according to tidal cycles and the amount of freshwater inflow. Despite this tremendously variable environment, the historical Estuary probably offered relatively consistent spring transport flows that moved delta smelt juveniles and larvae downstream to the mixing zone (Peter Moyle, U.C. Davis pers. comm.). Since the 1850's, however, the amount and extent of suitable habitat for the delta smelt has declined dramatically. The advent in 1853 of hydraulic mining in the Sacramento and San Joaquin rivers led to increased siltation and alteration of the circulation patterns of the Estuary (Nichols et al. 1986, Monroe and Kelly 1992). The reclamation of Merritt Island for agricultural purposes, in the same year, marked the beginning of the present-day cumulative loss of 94 percent of the Estuary's tidal marshes (Nichols *et al.* 1986, Monroe and Kelly 1992).

In addition to the degradation and loss of estuarine habitat, the delta smelt has been increasingly subject to entrainment, upstream or reverse flows of waters in the Delta and San Joaquin River, and constriction of low salinity habitat to deep-water river channels of the interior Delta (Moyle et al. 1992). These adverse conditions are primarily a result of drought and the steadily increasing proportion of river flow being diverted from the Delta by the CVP and SWP (Monroe and Kelly 1992). The relationship between the portion of the delta smelt population west of the Delta as sampled in the summer townet survey and the natural logarithm of Delta outflow from 1959 to 1988 (Department and Reclamation 1994). This relationship indicates that the summer townet index increased dramatically when outflow was between 34,000 and 48,000 cfs which placed X2 between Chipps and Roe islands. Placement of X2 downstream of the Confluence, Chipps and Roe islands provides delta smelt with low salinity and protection from entrainment, allowing for productive rearing habitat that increases both smelt abundance and distribution.

The results of seven surveys conducted by the Interagency Ecological Program (IEP) corroborate the dramatic decline in delta smelt. Existing baseline conditions, as mandated for delta smelt under the Service's consultations on CVP operations (Service 1994b, 1995), provide sufficient

Delta outflows from February 1 through June 30 to transport larval and juvenile delta smelt out of the "zone of influence" of the CVP and SWP pumps, and provide them low salinity, productive rearing habitat. This zone of influence has been delineated by DWR's Particle Tracking Model and expands or contracts with CVP and SWP combined pumping increases or decreases, respectively (Department and Reclamation 1993). With tidal effects contributing additional movement, the influence of the pumps may entrain larvae and juveniles as far west as the Confluence.

According to seven abundance indices designed to record trends in the status of the delta smelt, this species was consistently at low population levels during the last ten years (Stevens *et al.* 1990). These same indices also show a pronounced decline from historical levels of abundance (Stevens *et al.* 1990). The summer townet abundance index constitutes one of the more representative indices because the data have been collected over a wide geographic area (from San Pablo Bay upstream through most of the Delta) for the longest period of time (since 1959). The summer townet abundance index measures the abundance and distribution of juvenile delta smelt and provides data on the recruitment potential of the species. Except for three years since 1983 (1986, 1993, and 1994), this index has remained at consistently lower levels than experienced previously. As indicated, these consistently lower levels correlate with the 1983 to 1992 mean location of X2 upstream of the Confluence, Chipps and Roe islands.

The second longest running survey (since 1967), the fall midwater trawl survey (FMWT), measures the abundance and distribution of late juveniles and adult delta smelt in a large geographic area from San Pablo Bay upstream to Rio Vista on the Sacramento River and Stockton on the San Joaquin River (Stevens *et al.* 1990). The fall midwater trawl provides an indication of the abundance of the adult population just prior to upstream spawning migration. The index that is calculated from the FMWT survey uses numbers of sampled fish multiplied by a factor related to the volume of the area sampled. Until recently, except for 1991, this index has declined irregularly over the past 20 years. Since 1983, the delta smelt population has exhibited more low fall midwater trawl abundance indices, for more consecutive years, than previously recorded. The 1994 FMWT index of 101.7 is a continuation of this trend. This occurred despite the high 1994 summer townet index for reasons unknown. The 1995 summer townet was a low index value of 319 but resulted in a high FMWT index of 898.7 reflecting the benefits of large transport and habitat maintenance flows with the Bay-Delta Accord in place and a wet year. The abundance index of 128.3 for 1996 represented the fourth lowest on record. The abundance index of 305.6 for 1997 demonstrated that the relative abundance of delta smelt almost tripled over last years results, and delta smelt abundance continued to rise, peaking in 1999 to an abundance index of 863, only to fall back down to the low abundance indexes of 139 for 2002 and 213 for 2003.

Delta Smelt Critical Habitat

Delta smelt critical habitat has been affected by activities that destroy spawning and refugial areas and change hydrology patterns in Delta waterways. Critical habitat also has been affected by diversions that have shifted the position of X2 upstream of the confluence of the Sacramento and San Joaquin rivers. This shift has caused a decreased abundance of smelt. Existing baseline

conditions and implementation of the Service's 1994 and 1995 biological opinions concerning the operation of the Central Valley Project and the State Water Project, provide a substantial part of the necessary positive riverine flows and estuarine outflows to transport smelt larvae downstream to suitable rearing habitat in Suisun Bay outside the influence of marinas, agricultural diversions, and Federal and State pumping plants.

The demands on surface water resources in the Central Valley have increased. The proposed Freeport Regional Water Project would divert up to 185,000 acre-feet(af)/year of water from a point of diversion north of the delta at Freeport (Freeport Regional Water Authority 2003). The proposed expansion of Los Vaqueros Reservoir would entail an additional 400,000 af of off-stream storage, diverted from the delta using existing facilities as well as new facilities located at Old River and/or Middle River (CALFED 2003a and Reclamation 2003). Reclamation and DWR have proposed to increase pumping capacity at the SWP Banks pumping plant from 6,680 cubic feet per second (cfs) to 8,500 cfs and eventually to 10,300 cfs (CALFED 2002, 2003b). Reclamation and CDWR have also proposed construction of a 400 cfs intertie connecting their aqueducts, which would allow Reclamation to increase the pumping at their Tracy Pumping Plant from 4,200 cfs to 4,600 cfs. The CALFED Bay-Delta Program proposes to expand surface water storage capacity at existing reservoirs and strategically located off-stream sites by 3.5 million af (including the 400,000 af at Los Vaqueros) by: 1) north of the delta off stream storage; 2) Shasta enlargement; 3) Los Vaqueros Expansion; 4) in-delta storage; and 5) additional storage in the Upper San Joaquin (Friant) (CALFED 2002 and Reclamation 2003). Finally, the City of Stockton proposes to construct a new intake at the southwestern tip of Empire Tract on the San Joaquin River with an ultimate diversion capacity of 371 cfs (Environmental Science Associates 2003). The diversions would likely result in lower delta outflows and increased entrainment.

Giant Garter Snake

Surveys over the last two decades have located the giant garter snake as far north as the Butte Basin in the Sacramento Valley. Currently, the Service recognizes 13 separate populations of giant garter snake, with each population representing a cluster of discrete locality records (Service 1993b). The 13 extant population clusters largely coincide with historical riverine flood basins and tributary streams throughout the Central Valley (Hansen 1980, Brode and Hansen 1992): (1) Butte Basin, (2) Colusa Basin, (3) Sutter Basin, (4) American Basin, (5) Yolo Basin-Willow Slough, (6) Yolo Basin-Liberty Farms, (7) Sacramento Basin, (8) Badger Creek-Willow Creek, (9) Caldoni Marsh, (10) East Stockton-Diverting Canal and Duck Creek, (11) North and South Grasslands, (12) Mendota, and (13) Burrell-Lanare. These populations span the Central Valley from just southwest of Fresno (Burrell-Lanare) north to Chico (Hamilton Slough). The 11 counties where the giant garter snake is still presumed to occur are: Butte, Colusa, Glenn, Fresno, Merced, Sacramento, San Joaquin, Solano, Stanislaus, Sutter and Yolo.

Since April of 1995, the BRD has further documented occurrences of giant garter snakes within some of the 13 populations identified in the final rule. The BRD has studied populations of giant garter snakes at the Sacramento and Colusa National Wildlife Refuges within the Colusa Basin, at Gilsizer Slough within the Sutter Basin, and at the Badger Creek area of the Cosumnes River Preserve within the Badger Creek-Willow Creek area. These populations, along with the

American Basin population of giant garter snakes represent the largest extant populations. With the exception of the American Basin, these populations are largely protected from many of the threats to the species. Outside of these protected areas, giant garter snakes in these population clusters are still subject to all threats identified in the final rule. The remaining nine population clusters identified in the final rule are distributed discontinuously in small isolated patches and are vulnerable to extirpation by stochastic environmental, demographic, and genetic processes. All 13 population clusters are isolated from each other with no protected dispersal corridors. Opportunities for recolonization of small populations which may become extirpated is unlikely given the isolation from larger populations and lack of dispersal corridors between them.

The current distribution and abundance of the giant garter snake is much reduced from former times. Agricultural and flood control activities have extirpated the giant garter snake from the southern one third of its range in former wetlands associated with the historic Buena Vista, Tulare, and Kern lakebeds. These lakebeds once supported vast expanses of ideal giant garter snake habitat, consisting of cattail and bulrush dominated marshes. Vast expanses of bulrush and cattail floodplain habitat also typified much of the Sacramento Valley historically (Hinds 1952). Prior to reclamation activities beginning in the mid to late 1800s, about 60 percent of the Sacramento Valley was subject to seasonal overflow flooding in broad, shallow flood basins that provided expansive areas of giant garter snake habitat (Hinds 1952). Valley floor wetlands are subject to the cumulative effects of upstream watershed modifications, water storage and diversion projects, as well as urban and agricultural development; all natural habitats have been lost and an unquantifiably small percentage of seminatural wetlands remain extant. Only a small percentage of extant wetlands currently provides habitat suitable for the giant garter snake.

The giant garter snake currently is only known from a small number of populations. The status of these populations and the threats to these snakes and their habitats are detailed in the final rule that listed the giant garter snake as threatened (58 FR 54053). A number of land use practices and other human activities currently threaten the survival of the giant garter snake throughout the remainder of its range.

The draft recovery plan for the snake subdivided the giant garter snake's historic range into four recovery units (Service 1999a). These are: (1) the Sacramento Valley unit, extending from the vicinity of Red Bluff south to the confluence of the Sacramento and Feather Rivers; (2) the Mid-Valley unit, extending from the American and Yolo Basins south to Duck Creek near the City of Stockton; (3) the San Joaquin Valley unit, extending south from Duck Creek to the Kings River; and (4) the South Valley unit, extending south of the Kings River to the Kern River Basin. Portions of the Mid-Valley and San Joaquin recovery units are within the action area for the WHCP.

The Mid-Valley Recovery Unit includes seven populations of the snake: American Basin, Yolo Basin–Willow Slough, Yolo Basin–Liberty Farms, Sacramento Area, Badger Creek/Willow Creek, Caldoni Marsh/White Slough, and East Stockton. The status of the seven snake populations in the Mid-Valley Recovery Unit is very uncertain. The East Stockton population may be extirpated, and is not considered recoverable as a result of urban encroachment into habitat (Service 1999a). Five of the remaining six populations within the recovery unit are very

small, highly fragmented and isolated, and, except for the Badger Creek/Willow Slough population, are also threatened by urbanization. This latter population is within a small isolated area. Within the Mid-Valley unit, only the American Basin population supports a sizeable snake population which is dependent largely upon rice lands. The American Basin population, although threatened by urban development, receives protection from the Natomas Basin Habitat Conservation Plan (HCP), which has a goal of maintaining a viable snake population in the basin.

The remaining two recovery units are located to the south in the San Joaquin Valley, where the best available data indicate that the snake's status is precarious. The San Joaquin Valley Recovery Unit contains three historic snake populations: North and South Grasslands; Mendota Area; and Burrel/Lanare Area (Service 1999a). This recovery unit formerly supported large snake populations, but numbers have declined severely in recent decades, and recent survey efforts indicate numbers are very low compared to Sacramento Valley populations.

The draft recovery criteria require multiple, stable populations within each of the four recovery units, with subpopulations well-connected by corridors of suitable habitat. Currently, only the Sacramento Valley Recovery Unit, at the northern end of the species' range, is known to support relatively large, stable populations. Habitat corridors connecting populations or subpopulations, even for the Sacramento Valley Recovery Unit, are not present and/or protected.

Further descriptions of the three subpopulations located in the project area that may be affected by the WHCP are provided below:

Yolo Basin/Liberty Farms: Two CNDDB records from an irrigation canal network, combined with an absence of suitable, natural habitat in the area, suggest this population is restricted entirely to degraded, artificial habitat. Livestock grazing appears to be a primary threat. Based on habitat scarcity and an associated small population size, threats are imminent and severe, similar to those at Willow Slough, absent the threat of urban development.

Water sources for this area are primarily the agricultural waterways associated with the Delta. The Yolo Bypass and the upstream sources described in the Yolo Basin - Willow Slough subpopulations also are potential sources of water.

Sacramento Basin: Seven CNDDB locality records are known for the Sacramento Basin subpopulations. These records date 1992 and prior. These locality records include Beach Lake, Snodgrass Slough, Stone Lakes NWR, and Laguna, Morrison and Elk Grove Creeks. Surveys conducted by the BRD during the summer of 1997 did not detect snakes on Stone Lakes NWR (G. Wylie pers. comm.). Because the Stone Lakes NWR has little upland refugia, Dr. Wylie concluded that snake populations in the area may have been severely reduced by the prolonged flooding during January 1997, and that snake populations have not had sufficient time to recover. However, Stone Lakes NWR contains suitable supporting habitat. Numerous development projects have been constructed in or near snake habitat in this rapidly urbanizing area. Any remaining populations are vulnerable to secondary effects of urbanization, such as increased predation by house cats and increased vehicular mortality. Most documented localities have been

adversely impacted by development, including freeway construction, flood control projects, and commercial development. Several former localities are known to have been lost and/or depleted to the extent that continued viability is in question (Brode and Hansen 1992).

The scarcity of remaining suitable habitat, flooding, stochastic processes, and continued threats of habitat loss pose a severe, imminent threat to this population.

Stone Lakes NWR is the largest remaining parcel of snake habitat in this subpopulation. Currently, the refuge receives water from Morrison and Laguna Creeks and from the Delta via Snodgrass Slough.

White Slough/Caldoni Marsh: Four CNDDB locality records are known from the Caldoni Marsh area. Also known as White Slough Wildlife Area, only about 50 acres of suitable habitat remains, the most valuable portion situated on private land. Approximately 280 acres of habitat was eliminated during the construction of Interstate 5 around 1978 to 1979. Restricted to such a small patch size of remaining habitat, this population is highly vulnerable to extinction from stochastic processes. A locality record along Eight Mile Road possibly connected with this population apparently has been extirpated due to habitat loss (J. Brode, CDFG, pers. comm. 1992; G. Hansen, *in litt.*, 1992). Several snakes were observed in the Caldoni Marsh area during 1995 surveys (G. Hansen, pers. comm. 1996).

White Slough is on the eastern periphery of and is hydrologically a part of the Delta. The Delta hydrology could significantly affect contaminants distribution within the Caldoni Marsh - White Slough area. Contaminants distribution in this area would depend on predominant flow. Location within the San Joaquin Valley combined with Delta hydrology could produce high concentrations of contaminants, particularly selenium, in this area.

The draft recovery criteria require multiple, stable populations within each of the four recovery units, with subpopulations well-connected by corridors of suitable habitat. Currently, only the Sacramento Valley Recovery Unit, at the northern end of the species' range, is known to support relatively large, stable populations. Habitat corridors connecting populations or subpopulations, even for the Sacramento Valley Recovery Unit, are not present and/or protected.

Since April of 1995, the BRD has further documented occurrences of snakes within some of the 13 populations identified in the final rule. The BRD has studied populations of snakes at the Sacramento and Colusa National Wildlife Refuges within the Colusa Basin, at Gilsizer Slough within the Sutter Basin, at the Badger Creek area of the Cosumnes River Preserve within the Badger Creek-Willow Creek area, and in the Natomas Basin within the American Basin. These populations of snakes represent the largest extant populations. With the exception of the American Basin, these populations are largely protected from many of the threats to the species. Outside of protected areas, snakes in these population clusters are still subject to all threats identified in the final rule. The remaining nine population clusters identified in the final rule are distributed discontinuously in small isolated patches and are vulnerable to extirpation by stochastic environmental, demographic, and genetic processes. Recent surveys conducted by CDFG in cooperation with BRD in the Grasslands Area in the San Joaquin Valley have detected

snakes, but in numbers much lower than those found in the Sacramento Valley populations. All 13 population clusters are isolated from each other with no protected dispersal corridors. Opportunities for recolonization of small populations which may become extirpated is unlikely given the isolation from larger populations and lack of dispersal corridors between them.

The environmental baseline for the snake includes aquatic and terrestrial habitat within the boundaries of the Delta, including sloughs, irrigation canals, wetlands and fields that may be affected by projects proposed for completion under the EDCP.

Valley Elderberry Longhorn Beetle

Extensive destruction of California's Central Valley riparian forests has occurred during the last 150 years due to agricultural and urban development (Katibah 1984, Katibah *et al.* 1984, Smith 1977, Thompson 1961). Based on a 1979 aerial survey, only about 102,000 acres out of an estimated 922,000 acres of Central Valley riparian forest remain (Katibah *et al.* 1981). More extreme figures were given by Frayer *et al.* (1989), who reported that approximately 85 percent of all wetland acreage in the Central Valley was lost before 1939; and that from 1939 to the mid-1980's, the acreage of wetlands dominated by forests and other woody vegetation declined from 65,400 acres to 34,600 acres. Differences in methodology may explain the differences between the studies. In any case, the historical loss of riparian habitat in the Central Valley strongly suggests that the range of the beetle has been reduced and its distribution greatly fragmented. Loss of non-riparian habitat where elderberry occurs (*e.g.*, savanna and grassland adjacent to riparian habitat, oak woodland, mixed chaparral-woodland), and where the beetle has been recorded (Barr 1991), suggests further reduction of the beetle's range and increased fragmentation of its upland habitat. In Sacramento County, some riparian forest along the American River corridor is protected as parks and open space, but elderberries in savanna and streamside riparian habitats in the southern portion of the County are vulnerable to expansion of residential and commercial developments.

The beetle's current distribution is patchy throughout the remaining habitat of the Central Valley from Redding to Bakersfield. Surveys conducted in 1991 (Barr 1991) found evidence of beetle activity at 28 percent of the 230 sites with elderberry. The beetle appears to be only locally common, *i.e.*, found in population clusters which are not evenly distributed across available elderberry shrubs. Frequently only particular clumps or trees in the study areas were found to harbor the beetle.

Habitat fragmentation not only isolates small populations, but also increases the interface between habitat and urban or agricultural land, increasing negative edge effects such as the invasion of non-native species (Huxel in prep., Soule 1990) and pesticide contamination (Barr 1991). There are several edge effect-related factors that may be related to the decline of the beetle. Recent evidence indicates that the invasive Argentine ant poses a risk to the long-term survival of the beetle. Surveys along Putah Creek found beetle presence where Argentine ants were not present or had recently colonized, and beetle absence from otherwise suitable sites where Argentine ants had become established (Huxel in prep.). The Argentine ant has negatively impacted populations of other native arthropod species (Holway 1998; Ward 1987). Predation

on eggs, larvae, and pupae are the most likely impacts these ants have on the beetle. In Portugal, Argentine ants have been found to be significant egg predators on the eucalyptus borer (*Phorocantha semicincta*), a cerambycid like the valley elderberry longhorn beetle. Egg predation on the beetle could lead to local extirpations, as indicated by a population viability study suggesting that egg and juvenile mortality are significant factors affecting probability of extinction for the beetle (Huxel and Collinge, in prep.). The Argentine ant has been expanding its range throughout California since its introduction around 1907, especially in riparian woodlands associated with perennial streams (Ward 1987). Huxel (*in prep.*) states that, given the potential for Argentine ants to spread with the aid of human activities such as movement of plant nursery stock and agricultural products, this species may come to infest most drainages in the Central Valley along the valley floor, where the beetle is found.

Direct spraying and drift of pesticide, including herbicides and/or insecticides, in or near riparian areas (which is done to control mosquitos, crop diseases, invasive and/or undesirable plants, or other pests) is likely to adversely affect the beetle and its habitat. Although there have been no studies specifically focusing on the effects of pesticides on the beetle, evidence suggests that the species is likely to be affected by pesticides. As of 1980, the prevalent land use adjacent to riparian habitat in the Sacramento Valley was agriculture, even in regions where agriculture was not generally the most common land use (Katibah *et al.* 1984), therefore the species is likely vulnerable to pesticide contamination from adjacent agricultural practices. Recent studies of major rivers and streams documented that 96% of all fish, 100% of all surface water samples and 33% of major aquifers contained one or more pesticides at detectable levels (Gilliom 1999). Pesticides were identified as one of the 15 leading causes of impairment for streams included on the Federal Water Pollution Control Act, as amended (Clean Water Act), section 303(d) lists of impaired waters. As the beetle occurs primarily in riparian habitat, the contamination of rivers and streams affects this species and its habitat. Pesticides have been identified as one of a number of potential causes of pollinator species' declines and declines of other insects beneficial to agriculture (Ingraham *et al.* 1996), therefore it is likely that the beetle, typically occurring adjacent to agricultural lands, has suffered a decline due to pesticides.

Effects of the Proposed Action

Delta Smelt and its Critical Habitat

Acute toxicology studies performed by DFG-Aquatic Toxicology Laboratory (2004) determined that Weedar ®64 (the active ingredient is 2,4-D Dimethylene Salt) and Rodeo® (the active ingredient is Glyphosate) are non-toxic to larval delta smelt at the levels used by the WHCP.

Acute toxicology studies performed by DFG-Aquatic Toxicology Laboratory (2004) determined that Reward® (the active ingredient is Diquat) is toxic to larval delta smelt at the levels used by the WHCP and its use would result in delta smelt mortality if used when larval delta smelt are present. Therefore the use of Reward® when delta smelt are present would result in the harm, harassment and mortality of delta smelt. This effect is minimized by the WHCP treatment restrictions, which limit the WHCP to operate from July 1st through November 30th, unless the Service determines that one or more of their herbicides and adjuvants are non-toxic and therefore

acceptable for earlier usage. Most delta smelt will be out of the Delta by July 1st. This effect can be minimized by restricting the usage of Reward® until August 1st, when all delta smelt are expected to be outside of the delta.

Acute toxicology studies performed by DFG-Aquatic Toxicology Laboratory (2004) determined that R-11® (the active ingredients are Alkyl Aryl Polyethoxylates/Compounded Silicone/Linear Alcohol) could cause toxicity at its application rates, but that this could be avoided by ensuring that the spray is applied to the water hyacinth and not in the water column. They noted that throughout the 2002-2003 season, R-11® was only detected within the water column once and at only one treatment site. Therefore the improper use of R-11® when delta smelt are present would result in the harm, harassment and mortality of delta smelt. This effect is minimized by the WHCP treatment restrictions, which limit the WHCP to operate from July 1st through November 30th, unless the Service determines that one or more of their herbicides and adjuvants are non-toxic and therefore acceptable for earlier usage. Most delta smelt will be out of the Delta by July 1st. This effect can be minimized by restricting the usage of R-11® until August 1st, when all delta smelt are expected to be outside of the delta.

Preliminary lab work conducted by the DFG-Aquatic Toxicology Lab showed Placement® (the active ingredients are Amine Salts, Aromatic Acid, and Petroleum Distillates) to be the most toxic of the three adjuvants in the WHCP. This effect is minimized by the WHCP treatment restrictions, which limit the WHCP to operate from July 1st through November 30th, unless the Service determines that one or more of their herbicides and adjuvants are non-toxic and therefore acceptable for earlier usage. Most delta smelt will be out of the Delta by July 1st. This effect can be minimized by restricting the usage of Placement® until August 1st, when all delta smelt are expected to be outside of the delta.

Acute toxicity studies by the Washington State University have indicated that Agri-Dex® (the active ingredients are Paraffin Base Petroleum Oil/Polyoxyethylate Polyol Fatty Acid Esters) is practically non-toxic and is less toxic to fish and aquatic invertebrates than R-11®. Agri-Dex® was also shown to be less toxic to fish and aquatic invertebrates than R-11® in some preliminary lab work conducted by the DFG-Aquatic Toxicology Lab.

No permanent effects to delta smelt critical habitat will occur as a result of the WHCP. Temporary indirect effects to critical habitat include habitat loss, decreased dissolved oxygen levels (due to decaying water hyacinth), and decreases in the abundance of aquatic invertebrates that form the prey base of the delta smelt.

The WHCP will assist in the implementation of several recovery actions outlined in the "Recovery Plan for the Sacramento/San Joaquin Delta Native Fishes" (Delta Recovery Plan) (Service 1996). The WHCP will assist in developing native Delta habitat and vegetation zones (recovery action #1121), and eliminate loss of shallow water habitat by removing the competition from the non-native macrophyte (recovery action #132). The monitoring plan and toxicological investigations being proposed will assist in implementing recovery action #53. Other potential beneficial effects of the proposed WHCP include: reduction in the amount of an invasive non-native aquatic macrophyte in the Delta and its tributaries, an increase in DO levels in slow

moving or dead-end sloughs, and a potential increase in the amount and distribution of native aquatic plants and animal species associated with them. This increase in native flora and fauna could potentially increase the forage base for listed species.

Giant Garter Snake

Acute toxicology studies performed by DFG-Pesticide Investigation Unit (2004) determined that none of the proposed herbicides or adjuvants would have an acute effect on garter snakes at the levels used for the WHCP.

The primary effects to giant garter snake as a result of the WHCP include temporary destruction of habitat, loss of prey base after pesticide application, and reduced water quality. Direct impact caused by boating and vehicle activity may result in harm to the giant garter snake. Use of the herbicides in the WHCP could result in a loss of intertidal wetland vegetation, such as tules and cattails. The snake needs a component of herbaceous wetland vegetation, such as cattails (*Typha* spp.) and bulrushes (*Scirpus* spp.) for escape cover and foraging habitat (Draft Recovery Plan for the Giant Garter Snake, Service 1999). Loss of giant garter snake prey base may result from application of herbicides.

Temporary indirect effects to the snake could also occur due to loss of intertidal wetland vegetation following herbicide use, disturbance due to staging or maneuvering of boats or vehicles in the implementation of the WHCP. Additional indirect effects include mortality from predatory fish and birds, vehicular traffic, agricultural practices, and maintenance of water channels.

The proposed WHCP will assist in implementing recovery task #4.7 (study the effects of contaminants on giant garter snake) outlined in the "Draft Recovery Plan for the Giant Garter Snake" (Service 1999).

Valley Elderberry Longhorn Beetle

The valley elderberry longhorn beetle may be effected by the WHCP if herbicides, derivatives, or dispersants come in contact with nearby elderberry shrubs (*Sambucus* sp.) either by direct or indirect (drift, treated water inundation) contact. No information is available on the direct effects of herbicide application on the valley elderberry longhorn beetle, however the proposed chemicals may kill or greatly affect valley elderberry longhorn beetle habitat. The increase in habitat loss for the valley elderberry longhorn beetle may result in increased location fragmentation and harm to the valley elderberry longhorn beetle. The effects of the herbicide application may weaken elderberry health and result in other animal species colonizing the shrub and displacing the valley elderberry longhorn beetle.

Cumulative Effects

Delta Smelt and its Critical Habitat

Cumulative effects on the delta and its designated critical habitat include the impacts of point and non-point source chemical contaminant discharges. These contaminants include selenium and numerous pesticides and herbicides associated with discharges related to agricultural and urban activities. Implicated as potential sources of mortality for delta smelt, these contaminants may adversely affect delta smelt reproductive success and survival rates. Spawning habitat may also be affected if submersed aquatic plants used as substrates for adhesive egg attachment are lost due to toxic substances.

Additional cumulative effects may result from any continuing or future non-Federal diversions of water that may entrain adult or larval fish or that may decrease outflows incrementally, thus shifting the position of the delta smelt's preferred habitat upstream. Water diversions through intakes serving numerous small, private agricultural lands and duck clubs in the Delta, upstream of the Delta, and in Suisun Bay contribute to these cumulative effects. These diversions also include municipal and industrial uses, as well as providing water for power plants. State or local levee maintenance may also destroy or adversely modify critical habitat by disturbing spawning or rearing habitat and release contaminants into the water.

The introduction of exotic species may occur when levees are breached or when separate creeks or river systems are reconnected during various projects. Several exotic species may adversely affect the smelt and splittail, including the Asian clam (*Potamocorbula amurensis*) and three non-native species of euryhaline copepods. The Asian clam could potentially play an important role in affecting the phytoplankton dynamics. The exotic copepods may displace native species and at least one species of copepods (*Sinocalanus doerri*) is difficult for larval fishes to catch because of its fast swimming and effective escape response. Reduced feeding efficiency and ingestion rates weaken and slow the growth of young and make them more vulnerable to starvation and predation.

Other cumulative effects include: wave action in water channels caused by boats may degrade riparian and wetland habitat and erode banks; the dumping of domestic and industrial waste may present hazards to the fish because they could become trapped in the debris, injure themselves, or ingest the debris; golf courses may reduce habitat and introduce pesticides and herbicides into the environment; oil and gas development and production remove habitat and may introduce pollutants into the delta; agricultural uses on levees may reduce riparian and wetland habitats; residential or agricultural land use can fragment and reduce wildlife habitat and corridors; unscreened agricultural diversions throughout the delta divert all life stages of the fish (Service 1995); and grazing activities may degrade or reduce suitable habitat and increase erosion and sedimentation.

Giant Garter Snake

Cumulative effects that may affect giant garter snakes throughout their range include: unpredictable fluctuations in aquatic habitat due to water management; dredging and clearing vegetation from irrigation canals; discing, mowing, ornamental cultivation, and routine grounds maintenance of upland habitat; increased vehicular traffic on access roads adjacent to aquatic habitat; increased boat use and access into giant garter snake habitat; use of burrow fumigants on

levees and other potential upland refugia; and contaminated runoff from agriculture and urbanization. Introduced bullfrogs also pose a great threat to a variety of aquatic species, including snakes, fish, and other frog species. Adult bullfrogs are accomplished predators which can populate an area quickly and out compete the natives.

An additional threat to some populations of giant garter snakes include proposed urban development. Many remaining populations are vulnerable to secondary effects of urbanization, such as increased predation by house cats and vehicular mortality. Some documented localities have been adversely impacted by development, including freeway construction, flood control projects, and commercial development. Incidental disturbance from human activity may also cause disruption of normal foraging and reproductive activities.

Valley Elderberry Longhorn Beetle

Cumulative effects on the beetle throughout its range include continuing loss and alteration of riparian habitat and other habitats where elderberry plants and the beetle live, to the extent that this habitat loss is not subject to Federal jurisdiction. Elderberry shrubs and associated riparian habitat may be destroyed by agricultural conversion, removal of riparian vegetation, and recreational, industrial, and urban development. Levee construction and maintenance, channelization of streams and rivers, and riprapping of shoreline can destroy elderberry plants at construction sites and alter river hydraulics to cause additional erosion of riparian habitat downstream. Competition from invasive exotic plants such as Chinese tree-of-heaven (*Ailanthus altissima*) and black locust (*Robinia pseudoacacia*) may negatively affect elderberries. Grazing by livestock may damage or destroy elderberry plants and inhibit regeneration of seedlings. Direct spraying or drift of herbicide or insecticide in or near riparian areas (which may be done to control mosquitos, crop diseases, or other pests) will continue to adversely affect the beetle and its habitat. The increased human population growth in the Central Valley and other parts of California is expected to drive further development of agriculture, cities, industry, transportation, and water resources in the foreseeable future, and these cumulative effects are expected to continue.

Conclusion

After reviewing the current status of the delta smelt, giant garter snake, valley elderberry longhorn beetle, the environmental baseline, the effects of the proposed WHCP, and the cumulative effects, it is the Service's biological opinion that the proposed WHCP is not likely to jeopardize the continued existence of the delta smelt, giant garter snake, valley elderberry longhorn beetle, or result in the destruction or adverse modification of critical habitat for Delta smelt. We base this determination on the temporary nature of the effects, proposed WHCP treatment restrictions, and the non-toxicity of Weedar®64, Rodeo®, and Agri-dex® at the levels used in the WHCP. Critical habitat has been designated for the valley elderberry longhorn beetle on the American River in Sacramento County; however, this action is not expected to affect that area and no destruction or adverse modification of valley elderberry longhorn beetle critical habitat is anticipated. Critical habitat has not been designated for the giant garter snake, therefore none will be adversely modified or destroyed.

INCIDENTAL TAKE STATEMENT

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

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

Amount or Extent of Take

Delta Smelt

The Service anticipates as much as 1,733 acres of delta smelt critical habitat could be temporarily impacted annually as a result of the chemical control of Water Hyacinth. The Service anticipates that incidental take of delta smelt will occur. However, the Service anticipates that any take of delta smelt will be difficult to detect and quantify for a number of reasons: they have a relatively small body size; they are relatively secretive; their presence in the delta coincides with relatively turbid conditions, which makes their detection difficult; and additionally, their presence in aquatic vegetation makes them difficult to detect. Therefore, it is not possible to provide precise numbers of delta smelt that could be injured, harassed, harmed, or killed from the WHCP. Accordingly, the Service is quantifying take incidental to the project as the acreage of Delta and upland tributaries under chemical treatment for Water Hyacinth. The Service anticipates that annually from December 1 through June 30, all delta smelt inhabiting up to 1,733 acres of delta smelt habitat may be harmed and/or harassed by the temporary modification and degradation of habitat as a result of the WHCP. The Service also anticipates that annually from July 1 through November 30, all delta smelt inhabiting up to 1,733 acres of delta smelt habitat delta smelt

habitat may be harmed, harassed, injured, or killed by acute toxicity and temporary modification and degradation of habitat as a result of the WHCP. Because the species is wide-ranging and its distribution varies from one year to the next, take may vary from year to year. Additionally, losses of the species may be masked by seasonal fluctuations in numbers. Upon implementation of the following reasonable and prudent measures, incidental take associated with the WHCP in the form of harm, harassment, injury, or mortality to delta smelt, the USDA and DBW will become exempt from the prohibitions described under section 9 of the Act.

Giant Garter Snake

The Service anticipates incidental take of giant garter snakes will occur. Giant garter snakes are secretive and notoriously sensitive to human activities. Individual snakes are difficult to detect unless they are observed, undisturbed, at a distance. Most close-range observations represent chance encounters that are difficult to predict. It is not possible to make an accurate estimate of the number of snakes that will be harassed, harmed or killed during WHCP activities. In instances when take is difficult to detect, the Service estimates take in numbers of species per acre of habitat lost as a result of the action. Therefore, the Service anticipates that annually all giant garter snakes inhabiting the WHCP treatment area may be harmed and/or harassed by temporary modification and degradation of habitat as a result of the WHCP. The Service also estimates that approximately 1 snake may be injured or killed annually by upland activities and temporary modification and degradation of habitat as a result of the WHCP. Should the number of snakes harassed, harmed, or killed as a result of WHCP operations be greater than those outlined above the USDA and DBW shall contact the Service to discuss further avoidance measures. Upon implementation of the following reasonable and prudent measures, incidental take associated with the WHCP in the form of harm, harassment, injury, or mortality to the giant garter snake, the USDA and DBW will become exempt from the prohibitions described under section 9 of the Act.

Valley Elderberry Longhorn Beetle

The Service expects that incidental take of beetle larvae will be difficult to detect or quantify because of the secretive nature of the species and because the early stages occur within the elderberry bushes. Due to the difficulty in quantifying the number of individuals that will be injured or killed, the Service is quantifying incidental take as the number of elderberry stems over 1 inch in diameter at ground level that will become unsuitable or damaged as a result of the action. The Service has determined that incidental take will be in the form of killing, harming, or harassing individuals resulting from the loss of an undetermined number of elderberry shrubs and stems of suitable size to be potential habitat for the beetle. Take in the form of harm and harassment will occur in locations where elderberry shrubs exist on lands surrounding the project area of the WHCP. Therefore, the Service estimates that up to 40 elderberry stems will become unsuitable for use by the beetle as a result of the WHCP. Upon implementation of the following reasonable and prudent measures, incidental take associated with the WHCP in the form of harm, harassment, injury, or mortality to valley elderberry longhorn beetle, the USDA and DBW will become exempt from the prohibitions described under section 9 of the Act.

Effect of the Take

The Service has determined that this level of anticipated take is not likely to result in jeopardy to the delta smelt, valley elderberry longhorn beetle, or giant garter snake. We base this determination on the temporary nature of the effects, proposed WHCP treatment restrictions, and the non-toxicity of Weedar®64, Rodeo®, and Agri-dex® at the levels used in the WHCP. The critical habitat for the smelt and valley elderberry longhorn beetle will not be adversely modified or destroyed by the proposed action. Critical habitat has not been proposed or designated for the giant garter snake; therefore, none will be adversely modified or destroyed.

Reasonable and Prudent Measures

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize the impact of incidental take on the delta smelt, valley elderberry longhorn beetle and giant garter snake:

> The potential for harassment, harm, or kill of delta smelt, giant garter snake, valley elderberry longhorn beetles and elderberry shrubs (habitat) shall be minimized

Terms and Conditions

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

1. The WHCP shall be implemented as described in this biological opinion.

2. The USDA and DBW shall submit to the Service an annual project review and monitoring report by January 31st of each year. The annual report shall detail the previous periods sites treated, amount of chemical used, acreages treated, whether listed species or its habitat were present, treatment methods, monitoring results, and times of treatment.

3. Chemical treatment shall be restricted as follows:

   a. To minimize take of delta smelt, the herbicide Reward® (the active ingredient is Diquat) and the adjuvants R-11® (the active ingredients are Alkyl Aryl Polyethoxylates/Compounded Silicone/Linear Alcohol) and Placement® (the active ingredients are Amine Salts, Aromatic Acid, and Petroleum Distillates), can only be used from August 1st through November 30th in WHCP treatment sites 1-132, 173-176, 241-289, 300-309, and 600.

   b. At WHCP treatment sites 200-239, 310-325, 401-427, 500-537, 700-718, and 900-929, the usage of the herbicide Reward® (the active ingredient is Diquat) and the adjuvants R-11® (the active ingredients are Alkyl Aryl

Polyethoxylates/Compounded Silicone/Linear Alcohol) and Placement® (the active ingredients are Amine Salts, Aromatic Acid, and Petroleum Distillates), are not restricted to a period of time.

c. At all WHCP treatment sites, the usage of the herbicides Weedar ®64 (the active ingredient is 2,4-D Dimethylene Salt) and Rodeo® (the active ingredient is Glyphosate) and the adjuvant Agri-Dex® (the active ingredients are Paraffin Base Petroleum Oil/Polyoxyethylate Polyol Fatty Acid Esters), are not restricted to a period of time.

4. The USDA and the DBW shall insure that any other agencies, county governments, or contractors who are under contract with the USDA or DBW to implement the WHCP are briefed on and comply with the conditions of this Biological Opinion.

5. Personnel involved in this project will receive Service-approved worker environmental awareness training. Under this program, personnel will be informed about the presence of giant garter snakes and habitat associated with the species and that unlawful take of the animal or destruction of its habitat is a violation of the Act. Prior to chemical application activities, a qualified biologist approved by the Service will instruct all operators about: 1) the life history of the giant garter snake; 2) the importance of irrigation canals, marshes/wetlands, and seasonally flooded areas, to the giant garter snake; and 3) the terms and conditions of the biological opinion. Proof of this instruction will be submitted in writing to the SFWO two weeks prior to implementation of the WHCP operations, attention: Endangered Species Division, fax number: (916) 414-6712, and should reference the number of this biological opinion.

6. All disturbance of upland giant garter snake habitat shall be conducted between May 1 and October 1. This is the "active season" for giant garter snakes and direct impacts are lessened, because giant garter snakes are actively moving and avoiding danger.

7. The clearing of vegetation for land based spraying will be to the minimal amount necessary to facilitate WHCP operations. Clearing will not be allowed in areas designated as environmentally sensitive for the giant garter snake.

8. If the USDA and DBW discover any valley elderberry longhorn beetle habitat that has been directly or indirectly damaged or destroyed as a result of chemical treatments associated with the WHCP, the USDA and DBW shall compensate for any impacts to valley elderberry longhorn beetle habitat following the Service July 9, 1999, *Conservation Guidelines for the Valley Elderberry Longhorn Beetle* and approved on by the Service.

9. To minimize impacts to valley elderberry longhorn beetle habitat, herbicide application will occur away from and down wind of elderberry shrubs. In situations where treatment cannot occur away from habitat, a maximum of one half of the area may be treated at one time. If elderberry shrubs are present 100 feet of the outside

edge of the perimeter of the treatment area, herbicide application shall occur during low tide.

10. Personnel involved in this project will receive Service-approved worker environmental awareness training. Under this program, personnel will be informed about the presence of the valley elderberry longhorn beetle and habitat associated with the species and that unlawful take of the animal or destruction of its habitat is a violation of the Act. Prior to chemical application activities, a qualified biologist approved by the Service will instruct all operators about: 1) the life history of the valley elderberry longhorn beetle; 2) the importance of elderberry shrubs and associated riparian habitats, to the valley elderberry longhorn beetle; and 3) the terms and conditions of the biological opinion. Proof of this instruction will be submitted in writing to the SFWO two weeks prior to implementation of the WHCP operations, attention: Endangered Species Division, fax number: (916) 414-6712, and should reference the number of this biological opinion.

Reporting Requirements

The Service is to be notified immediately of the finding of any listed species or any unanticipated take or suspected take of species addressed in this opinion. Notification must include the date, time, and precise location of the incident/specimen(s) and any other pertinent information. The Service contact person for this is Mike Nepstad (916) 414-6625.

Any salvaged giant garter snake, delta smelt, or valley elderberry longhorn beetle specimens taken shall be properly preserved in accordance with the Natural History Museum of Los Angeles County's policy of accessioning (10% formalin in a quart jar or freezing). Information concerning how the specimen was taken, length of the interval between death and preservation, the environmental conditions, the incidental take permit number (1-1-04-F-0149), and any other relevant information shall be written on 100% rag content paper, with indelible ink, and included in the container with the specimen. Preserved specimens shall be delivered to the Service's Division of Law Enforcement at 2800 Cottage Way, Room W-2928, Sacramento, California 95825 (telephone: 916/414-6660).

All observations of delta smelt, giant garter snakes, valley elderberry longhorn beetles (live, injured, or dead– or fresh beetle exit holes) shall be recorded on California Natural Diversity Data Base (NDDB) field sheets and sent to the Department of Fish and Game, Wildlife Habitat Data Analysis Branch, 1416 Ninth Street, Sacramento, California 95814.

CONSERVATION RECOMMENDATIONS

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

habitat, implementation of recovery actions, or development of information and data bases.

1. The Service recommends DBW and USDA enhance and restore aquatic and wetland habitat in the Sacramento-San Joaquin River estuary as part of the CALFED program.

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

3. The Service recommends DBW and USDA work to assist the Service in implementing recovery actions identified in the recovery plans for the valley elderberry longhorn beetle, giant garter snake, and Sacramento-San Joaquin Delta native fishes.

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

REINITIATION - CLOSING STATEMENT

This concludes formal consultation with USDA on the proposed mechanical and chemical control of the exotic and invasive aquatic plant Water Hyacinth. As provided in 50 CFR 402.16, re-initiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the proposed action may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in this opinion; or (4) a new species or critical habitat is designated that may be affected by the proposed action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending re-initiation.

If you have any questions regarding this biological opinion on the WHCP, please contact Mike Nepstad or Dan Buford of the Sacramento Fish and Wildlife Office at (916) 414-6625.

Sincerely,

Cay C. Goude

Cay C. Goude
Acting Field Supervisor

cc:
ARD (ES), Portland, OR
California Department of Boating and Waterways, Sacramento CA (Attn: Marcia Carlock)

Literature Cited

Arthur, J.F. and M.D. Ball 1978. Entrapment of suspended materials in the San Francisco Bay-Delta Estuary. U.S. Dept. Interior, Bureau of Reclamation, Sacramento, California.

_____. 1979. Factors influencing the entrapment of suspended material in the San Francisco Bay-Delta Estuary. Pages 143-174 *in* T.J. Conomos, editor. Pacific Division, Amer. Assoc. Advance. Sci., San Francisco, California

_____. 1980. The significance of the entrapment zone location to the phytoplankton standing crop in the San Francisco Bay-Delta Estuary. U.S. Dept. Interior, Water and Power Resources Service.

Barr, C. B. 1991. The distribution, habitat, and status of the valley elderberry longhorn beetle *Desmocerus californicus dimorphus*. U.S. Fish and Wildlife Service; Sacramento, California.

Bimber, K. L. 1976. Respiratory stress in yellow perch induced by subtoxic concentrations of diquat. Ohio J. Sci. 76(2): 87 90, 10-94.

Bolger, D.T., A.C. Alberts, and M.E. Soule. Occurrence Patterns of Bird Species in Habitat Fragments: Sampling, Extinction, and Nested Species Subsets. American Naturalist 137: 155-156.

Brett, J.R. 1976. Scope for metabolism and growth of sockeye salmon *Oncorhynchus nerka*, and some related energetics. Journal of the Fisheries Research Board of Canada 33:307-313.

Brode, J. and G. Hansen. 1992. Status and future management of the giant garter snake (*Thamnophis gigas*) within the southern American Basin, Sacramento and Sutter counties, California. California Department of Fish and Game, Inland Fisheries Division, Jan. 1992.

Bureau of Reclamation. 2003. Notice of Initiation of Federal Feasibility Studies. Mid-Pacific Regional Office, Sacramento California.

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

_____. 2002. Annual Report 2002. Sacramento, California. 80 pp.

_____. 2003a. CALFED Los Vaqueros Reservoir Studies [database on the internet]. Updated on May 27, 2003. Available from http://www.lvstudies.com/default.asp. Accessed on October 10, 2003.

_____. 2003b. CALFED Implementation: The Role of the Napa Proposal. Powerpoint Presentation. Sacramento, California.

California Natural Diversity Database (CNDDB). 1998. Natural Heritage Division, California Department of Fish and Game. State of California.

Collinge, S.K. 1996. Ecological Consequences of Habitat Fragmentation: Implications for Landscape Architecture and Planning. Landscape and Urban Planning 36:59-77.

Collinge, S.K., M. Holyoak, C.B. Barr, and J.T. Marty. 2001. Riparian habitat fragmentation and population persistence of the threatened valley elderberry longhorn beetle in central California. Biological Conservation 100:103-113.

Conrad, S.G., R.L. MacDonald, and R.F. Holland. 1 977. Riparian Vegetation and Flora of the Sacramento Valley. Pp. 47-56. *in* A. Sands (ed), Riparian Forests in California: their Ecology and Conservation. UC Davis. May 14.

Department of Fish and Game. 1999. Fall Midwater Trawl [database on the internet]. Available from http://www.delta.ca.gov/data/mwt99/index.html. Accessed on September 18, 2002.

_____ 2000. 20mm Survey [database on the internet]. Available from http://www.delta.ca.gov/data/20mm/2000/. Accessed on September 18, 2002.

_____ 2001. 2001 Summer Townet Survey [database on the internet]. Available from http://www.delta.dfg.ca.gov/data/skt/skt2002/index.html. Accessed on September 18, 2002.

_____. 2004. Comment Letter on the Five Year Status Review of the Delta Smelt. 2 pp.

_____ Aquatic Toxicology Laboratory. 2004. Acute Toxicologies of Herbacides Used in to Control Water Hyacinth and Brazilian Elodea on Larval Delta Smelt and Sacramento Splittail. Draft. Sacramento County, California. 14 pp + appendices.

_____ Pesticides Investigations Unit. 2004. Acute Oral and Dermal Toxicity of Aquatic Herbicides and a Surfactant to Garter Snakes. Office of Spill Prevention and Response. Administrative Report 2004-01. 22 pp.

Department of Water Resources. 1979. Land Use Changes in the Sacramento River Riparian Zone, Redding to Colusa, 1972-1977. Northern District Report, June 1979.

Department of Water Resources and U.S. Bureau of Reclamation, Mid-Pacific Region 1993. Effects of the Central Valley Project and State Water Project on delta smelt. Sacramento County, California. 134 pp.

_____ and U.S. Bureau of Reclamation, Mid-Pacific Region 1994. Effects of the Central

Valley Project and State Water Project on delta smelt and Sacramento splittail. Sacramento, California. 230 pp.

Environmental Science Associates. 2003. Stockton Delta Water Supply Project. 25 pp.

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

Fahrig, L. 1997. Relative Effects of Habitat Loss and Fragmentation on Population Extinction. Journal of Wildlife Management 61:603-610.

Fitch, H.S. 1941. Geographic variation in garter snakes of the genus *Thamnophis sirtalis* in the Pacific coast region of North America. American Midland Naturalist, 26:570-592.

Frayer, W. E., D. D. Peters, and H. R. Pywell. 1989. Wetlands of the California Central Valley: Status and Trends, 1939 - mid-1980's. U.S. Fish & Wildlife Service, Region 1. Portland, OR.

Freeport Regional Water Authority. 2003. Draft Environmental Impact Report/Environmental Impact Statement.

Ganssle, D. 1966. Fishes and decapods of San Pablo and Suisun bays. Pp.64-94 in D.W. Kelley, ed.: Ecological studies of the Sacramento-San Joaquin Estuary, Part 1. Calif. Dept. Fish and Game, Fish Bulletin No. 133.

Gillett, J. W. 1970. The biological impact of pesticides in the environment. Environmental Health Sciences Series No. 1. Oregon State University, Corvallis, OR, 10-96.

Gilliom, Robert, J. 1999. Pesticides in the Nation's Water Resources. U.S. Geological Survey. Water Environment Federation Briefing Series Presentation. Capitol Building, Washington D.C. March 19, 1999.

Hansen, G.E. 1988. Review of the status of the giant garter snake (*Thamnophis couchi gigas*) and its supporting habitat during 1986-1987. Final report for Calif. Depart. Fish and Game Contract C-2060. Unpubl. 31 pp.

Hansen, G. E. and J. M. Brode. 1980. Status of the giant garter snake *Thamnophis couchi gigas* (Fitch). California Department of Fish and Game, Inland Fisheries Endangered Species Program Special Publication 80-5, 14 pp.

Hansen, R. W. 1980. Western aquatic garter snakes in central California: an ecological and evolutionary perspective. Master of Arts thesis, California State University, Fresno, California, 78 pp.

Hansen, R. W. and G. E. Hansen. 1990. *Thamnophis gigas* (giant garter snake) reproduction. Herpetological Review, 21(4): 93-94.

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

Hinds, N.E.A. 1952. Evolution of the California landscape. Calif. Div. of Mines Bull. No. 158. 240 pp.

Holway, D.A. 1995. Distribution of the Argentine ant (*Linepithema humile*) in Northern California. Conservation Biology 9:1634-1637.

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

Huxell, G.R. 2000. Effects of Argentine Ant on the Threatened Valley Elderberry Longhorn Beetle. Biological Invasions.

Ingraham, M. G.P. Nabhan, S. Buchmann. 1996. Impending Pollination Crisis Threatens Biodiversity and Agriculture. Tropinet 7:1.

Johnson, W. W. and Finley, M. T. 1980. Handbook of Acute Toxicity of Chemicals to Fish and Aquatic Invertebrates, Resource Publication 137. U.S. Department of Interior, Fish and Wildlife Service, Washington, DC,.7-38.

Jones & Stokes Associates. 1988. Final Report: Field Investigation of Life History Characteristics of the Valley Elderberry Longhorn Beetle along the Cosumnes River, Sacramento County, California. Prepared for the U.S. Fish and Wildlife Service. Prepared by Jones & Stokes Associates, Inc.; Sacramento, California.. 6 pp. with appendix.

Katibah, E. F. 1984. A brief history of riparian forests in the Central Valley of California. pp. 23-29. In: R.E. Warner and K. M. Hendrix, eds. California riparian systems: ecology, conservation, and productive management. University of California Press, Berkeley.

Katibah, E. F., K. J. Dummer, and N. Nedeff. 1981. Evaluation of the riparian vegetation resource in the Great Central Valley of California using remote sensing techniques. Technical Papers of the American Society of Photogrammetry. pp. 234-246. ASP-ACSM Fall Tech. Mtg., San Francisco, Sept. 9-11 and Honolulu Sept. 14-16, 1981.

Katibah, E.F., K.J. Dummer, and N. Nedeff. 1984. Current condition of riparian resources in the Central Valley of California. pp. 314-321 In: R.E. Warner and K. M. Hendrix, eds. California riparian systems: ecology, conservation, and productive management. University of California Press, Berkeley.

Kidd, H. and James, D. R., Eds. 1991. The Agrochemicals Handbook, Third Edition. Royal Society of Chemistry Information Services, Cambridge, UK, (As Updated).10-2.

Knutson, A.C., Jr. and J.J. Orsi. 1983. Factors regulating abundance and distribution of the shrimp *Neomysis mercedis* in the Sacramento-San Joaquin Estuary. Transactions of the American Fisheries Society 112:476-485.

Lande, R. 1988. Genetics and Demography in Biological Conservation. Science 241:1455-1460.

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

McCarten, N.F. and C.A. Patterson. 1987. Vegetation Quality and Rare Plant Study of Riparian Plant Communities along the Middle Sacramento River, California. CDFG Non-game Heritage Program. November.

McGill, Robert, R., Jr. 1975. Land use Changes in the Sacramento River Riparian Zone, Redding to Colusa. State of California, Resources Agency, Department of Water Resources. April, 1975. 23 pp.

Monsanto Company. 1985. Toxicology of Glyphosate and Roundup Herbicide. St. Louis, MO, 10-97.

Monroe, M.W. and J. Kelly 1992. State of the Estuary: A report on conditions and problems in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. San Francisco Estuary Project, Oakland, California.

Moyle, P.B. 1976. Inland Fishes of California. University of California Press, Berkeley, California. 405 pp.

Moyle, Peter B. 2003. Comment Letter on the Five Year Status Review of the Delta Smelt. 4pp.

Moyle, P. B. and J. Cech, Jr. 1988. Fishes: An Introduction to Ichthyology. Prentice Hall, Englewood Cliffs, New Jersey. 559 pages.

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

National Research Council Canada. 1978. Phenoxy Herbicides -- Their Effects on Environmental Quality with Accompanying Scientific Criteria for 2,3,7,8--Tetrachlorodibenzo-p-dioxin (TCDD). Ottawa, Canada, 7-25.

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

Orsi, J.J. and W.L. Mecum. 1986. Zooplankton distribution and abundance in the Sacramento-San Joaquin Delta in relation to certain environmental factors. Estuaries 9(4B):326-339.

Pimentel, D. 1971. Ecological Effects of Pesticides on Nontarget Species. Executive Office of the President's Office of Science and Technology, U.S. Government Printing Office, Washington, DC,10-29.

Primack, R.B. 1998. Essentials of Conservation Biology. Second Edition. Sinaur Associates. Sunderland, Massachusetts.

Radtke, L. D. 1966. Distribution of smelt, juvenile sturgeon, and starry flounder in the Sacramento-San Joaquin Delta. Pp. 115-119 in J. L. Turner and D. W. Kelley, eds.: Ecological studies of the Sacramento-San Joaquin Estuary, Part 2. California Department of Fish and Game Fish Bulletin No. 136.

Ritter, J. 2000. Valley of plenty fights to survive the irrigated marvel, that is the world's richest farmland is losing ground to economics and urban sprawl. USA Today. March 2.

Roberts, W.G., J.G. Howe, and J. Major. 1977. A Survey of Riparian Forest Flora and Fauna in California. Pp.3-20. *in* A. Sands (ed), Riparian Forests in California: their Ecology and Conservation. UC Davis. May 14.

Rossman, D. A. and G. R. Stewart. 1987. Taxonomic reevaluation of *Thamnophis couchi*. Occasional Papers of the Museum of Zoology, Louisiana State University, No. 63, 23 pp.

Rossman, D.A., N.B. Ford, and R.A. Seigel. 1996. The garter snakes: evolution and ecology. University of Oklahoma Press, Norman. 331 pp.

Shaffer, M.L. 1981. Minimum Populations Sizes for Species Conservation. Bioscience 31: 131-134.

Simonin, H. A. and Skea, J.C. 1977. Toxicity of diquat and cutrine to fingerling brown trout. NY Fish & Game J. 24(1): 37 45, 10-93.

Smith, F. 1977. A short review of the status of riparian forests in California. pp. 1-2 In: Riparian forests in California: their ecology and conservation. A. Sands, ed. Institute of Ecology Publication No. 15, Davis, California.98 pages plus appendices.

Soule, M. 1990. The Onslaught of Alien Species and Other Challenges in the Coming Decades. Conservation Biology 4:233-239.

Souza, K. and M. Bryant. 2002. Townet Survey and Fall Midwater Trawl. Interagency Ecological Program for the San Francisco Estuary. Newsletter 15(2):21-24.

Stevens, D. E. 1996. Distribution and food habits of American Shad (*Alosa sapidissima*) in the Sacramento-San Joaquin Delta. Pp. 97-107. *In*: J.L. Turner and D.W. Kelley (Eds.). Ecological studies of the San Francisco Bay Estuary. California Fish and Game Bulletin No. 136.

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

Stevens, D. E., S. W. Miller, and B. C. Bolster 1990. Report to the Fish and Game Commission: A status review of the delta smelt (*Hypomesus transpacificus*) in California. California Department of Fish and Game Candidate Species Status Rept. 90-2. 149 pages.

Stevens, J. T. and Sumner, D. D. 1991. Herbicides. In Handbook of Pesticide Toxicology. Hayes, W. J., Jr. and Laws, E. R., Jr., Eds. Academic Press, New York, NY,.7-2.

Swanson, C. And J. J. Cech, Jr. 1995. Environmental tolerances and requirements of the delta smelt, Hypomesus transpacificus. Final Report. Davis, California. 77 pp.

Sweetnam, D.A. 1999. Status of delta smelt in the Sacramento-San Joaquin Estuary. California Fish and Game 85(1):22-27.

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

Thompson, K. 1961. Riparian forests of the Sacramento Valley, California. Annals of the Association of American Geographers 51: 294-315.

_____. 1977. Riparian forests of the Sacramento Valley, California. Pp 35-38 *in* A. Sands (ed), Riparian Forests in California: their Ecology and Conservation. UC Davis. May 14, 1977.

Tucker, B. V. 1980.Diquat Environmental Chemistry. Chevron Chemical Corporation, Ortho Agricultural Division. Richmond, VA, 10-95.

Turner, J.L. and D.W. Kelly. 1966. Ecological studies of the Sacramento-San Joaquin Delta. Calif. Dept. of Fish and Game Bulletin No. 136.

U.S. Army Corps of Engineers. 1998. Appropriate Use of Aquatic Herbicides. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS Land and Water [Land Water], vol. 42, no. 4, pp. 44-48.

U.S. Department of Agriculture (U.S. Forest Service). 1992a. Pesticides in Ground Water Database: A Compilation of Monitoring Studies: 1971-1991 National Summary. Washington, DC.7-24.

_____. 1992b. Pesticide tolerance for glyphosate. Federal Register 57:8739-8740, 57:8798.

U.S. Fish and Wildlife Service. 1984. Recovery plan for the valley elderberry longhorn beetle. Endangered Species Program, Portland, Oregon.

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

_____. 1993b. Endangered and threatened wildlife and plants: Determination of threatened status for the giant garter snake. Federal Register 58:54053-54066.

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

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

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

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

_____. 1999a. Draft Recovery Plan for the Giant Garter Snake (Thamnopsis gigas). Portland, Oregon. ix+192 pp.

_____. 1999b. Conservation Guidelines for the Valley Elderberry Longhorn Beetle. Sacramento California. 13 pp.

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

U.S. National Library of Medicine. 1995. Hazardous Substances Databank. Bethesda, MD.7-10

Wang, J.C.S. 1986. Fishes of the Sacramento-San Joaquin estuary and adjacent waters, California: A guide to the early life histories. Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary. Sacramento, California. Technical Report 9.

Wang, J.C.S. 1991. Early life stages and early life history of the delta smelt, *Hypomesus transpacificus*, in the Sacramento-San Joaquin Estuary, with comparison of early life

stages of the longfin smelt, *Spirinchus thaleichthys*. Interagency Ecological Studies Program for the Sacramento-San Joaquin Estuary. Sacramento, California. Technical Report 28.

Ward, P.S. 1987. Distribution of the Introduced Argentine Ant (*Iridomyrex humilis*) in Natural Habitats of the Lower Sacramento Valley and its Effects on the Indigenous Ant Fauna. Hilgardia 55:1-16.

Warner, R.E. and K.M. Hendrix. 1985. Riparian Resources of the Central Valley and California Desert. California Department of Fish and Game, Sacramento, California. 226 pp.

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

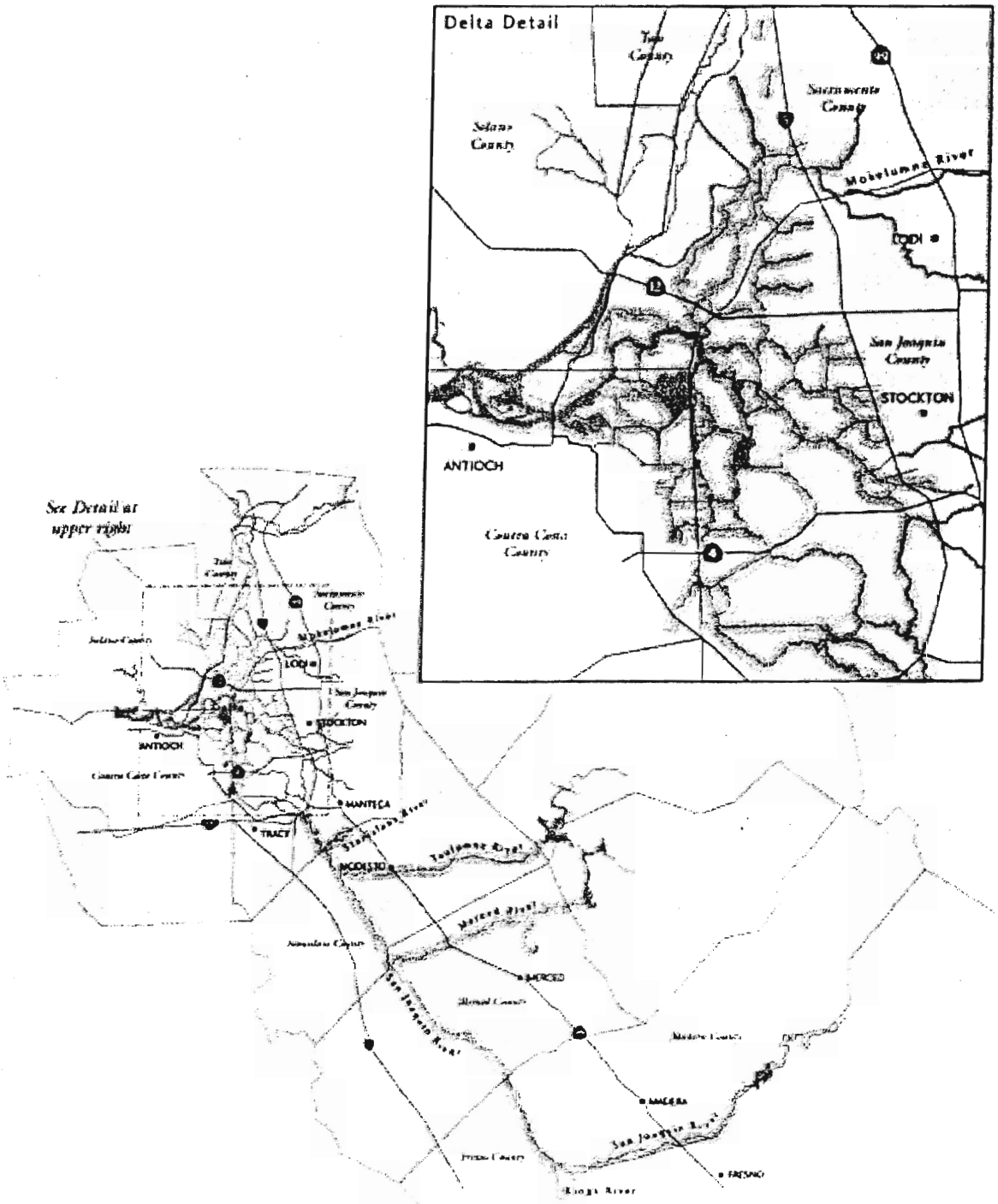
Weed Science Society of America. 1994. Herbicide Handbook, 7th Edition. Champaign, IL. 59pp.

Weihs, D. 1974. Energetic advantages of burst swimming of fish. J. Theor. Bio. 48:215-229.

Wilcove, D.S., D. Rothstein, J. Dubow, A. Phillips, and E. Losos. 1998. Quantifying Threats to Imperiled Species in the United States. Bioscience 48 (8): 607-615.

Wylie, G. D., M. Cassaza, and J. K. Daugherty. 1997. 1996 Progress report for the giant garter snake study. Preliminary report, USGS, Biological Resources Division.

Attachment A



WHCP Permits

NOAA-Fisheries Biological Opinion (151422SWR2005SA00681:JSS)

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

In Response Refer To:
151422SWR2005SA00681:JSS

APR 04 2006

James N. Seiber
Director
United States Department of Agriculture
Pacific West Area, Western Regional Research Center
Agricultural Research Service
800 Buchanan Street
Albany, California 94710-1105

Dear Director Seiber:

This letter transmits NOAA's National Marine Fisheries Service's (NMFS) biological and conference opinion (Enclosure 1) based on our review of the proposed Water Hyacinth Control Program (WHCP) in the Sacramento-San Joaquin Delta (Delta) in the state of California, and its effects on Federally listed endangered Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), threatened Central Valley spring-run Chinook salmon (*O. tshawytscha*), threatened Central Valley steelhead (*O. mykiss*), proposed threatened southern distinct population segment (DPS) of North American green sturgeon (*Acipenser medirostris*), and designated critical habitat for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon and Central Valley steelhead in accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.). Your September 9, 2005, request for formal consultation was received on September 14, 2005. A response was sent on October 19, 2005, indicating that NMFS would require additional information from the U.S. Department of Agriculture-Agricultural Research Services (USDA-ARS) in order to initiate the consultation process. A complete biological assessment was received from the USDA-ARS via the California Department of Boating and Waterways (DBW) that fulfilled the request for additional information on November 14, 2005.

This biological and conference opinion (Enclosure 1) is based on information provided from the annual reports for the WHCP from 2003, 2004, 2005, the September 9, 2005 request letter, the November 14, 2005 biological assessment, and the September 28, and November 4, 2005 meetings between staff from NMFS, the USDA-ARS, and DBW for the proposed WHCP project. A complete administrative record of this consultation is on file at the Sacramento, California, field office of NMFS.

Based on the best available scientific and commercial information, the biological and conference opinion concludes that the WHCP, as proposed by the USDA-ARS and DBW, is not likely to jeopardize the continued existence of the listed or proposed species or adversely modify designated critical habitat. NMFS also has included an incidental

take statement with reasonable and prudent measures and non-discretionary terms and conditions that are necessary and appropriate to avoid, minimize, or monitor incidental take associated with the project. The conference opinion concerning the proposed listing of green sturgeon does not take the place of consultation under section 7(a) 2 of the ESA. The conference opinion may be adopted as a biological opinion when the proposed listing for the southern DPS of North American green sturgeon becomes final if no significant new information is developed, and no significant changes to the project are made that would alter the contents of this opinion.

This letter also transmits NMFS' Essential Fish Habitat (EFH) conservation recommendations for Pacific salmon (*O. tshawytscha*), starry flounder (*Platichthys stellatus*) and English sole (*Parophrys vetulus*) as required by the Magnuson-Stevens Fishery Conservation and Management Act (MSA) as amended (16 U.S.C. 1801 *et seq.*; Enclosure 2). The document concludes that the WHCP will adversely affect the EFH of Pacific salmon, starry flounder, and English sole in the action area and adopts certain terms and conditions of the incidental take statement and the ESA conservation recommendations of the biological and conference opinion as the EFH conservation recommendations.

The USDA-ARS has a statutory requirement under section 305(b)(4)(B) of the MSA to submit a detailed response in writing to NMFS within 30 days of receipt of these conservation Recommendations that includes a description of the measures proposed for avoiding, mitigating, or offsetting the impact of the activity on EFH (50 CFR 600.920 (j)). If unable to complete a final response within 30 days, the Corps should provide an interim written response within 30 days before submitting its final response.

Please contact Mr. Jeffrey Stuart in our Sacramento Area Office at (916) 930-3607 or via e-mail at J.Stuart@noaa.gov if you have any questions regarding this response or require additional information.

Sincerely,

Russell M Strach

for Rodney R. McInnis
Regional Administrator

Enclosures (2)

cc:

NOAA Fisheries-PRD, Long Beach, CA
Stephen A. Meyer, ASAC, NOAA Fisheries, Sacramento, CA
USDA-ARS, Lars Anderson, Weed Science Program, UC-Davis - One Shields Avenue, Davis, CA 95616

DBW, Marcia Carlock, 2000 Evergreen Street, Suite 100, Sacramento, CA 95815

U.S. Fish and Wildlife Service, Ryan Olah, 2800 Cottage Way, Suite W-2605, Sacramento, CA 95825

James Starr, California Department of Fish and Game, 4001 North Wilson Way, Stockton, CA 94205

California Regional Water Quality Control Board, Emily Alejandro, 3443 Routier Road, Suite A, Sacramento, CA 95827

APR 0 4 2006

BIOLOGICAL AND CONFERENCE OPINION

ACTION AGENCY: U.S. Department of Agriculture-Agricultural Research Service

ACTIVITY: Water Hyacinth Control Program

CONSULTATION CONDUCTED BY: Southwest Region, National Marine Fisheries Service

FILE NUMBER: 151422SWR2005SA00681:JSS

I. CONSULTATION HISTORY

Previous consultations by NOAA's National Marine Fisheries Service (NMFS) addressing the effects of the Water Hyacinth Control Program (WHCP) on listed salmonids resulted in the issuance of biological opinions on June 8, 2001; June 11, 2002; and August 11, 2003. These biological opinions respectively concluded that the WHCP was not likely to jeopardize the continued existence of Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), Central Valley spring-run Chinook salmon (*O. tshawytscha*), and Central Valley steelhead (*O. mykiss*), or adversely modify designated critical habitat for the 2001, 2002, and 2003 through 2005 application seasons.

On September 14, 2005, NMFS received the U.S. Department of Agriculture-Agricultural Research Service (USDA-ARS) request for initiation of formal section 7 consultation under the Endangered Species Act (ESA) for the WHCP covering application seasons 2006 through 2010.

On September 28, 2005, a meeting was held at NMFS' Sacramento offices between staff from the USDA-ARS, the California Department of Boating and Waterways (DBW) and NMFS to discuss the WHCP consultation and the necessary information to be included in the project's biological assessment (BA).

On October 19, 2005, NMFS formally responded to the USDA-ARS' request for formal section 7 consultation regarding the WHCP with a letter indicating that the information provided in the initiation package was incomplete and that further detailed information was necessary to continue the consultation. The information requested by NMFS had been discussed in the September 28, 2005 meeting between agency staff.

On November 4, 2005, a second meeting was held at NMFS' Sacramento offices between staff from the aforementioned agencies to discuss the progress of the BA.

On November 14, 2005, a copy of the final BA for the WHCP was delivered to the offices of NMFS in Sacramento by staff from the DBW and formal consultation was initiated for the project.

II. DESCRIPTION OF THE PROPOSED PROJECT

The DBW, through their Federal sponsor, the USDA-ARS, is proposing a continuation of their ongoing WHCP in the affected waters of the Central Valley of California for the next five years (2006-2010). The WHCP is an ongoing program that is designed to control the growth and spread of the invasive, non-native aquatic plant *Eichhornia crassipes* (water hyacinth) in the Sacramento – San Joaquin Delta (Delta), several tributaries that flow into the delta (*i.e.* Morrison Creek, and the Merced, Mokelumne, Tuolumne, and San Joaquin Rivers) as well as several sloughs that feed into the Delta. Tables and figures mentioned in text will be given in appendix A and B, respectively, at the end of the document. Please see Appendix B, Figure 1 for a map of the project action area.

A. Project objectives

The primary purpose of the WHCP is to prevent the growth and spread of water hyacinth in the affected areas of the Delta and its adjoining waters (DBW 2005b). The DBW has been charged with preventing degradation of the beneficial uses of the Delta waters by the infestation of the water hyacinth and thus seeks to minimize the negative impacts of the water hyacinth on navigation, recreation, and agricultural activities (diversions) in the affected waterways of the Delta. DBW will clear and maintain adequate navigation channels for Delta boaters and clear infested waters surrounding marinas, boat launching ramps, agricultural diversions, and domestic water pumping intakes. In addition to these stated primary objectives, DBW seeks to improve the Delta's aquatic habitat by removing the non-native water hyacinth and creating opportunities for native plants to recolonize the infested areas. The DBW has identified a total of ten specific objectives to be achieved by the WHCP and their associated performance measures that will be used to evaluate the success of the WHCP (Table 1).

Table 1: WHCP Objectives and Performance Measures (from DBW 2005)

Objectives	
1.	Limit future growth and spread of water hyacinth in the Delta.
2.	Improve boat and vessel navigation in the Delta.
3.	Utilize the most efficacious methods available with the least environmental impacts.
4.	Prioritize sites so that the WHCP activities are focused on sites with a high degree of infestation, as well as navigational, agricultural, or recreational significance.
5.	Employ a combination of control methods to allow maximum flexibility.
6.	Improve the WHCP as more information becomes available on control methods used in the Delta.
7.	Monitor results of the WHCP to fully understand impacts of the WHCP on the environment of the Delta.
8.	Improve shallow water habitats for native species by controlling water hyacinth.
9.	Decrease WHCP control efforts, when and if sufficient efficacy of water hyacinth control is realized.
10.	Minimize use of methods that could cause adverse environmental impacts.

Performance Measures
• Reduce total acres of water surface infested with water hyacinth
• Reduce water hyacinth biomass at high priority navigation sites currently infested with water hyacinth
• Reduce water hyacinth biomass at nursery sites.
• Prevent infestation of new sites.
• Produce fewer incidents of boat navigation, agricultural, and recreation problems related to water hyacinth.
• Prepare reports for regulatory agencies
• Increase the total efficacy level of the WHCP, and each control method over time.
• Increase the number of shallow-water sites suitable for native species.
• Limit the number and significance of environmental impacts resulting from the WHCP.
• Limit the number of acres treated with methods that have the potential for adverse environmental impacts.
• Reduce the quantity of herbicides applied to the Delta over time.

B. Project Activities

The WHCP is a program intended to control water hyacinth, an invasive, non-native aquatic weed in the Delta. The Federal nexus for this activity is the USDA-ARS, which has the responsibility to conduct research and provide technical input into the control of nuisance weeds and agricultural pests. The DBW is the state lead for this project, with whom the USDA-ARS has contracted with to conduct the application of the program.

1. Chemical Control

Currently, the primary WHCP treatment methods utilize chemical herbicides in conjunction with adjuvents. The chemical compounds available to the DBW for application to infested waters during the 2006-2010 treatment seasons include:

a. *Herbicides*

1. Reward® (active ingredient: diquat dibromide, Environmental Protection Agency (EPA) Registration Number 10182-404)

2. Weedar 64® (active ingredient: 2,4-Dichlorophenoxyacetic acid (2,4-D), dimethylamine salt). EPA Registration Number 71368-264.

3. Rodeo® and Aquamaster (active ingredient glyphosate). EPA Registration Number 524-00343.

b. *Adjuvants*

1. R-11® Spreader-Activator (active ingredients: alkyl aryl polyethoxylates, compounded silicone, and linear alcohol). California State Registration 2935-50142-AA.

2. Agri-Dex® (active ingredients: paraffin base petroleum oil and polyoxyethylate polyol fatty acid esters). California State Registration 5905-50017-AA.

Of the three aquatic herbicides selected for use in the program, only two have been used regularly, 2,4-D and glyphosate. These will remain the two preferred herbicides for use during the 2006 to 2010 application seasons. The compound 2,4-D accounted for between 75 percent and 90 percent of the herbicides applied in the past three treatment seasons for the WHCP and glyphosate has accounted for the remainder. DBW has not determined whether the herbicide diquat dibromide will be used during the next five application seasons.

In addition to the herbicides, two different adjuvants have been used in the application program during the period from 2003 to 2005. They are: (1) R-11®, a combined spreading-activating compound for increasing the efficiency of action for agricultural chemicals where quick wetting and uniform coverage are required and (2) Agri-Dex®, a nonionic compound that improves pesticide application by modifying the wetting and deposition characteristics of the application solution.

Agri-Dex® will be the primary adjuvant used in the WHCP. R-11 has been deemed unsuitable for the majority of applications in the waters of the Delta. R-11 can, however, be used in portions of the Stone/Beach Lakes complex where contact with listed fish species is unlikely to occur.

Please see Table 2 (Appendix A) for an accounting of chemical usage and acreage treated for the 2003 through 2005 application seasons (DBW 2004, 2005a, 2006).

2. Biological Control

The USDA-ARS and DBW are conferring with the California Department of Food and Agriculture (DFA) to develop and implement biological control methods for the WHCP. The DBW has contracted with the DFA to search for populations of weevils belonging to the genus *Neochetina* within the Delta. These weevils are a naturally occurring consumer of the water hyacinth, endemic to the plant's native South American habitat. This genus of weevils was previously released into the Delta several decades ago, but had not established a large enough population to achieve control of the water hyacinth infestation. Remnant populations of these earlier releases still remain in the Delta, but are scattered and small in size. If populations of these weevils are found, DFA will determine if they are infected with a microsporidian disease that could interfere with biological control efforts. DBW intends to utilize these weevils to colonize water hyacinth nurseries and establish self-sustaining populations of the insect as an ongoing control of water hyacinth infestation in these locales. Pending the results of the DFA investigations, DBW intends to submit a final biological control study proposal to NMFS to be

included as an amendment to this or future biological opinions, which will fulfill earlier requirements to establish an integrated pest management program for water hyacinth in the Delta as described in the project's biological assessment (DBW 2005b). Therefore, biological control operations will not be addressed further in this biological opinion.

3. Mechanical and Physical Removal

The DBW has received concurrence under a separate consultation (SWR-03-SA-8373:JSS) to implement a manual and mechanical removal of water hyacinth infestations from Delta waterways during the non-spraying season. This period is typically from the end of the herbicide spraying season in mid October (October 15) to the beginning of the permitted herbicide spray application season in spring (date varies depending on location). Personnel from the DBW will manually remove small infestations of water hyacinth with rakes in critical areas and deposit the vegetation on adjacent levee banks where the plants will desiccate naturally and perish. Mechanical removal will require DBW personnel to use motorized water-craft to "herd" mats of water hyacinth out into the main channels of the Delta where they will be carried by currents out of the Delta system and eventually perish in the higher salinity of Suisun Bay. Mechanical and physical removal operations will not be further addressed in this biological opinion.

4. Daily Protocol

The proposed WHCP treatment season would extend from approximately April 1 through October 15. Five crews, each consisting of a Specialist and a Technician, would carry out the spraying of herbicides in an assigned region of the Delta. Spraying would be conducted five days a week, with each team spraying about 25 acres per day in total, at one to three sites in a given day. The maximum area that could be treated in a day could range as high as 50 acres a day in the summer, when crews work overtime and weather and tidal conditions are conducive to treatment. A Field Supervisor would manage daily operations from the DBW Field Office in Stockton, California, and would be responsible for determining daily spraying needs and assign teams to sites based on local conditions, available personnel, and equipment resources. The Field Supervisor will also assure that the Notice of Intent (NOI) requirements are met by reporting the locations of the treatment sites to the respective county Agricultural Commissioner no later than the Friday prior to the week of treatment. Each boat crew will document herbicide applications on a daily basis, make sure that application rates are compliant with label instructions for each respective chemical product, are applied at designated treatment sites only, are performed in a manner consistent with the WHCP protocols and use permits, and overseen by the Project Supervisor. The application of herbicides will be conducted with hand held sprayers operated from 19 to 21-foot aluminum air or outboard boats. The boats are equipped for direct metering of herbicides, adjuvants and water into the pump system of the spraying unit. The herbicide/adjuvant mixture will be sprayed directly onto the floating mats of water hyacinth. Waste products, including both active and inert components of the herbicidal mixtures, degraded components of the herbicidal mixtures, and dead and decaying vegetable matter, would be left to sink to the bottom or be carried downstream by the river and tidal currents. Operating protocols will prohibit treatments when wind conditions exceed a maximum threshold (10 mph) or when water flow or wave action is excessive.

The DBW will follow the California Department of Pesticide Regulation procedures for pesticide application. Restricted Use Permits from the relevant county agriculture commissioners will be obtained prior to the initiation of the spraying program. Monitoring protocols for water quality and pesticide concentrations in treated water bodies will be strictly adhered to in compliance with the water quality monitoring protocols approved by the Central Valley Regional Water Quality Board (Regional Board) per the criteria set forth in the General Permit.

C. Proposed Conservation Measures

The DBW was initially covered under the Individual Permit issued by the Regional Board on March 7, 2001 for the application of herbicides in conjunction with the WHCP. This order expires March 7, 2006. On April 12, 2002, the USDA-ARS and DBW applied for a General Permit under the "emergency basis" resulting from the Headwaters, Inc. v. Talent Irrigation District (Talent Decision) issued in 2001 by the Ninth Circuit Court of Appeals. As a requirement of the General Permit, the DBW would follow monitoring protocol terms imposed by the Regional Board. The general goals of the monitoring plan are to:

1. Document compliance with the requirements of the General Permit

2. Support the development, implementation, and effectiveness of the implementation of Best Management Procedures (BMPs)

3. Demonstrate the full recovery of water quality and protection of beneficial uses of the receiving waters following completion of resource or pest management projects

4. Identify and characterize aquatic pesticide application projects conducted by the DBW

5. Assure that the Monitoring Plan provides for monitoring of projects that are representative of all pesticides and application methods used by the DBW.

The General Permit does not specify numeric limits for water quality criteria, but rather gives narrative guidelines for dischargers to follow. The General Permit allows for temporary excursions above the numeric criteria listed in the California Toxics Rule (CTR) and EPA water quality criteria, as long as full restoration of water quality and beneficial uses of the receiving waters are returned to pre-treatment levels following completion of the action. However, DBW anticipates following both the EPA aquatic species toxicity limits and drinking water standards that follow:

- Diquat--the maximum-labeled rate for water column concentration is 370 parts per billion (ppb). The EPA drinking water concentration standard (Maximum Contaminant Level, or MCL) is 20 ppb. EPA lists the protective criteria for freshwater life as 0.5 ppb. The DBW anticipates treating within the labeled rates the day of treatment and returning to EPA criteria within 24 hours after treatment.

- Glyphosate--application rates will be limited to ensure a MCL that does not exceed 700 ppb in water bodies designated as municipal and domestic water supplies. The DBW anticipates treating within the labeled rates the day of treatment and returning to EPA criteria within 24 hours after treatment.

- 2,4-D--the application rate will be limited to ensure a MCL that does not exceed 70 ppb in water bodies designated as municipal or domestic water supplies. Regional Board has further restricted the level of permissible 2,4-D concentrations in receiving waters to 20 ppb in the individual National Pollution Discharge Elimination System (NPDES) permit (Section A-14, Receiving Water Limitations). The DBW anticipates treating within the labeled rates the day of treatment and returning to EPA criteria within 24 hours after treatment.

In order to fulfill the requirements of the General Permit, the DBW has implemented pre-treatment and post-treatment monitoring for biological, chemical, and physical indicators associated with each form of WHCP treatment. These elements are required according to the terms of the monitoring plan associated with the General Permit (Attachment B of the General Permit). The objectives of the program's monitoring are to: (1) determine if environmental conditions are conducive to chemical or mechanical treatment; (2) collect data for environmental baseline conditions, for assessment of environmental impacts and treatment efficacy, and (3) determine if treatment protocols need to be modified to reduce environmental impacts.

Pre-treatment monitoring involves taking measurements of physical and chemical parameters, including water temperature, water flow rate, turbidity, dissolved oxygen (DO), pH, and concentrations of aquatic herbicides prior to treatment. Post-treatment monitoring consists of taking measurements of DO, pH, and aquatic herbicides concentrations. Water hyacinth biomass and coverage are quantified before and after treatment to determine overall efficacy of the WHCP and possible modifications to the treatment protocol. Specific mitigation measures for the water hyacinth control program are proposed by the DBW to avoid or minimize potential impacts where available. Consultation with various state and federal agencies regarding impacts and mitigation measures for future revisions or additions to the mitigation measures will be on going.

1. Environmental Monitoring

The monitoring program includes a daily log with site specifics (*e.g.* location, wind, chemicals used, location of listed species/species habitat), DO levels, pH, and pre-treatment and post-treatment levels of chemical residues. Three times each year, replicated (n=2) monitoring of pre-treatment and post-treatment chemical residue concentrations will be conducted in each of the water type categories (tidal, slow-moving, fast-flowing, dead-end slough). Each type of herbicide applied will have a complete set of residue determinations performed.

2. Pre-Treatment

One hour prior to treatment, readings of the ambient DO, temperature, and turbidity will be taken in the treatment area at the midpoint of the water column or at a depth of 5 feet, whichever is

closer to the surface. An ambient chemical residue sample will also be taken in the treatment area at the midpoint of the water column or at a depth of 5 feet, whichever is closer to the surface, and within 3 feet of the water hyacinth mat, if possible, at the same location.

3. Post-Treatment

Upon completion of the chemical application, DBW will take ambient DO, temperature and turbidity readings at the mid-point of the water column or at a depth of 5 feet; whichever is closer to the surface, at the following three locations:

1. 100 feet up current of the treatment area.
2. Within the treatment area at the same location as the pre-treatment sample; and
3. 25 feet down-current of the treatment area

These DO, temperature and turbidity readings will continue until dead plants are no longer observable and the DO readings within and 25 feet down-current of the treatment area are within 0.5 mg/L of the readings 100 feet up-current of the treatment area.

Chemical residue and toxicity samples:

- Direction of water flow will be determined prior to the initiation of spraying. After the initial water sample has been taken, the spray crew will flag the starting point and spray in a down-current direction, traveling with the current.

- When the spray crew has passed the initial sampling location, the monitoring crew will take the first post-treatment sample 100 feet upstream of the flagged starting point.

- The monitoring crew will then take the second sample at the initial sample location for chemical residue and toxicity studies. The monitoring crew will contact the spraying crew to stop at this point, and the spraying crew will flag the end point of the application area.

- The monitoring crew will sample water 25 feet down-current from the flagged stopping point.

The time, latitude, and longitude of the sampling location for each set of samples will be recorded for later incorporation into a GIS database.

The DBW has Memoranda of Understanding (MOUs) with regional water agencies outlining application restrictions. Prior to any future work within close proximity of drinking water intakes, the DBW will develop a protocol for sampling post-treatment chemical residue around the intakes. Currently, label recommendations for Reward® concentration cannot exceed 20 ppb in drinking water.

Other monitoring protocols being carried out by DBW and relevant to listed salmonid species includes field observations for any dead fish and native vegetation; visual assessment of water

quality and photo documentation of native vegetation present at treatment sites before and after chemical control applications.

The WHCP technical crew is trained in fish species identification and recognition of fish habitat in the Delta and associated waterways by the DBW environmental scientist assigned to the program.

4. WHCP Adaptive Management

The DBW proposes to employ an adaptive management strategy for conducting the WHCP. This strategy will allow the DBW to re-evaluate its project protocol as new data and information becomes available that enhances the efficiency of the program or minimizes its environmental impact. The proposed adaptive management strategies include:

- Evaluating the need for control measures on a site by site basis;
- Selecting appropriate indicators for pre-treatment environmental monitoring;
- Monitoring indicators following treatment and evaluating data to determine program efficacy and environmental impacts;
- Support ongoing research to explore the impacts of the WHCP and alternative control methodologies;
- Report findings from monitoring evaluations and research to regulatory agencies and stakeholders;
- Adjust program actions, as necessary, in response to recommendations and evaluations by regulatory agencies and stakeholders.

5. Temporal and Spatial Restrictions to Herbicide Applications

The application of herbicides in the waters of the action area has been modified by DBW, in response to on-going consultations with NMFS, to minimize or avoid potential adverse effects upon listed salmonids and North American green sturgeon. DBW has indicated that the following temporal and spatial limitations and restrictions will be incorporated into their application protocols for the WHCP and become part of the project description:

1. The following sites may be treated from April 1 to November 30 under the following specified conditions:

    a. The San Joaquin River upstream of the confluence with the Merced River (Hills Ferry) and associated sloughs and canals in Merced and Fresno counties south of the confluence of the Merced and San Joaquin Rivers;

b. The Stone/Beach Lakes complex in Sacramento County (except for site 220, which will only be treated April 1 through October 15).

2. The following sites may be treated April 1 through October 15 of each application season. Treated sections will start at the inner margin of the infested water body and move progressively outwards towards the main channel as practicable:

   a. Sloughs on the east side of the Delta which have minimal current and unsuitable salmonid habitat:
      i. Fourteen Mile Slough east of Shima Tract
      ii. Pixley Slough
      iii. Rio Blanco Tract
      iv. White and Disappointment Sloughs, east of Honker Cut
      v. Sycamore Slough
      vi. Hog Slough
      vii. Beaver Slough
      viii. Lost Slough
      ix. Snodgrass Slough above the Delta Cross Channel

3. Areas available to herbicide treatment from April 15 through October 15 are portions of the south Delta that are within the region bounded by the placement of the four south Delta temporary barriers. Herbicide applications may commence once the barriers are in place and the Head of Old River Barrier is closed. These waterways include portions of Old River, Middle River, Paradise Cut, Salmon Cut, Tom Paine Slough, Sugar Slough, Grant Line, Fabian and Bell Canals. Additionally, off channel sites along the Merced River that have no hydrological connectivity to the mainstem Merced River may also be treated as early as April 15.

4. Treatment may occur as early as May 15 (but continue no later than October 15) in the Merced River, Tuolumne River and the mainstem San Joaquin River upstream of the confluence with the Stanislaus River to the confluence with the Merced River depending on water temperatures, with the stipulation that water temperatures must be 21 °C (69.8 °F) or greater for one week prior to the application of herbicides in each prospective area.

5. The remainder of the project area may be treated after June 1, or when Interagency Ecological Program (IEP) data indicates that the pulse of migrating salmon have moved through the Delta. If IEP data shows that fish are still present in these reaches, spraying activities may be suspended upon the discretion of NMFS personnel.

6. Between July 1 and October 15, there are no restrictions for areas to be sprayed within the project area.

D. Action Area

The WHCP includes portions of nine counties that encompass much of the Sacramento-San Joaquin Delta and its upland tributaries. The nine counties are: Contra Costa, Fresno, Madera, Merced, Sacramento, San Joaquin, Stanislaus, and Yolo. Merced and Fresno counties will be treated by the agricultural commissions of those counties under the direction of the DBW. The DBW will conduct the program in the other seven counties. The general boundaries for the treatment area in the Delta and its tributaries are as follows:

- West up to and including Sherman Island, at the confluence of the Sacramento and San Joaquin Rivers;
- West up to the Sacramento Northern Railroad to include water bodies north of the southern confluence of the Sacramento River and the Sacramento River Deep Water Ship Channel (SDWSC);
- North to the northern confluence of the Sacramento River and the SDWSC, plus waters of Lake Natoma;
- South along the San Joaquin River and Kings River to Mendota, just west of Fresno;
- East along the San Joaquin River to Friant Dam on Millerton Lake;
- East along the Tuolumne River to La Grange Reservoir; below Don Pedro Reservoir; and
- East along the Merced River to Merced Falls, below Lake McClure.

Within the project area are 367 possible treatment sites which average between one and two miles in length (see Table 3, Appendix A). These sites include those that were listed in the 2002 WHCP, sites that were omitted from the action area in 2002, and additional sites that have been added to the WHCP since 2003. Each year, sites will be prioritized after DBW crews complete a spring survey. High priority sites will generally have the greatest impacts to navigation, create extensive obstructions to pumping facilities, or have high levels of infestation.

III. STATUS OF THE SPECIES AND CRITICAL HABITAT

The following Federally listed and proposed species (Evolutionarily Significant Units [ESUs] or Distinct Population Segments [DPSs]) and designated critical habitat occur in the action area and may be affected by the proposed project:

Sacramento River winter-run Chinook salmon ESU
endangered (June 28, 2005, 70 FR 37160)

Sacramento River winter-run Chinook salmon critical habitat
(June 16, 1993, 58 FR 33212)

Central Valley spring-run Chinook salmon ESU
threatened (June 28, 2005, 70 FR 37160)

Central Valley spring-run Chinook salmon critical habitat
(September 2, 2005, 70 FR 52488)

Central Valley steelhead DPS
Threatened (January 5, 2006 71 FR 834)

Central Valley steelhead designated critical habitat
(September 2, 2005, 70 FR 52488)

Southern DPS of North American green sturgeon (*Acipenser medirostris*)
proposed threatened (April 6, 2005, 70 FR 17386)

The designated critical habitat of Sacramento River winter-run Chinook salmon occurs along the main channel of the Sacramento River downstream to Chipps Island and includes Sutter, Steamboat, and Cache Sloughs as well as the lower segments of the San Joaquin River adjacent to Kimball, Browns and Winter Islands near RM 4 of the San Joaquin River. Critical habitat is inclusive of the aquatic habitat below the ordinary high water mark surrounding these islands and along the river and slough channels. Designated critical habitat for Central Valley steelhead occurs throughout the waters of the Delta and within the eastside tributaries below the first impassable barrier (Calaveras, Mokelumne, Stanislaus, Tuolumne, and Merced Rivers). Critical habitat extends up the lower section of the San Joaquin River to Hills Ferry, located at the confluence of the Merced River. Critical habitat lies below the ordinary high water mark in these waters. Designated critical habitat for Central Valley spring-run Chinook salmon borders the northern edge of the San Joaquin River from the confluence of the Mokelumne River west to the boundaries of the Suisun Bay and Sacramento Delta hydrologic sub units at approximately RM 4 of the San Joaquin River. This would include the waters of Three Mile Slough and New York Slough. Critical habitat for spring-run Chinook salmon in the action area includes the Sacramento River from Sherman Island upriver to the City of Sacramento, and would include the waters of Steamboat, Sutter, Miner, and Elk Sloughs. Individuals of both Chinook salmon ESUs can occupy waters within the action area during their migratory or rearing phases.

A. Species and Critical Habitat Listing Status

NMFS has recently completed an updated status review of 16 salmon ESUs, including Sacramento River winter-run Chinook salmon and Central Valley spring-run Chinook salmon, and concluded the species' status should remain as previously listed (70 FR 37160). On January 5, 2006, NMFS published a final listing determination for ten steelhead DPSs, including Central Valley steelhead and concludes that Central Valley steelhead will remain listed as threatened (71 FR 834).

Sacramento River winter-run Chinook salmon were originally listed as threatened in August 1989, under emergency provisions of the ESA, and formally listed as threatened in November 1990 (55 FR 46515). The ESU consists of only one population that is confined to the upper

Sacramento River in California's Central Valley. The Livingston Stone National Fish Hatchery population has been included in the listed Sacramento River winter-run Chinook salmon population as of June 28, 2005 (70 FR 37160). NMFS designated critical habitat for winter-run Chinook salmon on June 16, 1993 (58 FR 33212). The ESU was reclassified as endangered on January 4, 1994 (59 FR 440), due to increased variability of run sizes, expected weak returns as a result of two small year classes in 1991 and 1993, and a 99 percent decline between 1966 and 1991. Critical habitat was delineated as the Sacramento River from Keswick Dam (RM 302) to Chipps Island (RM 0) at the westward margin of the Delta, including Kimball Island, Winter Island, and Brown's Island; all waters from Chipps Island westward to the Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and the Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge, and all waters of San Francisco Bay north of the San Francisco-Oakland Bay Bridge. The critical habitat designation identifies those physical and biological features of the habitat that are essential to the conservation of the species and that may require special management consideration and protection. Within the Sacramento River this includes the river water, river bottom (including those areas and associated gravel used by winter-run Chinook salmon as spawning substrate), and adjacent riparian zone used by fry and juveniles for rearing. In the areas west of Chipps Island, including San Francisco Bay to the Golden Gate Bridge, this designation includes the estuarine water column, essential foraging habitat, and food resources utilized by winter-run Chinook salmon as part of their juvenile outmigration or adult spawning migrations.

Central Valley spring-run Chinook salmon were listed as threatened on September 16, 1999 (50 FR 50394). This ESU consists of spring-run Chinook salmon occurring in the Sacramento River basin. The Feather River Hatchery (FRH) spring-run Chinook salmon population has been included as part of the Central Valley spring-run Chinook salmon ESU as of June 28, 2005 (70 FR 37160). Critical habitat was designated for spring-run Chinook salmon in the Central Valley on September 2, 2005 (70 FR 52488). Critical habitat includes the stream channels to the ordinary high water line within designated stream reaches such as those of the Feather and Yuba Rivers, Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear Creeks, and the Sacramento River and Delta.

Central Valley steelhead were listed as threatened under the ESA on March 19, 1998 (63 FR 13347). This DPS consists of steelhead populations in the Sacramento and San Joaquin River (inclusive of and downstream of the Merced River) basins in California's Central Valley. The Coleman National Fish Hatchery and FRH steelhead populations have been included in the listed population of steelhead as of January 5, 2006 (71 FR 834). These populations were previously included in the DPS but were not deemed essential for conservation and thus not part of the listed steelhead population. Critical habitat was designated for steelhead in the Central Valley on September 2, 2005 (70 FR 52488). Critical habitat includes the stream channels to the ordinary high water line within designated stream reaches such as those of the American, Feather, and Yuba Rivers, and Deer, Mill, Battle, Antelope, and Clear Creeks in the Sacramento River basin; the Calaveras, Mokelumne, Stanislaus, and Tuolumne Rivers in the San Joaquin River basin; and, the Sacramento and San Joaquin Rivers and Delta.

The southern DPS of North American green sturgeon was proposed for listing as threatened on April 6, 2005 (70 FR 17386). The southern DPS presently contains only a single spawning

population in the Sacramento River; individuals may occur in the action area. No critical habitat has been designated or proposed for the southern DPS of North American green sturgeon.

B. Species Life History, Population Dynamics, and Likelihood of Survival and Recovery

1. Chinook Salmon

a. *General Life History*

Chinook salmon exhibit two generalized freshwater life history types (Healey 1991). "Stream-type" Chinook salmon, enter freshwater months before spawning and reside in freshwater for a year or more following emergence, whereas "ocean-type" Chinook salmon spawn soon after entering freshwater and migrate to the ocean as fry or parr within their first year. Spring-run Chinook salmon exhibit a stream-type life history. Adults enter freshwater in the spring, hold over summer, spawn in fall, and the juveniles typically spend a year or more in freshwater before emigrating. Winter-run Chinook salmon are somewhat anomalous in that they have characteristics of both stream- and ocean-type races (Healey 1991). Adults enter freshwater in winter or early spring, and delay spawning until spring or early summer (stream-type). However, juvenile winter-run Chinook salmon migrate to sea after only 4 to 7 months of river life (ocean-type). Adequate instream flows and cool water temperatures are more critical for the survival of Chinook salmon exhibiting a stream-type life history due to over-summering by adults and/or juveniles.

Chinook salmon typically mature between 2 and 6 years of age (Myers *et al.* 1998). Freshwater entry and spawning timing generally are thought to be related to local water temperature and flow regimes. Runs are designated on the basis of adult migration timing; however, distinct runs also differ in the degree of maturation at the time of river entry, thermal regime, and flow characteristics of their spawning site, and the actual time of spawning (Myers *et al.* 1998). Both spring-run and winter-run Chinook salmon tend to enter freshwater as immature fish, migrate far upriver, and delay spawning for weeks or months. For comparison, fall-run Chinook salmon enter freshwater at an advanced stage of maturity, move rapidly to their spawning areas on the mainstem or lower tributaries of the rivers, and spawn within a few days or weeks of freshwater entry (Healey 1991).

During their upstream migration, adult Chinook salmon require streamflows sufficient to provide olfactory and other orientation cues used to locate their natal streams. Adequate streamflows are necessary to allow adult passage to upstream holding habitat. The preferred temperature range for upstream migration is 38 °F to 56 °F (Bell 1991, California Department of Fish and Game (CDFG) 1998). Adult winter-run Chinook salmon enter San Francisco Bay from November through June (Hallock and Fisher 1985) and migrate past Red Bluff Diversion Dam (RBDD) from mid-December through early August (NMFS 1997). The majority of the run passes RBDD from January through May, with the peak passage occurring in mid-March (Hallock and Fisher 1985). The timing of migration may vary somewhat due to changes in river flows, dam operations, and water year type. Adult spring-run Chinook salmon enter the Delta from the Pacific Ocean beginning in January and enter natal streams from March to July (Myers *et al.*

1998). In Mill Creek, Van Woert (1964) noted that of 18,290 spring-run Chinook salmon observed from 1953 to 1963, 93.5 percent were counted between April 1 and July 14, and 89.3 percent were counted between April 29 and June 30. Typically, spring-run Chinook salmon utilize mid- to high elevation streams that provide appropriate temperatures and sufficient flow, cover, and pool depth to allow over-summering while conserving energy and allowing their gonadal tissue to mature.

Spawning Chinook salmon require clean, loose gravel in swift, relatively shallow riffles or along the margins of deeper runs, and suitable water temperatures, depths, and velocities for redd construction and adequate oxygenation of incubating eggs. Chinook salmon spawning typically occurs in gravel beds that are located at the tails of holding pools (U.S. Fish and Wildlife Service (FWS) 1995). The range of water depths and velocities in spawning beds that Chinook salmon find acceptable is very broad. Bell (1991) identifies the preferred water temperature for adult spring-run Chinook salmon migration as 38 °F to 56 °F. Boles (1988) recommends water temperatures below 65 °F for adult Chinook salmon migration, and Lindley *et al.* (2004) report that adult migration is blocked when temperatures reach 70 °F, and that fish can become stressed as temperatures approach 70 °F. The Bureau of Reclamation (Reclamation) reports that spring-run Chinook salmon holding in upper watershed locations prefer water temperatures below 60 °F; although, salmon can tolerate temperatures up to 65 °F before they experience an increased susceptibility to disease. The upper preferred water temperature for spawning Chinook salmon is 55 °F to 57 °F (Chambers 1956, Bjornn and Reiser 1995). Winter-run Chinook salmon spawning occurs primarily from mid-April to mid-August, with the peak activity occurring in May and June in the Sacramento River reach between Keswick dam and RBDD (Vogel and Marine 1991). The majority of winter-run Chinook salmon spawners are 3-years old. Physical Habitat Simulation Model (PHABSIM) results (FWS 2003a) indicate winter-run Chinook salmon suitable spawning velocities in the upper Sacramento River are between 1.54 feet per second (ft/s) and 4.10 ft/s, and suitable spawning substrates are between 1 and 5 inches in diameter. Initial habitat suitability curves (HSCs) show spawning suitability rapidly decreases for water depths greater than 3.13 feet (FWS 2003a). Spring-run Chinook salmon spawning occurs between September and October depending on water temperatures. Between 56 and 87 percent of adult spring-run Chinook salmon that enter the Sacramento River basin to spawn are 3 years old (Calkins *et al.* 1940, Fisher 1994). PHABSIM results indicate spring-run Chinook salmon suitable spawning velocities in Butte Creek are between 0.8 ft/s and 3.22 ft/s, and suitable spawning substrates are between 1 and 5 inches in diameter (FWS 2004). The initial HSC showed suitability rapidly decreasing for depths greater than 1.0 feet, but this effect was most likely due to the low availability of deeper water in Butte Creek with suitable velocities and substrates rather than a selection by spring-run Chinook salmon of only shallow depths for spawning (FWS 2004).

The optimal water temperature for egg incubation is 44 °F to 54 °F (Rich 1997). Incubating eggs are vulnerable to adverse effects from floods, siltation, desiccation, disease, predation, poor gravel percolation, and poor water quality. Studies of Chinook salmon egg survival to hatching conducted by Shelton (1995) indicated 87 percent of fry emerged successfully from large gravel with adequate subgravel flow. The length of time required for eggs to develop and hatch is dependent on water temperature and is quite variable. Alderdice and Velsen (1978) found that

the upper and lower temperatures resulting in 50 percent pre-hatch mortality were 61 °F and 37 °F, respectively, when the incubation temperature was held constant.

Winter-run Chinook salmon fry begin to emerge from the gravel in late June to early July and continue through October (Fisher 1994), with emergence generally occurring at night. Spring-run Chinook salmon fry emerge from the gravel from November to March and spend about 3 to 15 months in freshwater habitats prior to emigrating to the ocean (Kjelson *et al.* 1981). Post-emergent fry disperse to the margins of their natal stream, seeking out shallow waters with slower currents, finer sediments, and bank cover such as overhanging and submerged vegetation, root wads, and fallen woody debris. They then begin feeding on small insects and crustaceans.

When juvenile Chinook salmon reach a length of 50 to 57 mm, they move into deeper water with higher current velocities, but still seek shelter and velocity refugia to minimize energy expenditures. In the mainstems of larger rivers, juveniles tend to migrate along the margins and avoid the elevated water velocities found in the thalweg of the channel. When the channel of the river is greater than 9 to 10 feet in depth, juvenile salmon tend to inhabit the surface waters (Healey 1982). Stream flow and/or turbidity increases in the upper Sacramento River basin are thought to stimulate emigration. Emigration of juvenile winter-run Chinook salmon past RBDD may begin as early as mid-July, typically peaks in September, and can continue through March in dry years (Vogel and Marine 1991, NMFS 1997). From 1995 to 1999, all winter-run Chinook salmon outmigrating as fry passed RBDD by October, and all outmigrating pre-smolts and smolts passed RBDD by March (Martin *et al.* 2001). The emigration timing of Central Valley spring-run Chinook salmon is highly variable (CDFG 1998). Some fish may begin emigrating soon after emergence from the gravel, whereas others over-summer and emigrate as yearlings with the onset of intense fall storms (CDFG 1998). The emigration period for spring-run Chinook salmon extends from November to early May, with up to 69 percent of the young-of-the-year fish outmigrating through the lower Sacramento River and Delta during this period (CDFG 1998).

Fry and parr may rear within riverine or estuarine habitats of the Sacramento River, the Delta, and their tributaries. In addition, Central Valley spring-run Chinook salmon juveniles have been observed rearing in the lower reaches of non-natal tributaries and intermittent streams in the Sacramento Valley during the winter months (Maslin *et al.* 1997, Snider 2001). Within the Delta, juvenile Chinook salmon forage in shallow areas with protective cover, such as intertidal and subtidal mudflats, marshes, channels, and sloughs (McDonald 1960, Dunford 1975). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson *et al.* 1982, Sommer *et al.* 2001, MacFarlane and Norton 2002). Shallow water habitats are more productive than the main river channels, supporting higher growth rates, partially due to higher prey consumption rates, as well as favorable environmental temperatures (Sommer *et al.* 2001). Optimal water temperatures for the growth of juvenile Chinook salmon in the Delta are between 54 °F to 57 °F (Brett 1952). In Suisun and San Pablo Bays water temperatures reach 54 °F by February in a typical year. Other portions of the Delta (*i.e.*, South Delta and Central Delta) can reach 70 °F by February in a dry year. However, cooler temperatures are usually the norm until after the spring runoff has ended.

As Chinook salmon fry and fingerlings mature, they prefer to rear further downstream where ambient salinity is up to 1.5 to 2.5 parts per thousand (Healy 1980, 1982; Levings *et al.* 1986). Juvenile winter-run Chinook salmon occur in the Delta from October through early May based on data collected from trawls, beach seines, and salvage records at the Central Valley Project (CVP) and State Water Project (SWP) pumping facilities (CDFG 1998). The peak of listed juvenile salmon arrivals in the Delta generally occurs from January to April, but may extend into June. Upon arrival in the Delta, winter-run Chinook salmon spend the first 2 months rearing in the more upstream, freshwater portions of the Delta (Kjelson *et al.* 1981, 1982). Data from the CVP and SWP salvage records indicate that most spring-run Chinook salmon smolts are present in the Delta from mid-March through mid-May depending on flow conditions (CDFG 2000).

Within the estuarine habitat, juvenile Chinook salmon movements are dictated by the tidal cycles, following the rising tide into shallow water habitats from the deeper main channels, and returning to the main channels when the tide recedes (Levy and Northcote 1982, Levings 1982, Healey 1991). As juvenile Chinook salmon increase in length, they tend to school in the surface waters of the main and secondary channels and sloughs, following the tides into shallow water habitats to feed (Allen and Hassler 1986). In Suisun Marsh, Moyle *et al.* (1986) reported that Chinook salmon fry tend to remain close to the banks and vegetation, near protective cover, and in dead-end tidal channels. Kjelson *et al.* (1982) reported that juvenile Chinook salmon demonstrated a diel migration pattern, orienting themselves to nearshore cover and structure during the day, but moving into more open, offshore waters at night. The fish also distributed themselves vertically in relation to ambient light. During the night, juveniles were distributed randomly in the water column, but would school up during the day into the upper 3 meters of the water column. Available data indicates that juvenile Chinook salmon use Suisun Marsh extensively both as a migratory pathway and rearing area as they move downstream to the Pacific Ocean. Winter-run Chinook salmon fry remain in the estuary (Delta/Bay) until they reach a fork length of about 118 mm (*i.e.*, 5 to 10 months of age) and then begin emigrating to the ocean perhaps as early as November and continuing through May (Fisher 1994, Myers *et al.* 1998). Little is known about estuarine residence time of spring-run Chinook salmon. Juvenile Chinook salmon were found to spend about 40 days migrating through the Delta to the mouth of San Francisco Bay and grew little in length or weight until they reached the Gulf of the Farallones (MacFarlane and Norton 2002). Based on the mainly ocean-type life history observed (*i.e.*, fall-run Chinook salmon) MacFarlane and Norton (2002) concluded that unlike other salmonid populations in the Pacific Northwest, Central Valley Chinook salmon show little estuarine dependence and may benefit from expedited ocean entry. Spring-run yearlings are larger in size than fall-run yearlings and are ready to smolt upon entering the Delta; therefore, they are believed to spend little time rearing in the Delta.

b. *Population Trend – Sacramento River Winter-run Chinook Salmon*

The distribution of winter-run Chinook salmon spawning and rearing historically was limited to the upper Sacramento River and its tributaries, where spring-fed streams allowed for spawning, egg incubation, and rearing in cold water (Slater 1963, Yoshiyama *et al.* 1998). The headwaters of the McCloud, Pit, and Little Sacramento Rivers, and Hat and Battle Creeks, historically provided clean, loose gravel; cold, well-oxygenated water; and, optimal stream flows in riffle habitats for spawning and incubation. These areas also provided the cold, productive waters

necessary for egg and fry development and survival, and juvenile rearing over the summer. The construction of Shasta Dam in 1943 blocked access to all of these waters except Battle Creek, which has its own impediments to upstream migration (*i.e.*, the fish weir at the Coleman National Fish Hatchery and other small hydroelectric facilities situated upstream of the weir) (Moyle *et al.* 1989; NMFS 1997, 1998). Approximately, 299 miles of tributary spawning habitat in the upper Sacramento River is now inaccessible to winter-run Chinook salmon. Yoshiyama *et al.* (2001) estimated that in 1938, the Upper Sacramento had a "potential spawning capacity" of 14,303 redds. Most components of the winter-run Chinook salmon life history (*e.g.*, spawning, incubation, freshwater rearing) have been compromised by the habitat blockage in the upper Sacramento River.

Following the construction of Shasta Dam, the number of winter-run Chinook salmon initially declined but recovered during the 1960s. The initial recovery was followed by a steady decline from 1969 through the late 1980s following the construction of the RBDD. Since 1967, the estimated adult winter-run Chinook salmon population ranged from 117,808 in 1969, to 186 in 1994 (FWS 2001a, b; CDFG 2002b). The population declined from an average of 86,000 adults in 1967 to 1969 to only 1,900 in 1987 to 1989, and continued to remain low, with an average of 2,500 fish for the period from 1998 to 2000 (see Appendix B: Figure 2). Between the time Shasta Dam was built and the listing of winter-run Chinook salmon as endangered, major impacts to the population occurred from warm water releases from Shasta Dam, juvenile and adult passage constraints at RBDD, water exports in the southern Delta, acid mine drainage from Iron Mountain Mine, and entrainment at a large number of unscreened or poorly-screened water diversions (NMFS 1997, 1998).

Population estimates in 2001 (8,224), 2002 (7,441), 2003 (8,218), and 2004 (7,701) show a recent increase in the escapement of winter-run Chinook salmon. The 2003 run was the highest since the listing. Winter-run Chinook salmon abundance estimates and cohort replacement rates since 1986 are shown in Table 3. The population estimates from the RBDD counts have increased since 1986 (CDFG 2004a), there is an increasing trend in the 5-year moving average (491 from 1990-1994 to 5,451 from 1999-2003); and, the 5-year moving average of cohort replacement rates has increased and appears to have stabilized over the same period (Table 3).

Table 4. Winter-run Chinook salmon population estimates from RBDD counts, and corresponding cohort replacement rates for the years since 1986 (CDFG 2004a, Grand Tab CDFG February 2005).

Year	Population Estimate (RBDD)	5-Year Moving Average of Population Estimate	Cohort Replacement Rate	5-Year Moving Average of Cohort Replacement Rate	NMFS Calculated Juvenile Production Estimate (JPE)[a]
1986	2,596	-	-	-	
1987	2,186	-	-	-	
1988	2,885	-	-	-	
1989	696	-	0.27	-	
1990	433	1,759	0.20	-	
1991	211	1,282	0.07	-	40,100
1992	1,240	1,092	1.78	-	273,100

1993	387	593	0.90	0.64	90,500
1994	186	491	0.88	0.77	74,500
1995	1,297	664	1.05	0.94	338,107
1996	1,337	889	3.45	1.61	165,069
1997	880	817	4.73	2.20	138,316
1998	3,002	1,340	2.31	2.48	454,792
1999	3,288	1,961	2.46	2.80	289,724
2000	1,352	1,972	1.54	2.90	370,221
2001	8,224	3,349	2.74	2.76	1,864,802
2002	7,441	4,661	2.26	2.22	2,136,747
2003	8,218	5,705	6.08	3.02	1,896,649
2004	7,701	6,587	0.94	2.71	881,719
2005	15,730	9,463	2.11	2.83	3,831,286
median	1,769	1,550	1.78	2.49	338,107

[a]JPE estimates were derived from NMFS calculations utilizing RBDD winter-run counts through 2001, and carcass counts thereafter for deriving adult escapement numbers.

c. *Status - Sacramento River Winter-run Chinook Salmon*

Numerous factors have contributed to the decline of winter-run Chinook salmon through degradation of spawning, rearing, and migration habitats. The primary impacts include blockage of historical habitat by Shasta and Keswick Dams, warm water releases from Shasta Dam, juvenile and adult passage constraints at RBDD, water exports in the southern Delta, heavy metal contamination from Iron Mountain Mine, high ocean harvest rates, and entrainment in a large number of unscreened or poorly screened water diversions within the Central Valley. Secondary factors include smaller water manipulation facilities and dams, loss of rearing habitat in the lower Sacramento River and Delta from levee construction, marshland reclamation, and interactions with, and predation by, introduced non-native species (NMFS 1997, 1998).

Since the listing of winter-run Chinook salmon, several habitat problems that led to the decline of the species have been addressed and improved through restoration and conservation actions. The impetus for initiating restoration actions stems primarily from the following: (1) ESA section 7 consultation Reasonable and Prudent Alternatives (RPAs) on temperature, flow, and operations of the CVP and SWP; (2) Regional Board decisions requiring compliance with Sacramento River water temperatures objectives which resulted in the installation of the Shasta Temperature Control Device in 1998; (3) a 1992 amendment to the authority of the CVP through the Central Valley Project Improvement Act (CVPIA) to give fish and wildlife equal priority with other CVP objectives; (4) fiscal support of habitat improvement projects from the California Bay Delta Authority (CALFED) Bay-Delta Program (*e.g.*, installation of a fish screen on the Glenn-Colusa Irrigation District (GCID) diversion); (5) establishment of the CALFED Environmental Water Account (EWA); (6) EPA actions to control acid mine runoff from Iron Mountain Mine; and, (7) ocean harvest restrictions implemented in 1995.

The susceptibility of winter-run Chinook salmon to extinction remains linked to the elimination of access to most of their historical spawning grounds and the reduction of their population structure to a small population size. Recent trends in winter-run Chinook salmon abundance and cohort replacement are positive and may indicate some recovery since the listing. Although NMFS recently proposed that this ESU be upgraded from endangered to threatened status, it made the decision in its Final Listing Determination (June 28, 2005, 70 FR 37160) to continue to list the Sacramento River winter-run Chinook salmon ESU as endangered. This population remains below the recovery goals established for the run (NMFS 1997, 1998) and the naturally-spawned component of the ESU is dependent on one extant population in the Sacramento River. In general, the recovery criteria for winter-run Chinook salmon include a mean annual spawning abundance over any 13 consecutive years of at least 10,000 females with a concurrent geometric mean of the cohort replacement rate greater than 1.0.

d. *Population Trend – Central Valley Spring-run Chinook Salmon*

Historically, the predominant salmon run in the Central Valley was the spring-run Chinook salmon, which occupied the upper and middle reaches (1,000 to 6,000 feet) of the San Joaquin, American, Yuba, Feather, Sacramento, McCloud, and Pit Rivers, with smaller populations in most tributaries with sufficient habitat for over-summering adults (Stone 1874, Rutter 1904, Clark 1929). The Central Valley drainage as a whole is estimated to have supported spring-run Chinook salmon runs as large as 600,000 fish between the late 1880s and 1940s (CDFG 1998). Before the construction of Friant Dam, nearly 50,000 adults were counted in the San Joaquin River alone (Fry 1961). Construction of other low elevation dams in the foothills of the Sierras on the American, Mokelumne, Stanislaus, Tuolumne, and Merced Rivers extirpated Central Valley spring-run Chinook salmon from these watersheds. Naturally-spawning populations of Central Valley spring-run Chinook salmon currently are restricted to accessible reaches of the upper Sacramento River, Antelope Creek, Battle Creek, Beegum Creek, Big Chico Creek, Butte Creek, Clear Creek, Deer Creek, Feather River, Mill Creek, and Yuba River (CDFG 1998).

On the Feather River, significant numbers of spring-run Chinook salmon, as identified by run timing, return to the FRH. In 2002, the FRH reported 4,189 returning spring-run Chinook salmon, which is 22 percent below the 10-year average of 4,727 fish. However, coded-wire tag (CWT) information from these hatchery returns indicates substantial introgression has occurred between fall-run and spring-run Chinook salmon populations within the Feather River system due to hatchery practices. Because Chinook salmon are not temporally separated in the hatchery, spring-run and fall-run Chinook salmon are spawned together, thus compromising the genetic integrity of the spring-run Chinook salmon stock. The number of naturally-spawning spring-run Chinook salmon in the Feather River has been estimated only periodically since the 1960s, with estimates ranging from 2 fish in 1978 to 2,908 in 1964. However, the genetic integrity of this population is questionable because of the significant temporal and spatial overlap between spawning populations of spring-run and fall-run Chinook salmon (Good *et al.* 2005). For the reasons discussed above, the Feather River spring-run Chinook population numbers are not included in the following discussion of ESU abundance.

Since 1969, the Central Valley spring-run Chinook salmon ESU (excluding Feather River fish) has displayed broad fluctuations in abundance ranging from 25,890 in 1982 to 1,403 in 1993

(CDFG unpublished data). Even though the abundance of fish may increase from one year to the next, the overall average population trend has a negative slope during this time period (see Appendix B: Figure 3). The average abundance for the ESU was 12,499 for the period of 1969 to 1979, 12,981 for the period of 1980 to 1990, and 6,542 for the period of 1991 to 2001. In 2002 and 2003, total run size for the ESU was 13,218 and 8,775 adults respectively, well above the 1991 to 2001 average.

Evaluating the ESU as a whole masks significant changes that are occurring among basin metapopulations. For example, while the mainstem Sacramento River population has undergone a significant decline, the tributary populations have demonstrated substantial increases. The average population abundance of Sacramento River mainstem spring-run Chinook salmon has recently declined from a high of 12,107 fish for the period 1980 to 1990, to a low of 609 for the period between 1991 and 2001, while the average abundance of Sacramento River tributary populations increased from a low of 1,227 to a high of 5,925 over the same period. Although tributaries such as Mill and Deer Creeks have shown positive escapement trends since 1991, recent escapements to Butte Creek, including 20,259 in 1998, 9,605 in 2001, and 8,785 in 2002, are responsible for the overall increase in tributary abundance (CDFG 2002a, 2004b; CDFG, unpublished data). The Butte Creek estimates, which account for the majority of this ESU, do not include prespawning mortality. In the last several years as the Butte Creek population has increased, mortality of adult spawners has increased from 21 percent in 2002 to 60 percent in 2003 due to over-crowding and diseases associated with high water temperatures. This trend may indicate that the population in Butte Creek may have reached its carrying capacity (Ward *et al.* 2003) or has reached historical population levels (*i.e.*, Deer and Mill creeks). Table 4 shows the population trends from the three tributaries since 1986, including the 5-year moving average, cohort replacement rate, and estimated JPE.

Table 5. Spring-run Chinook salmon population estimates from CDFG Grand Tab (February 2005) with corresponding cohort replacement rates for years since 1986.

Year	Sacramento River Basin Escapement Run Size	5-Year Moving Average of Population Estimate	Cohort Replacement Rate	5-Year Moving Average of Cohort Replacement Rate	NMFS Calculated JPE[a]
1986	24,263	-	-	-	4,396,998
1987	12,675	-	-	-	2,296,993
1988	12,100	-	-	-	2,192,790
1989	7,085	-	0.29	-	1,283,960
1990	5,790	12,383	0.46	-	1,049,277
1991	1,623	7,855	0.13	-	294,124
1992	1,547	5,629	0.22	-	280,351
1993	1,403	3,490	0.24	0.27	254,255
1994	2,546	2,582	1.57	0.52	461,392
1995	9,824	3,389	6.35	1.70	1,780,328
1996	2,701	3,604	1.93	2.06	489,482
1997	1,431	3,581	0.56	2.13	259,329
1998	24,725	8,245	2.52	2.58	4,480,722

1999	6,069	8,950	2.25	2.72	1,099,838
2000	5,457	8,077	3.81	2.21	988,930
2001	13,326	10,202	0.54	1.94	2,414,969
2002	13,218	12,559	2.18	2.26	2,395,397
2003	8,902	9,394	1.63	2.08	1,613,241
2004	9,872	10,155	0.74	1.78	1,789,027
2005	14,312	11,926	1.08	1.23	2,593,654
median	7,994	9,172	1.33	1.74	1,448,601

[a]NMFS calculated the spring-run JPE using returning adult escapement numbers to the Sacramento River basin prior to the opening of the RBDD for spring-run migration, and then escapement to Mill, Deer, and Butte Creeks for the remaining period, and assuming a female to male ratio of 6:4 and prespawning mortality of 25 percent. NMFS utilized the female fecundity values in Fisher (1994) for spring-run Chinook salmon (4,900 eggs/female). The remaining survival estimates used the winter-run values for calculating JPE.

The extent of spring-run Chinook salmon spawning in the mainstem of the upper Sacramento River is unclear. Very few spring-run Chinook salmon redds (less than 15 per year) were observed from 1989 through 1993, and none in 1994, during aerial redd counts (FWS 2003a). Recently, the number of redds in September has varied from 29 to 105 during 2001 though 2003 depending on the number of survey flights (CDFG, unpublished data). In 2002, based on RBDD ladder counts, 485 spring-run Chinook salmon adults may have spawned in the mainstem Sacramento River or entered upstream tributaries such as Clear or Battle Creek (CDFG 2004b). In 2003, no adult spring-run Chinook salmon were believed to have spawned in the mainstem Sacramento River. Due to geographic overlap of ESU and resultant hybridization since the construction of Shasta Dam, Chinook salmon that spawn in the mainstem Sacramento River during September are more likely to be identified as early fall-run rather than spring-run Chinook salmon.

e. *Status of Spring-run Chinook Salmon*

The initial factors that led to the decline of spring-run Chinook salmon in the Central Valley were related to the loss of upstream habitat behind impassable dams. Since this initial loss of habitat, other factors have contributed to the instability of the spring-run Chinook salmon population and have negatively affected the ESU's ability to recover. These factors include a combination of physical, biological, and management factors such as climatic variation, water management activities, hybridization with fall-run Chinook salmon, predation, and over-harvesting (CDFG 1998). Since spring-run Chinook salmon adults must hold over for months in small tributaries before spawning, they are much more susceptible to the effects of high water temperatures.

During the drought from 1986 to 1992, Central Valley spring-run Chinook salmon populations declined substantially. Reduced flows resulted in warm water temperatures that impacted adults, eggs, and juveniles. For adult spring-run Chinook salmon, reduced instream flows delayed or completely blocked access to holding and spawning habitats. Water management operations (*i.e.,* reservoir release schedules and volumes) and the unscreened and poorly screened diversions in the Sacramento River, Delta, and tributaries compounded drought-related problems

by reducing river flows, elevating river temperatures, and entraining juveniles into the diversions.

Several actions have been taken to improve habitat conditions for spring-run Chinook salmon, including: improved management of Central Valley water (*e.g.*, through use of CALFED EWA and CVPIA (b)(2) water accounts); implementing new and improved screen and ladder designs at major water diversions along the mainstem Sacramento River and tributaries; and, changes in ocean and inland fishing regulations to minimize harvest. Although protective measures likely have contributed to recent increases in spring-run Chinook salmon abundance, the ESU is still below levels observed from the 1960s through 1990. Threats from hatchery production (*i.e.*, competition for food between naturally-spawned and hatchery fish, run hybridization and genomic homogenization), climatic variation, high temperatures, predation, and water diversions still persist. Because the Central Valley spring-run Chinook salmon ESU is confined to relatively few remaining watersheds and continues to display broad fluctuations in abundance, the population is at a moderate risk of extinction.

2. Steelhead

a. *General Life History*

Steelhead can be divided into two life history types, based on their state of sexual maturity at the time of river entry and the duration of their spawning migration, stream-maturing and ocean-maturing. Stream-maturing steelhead enter freshwater in a sexually immature condition and require several months to mature and spawn, whereas ocean-maturing steelhead enter freshwater with well-developed gonads and spawn shortly after river entry. These two life history types are more commonly referred to by their season of freshwater entry (*i.e.,* summer (stream-maturing) and winter (ocean-maturing) steelhead). Only winter steelhead currently are found in Central Valley rivers and streams (McEwan and Jackson 1996), although there are indications that summer steelhead were present in the Sacramento river system prior to the commencement of large-scale dam construction in the 1940s (Interagency Ecological Program [IEP] Steelhead Project Work Team 1999). At present, summer steelhead are found only in North Coast drainages, mostly in tributaries of the Eel, Klamath, and Trinity River systems (McEwan and Jackson 1996).

Winter steelhead generally leave the ocean from August through April, and spawn between December and May (Busby *et al.* 1996). Timing of upstream migration is correlated with higher flow events, such as freshets or sand bar breaches, and associated lower water temperatures. In general, the preferred water temperature for adult steelhead migration is 46 °F to 52 °F (McEwan and Jackson 1996, Myrick 1998, Myrick and Cech 2000). Thermal stress may occur at temperatures beginning at 66 °F and mortality has been demonstrated at temperatures beginning at 70 °F, although some races of steelhead may have higher or lower temperature tolerances depending upon their evolutionary history. Lower latitudes and elevations would tend to favor fish tolerant of higher ambient temperatures (see Matthews and Berg (1997) for discussion of *O. mykiss* from Sespe Creek in Southern California). The preferred water temperature for steelhead spawning is 39 °F to 52 °F, and the preferred water temperature for steelhead egg incubation is 48 °F to 52 °F (McEwan and Jackson 1996, Myrick 1998, Myrick and Cech 2000). The

minimum stream depth necessary for successful upstream migration is 13 cm (Thompson 1972). Preferred water velocity for upstream migration is in the range of 40-90 cm/s, with a maximum velocity, beyond which upstream migration is not likely to occur, of 240 cm/s (Thompson 1972, Smith 1973).

Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more than once before death (Busby *et al.* 1996). However, it is rare for steelhead to spawn more than twice before dying; most that do so are females (Nickelson *et al.* 1992, Busby *et al.* 1996). Iteroparity is more common among southern steelhead populations than northern populations (Busby *et al.* 1996). Although one-time spawners are the great majority, Shapovalov and Taft (1954) reported that repeat spawners are relatively numerous (17.2 percent) in California streams. Most steelhead spawning takes place from late December through April, with peaks from January though March (Hallock *et al.* 1961). Steelhead spawn in cool, clear streams featuring suitable gravel size, depth, and current velocity, and may spawn in intermittent streams as well (Everest 1973, Barnhart 1986).

The length of the incubation period for steelhead eggs is dependent on water temperature, DO concentration, and substrate composition. In late spring, following yolk sac absorption, fry emerge from the gravel and actively begin feeding in shallow water along stream banks (Nickelson *et al.* 1992).

Steelhead rearing during the summer takes place primarily in higher velocity areas in pools, although young-of-the-year also are abundant in glides and riffles. Winter rearing occurs more uniformly at lower densities across a wide range of fast and slow habitat types. Productive steelhead habitat is characterized by complexity, primarily in the form of large and small woody debris. Cover is an important habitat component for juvenile steelhead both as velocity refugia and as a means of avoiding predation (Shirvell 1990, Meehan and Bjornn 1991). Some older juveniles move downstream to rear in large tributaries and mainstem rivers (Nickelson *et al.* 1992). Juveniles feed on a wide variety of aquatic and terrestrial insects (Chapman and Bjornn 1969), and older juveniles sometimes prey upon emerging fry.

Steelhead generally spend 2 years in freshwater before emigrating downstream (Hallock *et al.* 1961, Hallock 1989). Rearing steelhead juveniles prefer water temperatures of 45 °F to 58 °F and have an upper lethal limit of 75 °F. They can survive up to 81 °F with saturated DO conditions and a plentiful food supply. Reiser and Bjornn (1979) recommended that DO concentrations remain at or near saturation levels with temporary reductions no lower than 5.0 mg/l for successful rearing of juvenile steelhead. During rearing, suspended and deposited fine sediments can directly affect salmonids by abrading and clogging gills, and indirectly cause reduced feeding, avoidance reactions, destruction of food supplies, reduced egg and alevin survival, and changed rearing habitat (Reiser and Bjornn 1979). Bell (1973) found that silt loads of less than 25 mg/l permit good rearing conditions for juvenile salmonids.

Juvenile steelhead emigrate episodically from natal streams during fall, winter, and spring high flows. Emigrating Central Valley steelhead use the lower reaches of the Sacramento River and the Delta for rearing and as a migration corridor to the ocean. Some may utilize tidal marsh areas, non-tidal freshwater marshes, and other shallow water areas in the Delta as rearing areas

for short periods prior to their final emigration to the sea. Barnhart (1986) reported that steelhead smolts in California range in size from 140 to 210 mm (fork length). Hallock *et al.* (1961) found that juvenile steelhead in the Sacramento River basin migrate downstream during most months of the year, but the peak period of emigration occurred in the spring, with a much smaller peak in the fall.

b. *Population Trend – Central Valley Steelhead*

Steelhead historically were well-distributed throughout the Sacramento and San Joaquin Rivers (Busby *et al.* 1996). Steelhead were found from the upper Sacramento and Pit River systems (now inaccessable due to Shasta and Keswick Dams) south to the Kings and possibly the Kern River systems (now inaccessible due to extensive alterations from numerous water diversion projects) and in both east and west-side Sacramento River tributaries (Yoshiyama *et al.* 1996). The present distribution has been greatly reduced (McEwan and Jackson 1996). The California Advisory Committee on Salmon and Steelhead (1988) reported a reduction of steelhead habitat from 6,000 miles historically to 300 miles currently. Historically, steelhead probably ascended Clear Creek past the French Gulch area, but access to the upper basin was blocked by Whiskeytown Dam in 1964 (Yoshiyama *et al.* 1996).

Historic Central Valley steelhead run sizes are difficult to estimate given the paucity of data, but may have approached 1 to 2 million adults annually (McEwan 2001). By the early 1960s the steelhead run size had declined to about 40,000 adults (McEwan 2001). Over the past 30 years, the naturally-spawned steelhead populations in the upper Sacramento River have declined substantially (see Appendix B: Figure 4). Hallock *et al.* (1961) estimated an average of 20,540 adult steelhead through the 1960s in the Sacramento River, upstream of the Feather River. Steelhead counts at the RBDD declined from an average of 11,187 for the period of 1967 to 1977, to an average of approximately 2,000 through the early 1990s, with an estimated total annual run size for the entire Sacramento-San Joaquin system, based on RBDD counts, to be no more than 10,000 adults (McEwan and Jackson 1996, McEwan 2001). Steelhead escapement surveys at RBDD ended in 1993 due to changes in dam operations.

Nobriga and Cadrett (2003) compared CWT and untagged (wild) steelhead smolt catch ratios at Chipps Island trawl from 1998 through 2001 to estimate that about 100,000 to 300,000 steelhead juveniles are produced naturally each year in the Central Valley. In the draft *Updated Status Review of West Coast Salmon and Steelhead* (NMFS 2003), the Biological Review Team (BRT) made the following conclusion based on the Chipps Island data:

> "If we make the fairly generous assumptions (in the sense of generating large estimates of spawners) that average fecundity is 5,000 eggs per female, 1 percent of eggs survive to reach Chipps Island, and 181,000 smolts are produced (the 1998-2000 average), about 3,628 female steelhead spawn naturally in the entire Central Valley. This can be compared with McEwan's (2001) estimate of 1 million to 2 million spawners before 1850, and 40,000 spawners in the 1960s".

The only consistent data available on steelhead numbers in the San Joaquin River basin come from CDFG mid-water trawling samples collected on the lower San Joaquin River at Mossdale.

These data (see Appendix B, Figure 5) indicate a decline in steelhead numbers in the early 1990s, which have remained low through 2002 (CDFG 2003). In 2003, a total of 12 steelhead smolts were collected at Mossdale (CDFG, unpublished data).

Existing wild steelhead stocks in the Central Valley are mostly confined to the upper Sacramento River and its tributaries, including Antelope, Deer, and Mill Creeks and the Yuba River. Populations may exist in Big Chico and Butte Creeks and a few wild steelhead are produced in the American and Feather Rivers (McEwan and Jackson 1996).

Recent snorkel surveys (1999 to 2002) indicate that steelhead are present in Clear Creek (J. Newton, FWS, pers. comm. 2002, as reported in Good *et al.* 2005). Because of the large resident *O. mykiss* population in Clear Creek, steelhead spawner abundance has not been estimated.

Until recently, steelhead were thought to be extirpated from the San Joaquin River system. Recent monitoring has detected small self-sustaining populations of steelhead in the Stanislaus, Mokelumne, Calaveras, and other streams previously thought to be devoid of steelhead (McEwan 2001). On the Stanislaus River, steelhead smolts have been captured in rotary screw traps at Caswell State Park and Oakdale each year since 1995 (Demko *et al.* 2000). After 3 years of operating a fish counting weir on the Stanislaus River only two adult steelhead have been observed moving upstream, although several large rainbow trout (*O. mykiss*) have washed up on the weir in late winter (S.P. Cramer 2005). It is possible that naturally-spawning populations exist in many other streams but are undetected due to lack of monitoring programs (IEP Steelhead Project Work Team 1999). Incidental catches and observations of steelhead juveniles also have occurred on the Tuolumne and Merced Rivers during fall-run Chinook salmon monitoring activities, indicating that steelhead are widespread, if not abundant, throughout accessible streams and rivers in the Central Valley (Good *et al.* 2005).

c. *Status - Central Valley Steelhead*

Both the BRT (Good *et al.* 2005) and the Artificial Propagation Evaluation Workshop (69 FR 33102) concluded that the Central Valley steelhead DPS presently is "in danger of extinction". Steelhead have been extirpated from most of their historical range in this region. Habitat concerns in this DPS focus on the widespread degradation, destruction, and blockage of freshwater habitat within the region, and water allocation problems. Widespread hatchery steelhead production within this DPS also raises concerns about the potential ecological interactions between introduced stocks and native stocks. Because the Central Valley steelhead population has been fragmented into smaller isolated tributaries without any large source population and the remaining habitat continues to be degraded by water diversions, the population remains at an elevated risk for future population declines.

3. <u>Southern Distinct Population Segment of North American Green Sturgeon</u>

a. *General Life History*

(1) ***Adult Distribution and Feeding***. In North America, spawning populations of the anadromous green sturgeon currently are found in only three river systems, the Sacramento and

Klamath Rivers in California and the Rogue River in southern Oregon. Spawning has only been reported in one Asian river, the Tumin River in eastern Asia. Green sturgeon are known to range from Baja California to the Bering Sea along the North American continental shelf. Data from commercial trawl fisheries and tagging studies indicate that the green sturgeon occupy waters within the 110 meter contour (NMFS 2005a). During the late summer and early fall, subadults and nonspawning adult green sturgeon frequently can be found aggregating in estuaries along the Pacific coast (Emmett *et al.* 1991). Particularly large concentrations occur in the Columbia River estuary, Willapa Bay, and Grays Harbor, with smaller aggregations in San Francisco and San Pablo Bays (Emmett *et* al 1991, Moyle *et al.* 1992, Beamesderfer *et al.* 2004). Recent acoustical tagging studies on the Rogue River (Erickson *et al.* 2002) have shown that adult green sturgeon will hold for as long as 6 months in deep (> 5m), low gradient reaches, off channel sloughs or coves of the river during summer months when water temperatures were between 15 °C and 23 °C. When ambient temperatures in the river dropped in autumn and early winter (< 10 °C) and flows increased, fish moved downstream and into the ocean.

Adult green sturgeon are believed to feed primarily upon benthic invertebrates such as clams, mysid and grass shrimp, and amphipods (Radtke 1966, J. Stuart, NMFS, pers. obs., unpublished data). Adult sturgeon caught in Washington state waters were found to have fed on Pacific sand lance (*Ammodytes hexapterus*) and callianassid shrimp (Moyle *et al.* 1992).

(2) ***Spawning***. Adult green sturgeon are believed to spawn every 3 to 5 years and reach sexual maturity only after several years of growth (10 to 15 years based on sympatric white sturgeon (*A. transmontanus*) sexual maturity). Adult female green sturgeon produce between 60,000 and 140,000 eggs, depending on body size, with a mean egg diameter of 4.3 mm (Moyle *et al.* 1992, Van Eenennaam *et al.* 2001). They have the largest egg size of any sturgeon, and the volume of yolk ensures an ample supply of energy for the developing embryo. The eggs are less adhesive and more dense than than those of white sturgeon (Kynard *et al.* 2005). Green sturgeon adults begin their upstream spawning migrations into freshwater in late February with spawning occuring between March and July. Peak spawning is believed to occur between April and June in deep, turbulent, mainstem channels over large cobble and rocky substrates with crevices and interstices. Females broadcast spawn their eggs over this substrate, and the fertilized eggs sink into the interstices of the substrate where they develop further (Kynard *et al.* 2005).

(3) ***Egg Development.*** Green sturgeon larvae hatched from fertilized eggs after approximately 169 hours at a water temperature of 15 °C (Van Eenennaam *et al.* 2001, Deng *et al.* 2002), which is similar to the sympatric white sturgeon development rate (176 hours). Van Eenennaam *et al.* (2005) indicated that an optimum range of water temperature for egg development ranged between 14 °C and 17 °C. Temperatures over 23 °C resulted in 100 percent mortality of fertilized eggs before hatching. Eggs incubated at water temperatures between 17.5 °C and 22 °C resulted in elevated mortalities and an increased occurrence of morphological abnormalities in those eggs that did hatch. At incubation temperatures below 14 °C, hatching mortality also increased significantly, and morphological abnormalities increased slightly, but not statistically so.

(4) ***Early Development.*** Newly hatched green sturgeon are approximately 12.5 to 14.5 mm in length and have a large ovoid yolk sac that supplies nutritional energy until exogenous feeding

occurs. The larvae are less developed in their morphology than older juveniles and external morphology resembles a "tadpole" with a continuous fin fold on both the dorsal and ventral sides of the caudal trunk. The eyes are well developed with differentiated lenses and pigmentation. Olfactory and auditory vesicles are present while the mouth and respiratory structures are only shallow clefts on the head. At 10 days of age, the yolk sac has become greatly reduced in size and the larvae initiates exogenous feeding through a functional mouth. The fin folds have become more developed and formation of fin rays begins to occur in all fin tissues. By 45 days of age, the green sturgeon larvae have completed their metamorphosis, which is characterized by the development of dorsal, lateral, and ventral scutes, elongation of the barbels, rostrum, and caudal peduncle, reabsorption of the caudal and ventral fin folds, and the development of fin rays. The juvenile fish resembles the adult form, including the dark olive coloring, with a dark mid-ventral stripe (Deng *et al.* 2002).

Green sturgeon larvae do not exhibit the initial pelagic swim-up behavior characteristic of other *Acipenseridae*. They are strongly oriented to the bottom and exhibit nocturnal activity patterns. After 6 days, the larvae exhibit nocturnal swim-up activity (Deng *et al.* 2002) and nocturnal downstream migrational movements (Kynard *et al.* 2005). Juvenile fish continue to exhibit nocturnal behavioral beyond the metamorphosis from larvae to juvenile stages. Kynard *et al.*'s (2005) laboratory studies indicated that juvenile fish continued to migrate downstream at night for the first 6 months of life. When ambient water temperatures reached 8 °C, downstream migrational behavior diminished and holding behavior increased. This data suggests that 9- to 10- month old fish would hold over in their natal rivers during the ensuing winter following hatching, but at a location downstream of their spawning grounds.

Green sturgeon juveniles tested under laboratory conditions had optimal bioenergetic performance (*i.e.*, growth, food conversion, swimming ability) between 15 °C and 19 °C under either full or reduced rations (Mayfield and Cech 2004). This temperature range overlaps the egg incubation temperature range for peak hatching success previously discussed. Ambient water temperature conditions in the Rogue and Klamath River systems range from 4 °C to approximately 24 °C. The Sacramento River has similar temperature profiles, and, like the Rogue and Klamath Rivers, is a regulated system with several dams controlling flows on its mainstem (Shasta and Keswick Dams), and its tributaries (Whiskeytown, Oroville, Folsom, and Nimbus Dams).

Larval and juvenile green sturgeon are subject to predation by both native and introduced fish species. Smallmouth bass (*Micropterus dolomieui*) have been recorded on the Rogue River as preying on juvenile green sturgeon, and prickly sculpin (*Cottus asper*) have been shown to be an effective predator on the larvae of sympatric white sturgeon (Gadomski and Parsley 2005). This latter study also indicated that the lowered turbidity found in tailwater streams and rivers due to dams increased the effectiveness of sculpin predation on sturgeon larvae under laboratory conditions.

b. *Population Trend –Southern Distinct Population Segment of North American Green Sturgeon*

Based on the distribution of sturgeon eggs, larvae, and juveniles the in the Sacramento River, CDFG (2002c) indicated that southern DPS of green sturgeon spawn in late-spring and early-

summer above Hamilton City possibly to Keswick Dam. Young green sturgeon appear to rear for the first 1 to 2 months in the Sacramento River between Keswick Dam and Hamilton City (CDFG 2002c). Juvenile green sturgeon first appear in FWS sampling efforts at RBDD in June and July at lengths ranging in fork length from 24 to 31 mm (CDFG 2002c). Sampling efforts at Glen Colusa Irrigation District on the Sacramento River yield green sturgeons averaging approximately 29 mm in length with a peak abundance occurring in July (Adams *et al.* 2002). Since 1980, trawling studies in the San Francisco Bay estuary and Delta have taken a total of 61 juvenile green sturgeon ranging in size from 20 to 112 cm total length and although most juveniles are captured between April and October, they have been captured in nearly every month of the year (CDFG 2002c, IEP Relational Database search May 31, 2005). Juveniles spend between 1 and 4 years in fresh and estuarine waters and enter the marine environment at lengths of approximately 300 mm (Adams *et al.* 2002).

Spawning in the Feather River is suspected to have occurred in the past due to the continued presence of adult green sturgeon in the river below Oroville Dam. This continued presence of adults below the dam suggests that fish are trying to migrate upstream to spawning areas now blocked by the dam, which was constructed in 1968. Due to the extreme longevity of green sturgeon (and sturgeon in general), it is possible that these adults represent adults which have previously spawned in the Feather River system prior to the construction of the dam.

Spawning in the San Joaquin River system has not been recorded, but alterations of the San Joaquin River tributaries (Stanislaus, Tuolumne, and Merced Rivers) and its mainstem occurred early in the European settlement of the region. During the later half of the 1800s impassable barriers were built on these tributaries where the water courses left the foothills and entered the valley floor. Therefore, these low elevation dams have blocked potentially suitable spawning habitats located further upstream for over a century. Additional destruction of riparian and stream channel habitat by industrialized gold dredging further disturbed any valley floor habitat that was still available for sturgeon spawning. It is likely that both white and green sturgeon utilized the San Joaquin River basin for spawning prior to the onset of European influence, based on past use of the region by populations of Central Valley spring-run Chinook salmon and Central Valley steelhead. These two populations of salmonids have either been extirpated or greatly diminished in their use of the San Joaquin River basin over the past two centuries.

Population abundance information concerning the southern DPS of North American green sturgeon is scant as described in the status review (Adams 2002). Limited population abundance information comes from incidental captures of green sturgeon from the white sturgeon monitoring program by the CDFG sturgeon tagging program (CDFG 2002c). CDFG (2002c) utilizes a multiple-census or Peterson mark-recapture method to estimate the legal population of white sturgeon captures in trammel nets. By comparing ratios of white sturgeon to green sturgeon captures, CDFG provides estimates of adult and sub-adult green sturgeon abundance. Estimated abundance between 1954 and 2001 ranged from 175 fish to more than 8,000 per year and averaged 1,509 fish per year. Unfortunately, there are many biases and errors associated with these data, and CDFG does not consider these estimates reliable. Fish monitoring efforts at RBDD and GCID on the upper Sacramento River have captured between 0 and 2,068 juvenile green sturgeon per year, mostly between June and July (Adams 2002). The only existing information regarding changes in the abundance of the southern DPS of green sturgeon includes

changes in their abundance at the John Skinner Fish Protection Facility between 1968 and 2001 (SWP facility). The estimated number of green sturgeon taken at the SWP facility prior to 1986 was 732; since 1986, the average number has dropped to 47 (70 FR 17386). For the Tracy Fish Collection Facility (CVP facility), the average number prior to 1986 was 889; from 1986 to 2001 the average has dropped to 32 (70 FR 17386). In light of the increased volume of water exports, particularly during the previous 10 years, it is apparent that green sturgeon population abundance is dropping. Catches of sub-adult and adult green sturgeon by the IEP between 1996 and 2004 ranged from 1 to 212 green sturgeon per year (212 occurred in 2001), however, the proportion of the southern DPS of North American green sturgeon is unknown due to the comingling of the Northern and Southern population segments in San Pablo Bay. Additional analysis of green and white sturgeon taken at the SWP and CVP facilities indicates that take of both green and white sturgeon per acre-foot of water exported has decreased substantially since the 1960s (70 FR 17386).

c. *Status –Southern Distinct Population Segment of North American Green Sturgeon*

The southern DPS of North American green sturgeon historically was smaller than the sympatric population of white sturgeon in the San Francisco Bay estuary and its associated tributaries. The population has apparently been declining over the past several decades based on harvest numbers from sport and commercial fisheries and the entrainment rates at the CVP and SWP. The principle factor for this decline is the reduction of green sturgeon spawning habitat to a limited area below Keswick Dam on the Sacramento River. The construction of impassable barriers, particularly large dams, has greatly reduced the access of green sturgeon to their historical spawning areas. Reduced flows have corresponded with weakened year class recruitment in the sympatric white sturgeon population and it is believed to have the same effect upon green sturgeon recruitment. In addition to the adverse effects of impassable barriers, numerous agricultural water diversions exist in the Sacramento River and the Delta along the migratory route of larval and juvenile sturgeon. Entrainment, or, if equipped with a fish screen, impingement are considered serious threats to sturgeon during their downstream migration. Fish screens have not been designed with criteria that address sturgeon behavior or swimming capabilities. The benthic oriented sturgeon are also more susceptible to contaminated sediments through dermal contact and through their feeding behavior of ingesting prey along with contaminated sediments before winnowing out the sediment. Their long life spans allow them to accumulate high body burdens of contaminants, that potentially will reach concentrations with deleterious physiological effects. All of the above threats have been identified by the BRT as potentially affecting the continued existence of the southern DPS of North American green strurgeon (70 FR 17386).

C. Factors Affecting the Species and Critical Habitat

A number of documents have addressed the history of human activities, present environmental conditions, and factors contributing to the decline of salmon and steelhead species in the Central Valley. For example, NMFS prepared range-wide status reviews for West coast Chinook salmon (Myers *et al.* 1998), steelhead (Busby *et al.* 1996) and green sturgeon (Adams *et al.* 2002, NMFS 2005a). Also, the NMFS BRT published a draft updated status review for West coast Chinook salmon and steelhead in November 2003 (NMFS 2003) and a final review in June 2005 (Good *et*

al. 2005). Information also is available in Federal Register notices announcing ESA listing proposals and determinations for some of these species and their critical habitat (*e.g.*, 58 FR 33212, 59 FR 440, 62 FR 24588, 62 FR 43937, 63 FR 13347, 64 FR 24049, 64 FR 50394, 65 FR 7764). The Final Programmatic Environmental Impact Statement/Report (EIS/EIR) for the CALFED Bay-Delta Program (CALFED 1999), and the Final Programmatic EIS for the CVPIA (Department of Interior (DOI) 1999), provide an excellent summary of historical and recent environmental conditions for salmon and steelhead in the Central Valley.

The following general description of the factors affecting Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, the southern DPS of North American green sturgeon, and their habitat is based on a summary of these documents.

In general, the human activities that have affected listed anadromous salmonids, proposed North American green sturgeon, or their habitats consist of: (1) dam construction that blocks previously accessible habitat; (2) water development and management activities that affect water quantity, flow timing, quality, and stream function; (3) land use activities such as agriculture, flood control, urban development, mining, road construction, and logging that degrade aquatic and riparian habitat; (4) hatchery operation and practices; (5) harvest activities; and, (6) ecosystem restoration actions.

1. Habitat Blockage

Hydropower, flood control, and water supply dams of the CVP, SWP, and other municipal and private entities permanently have blocked or hindered salmonid access to historical spawning and rearing grounds. Clark (1929) estimated that originally there were 6,000 linear miles of salmon habitat in the Central Valley system and that 80 percent of this habitat had been lost by 1928. Yoshiyama *et al.* (1996) calculated that roughly 2,000 linear miles of salmon habitat was actually available before dam construction and mining, and concluded that 82 percent is not accessible today.

In general, large dams on every major tributary to the Sacramento River, San Joaquin River, and the Delta block salmon and steelhead access to the upper portions of their respective watersheds. On the Sacramento River, Keswick Dam blocks passage to historic spawning and rearing habitat in the upper Sacramento, McCloud, and Pit Rivers. Whiskeytown Dam blocks access to the upper watershed of Clear Creek. Oroville Dam and associated facilities block passage to the upper Feather River watershed. Nimbus Dam blocks access to most of the American River basin. Friant Dam construction in the mid-1940s has been associated with the elimination of spring-run Chinook salmon in the San Joaquin River upstream of the Merced River (Department of Interior [DOI] 1999). On the Stanislaus River, construction of Goodwin Dam (1912), Tulloch Dam (1957), and New Melones Dam (1979) blocked both spring- and fall-run Chinook salmon (CDFG 2001) as well as Central Valley steelhead. Similarly, La Grange Dam (1893) and New Don Pedro Dam (1971) blocked upstream access to salmonids on the Tuolumne River. Upstream migration on the Merced River was blocked in 1910 by the construction of Merced Falls and Crocker-Huffman Dams and later New Exchequer Dam (1967) and McSwain Dam (1967). These dams also had the potential to block any spawning populations of green sturgeon in these tributaries.

As a result of the dams, winter-run Chinook salmon, spring-run Chinook salmon, and steelhead populations on these rivers have been confined to lower elevation mainstems that historically only were used for migration. Population abundances have declined in these streams due to decreased quantity and quality of spawning and rearing habitat. Higher temperatures at these lower elevations during late-summer and fall are a major stressor to adults and juvenile salmonids. Green sturgeon populations would be similarly affected by these barriers and alterations to the natural hydrology.

The Suisun Marsh Salinity Control Gates (SMSCG), located on Montezuma Slough, were installed in 1988, and are operated with gates and flashboards to decrease the salinity levels of managed wetlands in Suisun Marsh. The SMSCG have delayed or blocked passage of adult Chinook salmon migrating upstream (Edwards *et al.* 1996, Tillman *et al.* 1996, California Department of Water Resources (DWR) 2002). The effects of the SMSCG on sturgeon are unknown at this time.

2. Water Development

The diversion and storage of natural flows by dams and diversion structures on Central Valley waterways have depleted streamflows and altered the natural cycles by which juvenile and adult salmonids base their migrations. As much as 60 percent of the natural historical inflow to Central Valley watersheds and the Delta has been diverted for human uses. Depleted flows have contributed to higher temperatures, lower DO levels, and decreased recruitment of gravel and large woody debris (LWD). More uniform flows year-round have resulted in diminished natural channel formation, altered foodweb processes, and slower regeneration of riparian vegetation. These stable flow patterns have reduced bedload movement (Mount 1995, Ayers 2001), caused spawning gravels to become embedded, and decreased channel widths due to channel incision, all of which has decreased the available spawning and rearing habitat below dams.

Water diversions for irrigated agriculture, municipal and industrial use, and managed wetlands are found throughout the Central Valley. Hundreds of small and medium-size water diversions exist along the Sacramento River, San Joaquin River, and their tributaries. Although efforts have been made in recent years to screen some of these diversions, many remain unscreened. Depending on the size, location, and season of operation, these unscreened diversions entrain and kill many life stages of aquatic species, including juvenile salmonids. For example, as of 1997, 98.5 percent of the 3,356 diversions included in a Central Valley database were either unscreened or screened insufficiently to prevent fish entrainment (Herren and Kawasaki 2001). Most of the 370 water diversions operating in Suisun Marsh are unscreened (FWS 2003b).

Outmigrant juvenile salmonids in the Delta have been subjected to adverse environmental conditions created by water export operations at the CVP/SWP. Specifically, juvenile salmonid survival has been reduced by the following: (1) water diversion from the mainstem Sacramento River into the Central Delta via the Delta Cross Channel; (2) upstream or reverse flows of water in the lower San Joaquin River and southern Delta waterways; (3) entrainment at the CVP/SWP export facilities and associated problems at Clifton Court Forebay; and, (4) increased exposure to introduced, non-native predators such as striped bass (*Morone saxatilis*), largemouth bass

(*Micropterus salmoides*), and sunfishes (*Centrarchidae* spp.). Entrainment of green sturgeon at the CVP/SWP export facility is known to occur as well.

3. Land Use Activities

Land use activities continue to have large impacts on salmonid habitat in the Central Valley watershed. Until about 150 years ago, the Sacramento River was bordered by up to 500,000 acres of riparian forest, with bands of vegetation extending outward for 4 or 5 miles (California Resources Agency 1989). By 1979, riparian habitat along the Sacramento River diminished to 11,000 to 12,000 acres, or about 2 percent of historic levels (McGill 1987). The degradation and fragmentation of riparian habitat had resulted mainly from flood control and bank protection projects, together with the conversion of riparian land to agriculture. Removal of snags and driftwood in the Sacramento and San Joaquin River basins has reduced sources of LWD needed to form and maintain stream habitat that salmon depend on for various life stages.

Increased sedimentation resulting from agricultural and urban practices within the Central Valley is a primary cause of salmonid habitat degradation (NMFS 1996). Sedimentation can adversely affect salmonids during all freshwater life stages by: clogging or abrading gill surfaces, adhering to eggs, hampering fry emergence (Phillips and Campbell 1961), burying eggs or alevins, scouring and filling in pools and riffles, reducing primary productivity and photosynthesis activity (Cordone and Kelley 1961), and affecting intergravel permeability and DO levels. Excessive sedimentation over time can cause substrates to become embedded, which reduces successful salmonid spawning and egg and fry survival (Waters 1995).

Land use activities associated with road construction, urban development, logging, mining, agriculture, and recreation have significantly altered fish habitat quantity and quality through the alteration of streambank and channel morphology; alteration of ambient water temperatures; degradation of water quality; elimination of spawning and rearing habitat; fragmentation of available habitats; elimination of downstream recruitment of LWD; and, removal of riparian vegetation, resulting in increased streambank erosion (Meehan 1991). Urban stormwater and agricultural runoff may be contaminated with herbicides and pesticides, petroleum products, sediment, *etc.* Agricultural practices in the Central Valley have eliminated large trees and logs and other woody debris that would otherwise be recruited into the stream channel (NMFS 1998). LWD influences stream morphology by affecting channel pattern, position, and geometry, as well as pool formation (Keller and Swanson 1979, Bilby 1984, Robison and Beschta 1990).

Since the 1850s, wetlands reclamation for urban and agricultural development has caused the cumulative loss of 79 and 94 percent of the tidal marsh habitat in the Delta downstream and upstream of Chipps Island, respectively (Conomos *et al.* 1985, Nichols *et al.* 1986, Wright and Phillips 1988, Monroe *et al.* 1992, Goals Project 1999). Prior to 1850, approximately 1400 km^2 of freshwater marsh surrounded the confluence of the Sacramento and San Joaquin Rivers, and another 800 km^2 of saltwater marsh fringed San Francisco Bay's margins. Of the original 2,200 km^2 of tidally influenced marsh, only about 125 km^2 of undiked marsh remains today. In Suisun Marsh, saltwater intrusion and land subsidence gradually has led to the decline of agricultural production. Presently, Suisun Marsh consists largely of tidal sloughs and managed wetlands for

duck clubs, which first were established in the 1870s in western Suisun Marsh (Goals Project 1999).

Dredging of river channels to enhance inland maritime trade and to provide raw material for levee construction has significantly and detrimentally altered the natural hydrology and function of the river systems in the Central Valley.

Juvenile salmonids are exposed to increased water temperatures in the Delta during the late spring and summer due to the loss of riparian shading, and by thermal inputs from municipal, industrial, and agricultural discharges. Studies by DWR on water quality in the Delta over the last 30 years have shown a steady decline in the food sources available for juvenile salmonids and sturgeon and an increase in the clarity of the water due to a decline in the phytoplankton and zooplankton abundance. These conditions have contributed to increased mortality of juvenile Chinook salmon, steelhead, and sturgeon as they move through the Delta.

4. Water Quality

The water quality of the Delta has been negatively impacted over the last 150 years. Increased water temperatures, decreased DO levels, and increased turbidity and contaminant loads have degraded the quality of the aquatic habitat for the rearing and migration of salmonids. The Regional Board, in its 1998 Clean Water Act §303(d) list characterized the Delta as an impaired waterbody having elevated levels of chlorpyrifos, dichlorodiphenyltrichlor (*i.e.* DDT), diazinon, electrical conductivity, Group A pesticides (aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexane (including lindane), endosulfan and toxaphene), mercury, low DO, organic enrichment, and unknown toxicities (Regional Board 1998, 2001).

In general, water degradation or contamination can lead to either acute toxicity, resulting in death when concentrations are sufficiently elevated, or more typically, when concentrations are lower, to chronic or sublethal effects that reduce the physical health of the organism, and lessens its survival over an extended period of time. Mortality may become a secondary effect due to compromised physiology or behavioral changes that lessen the organism's ability to carry out its normal activities. For example, increased levels of heavy metals are detrimental to the health of an organism because they: interfere with metabolic functions by inhibiting key enzyme activity in metabolic pathways; decrease neurological function; degrade cardiovascular output; and act as mutagens, teratogens or carcinogens in exposed organisms (Rand *et al.* 1995, Goyer 1996). For listed species, these effects may occur directly to the listed fish or to its prey base, which reduces the forage base available to the listed species.

Sediments can either act as a sink or as a source of contamination depending on hydrological conditions and the type of habitat the sediment occurs in. Sediment provides habitat for many aquatic organisms and is a major repository for many of the more persistent chemicals that are introduced into the surface waters. In the aquatic environment, most anthropogenic chemicals and waste materials including toxic organic and inorganic chemicals eventually accumulate in sediment (Ingersoll 1995).

Direct exposure to contaminated sediments may cause deleterious effects to listed salmonids or the proposed threatened green sturgeon. This may occur if a fish swims through a plume of the resuspended sediments or rests on contaminated substrate and absorbs the toxic compounds through one of several routes: dermal contact, ingestion, or uptake across the gills. Elevated contaminant levels may be found in localized "hot spots" where discharge occurs or where river currents deposit sediment loads. Sediment contaminant levels can thus be significantly higher than the overlying water column concentrations (EPA 1994). However, the more likely route of exposure to salmonids or sturgeon is through the food chain, when the fish feed on organisms that are contaminated with toxic compounds. Prey species become contaminated either by feeding on the detritus associated with the sediments or dwelling in the sediment itself. Therefore, the degree of exposure to the salmonids depends on their trophic level and the amount of contaminated forage base they consume. Response of salmonids to contaminated sediments is similar to water borne exposures.

5. Hatchery Operations and Practices

Five hatcheries currently produce Chinook salmon in the Central Valley and four of these also produce steelhead. Releasing large numbers of hatchery fish can pose a threat to wild Chinook salmon and steelhead stocks through genetic impacts, competition for food and other resources between hatchery and wild fish, predation of hatchery fish on wild fish, and increased fishing pressure on wild stocks as a result of hatchery production (Waples 1991). The genetic impacts of artificial propagation programs in the Central Valley primarily are caused by straying of hatchery fish and the subsequent interbreeding of hatchery fish with wild fish. In the Central Valley, practices such as transferring eggs between hatcheries and trucking smolts to distant sites for release contribute to elevated straying levels (DOI 1999). For example, Nimbus Hatchery on the American River rears Eel River steelhead stock and releases these fish in the Sacramento River basin. One of the recommendations in the Joint Hatchery Review Report (NMFS and CDFG 2001) was to identify and designate new sources of steelhead brood stock to replace the current Eel River origin brood stock.

Hatchery practices as well as spatial and temporal overlaps of habitat use and spawning activity between spring- and fall-run fish have led to the hybridization and homogenization of some subpopulations (CDFG 1998). As early as the 1960s, Slater (1963) observed that early fall- and spring-run Chinook salmon were competing for spawning sites in the Sacramento River below Keswick Dam, and speculated that the two runs may have hybridized. The FRH spring-run Chinook salmon have been documented as straying throughout the Central Valley for many years (CDFG 1998), and in many cases have been recovered from the spawning grounds of fall-run Chinook salmon, an indication that FRH spring-run Chinook salmon may exhibit fall-run life history characteristics. Although the degree of hybridization has not been comprehensively determined, it is clear that the populations of spring-run Chinook salmon spawning in the Feather River and counted at RBDD contain hybridized fish.

The management of hatcheries, such as Nimbus Hatchery and FRH, can directly impact spring-run Chinook salmon and steelhead populations by oversaturating the natural carrying capacity of the limited habitat available below dams. In the case of the Feather River, significant redd superimposition occurs in-river due to hatchery overproduction and the inability to physically

separate spring- and fall-run Chinook salmon adults. This concurrent spawning has led to hybridization between the spring- and fall-run Chinook salmon in the Feather River. At Nimbus Hatchery, operating Folsom Dam to meet temperature requirements for returning hatchery fall-run Chinook salmon often limits the amount if water available for steelhead spawning and rearing the rest of the year.

The increase in Central Valley hatchery production has reversed the composition of the steelhead population, from 88 percent naturally produced fish in the 1950s (McEwan 2001) to an estimated 23 to 37 percent naturally produced fish currently (Nobriga and Cadrett 2001). The increase in hatchery steelhead production proportionate to the wild population has reduced the viability of the wild steelhead populations, increased the use of out-of-basin stocks for hatchery production, and increased straying (NMFS and CDFG 2001). Thus, the ability of natural populations to successfully reproduce and continue their genetic integrity likely has been diminished.

The relatively low number of spawners needed to sustain a hatchery population can result in high harvest-to-escapements ratios in waters where fishing regulations are set according to hatchery population. This can lead to over-exploitation and reduction in the size of wild populations existing in the same system as hatchery populations due to incidental bycatch (McEwan 2001).

Hatcheries also can have some positive effects on salmonid populations. Artificial propagation has been shown to be effective in bolstering the numbers of naturally spawning fish in the short term under specific scenarios, artificial propagation programs can also aid in conserving genetic resources and guarding against catastrophic loss of naturally-spawned populations at critically low abundance levels, as was the case with the Sacramento River winter-run Chinook salmon population during the 1990s. However, relative abundance is only one component of a viable salmonid population.

6. Commercial and Sport Harvest

a. *Ocean Harvest*

(1) ***Chinook salmon.*** Extensive ocean recreational and commercial troll fisheries for Chinook salmon exist along the Central California coast, and an inland recreational fishery exists in the Central Valley for Chinook salmon and steelhead. Ocean harvest of Central Valley Chinook salmon is estimated using an abundance index, called the Central Valley Index (CVI). The CVI is the ratio of Chinook salmon harvested south of Point Arena (where 85 percent of Central Valley Chinook salmon are caught) to escapement. CWT returns indicate that Sacramento River salmon congregate off the California coast between Point Arena and Morro Bay.

Since 1970, the CVI for winter-run Chinook salmon generally has ranged between 0.50 and 0.80. In 1990, when ocean harvest of winter-run Chinook salmon was first evaluated by NMFS and the Pacific Fisheries Management Council (PFMC), the CVI harvest rate was near the highest recorded level at 0.79. NMFS determined in a 1991 biological opinion that continuance of the 1990 ocean harvest rate would not prevent the recovery of winter-run Chinook salmon. Through the early 1990s, the ocean harvest index was below the 1990 level (*i.e.*, 0.71 in 1991 and 1992, 0.72 in 1993, 0.74 in 1994, 0.78 in 1995, and 0.64 in 1996). In 1996 and 1997, NMFS issued a

biological opinion which concluded that incidental ocean harvest of winter-run Chinook salmon represented a significant source of mortality to the endangered population, even though ocean harvest was not a key factor leading to the decline of the population. As a result of these opinions, measures were developed and implemented by the PFMC, NMFS, and CDFG to reduce ocean harvest by approximately 50 percent.

Ocean fisheries have affected the age structure of spring-run Chinook salmon through targeting large fish for many years and reducing the numbers of 4- and 5-year-old fish (CDFG 1998). There are limited data on spring-run Chinook salmon ocean harvest rates. An analysis of 6 tagged groups of FRH spring-run Chinook salmon by Cramer and Demko (1997) indicated that harvest rates of 3-year-old fish ranged from 18 percent to 22 percent, 4-year-old fish ranged from 57 percent to 84 percent, and 5-year-olds ranged from 97 percent to 100 percent. The almost complete removal of 5-year-olds from the population effectively reduces the age structure of the species, which reduces its resiliency to factors that may impact a particular year class (*e.g.*, prespawning mortality from lethal instream water temperatures).

(2) *Steelhead.* There is essentially no ocean harvest of steelhead.

(3) *Green sturgeon.* Ocean harvest for green sturgeon occurs primarily along the Oregon and Washington coasts and within their coastal estuaries. A commercial fishery for sturgeon still exists within the Columbia River, where they are caught in gill nets along with the more commercially valuable white sturgeon. Green sturgeon are also caught by recreational fisherman, and it is the primary bottomfish landed in Willapa Bay. Within the San Francisco Bay estuary, green sturgeon are captured by sport fisherman targeting the more desirable white sturgeon, particularly in San Pablo and Suisun Bays (Emmett *et al.* 1991).

b. *Freshwater Sport Harvest*

(1) *Chinook salmon.* Historically in California, almost half of the river sportfishing effort was in the Sacramento-San Joaquin River system, particularly upstream from the city of Sacramento (Emmett *et al.* 1991). Since 1987, the Fish and Game Commission has adopted increasingly stringent regulations to reduce and virtually eliminate the in-river sport fishery for winter-run Chinook salmon. Present regulations include a year-round closure to Chinook salmon fishing between Keswick Dam and the Deschutes Road Bridge and a rolling closure to Chinook salmon fishing on the Sacramento River between the Deschutes River Bridge and the Carquinez Bridge. The rolling closure spans the months that migrating adult winter-run Chinook salmon are ascending the Sacramento River to their spawning grounds. These closures have virtually eliminated impacts on winter-run Chinook salmon caused by recreational angling in freshwater.

In 1992, the California Fish and Game Commission adopted gear restrictions (all hooks must be barbless and a maximum of 5.7 cm in length) to minimize hooking injury and mortality of winter-run Chinook salmon caused by trout anglers. That same year, the Commission also adopted regulations which prohibited any salmon from being removed from the water to further reduce the potential for injury and mortality.

In-river recreational fisheries historically have taken spring-run Chinook salmon throughout the species' range. During the summer, holding adult spring-run Chinook salmon are easily targeted by anglers when they congregate in large pools. Poaching also occurs at fish ladders, and other areas where adults congregate; however, the significance of poaching on the adult population is unknown. Specific regulations for the protection of spring-run Chinook salmon in Mill, Deer, Butte, and Big Chico creeks were added to the existing CDFG regulations in 1994. The current regulations, including those developed for winter-run Chinook salmon, provide some level of protection for spring-run fish (CDFG 1998).

(2) *Steelhead*. There is little information on steelhead harvest rates in California. Hallock *et al.* (1961) estimated that harvest rates for Sacramento River steelhead from the 1953-1954 through 1958-1959 seasons ranged from 25.1 percent to 45.6 percent assuming a 20 percent non-return rate of tags. Staley (1975) estimated the harvest rate in the American River during the 1971-1972 and 1973-1974 seasons to be 27 percent. The average annual harvest rate of adult steelhead above RBDD for the 3-year period from 1991-1992 through 1993-1994 was 16 percent (McEwan and Jackson 1996). Since 1998, all hatchery steelhead have been marked with an adipose fin clip allowing anglers to distinguish hatchery and wild steelhead. Current regulations restrict anglers from keeping unmarked steelhead in Central Valley streams (CDFG 2004c). Overall, this regulation has greatly increased protection of naturally produced adult steelhead.

(3) *Green sturgeon.* Green sturgeon are caught incidentally by sport fisherman targeting the more highly desired white sturgeon within the Delta waterways and the Sacramento River. Due to slot limits imposed on the sport fishery by the CDFG, only sturgeon between 46 and 72 inches may be retained by sport fisherman with a daily bag limit of 1 fish in possession. This protects both fish that are sexually immature and have not yet had an opportunity to spawn, and those larger females that have the greatest reproductive value to the population.

7. Predation

Accelerated predation also may be a factor in the decline of winter-run Chinook salmon and spring-run Chinook salmon, and to a lesser degree steelhead. Human-induced habitat changes such as alteration of natural flow regimes and installation of bank revetment and structures such as dams, bridges, water diversions, piers, and wharves often provide conditions that both disorient juvenile salmonids and attract predators (Stevens 1961, Decato 1978, Vogel *et al.* 1988, Garcia 1989).

On the mainstem Sacramento River, high rates of predation are known to occur at the RBDD, Anderson Cottonwood Irrigation District's diversion dam, GCID's diversion dam, areas where rock revetment has replaced natural riverbank vegetation, and at south Delta water diversion structures (*e*.g., Clifton Court Forebay; CDFG 1998). Predation at RBDD on juvenile winter-run Chinook salmon is believed to be higher than normal due to factors such as water quality and flow dynamics associated with the operation of this structure. Due to their small size, early emigrating winter-run Chinook salmon may be very susceptible to predation in Lake Red Bluff when the RBDD gates remain closed in summer and early fall (Vogel *et al.* 1988). In passing the dam, juveniles are subject to conditions which greatly disorient them, making them highly

susceptible to predation by fish or birds. Sacramento pikeminnow (*Ptychocheilus grandis*) and striped bass congregate below the dam and prey on juvenile salmon in the tail waters.

FWS found that more predatory fish were found at rock revetment bank protection sites between Chico Landing and Red Bluff than at sites with naturally eroding banks (Michny and Hampton 1984). From October 1976 to November 1993, CDFG conducted 10 mark/recapture studies at the SWP's Clifton Court Forebay to estimate pre-screen losses using hatchery-reared juvenile Chinook salmon. Pre-screen losses ranged from 69 percent to 99 percent. Predation by striped bass is thought to be the primary cause of the loss (Gingras 1997).

Other locations in the Central Valley where predation is of concern include flood bypasses, post-release sites for salmonids salvaged at the State and Federal fish facilities, and the SMSCG. Predation on salmon by striped bass and pikeminnow at salvage release sites in the Delta and lower Sacramento River has been documented (Orsi 1967, Pickard *et al.* 1982); however, accurate predation rates at these sites are difficult to determine. CDFG conducted predation studies from 1987 to 1993 at the SMSCG to determine if the structure attracts and concentrates predators. The dominant predator species at the SMSCG was striped bass, and the remains of juvenile Chinook salmon were identified in their stomach contents (NMFS 1997).

8. Environmental Variation

Natural changes in the freshwater and marine environments play a major role in salmonid abundance. Recent evidence suggests that marine survival among salmonids fluctuates in response to 20- to 30-year cycles of climatic conditions and ocean productivity (Hare *et al.* 1999, Mantua and Hare 2002). This phenomenon has been referred to as the Pacific Decadal Oscillation. In addition, large-scale climatic regime shifts, such as the El Niño condition, appear to change productivity levels over large expanses of the Pacific Ocean. A further confounding effect is the fluctuation between drought and wet conditions in the basins of the American west. During the first part of the 1990s, much of the Pacific Coast was subject to a series of very dry years, which reduced inflows to watersheds up and down the west coast.

A key factor affecting many West Coast stocks has been a general 30-year decline in ocean productivity. The mechanism whereby stocks are affected is not well understood, partially because the pattern of response to these changing ocean conditions has differed among stocks, presumably due to differences in their ocean timing and distribution. It is presumed that survival in the ocean is driven largely by events occurring between ocean entry and recruitment to a subadult life stage.

Salmon and steelhead are exposed to high rates of natural predation, particularly during freshwater rearing and migration stages. Predation rates on juvenile and adult green sturgeon have not been adequately studied to date. Ocean predation may also contribute to significant natural mortality, although it is not known to what extent. In general, salmonids are prey for pelagic fishes, birds, and marine mammals, including harbor seals, sea lions, and killer whales. There have been recent concerns that the rebound of seal and sea lion populations following their protection under the Marine Mammal Protection Act of 1972 has increased the number of salmonid deaths.

Unusual drought conditions may warrant additional consideration in California. Flows in 2001 were among the lowest flow conditions on record in the Central Valley. The available water in the Sacramento watershed and San Joaquin watershed was 70 percent and 66 percent of normal, according to the Sacramento River Index and the San Joaquin River Index, respectively. Back-to-back drought years could be catastrophic to small populations of listed salmonids that are dependent upon reservoir releases for their success (*e.g.*, Sacramento River winter-run Chinook salmon). Therefore, reservoir carryover storage (usually referred to as end-of-September storage) is a key element in providing adequate reserves to protect salmon and steelhead during extended drought periods. In order to buffer the effect of drought conditions and over allocation of resources, NMFS in the past has recommended that minimum carryover storage be maintained in Shasta and other reservoirs to help alleviate critical flow and temperature conditions in the fall. Green sturgeon's need for appropriate water temperatures would also benefit from river operations that maintain a suitable temperature profile for this species.

The future effects of global warming are of key interest to salmonid and green sturgeon survival. It is predicted that Sierra snow packs will dwindle with global warming and that the majority of runoff in California will be from rainfall in the winter rather than from melting snow pack in the mountains. This will alter river runoff patterns and transform the tributaries that feed the Central Valley from a spring/summer snowmelt dominated system to a winter rain dominated system. It can be rationally hypothesized that summer temperatures and flow levels will become unsuitable for salmonid survival. The cold snowmelt that furnishes the late spring and early summer runoff will be replaced by warmer precipitation runoff. This should truncate the period of time that suitable cold-water conditions exist below existing reservoirs and dams due to the warmer inflow temperatures to the reservoir from rain runoff. Without the necessary cold-water pool developed from melting snow pack filling reservoirs in the spring and early summer, late summer and fall temperatures below reservoirs, such as Lake Shasta, could potentially rise above thermal tolerances for juvenile and adult salmonids (*i.e.,* Sacramento River winter-run Chinook salmon and Central Valley steelhead) that must hold below the dam over the summer and fall periods. Similar, although potentially to a lesser degree, declines in green sturgeon populations are anticipated with reduced cold-water flows. Green sturgeon egg and larval development are optimized at water temperatures that are only slightly higher than those for salmonids. Lethal temperatures are similar to salmonids, although slightly higher than those for salmonids.

9. <u>Ecosystem Restoration</u>

a. *California Bay-Delta Authority*

Two programs included under CALFED; the Ecosystem Restoration Program (ERP) and the EWA, were created to improve conditions for fish, including listed salmonids, in the Central Valley. Restoration actions implemented by the ERP include the installation of fish screens, modification of barriers to improve fish passage, habitat acquisition, and instream habitat restoration. The majority of these actions address key factors affecting listed salmonids and emphasis has been placed in tributary drainages with high potential for steelhead and spring-run Chinook salmon production. Additional ongoing actions include new efforts to enhance fisheries monitoring and directly support salmonid production through hatchery releases. Recent habitat

restoration initiatives sponsored and funded primarily by the CALFED-ERP Program have resulted in plans to restore ecological function to 9,543 acres of shallow-water tidal and marsh habitats within the Delta. Restoration of these areas primarily involves flooding lands previously used for agriculture, thereby creating additional rearing habitat for juvenile salmonids. Similar habitat restoration is imminent adjacent to Suisun Marsh (*i.e.*, at the confluence of Montezuma Slough and the Sacramento River) as part of the Montezuma Wetlands project, which is intended to provide for commercial disposal of material dredged from San Francisco Bay in conjunction with tidal wetland restoration.

A sub-program of the ERP called the Environmental Water Program (EWP) has been established to support ERP projects through enhancement of instream flows that are biologically and ecologically significant. This program is in the development stage and the benefits to listed salmonids are not yet clear. Clear Creek is one of five watersheds in the Central Valley that has been targeted for action during Phase I of the EWP.

The EWA is designed to provide water at critical times to meet ESA requirements and incidental take limits without water supply impacts to other users. In early 2001, the EWA released 290 thousand acre feet of water from San Luis Reservoir at key times to offset reductions in south Delta pumping implemented to protect winter-run Chinook salmon, delta smelt, and splittail. However, the benefit derived by this action to winter-run Chinook salmon in terms of number of fish saved was very small. The anticipated benefits to other Delta fisheries from the use of the EWA water are much higher than those benefits ascribed to listed salmonids by the EWA release.

b. *Central Valley Project Improvement Act*

The CVPIA, implemented in 1992, requires that fish and wildlife get equal consideration with other demands for water allocations derived from the CVP. From this act arose several programs that have benefited listed salmonids: the Anadromous Fish Restoration Program (AFRP), the Anadromous Fish Screen Program (AFSP), and the Water Acquisition Program (WAP). The AFRP is engaged in monitoring, education, and restoration projects geared toward recovery of all anadromous fish species residing in the Central Valley. Restoration projects funded through the AFRP include fish passage, fish screening, riparian easement and land acquisition, development of watershed planning groups, instream and riparian habitat improvement, and gravel replenishment. The AFSP combines Federal funding with State and private funds to prioritize and construct fish screens on major water diversions mainly in the upper Sacramento River. The goal of the WAP is to acquire water supplies to meet the habitat restoration and enhancement goals of the CVPIA and to improve the DOI's ability to meet regulatory water quality requirements. Water has been used successfully to improve fish habitat for spring-run Chinook salmon and steelhead by maintaining or increasing instream flows in Butte and Mill Creeks and the San Joaquin River at critical times.

c. *Iron Mountain Mine Remediation*

EPA's Iron Mountain Mine remediation involves the removal of toxic metals in acidic mine drainage from the Spring Creek Watershed with a state-of-the-art lime neutralization plant.

Contaminant loading into the Sacramento River from Iron Mountain Mine has shown measurable reductions since the early 1990s (see Appendix J, Reclamation 2004). Decreasing the heavy metal contaminants that enter the Sacramento River should increase the survival of salmonid eggs and juveniles. However, during periods of heavy rainfall upstream of the Iron Mountain Mine, Reclamation substantially increases Sacramento River flows in order to dilute heavy metal contaminants being spilled from the Spring Creek debris dam. This rapid change in flows can cause juvenile salmonids to become stranded or isolated in side channels below Keswick Dam.

d. *State Water Project Delta Pumping Plant Fish Protection Agreement (Four-Pumps Agreement)*

The Four-Pumps Agreement Program has approved about $49 million for projects that benefit salmon and steelhead production in the Sacramento-San Joaquin basins and Delta since the agreement inception in 1986. Four-Pumps projects that benefit spring-run Chinook salmon and steelhead include water exchange programs on Mill and Deer Creeks; enhanced law enforcement efforts from San Francisco Bay upstream to the Sacramento and San Joaquin Rivers and their tributaries; design and construction of fish screens and ladders on Butte Creek; and, screening of diversions in Suisun Marsh and San Joaquin tributaries. Predator habitat isolation and removal, and spawning habitat enhancement projects on the San Joaquin tributaries benefit steelhead (see Chapter 15, Reclamation 2004).

The Spring-run Salmon Increased Protection Project provides overtime wages for CDFG wardens to focus on reducing illegal take and illegal water diversions on upper Sacramento River tributaries and adult holding areas, where the fish are vulnerable to poaching. This project covers Mill, Deer, Antelope, Butte, Big Chico, Cottonwood, and Battle Creeks, and has been in effect since 1996. Through the Delta-Bay Enhanced Enforcement Program, initiated in 1994, a team of 10 wardens focus their enforcement efforts on salmon, steelhead, and other species of concern from the San Francisco Bay Estuary upstream into the Sacramento and San Joaquin River basins. These two enhanced enforcement programs have had significant, but unquantified benefits to spring-run Chinook salmon attributed to CDFG (see Chapter 15, Reclamation 2004).

The Mill and Deer Creek Water Exchange projects are designed to provide new wells that enable diverters to bank groundwater in place of stream flow, thus leaving water in the stream during critical migration periods. On Mill Creek several agreements between Los Molinos Mutual Water Company (LMMWC), Orange Cove Irrigation District (OCID), CDFG, and DWR allows DWR to pump groundwater from two wells into the LMMWC canals to pay back LMMWC water rights for surface water released downstream for fish. Although the Mill Creek Water Exchange project was initiated in 1990 and the agreement allows for a well capacity of 25 cubic feet per second (cfs), only 12 cfs has been developed to date (Reclamation and OCID 1999). In addition, it has been determined that a base flow of greater than 25 cfs is needed during the April through June period for upstream passage of adult spring-run Chinook salmon in Mill Creek (Reclamation and OCID 1999). In some years, water diversions from the creek are curtailed by amounts sufficient to provide for passage of upstream migrating adult spring-run Chinook salmon and downstream migrating juvenile steelhead and spring-run Chinook salmon. However, the current arrangement does not ensure adequate flow conditions will be maintained in all years. DWR, CDFG, and FWS have developed the Mill Creek Adaptive Management Enhancement

Plan to address the instream flow issues. A pilot project using 1 of the 10 pumps originally proposed for Deer Creek was tested in summer 2003. Future testing is planned with implementation to follow.

10. Non-native Invasive Species

As currently seen in the San Francisco estuary, non-native invasive species (NIS) can alter the natural food webs that existed prior to their introduction. Perhaps the most significant example is illustrated by the Asiatic freshwater clams *Corbicula fluminea* and *Potamocorbula amurensis*. The arrival of these clams in the estuary disrupted the normal benthic community structure and depressed phytoplankton levels in the estuary due to the highly efficient filter feeding of the introduced clams (Cohen and Moyle 2004). The decline in the levels of phytoplankton reduces the population levels of zooplankton that feed upon them, and hence reduces the forage base available to salmonids transiting the Delta and San Francisco estuary which feed either upon the zooplankton directly or their mature forms. This lack of forage base can adversely impact the health and physiological condition of these salmonids as they emigrate through the Delta region to the Pacific Ocean.

Attempts to control the NIS also can adversely impact the health and well-being of salmonids within the affected water systems. For example, the control programs for the invasive water hyacinth and *Egeria densa* plants in the Delta must balance the toxicity of the herbicides applied to control the plants to the probability of exposure to listed salmonids during herbicide application. In addition, the control of the nuisance plants has certain physical parameters that must be accounted for in the treatment protocols, particularly the decrease in DO resulting from the decomposing vegetable matter left by plants that have died.

11. Summary

Land-use activities such as road construction, urban development, logging, mining, agriculture, and recreation are pervasive and have significantly altered fish habitat quantity and quality for Chinook salmon and steelhead through alteration of streambank and channel morphology; alteration of ambient water temperatures; degradation of water quality; elimination of spawning and rearing habitat; fragmentation of available habitats; elimination of downstream recruitment of LWD; and, removal of riparian vegetation resulting in increased streambank erosion. Human-induced habitat changes, such as: alteration of natural flow regimes; installation of bank revetment; and, building structures such as dams, bridges, water diversions, piers, and wharves, often provide conditions that both disorient juvenile salmonids and attract predators. Harvest activities, ocean productivity, and drought conditions provide added stressors to listed salmonid populations. In contrast, various ecosystem restoration activities have contributed to improved conditions for listed salmonids (*e.g.*, various fish screens). However, some important restoration activities (*e.g.*, Battle Creek) have not yet been initiated. Benefits to listed salmonids from the EWA have been smaller than anticipated.

D. Critical Habitat Condition and Function for Species' Conservation

The freshwater habitat of salmon, steelhead, and sturgeon in the Sacramento River, San Joaquin River, and Suisun Marsh watershed drainages varies in function depending on location. Spawning areas are located in accessible, upstream reaches of the Sacramento or San Joaquin Rivers and their watersheds where viable spawning gravels and water quality are found. Spawning habitat condition is strongly affected by water flow and quality, especially the primary constituent elements (PCEs) of temperature, DO, and silt load, all of which can greatly affect the survival of eggs and larvae. High quality spawning habitat is now inaccessible behind large dams in these watersheds, which limits salmonids to spawning in marginal tailwater habitat below the dams. Despite often intensive management efforts, the existing spawning habitat below dams is highly susceptible to inadequate flows and high temperatures due to competing demands for water, which impairs the habitat function.

Migratory corridors are downstream of the spawning area and include the Delta and Suisun Marsh. These corridors allow the upstream passage of adults and the downstream emigration of juveniles. Migratory habitat conditions are impaired in each of these drainages by the presence of barriers, which can include seasonal dams, unscreened or poorly-screened diversions, inadequate water flows, and degraded water quality.

Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their outmigration. Non-natal, intermittent tributaries also may be used for juvenile rearing by salmonids, but such use has not been documented for sturgeon. Rearing habitat condition is strongly affected by PCEs such as habitat complexity, food supply, and presence of predators of juvenile salmonids and sturgeon. Some complex, productive habitats with floodplains remain in the Sacramento and San Joaquin River systems (*e.g.*, the lower Cosumnes River, Sacramento River reaches with setback levees (*i.e.*, primarily located upstream of the City of Colusa) and the Yolo and Sutter bypasses). However, the channelized, leveed, and riprapped river reaches and sloughs that are common in the Delta and Suisun Marsh systems typically have low habitat complexity, low abundance of food organisms, and offer little protection from either fish or avian predators.

IV. ENVIRONMENTAL BASELINE

A. Factors Affecting the Species and Habitat in the Action Area

Starting in the mid-1800s, the U.S. Army Corps of Engineers (Corps) and other private consortiums began straightening river channels and artificially deepening them to enhance shipping commerce. This has led to declines in the natural meandering of river channels and the formation of pool and riffle segments. The deepening of channels beyond their natural depth also has led to a significant alteration in the transport of bedload in the riverine system as well as the local flow velocity in the channel (Mount 1995). The Sacramento Flood Control Project at the turn of the nineteenth century ushered in the start of large scale Corps actions in the Delta and along the rivers of California for reclamation and flood control. The creation of levees and the Sacramento and San Joaquin deep water ship channels (DWSCs) reduced the natural tendency of the San Joaquin and Sacramento Rivers to create floodplains along their banks with seasonal inundations during the wet winter season and the spring snow melt periods. These

annual inundations provided necessary habitat for rearing and foraging of juvenile native fish that evolved with this flooding process. The armored riprapped levee banks and active maintenance actions of reclamation districts precluded the establishment of ecologically important riparian vegetation, introduction of valuable LWD from these riparian corridors, and the productive intertidal mudflats characteristic of the undisturbed Delta habitat.

Low DO levels frequently are observed in the portion of the DWSC extending from Channel Point, downstream to Turner and Columbia Cuts. Over a 5-year period, starting in August 2000, a DO meter has recorded channel DO levels at Rough and Ready Island (Dock 20 of the Port of Stockton, West Complex). Over the course of this time period, there have been 297 days in which violations of the 5 mg/l DO criteria for the protection of aquatic life in the San Joaquin River between Channel Point and Turner and Columbia Cuts have occurred during the September through May migratory period for salmonids in the San Joaquin River. The data derived from the California Data Exchange Center files indicate that DO depressions occur during all migratory months, with significant events occurring from November through March when listed Central Valley steelhead adults and smolts would be utilizing this portion of the San Joaquin River as a migratory corridor (see Appendix A, Table 6).

Potential factors that contribute to these DO depressions are reduced river flows through the ship channel, released ammonia from the City of Stockton Wastewater Treatment Plant, upstream contributions of organic materials (*e.g.*, algal loads, nutrients, agricultural discharges) and the increased volume of the dredged ship channel. During the winter and early spring emigration period, increased ammonia concentrations in the discharges from the City of Stockton Waste Water Treatment Facility lowers the DO in the adjacent DWSC near the West Complex. In addition to the adverse effects of the lowered DO on salmonid physiology, ammonia is in itself toxic to salmonids at low concentrations. Likewise, adult fish migrating upstream will encounter lowered DO in the DWSC as they move upstream in the fall and early winter due to low flows and excessive algal and nutrient loads coming downstream from the upper San Joaquin River watershed. Levels of DO below 5 mg/L have been reported as delaying or blocking fall-run Chinook salmon in studies conducted by Hallock *et al.* (1970). As the river water and its constituents move downstream from the San Joaquin River channel to the DWSC, the channel depth increases from approximately 8 to 10 feet to over 35 feet. The water column is no longer mixed adequately to prevent DO from decreasing as it is consumed by biotic and abiotic factors. This is due to the increased amount of time the water spends away from the air-water interface where equilibration with atmospheric oxygen can occur. Photosynthesis by suspended algae is diminished by increased turbidity and circulation below the photosynthetic compensation depth. This is the depth to which light penetrates with adequate intensity to carry on photosynthesis in excess of the oxygen demands of cellular respiration. As the oxygen demand from respiration, defined as biological oxygen demand, exceeds the rate at which oxygen can be produced by photosynthesis and mixing, then the level of DO in the water column will decrease. Additional demands on oxygen are also exerted in non-biological chemical reactions in which compounds consume oxygen in an oxidation-reduction reaction.

NMFS completed consultation on the Port of Stockton (Port), West Complex Dredging project on July 19, 2005 (NMFS Project No. 151422SWR2003SA9009;9010JSS; NMFS 2005b). The Port is situated on the San Joaquin River between RM 37.5 and RM 41. The proposed Port of

Stockton, West Complex Dredging project will involve dredging approximately 576,000 cy of material from the waters of the San Joaquin River, adjacent to the Port's wharves at the West Complex. Disposal of this material will occur at the dredge material placement (DMP) site on Roberts Island, which also will be used to facilitate dredge material disposal associated with the project that is the focus of the present consultation. The dredging activities are anticipated to exacerbate the low DO conditions in the DWSC. However, the Port of Stockton, West Complex Dredging project is a part of a much larger action, called the West Complex Redevelopment project as described in the Port's draft EIR for the project (Environmental Science Associates 2003). Interrelated and interdependent activities include upland development of the former naval facilities on Rough and Ready Island with the intent of accommodating larger ships compared to those that currently use the DWSC. This development will result in an approximate doubling of ship traffic in the San Joaquin River. Hence, these activities will affect that portion of the action area for the current project that encompasses the waters adjacent to the Stockton DWSC.

In addition to the adverse effects of dredging and release of effluent from the DMP site, the Port of Stockton, West Complex Dredging project is expected to adversely affect Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead transiting the action area through increased shipping impacts including, but not limited to, propeller entrainment and changes in channel hydrodynamics (*e.g.*, creation of shear forces and turbulent mixing created by vessel passage).

The total incidental take associated with the Port of Stockton, West Complex Dredging project was estimated by NMFS as follows:

Species	Number Juveniles	Percentage of ESU/DPS	Number Adults	Percentage of ESU/DPS
Sacramento River winter-run Chinook salmon	2,500	0.80	0	0
Central Valley spring-run Chinook salmon	5000	0.32	0	0
Central Valley Steelhead	280	0.15	3	0.15

NMFS's biological opinion on the Port of Stockton, West Complex Dredging project (NMFS 2005b) did not assess the project's effects on the southern DPS of North American green sturgeon. However, NMFS (2005b) states the following:

> Recent discussions with CDFG staff have indicated that adult sturgeon have been recovered with obvious propeller scars, some resulting in death, during fish monitoring surveys (Gingras 2005). These incidents occurred immediately following the passage of large ocean going ships in the San Joaquin River channel.

The expected increase in shipping notwithstanding, this statement suggests that the ongoing impact of shipping at present levels likely is adversely affecting listed and proposed species.

B. Presence of Listed Salmonids in the Action Area

The action area for the WHCP includes the entire legal Delta as well as the eastside tributaries feeding the Delta and the San Joaquin River upstream to Friant Dam. All of the listed Central Valley steelhead in the San Joaquin River watershed originating from the Calaveras, Stanislaus, Tuolumne, or Merced Rivers must pass through the Delta on both their downstream emigration to the ocean as smolts and on their upstream spawning migrations as adults. Those few adults that survive to spawn a second time would also pass through this portion of the action area again. Those fish with origins in the Sacramento River watershed must pass through the northern treatment areas of the WHCP in the north Delta on the way to the ocean.

Based on fish monitoring studies, Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead juveniles and smolts from the Sacramento River watershed frequently enter into the San Joaquin River system based on river flows and SWP and CVP pumping rates. Fish from the Sacramento River can access the San Joaquin River from several points, the Delta Cross Channel via the North and South Forks of the Mokelumne River, Georgiana Slough, Three Mile Slough, and the mouth of the San Joaquin River near Antioch and Sherman Island.

C. Presence of North American Green Sturgeon in the Action Area

Both adult and juvenile North American green sturgeon are known to occur within the lower reaches of the San Joaquin River, the south Delta, the waterways of the north Delta and Sacramento River itself within the action area. Juveniles have been captured in the vicinity of Santa Clara Shoals and Brannan Island State Recreation Area, and in the channels of the south Delta (Moyle *et al.* 1992, Beamesderfer *et al.* 2004). Green sturgeon also have been recovered at both the SWP and CVP pumping facilities on Old River near Tracy, indicating that they must have transited through one of the many channels of the south Delta to reach that location. Both adult and juvenile green sturgeon may use the Delta as a migratory, resting, or rearing habitat. Green sturgeon presence in the Delta could occur in any month, as juveniles may reside there during their first few years of growth. Adults are likely to be present in the winter and early spring as they move through the Delta towards their spawning grounds in the upper Sacramento River watershed. Following spawning, the fish will pass through the Delta again on their way back to the ocean, but the duration and timing of this event is not well understood in the Sacramento River system.

V. EFFECTS OF THE ACTION

Pursuant to section 7(a)(2) of the ESA (16 U.S.C. §1536), Federal agencies are directed to ensure that their activities are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. This biological and conference opinion assesses the effects of the USDA-ARS' WHCP on endangered Sacramento River winter-run Chinook salmon, threatened Central Valley spring-run Chinook salmon, threatened Central Valley steelhead, proposed threatened southern DPS of North American green sturgeon, and their designated critical habitats. The proposed action is likely to adversely affect listed salmonids, North American green sturgeon, and their habitat primarily through the

application of herbicides and adjuvants to floating water hyacinth in infested areas, changes in water quality parameters associated with the application of herbicides and the decomposition of the treated plant material, and the collateral alterations of the plant communities in response to the application of herbicides to the non-native invasive water hyacinth. In the *Description of the Proposed Action* section of this opinion, NMFS provided an overview of the action. In the *Status of the Species* and *Environmental Baseline* sections of this opinion, NMFS provided an overview of the threatened and endangered species and critical habitats that are likely to be adversely affected by the activity under consultation.

Regulations that implement section 7(a)(2) of the ESA require that biological opinions evaluate the direct and indirect effects of Federal actions and actions that are interrelated with or interdependent to the Federal action to determine if it would be reasonable to expect them to appreciably reduce listed species' likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution (16 U.S.C. §1536, 50 CFR §402.02).

NMFS generally approaches "jeopardy" analyses in a series of steps. First, NMFS evaluates the available evidence to identify direct and indirect physical, chemical, and biotic effects of the proposed actions on individual members of listed species or aspects of the species' environment (these effects include direct, physical harm or injury to individual members of a species; modifications to something in the species' environment - such as reducing a species' prey base, enhancing populations of predators, altering its spawning substrate, altering its ambient temperature regimes; or adding something novel to a species' environment - such as introducing exotic competitors or a sound). Once NMFS has identified the effects of the action, the available evidence is evaluated to identify a species' probable response, including behavioral reactions, to these effects. These responses then will be assessed to determine if they can reasonably be expected to reduce a species' reproduction, numbers, or distribution (for example, by changing birth, death, immigration, or emigration rates; increasing the age at which individuals reach sexual maturity; decreasing the age at which individuals stop reproducing; among others). The available evidence is then used to determine if these reductions, if there are any, could reasonably be expected to appreciably reduce a species' likelihood of surviving and recovering in the wild.

The regulatory definition of adverse modification has been invalidated by the courts. Until a new definition is adopted, NMFS will evaluate destruction or adverse modification of critical habitat by determining if the action reduces the value of critical habitat for the conservation of the species.

A. Approach to Assessment

1. Information Available for the Assessment

To conduct the assessment, NMFS examined an extensive amount of evidence from a variety of sources. Detailed background information on the status of these species and critical habitat has been published in a number of documents including peer reviewed scientific journals, primary reference materials, governmental and non-governmental reports, scientific meetings, and environmental reports submitted by the project proponents. Additional information investigating

the effects of the project's actions on the listed species in question, their anticipated response to these actions, and the environmental consequences of the actions as a whole was obtained from the aforementioned resources.

2. Assumptions Underlying This Assessment

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

Exposure potential and risk assessment of listed species to herbicides is predicated on having a detailed understanding of the multiple avenues of physiological and behavioral interactions associated with the exposure in the natural environment. Although there is considerable information available concerning the herbicide concentrations required for acute mortality in fish and other aquatic organisms in controlled laboratory settings, specific data concerning listed salmonids and green sturgeon is lacking in most instances, and particularly so for natural systems. Furthermore, studies that are designed to investigate the sublethal effects of herbicide exposure are still rare, and even rarer are studies looking at the effects of herbicide exposure in complicated natural systems, with multiple stressors and contaminants present. In order to account for these unknowns, NMFS must apply the precautionary principle and err on the side of the species when assessing impacts of the project's actions.

B. Assessment

1. Natural History of Water Hyacinth

Water hyacinth is a non-native invasive free-floating aquatic macrophyte belonging to the South American pickerelweed family (*Pontederiacea*). It is considered to be one of the most invasive species worldwide, having been reported in 56 countries worldwide (Holm *et al.* 1977, Gopal and Sharma 1981).

Water hyacinth was first reported in California in a Yolo County slough in 1904 (Prokopovich *et al.* 1985). The plant gradually spread through the Delta and by the late 1970s had covered nearly 1,000 acres and 150 miles of the 700 miles of waterways in the Delta (U.S. Army Corps of Engineers 1985). The spread of water hyacinth in the Delta was probably inhibited by the cool winters and occasional freezes that occur in the Central Valley, which can kill or severely retard growth of the water hyacinth (Holm *et al.* 1977).

Water hyacinth grows in wetlands, marshes, shallow water bodies, slow moving waterways, lakes, reservoirs, and rivers. The plants often form large, thick mats that are monospecific in nature. Mats can reach dimensions that can block waterways and impede navigation, agricultural practices, and pursuit of recreational activities. Dense mats can also serve as breeding grounds for mosquitoes, which can increase the possibility of vector born diseases in surrounding areas (Savage *et al.* 1990, Meyers 1992, Rodriguez *et al.* 1993, and Manguin *et al.* 1996). During high

wind or river flow conditions, small floats of water hyacinth often break off from the larger mats and colonize new areas. Water hyacinths are tolerant of fluctuations in water levels, seasonal flow velocities, and extremes of nutrient availability, pH, toxicants, and temperatures. However, the plants are susceptible to even low levels of salinity, and perish in these environments.

The water hyacinth growth cycle starts in spring when over-wintering plants (old stem bases) initiate new growth by producing daughter plants. The minimum growth temperature is 54 °F, optimal growth temperatures are reached at 77-86 °F and maximum growth temperature is reached at 92-95 °F. The daughter plants increase in number during spring and summer until the maximum biomass is reached in September. When the density of the mats has reached its maximum, individual plants begin to increase in size, crowding out smaller plants. This decreases the overall number of plants in the mats, while still maintaining high biomass. Water hyacinth grows faster than any other tested plant (Wolverton and McDonald 1979) and can double its numbers in as little as 6 days (Mitchell 1976). During late summer and early fall, the plants reach their full bloom. By late fall, the flowers and leaves begin to die back, and by January most of the plants have gone dormant. Water hyacinths are not very tolerant to freezing conditions, and cold climates limit their northern range. Leaves can regrow after moderate freezing, but plants do not survive hard freezes or ice conditions.

2. Problems Associated with Water Hyacinth Infestation

Typically, aquatic vegetation plays an important, beneficial role in the functioning of an aquatic ecosystem. Aquatic vegetation produces oxygen through photosynthesis that leads to an elevation of ambient DO levels in the water column. Macrophytes provide shelter and habitat for invertebrates and juvenile fish whether they are rooted in the substrate or are free floating. Macrophytes also provide substrate for periphyton (algae, fungus, and microflora) to grow on which in turn provides food resources for grazing invertebrates. These invertebrates then provide the basis for the food resources of higher trophic levels, such as fish. Aquatic plants also enhance the cycling of nutrients and minerals in the aquatic ecosystems of which they are part. This is done by incorporating them into the plant tissue, which then serves as a nutritional substrate for herbivores or as a nutrient source for bacteria and fungi during their decay. Native aquatic plants are co-evolved with the other flora and fauna in their ecosystems and thus are in equilibrium with the other components of the ecosystem.

Non-native invasive species are those plants or organisms which have been introduced into an ecosystem in which they have not evolved. These species do not have the checks and balances on their numbers and range that native species have and are likely to adversely affect native species in the invaded ecosystem. Water hyacinth is such a species. The infestation of the Delta with water hyacinth has resulted in several negative impacts on this ecosystem. The increased biomass of water hyacinth has resulted in nighttime depletion of DO through increased levels of plant respiration, particularly during periods of elevated water temperatures. The extensive coverage of water hyacinth mats have excluded numerous species of submerged native plants by shading-out these plants or smothering emergent plants that become surrounded by the mats. Likewise, the extensive mats have created zones of hypoxic or anoxic water conditions due to extensive plant respiration and lack of water-air interface mixing. These conditions have altered the normal assemblages of invertebrate and vertebrate species normally found in ecosystems

without the water hyacinth (Baily and Litterick 1993, Toft 2000, CALFED 2000). Water hyacinths can also lead to abiotic changes in the ecosystem such as accretion of sediment and organic detritus under the mats due to reductions of water flows through the infested sites. Likewise, the ability of the water hyacinth to absorb vast amounts of nutrients and minerals through its extensive root structure can lead to the formation of nutrient sinks in the infested zones. These sinks essentially remove these nutrients from the ecosystem due to the inability of native organisms to feed on the water hyacinth, or survive in the conditions created by the water hyacinth.

3. Physio-chemical Properties of Program Herbicides and Adjuvants

The mode-of-action is the overall manner in which an herbicide affects a plant at the tissue or cellular level. Herbicides can be organized into those which are applied to foliage, and those which are applied almost strictly to soil. The foliar groups are further divided into three categories according to movement through the plant:

- Symplastically translocated (source to sink, capable of downward movement in plant),
- Apoplastcially translocated (capable of upward movement in plant), and
- Those which do not move appreciably and kill very quickly on contact.

Plants are complex organisms with well-defined structures and numerous biochemical processes that are necessary for life. Some of these vital metabolic pathways include photosynthesis, amino acid and protein synthesis, fat synthesis, pigment synthesis, nucleic acid synthesis, oxidative respiration for energy, and maintenance of cellular membrane integrity. Other essential processes include growth and differentiation, mitosis (cell division) in plant meristems, meiosis (sexual gamete production- pollen and seeds), uptake of ions and molecules, translocation of ions and compounds across cellular membranes, and transpiration. One or more of these essential processes must be disrupted in order for an herbicide to kill a plant (Ross and Childs 1996).

Foliar applied herbicides are either downwardly mobile, contact (non-translocated), or upwardly mobile in their mode-of–action. Downwardly mobile herbicides can be further divided into auxin growth regulators (2,4-D), aromatic amino acid synthesis inhibitors (glyphosate), branched chain amino acid inhibitors, chlorophyll/carotenoid pigment inhibitors, or lipid synthesis inhibitors (meristem membranes). Contact herbicides destroy by disrupting the cellular membranes of plants. Diquat belongs to this class of herbicides and functions by producing peroxides and free radicals in the cytoplasm upon exposure to light, which then destroy the lipid membranes of the cells almost immediately. Upwardly mobile herbicides move with the transpiration stream in the plant's xylem from the bottom to the top of the plant. This group of herbicides inhibits the photosynthetic pathways of metabolism. Soil applied herbicides inhibit cellular division in the roots, new shoots or both (Ross and Childs 1996).

Weedar ® 64, a dimethylamine salt formulation of 2,4-Dichlorophenoxyacetic acid (46.8 percent active ingredient) is an auxin growth regulator. This type of herbicide is applied to the foliage of plants, which almost immediately results in a bending and twisting of the leaves and stems. Delayed symptoms include root formation on dicot stems, misshapened leaves, stems, and

flowers and abnormal roots. The amine salt form has been shown to be less toxic to fish than the ester forms of the herbicide, while invertebrates show a higher sensitivity to both the ester and amine forms of the compound than fish. The half-life of Weedar ® in aquatic environments can be short, from several days to several weeks (Extoxnet 2001). Rates of breakdown increase with increased levels of nutrients, sediments, and dissolved organic carbon. Maximum concentrations in surface waters are reached in one day, and then dissipate rapidly, especially in moving water (USDA 2002). Microorganisms readily breakdown 2,4-D along two separate metabolic pathways, metabolizing the compound into either pyruvate or 3-oxo-adipate. These intermediate metabolites serve as precursors to other metabolic pathways in the degrading microorganisms (Hill *et al.* 2002). The manufacturer's Material Safety Data Sheet (MSDS, Rhône-Poulenc) indicates that this product is "for use in ponds, lakes, reservoirs, marshes, bayous, drainage ditches, canals, rivers, and streams that are quiescent or slow moving." It further stipulates that "to avoid fish kills from the decaying plant material consuming oxygen, buffer strips of at least 100 feet wide should be left, and that treatment of these strips should be delayed for 4 to 5 weeks or until the dead vegetation has decomposed". This will be the primary compound used for water hyacinth control by the DBW, accounting for more than 75 percent of chemical usage in the last three years. Concentrations of 2,4-D in the receiving waters shall not exceed 20 μg/L following application.

Rodeo®, an isopropylamine salt formulation of glyphosate (53.8 percent active ingredients) is a non-selective, slow acting systemic herbicide that inhibits aromatic amino acid synthesis. This type of herbicide is sprayed on the foliage due to its rapid degradation by microbes. Symptoms include yellowing of new growth and death of treated plants in days to weeks (Ross and Childs 1996). Glyphosate inhibits an essential enzyme pathway, the shikimic acid pathway. This inhibition prevents plants from synthesizing three key aromatic amino acids, phenylalanine, tyrosine, and tryptophan. These enzymes are essential for the normal growth and survival of most plants. Plants are inefficient at metabolizing glyphosate; therefore, the compound readily disseminates throughout the target plant and provides a more effective herbicide (Hartzler 2001). Animals do not synthesize either phenylalanine or tryptophan, and thus require them in their diets to survive (essential amino acids). Glyphosate rapidly degrades in aquatic systems either by photodegradation (≈28 days) or by microbial degradation into sarcosine or formaldehyde, which then enters the intermediate single carbon metabolism of the bacteria. Glyphosate is also strongly adsorbed to soil particles and suspended particulate matter in the water column, rendering it "biologically unavailable" to most aquatic organisms. Toxicological data indicates that the parent compound, glyphosate, is relatively benign to fish at expected acute field concentrations. Increased toxicity has been shown to occur when the parent compound is mixed with spray adjuvants and the inert portions of the manufacturer's formulation. The manufacture's MSDS (Monsanto) states that the product may be "applied to emergent weeds in all bodies of fresh and brackish water which may include flowing, non-flowing, and transient waters." Rodeo® does not effectively treat plants which are completely submerged or have the majority of their foliage under water. Restrictions also apply to the application of Rodeo® near potable water intakes. As with 2,4-D, hypoxic conditions may be formed in the water column due to excessive weed decay from previous treatments, thereby causing fish to suffocate from a lack of DO. It is recommended that treating the area in strips may avoid this problem. This will be the least used compound for water hyacinth control by the DBW. Concentrations of glyphosate in the receiving waters shall not exceed 700 μg/L following application.

Reward®, which contains 36.4 percent diquat dibromide as an active ingredient, is a "broad spectrum" contact herbicide that destroys lipid membranes and disrupts photosynthetic organelles. Diquat is readily absorbed through the plant cuticle and passes into the cytosol of the plant. It then forms superoxide free radicals that are subsequently converted into hydrogen peroxides by the enzyme superoxide dismutase. The hydrogen peroxide and superoxide anion can attack polyunsaturated lipids present in the cellular membranes to produce lipid hydroperoxides which, in turn, can react with unsaturated lipids to form more lipid free radicals, thereby perpetuating the system (Ecobichon in Klassen 1996). Diquat rapidly adsorbs to soil particles and suspended particles in water. It thus becomes relatively biologically unavailable to most aquatic organisms. Diquat dibromide's half-life is less than 48 hours in the water column, and may be on the order of 160 days in sediments due to its low bioavailability. Microbial degradation or sunlight may play roles in the degradation of the compound. Plants can absorb diquat from the water and concentrate it in the plant's tissues. Thus, low concentrations are effective for controlling aquatic weeds. Diquat is considered slightly toxic to fish and aquatic invertebrates. It has been reported to be less toxic in hard waters. There is little or no bioconcentration of diquat in fish due to its limited absorption from the gastrointestinal tract (Extoxnet 1993, 1996). One research paper indicated that yellow perch (*Perca flavescens*) exhibited respiratory difficulties when herbicide concentrations were similar to those present during aquatic vegetation control programs (Bimber 1976). The manufacturer's MSDS for Reward® (Zeneca) indicates that the herbicide may be applied to aquatic weeds. In public waters, the herbicide may be applied to still, slow-moving, or other quiescent bodies of water and that if warning signs are required by state law they must be posted within the restricted area (1600 feet downstream of the treatment site). Due to the likelihood of hypoxic or anoxic conditions resulting from the decay of dead plant material, the MSDS requires that only one third to one half of the water body be treated at any one time, especially if dense weeds are present, and to wait 24 hours between treatments. Diquat has not been used in the WHCP for the last three seasons (2003 through 2005) although DBW has retained it in its herbicide usage protocol for the next five years as described in the BA for the current consultation (DBW 2005). Concentrations of diquat in the receiving waters shall not exceed 0.5μg/L following application as directed by the current NPDES permit for the WHCP.

4. Effects of Herbicidal Application on Salmonids

The application of herbicides to waters of the Delta and the San Joaquin River Basin under the USDA-ARS' and DBW's WHCP actions from 2006 to 2010 potentially may affect Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and the Central Valley steelhead in both direct and indirect ways.

a. *Dissolved Oxygen Levels*

Juvenile salmonids may be directly affected through the reduction in DO levels resulting from the decomposition of plants killed from the herbicide application. Low DO levels (< 3 mg/L) can result in fish kills if fish are unable to move out of the zone of hypoxic or anoxic waters. Low DO levels are particularly harmful to salmonids, which have a high metabolic requirement for DO (Bjornn and Reiser 1991). Studies have shown that DO levels below 5 mg/L have a

significant negative effect on growth, food conversion efficiency, and swimming performance. High water temperatures, which result in reduced oxygen solubility, can compound the stress on fish caused by marginal DO concentrations (Bjornn and Reiser 1991). Stress from low DO can make juvenile salmonids more susceptible to predation and disease, and less likely to smolt due to insufficient energy reserves. Adult salmonids may experience delayed migration through Delta waters if DO is below concentrations needed for survival. Delay in upstream migration can have a negative impact on the maturation of gonadal tissue, particularly if ambient water temperatures in the Delta are also elevated. Salmonids exposed to elevated temperatures during gonadal maturation have reduced fertility and lower numbers of viable eggs (CALFED 2000). Previous studies have shown that levels of DO under water hyacinth mats can be hypoxic or even anoxic (Bailey and Litterick 1993, Toft 2000) having values that are less than 5 mg/L. Fish exposed to extended dissolved oxygen levels below 5 mg/L are usually compromised in their growth and survival (Piper *et al.* 1982). NMFS expects that fish and mobile invertebrates generally will avoid areas with large mats of water hyacinth due to the decreased ambient levels of DO in the water column. The applications of herbicides are expected to initially decrease DO levels even further in areas treated for the plant. This results from the decomposition of the dead vegetable matter and an increase in biological oxygen demand. This effect is expected to be transitory as the decaying vegetation is dispersed by tidal and river currents from the treatment area. Areas of higher tidal and river current exposure will be flushed faster than areas of low water body exchange, such as dead end sloughs and restricted peripheral channels. Additional parameters affecting the DO levels are the rate of decay for the treated vegetation which is dependent on ambient water temperature and microbial activity. Higher water temperatures should theoretically result in higher microbial activity, thus resulting in a faster decline in the DO levels. However, the duration of the depressed DO levels should be shorter than in a cooler temperature profile due to the vegetative biomass being metabolized at a faster rate. Conversely, a cooler ambient temperature would result in a prolonged DO depression, although perhaps not to the hypoxic levels reached in a warmer water profile.

b. *Narcosis*

Fish, which are exposed to elevated concentrations of polar and non-polar organic compounds, such as the herbicides used in the WHCP, can become narcotized. Narcosis is a generalized non-selective toxicity that is the result of a general disruption of cell membrane function. The process of narcosis is poorly understood, but is thought to involve either a "critical volume" change in cellular membranes due to the toxicant dissolving into the lipid membrane and altering its function, or by the "protein binding" process in which hydrophobic portions of receptor proteins in the lipid membrane are bound by the toxicant molecules, thus changing the receptor protein's function (Rand 1995). Exposure to elevated concentrations of the herbicides would occur in the very upper most portions of the water column, directly beneath the fringe of the water hyacinth mat. A fish with narcosis would be susceptible to predation as a result of a loss of equilibrium, a reduction in swimming ability or a lack of predator avoidance behavior. Furthermore, a fish with narcosis would also have difficulty maintaining its position in the water column, and potentially could be carried by water currents into areas of sub-optimal water quality where conditions may be lethal to salmonids (hypoxic regions underneath water hyacinth mats).

c. *Sublethal Effects on Salmonids*

In contrast to the acute lethality endpoints utilized by the WHCP, nonlethal or sublethal endpoints are more appropriate to the levels of exposure likely to be seen in the herbicide application protocol employed in the program. Sublethal or nonlethal endpoints do not require that mortality be absent; rather it indicates that death is not the primary toxic endpoint being examined. Rand (1995) states that the most common sublethal endpoints in aquatic organisms are behavioral (*e.g.*, swimming, feeding, attraction-avoidance, and predator-prey interactions), physiological (*e.g.*, growth, reproduction, and development), biochemical (*e.g.*, blood enzyme and ion levels), and histological changes. Some sublethal effects may indirectly result in mortality. Changes in certain behaviors, such as swimming or olfactory responses, may diminish the ability of the salmonids to find food or escape from predators and may ultimately result in death. Some sublethal effects may have little or no long-term consequences to the fish because they are rapidly reversible or diminish and cease with time. Individual fish of the same species may exhibit different responses to the same concentration of toxicant. The individual condition of the fish can significantly influence the outcome of the toxicant exposure. Fish with greater energy stores will be better able to survive a temporary decline in foraging ability, or have sufficient metabolic stores to swim to areas with better environmental conditions. Fish that are already stressed are more susceptible to the deleterious effects of contaminants, and may succumb to toxicant levels that are considered sublethal to a healthy fish.

Exposure of fish to the aromatic hydrocarbons typical of many families of pesticides, results in the biotransformation of these compounds by various detoxifying enzyme systems in the fish. Most organic contaminants are lipophilic, a property that makes these compounds readily absorbed across the lipid membranes of the gill, skin, and gastrointestinal tract. Following absorption, compounds that are susceptible to biotransformation are converted to more water soluble metabolites that are easier to excrete than the parent compound. Compounds that are resistant to metabolism are often sequestered in the lipid-rich tissues of the body. Although biotransformation is often considered a positive event in the detoxification of the contaminant, the parent compound of some contaminants are actually less toxic than the metabolites formed. These reactive intermediate metabolites can cause significant problems in other metabolic pathways, including alterations in the synthesis of DNA and RNA, redox cycling of reactive compounds, and induction of enzymatic systems that could lead to altered metabolism of environmentally encountered contaminants (Di Giulo *et al.* in Rand 1995). Within the Delta, mixtures of contaminants, particularly organophosphate pesticides are common. Induction of the biotransforming enzymatic pathways, particularly the P450 monooxygenases, may actually increase the sensitivity of a fish to environmental contaminants. Organophosphate insecticides are often activated by the mono-oxygenase system (Murty 1986, Dr. M.J. Lydy. Southern Illinois University, Carbondale, personal communication 2003), thus the higher the activity of the mono-oxygenase system, the higher the potential for the formation of reactive metabolites.

d. *Indirect Effects*

Indirect effects may result from temporary reductions in primary productivity and invertebrate populations in treated reaches, increased water temperatures in previously shaded habitats, and exposure to predation resulting from a loss of cover as a result of exposure to the chemical

compounds used in the WHCP. Invertebrate populations may be reduced either by direct toxic exposure to herbicides in the water column or indirectly by drifting decaying vegetation smothering the benthic substrate they inhabit. Either avenue would diminish the forage base needed by juvenile salmonids utilizing the Delta as a rearing habitat or within the natal rivers of the San Joaquin Basin where fry and fingerlings are present. Juvenile salmonids would then be forced to enlarge their forage area to successfully ingest the necessary caloric intake for survival. The rate of survival for juvenile salmonids would be a balance between the amounts of metabolic energy expended in swimming during foraging behavior versus the amount of caloric intake achieved from the prey captured during foraging. Caloric intake needs to exceed the metabolic cost of swimming in order for the juvenile fish to have sufficient energy reserves for growth and other metabolic needs. An additional indirect effect is the increase in monitoring for the status of listed fish (*i.e.* delta smelt), where listed fish other than the target species are caught as bycatch in the sampling procedures. This bycatch often results in the loss of the listed salmonids. Finally, operation of the program's vessels in the project area may result in direct and indirect effects due to wake turbulence, sediment resuspension, physical impact with propellers, and discharge of pollutants from the motor's exhaust and lubrication systems.

e. *Beneficial Effects*

Reductions in the percentage of water hyacinth infested waterways theoretically will result in better flows through these waterways, re-establishment of native aquatic vegetation, and recolonization of habitats with native invertebrate species. These changes should result in positive effects on the suitability of the Delta waterways for salmonid rearing and migration. Although these benefits are stated in the DBW BA, definitive data was not given to support this claim and hence must be taken as potential benefits rather than actual benefits.

f. *Potential Extent of Exposure*

The proposed spraying seasons for the WHCP (2006 - 2010) is the 8-month period from April through November in the action area (Delta plus San Joaquin River areas). This treatment period would overlap at least 1 month of adult winter-run Chinook salmon migration through the Delta (22 percent) and at least 2 months of the juvenile winter-run Chinook salmon emigration (29 percent); a majority of the spring-run Chinook salmon adult migration (66 percent) and some juvenile spring-run Chinook salmon emigration (16 percent), 2 months (33 percent) of the juvenile Central Valley steelhead migration through the Delta and 100 percent of the adult Central Valley steelhead emigration. During juvenile out-migration, the winter-run Chinook salmon are at the sub-yearling stage (age zero), spring-run Chinook salmon are at the yearling stage (age 1), and Central Valley steelhead smolts are post-yearlings (age 1.5 – 2 years).

Segments of the North American green sturgeon southern population are expected to be in the waters of the Delta year round. NMFS anticipates that juvenile green sturgeon may be rearing in the channels of the Delta for the first few years of their life before migrating to marine waters as young adults. Adult green sturgeon must transit the Delta in late winter and early spring on their way upstream to spawning grounds in the upper Sacramento River and return through the Delta after spawning is completed in July. The length of time spent in the Delta during these

migrations is unclear at this time, but may span several weeks to months and will likely occur during the eight-month period of the WHCP application season.

5. Toxicity of WHCP Herbicides

Water hyacinth is a floating macrophyte, thus the herbicides are applied by spraying the foliage of the plant above the surface of the water. A conservative estimate of the amount of herbicide entering the water column under normal conditions is approximately 10 to 20 percent of the sprayed volume (Anderson 1982).

a. *Weedar®*

Under the WHCP, Weedar® (2,4-D) will be applied at the rate of 2 to 4 quarts per acre (or 4 pounds equivalent per acre) with an instantaneous concentration of 1,200 to 9,600 parts per million (ppm) from the sprayer unit nozzle (actual concentration of active ingredient is 46.8 percent therefore 560 ppm to 4,800 ppm). Instantaneous field concentrations for the herbicide were calculated by DBW to be 1.50 mg/L to 3.10 mg/L in 1 acre-foot of water, and 150 µg/L to 310 µg/L per 10 acre-feet of water if all of the herbicide were to enter the water and complete mixing were to occur. However, actual field concentrations are likely to be much different. Less than 10 to 20 percent of the herbicide enters the water column from the overlying water hyacinth mat, but mixing is neither instantaneous nor homogenous. In addition, complete mixing will only occur after an appreciable time lag, and herbicide concentrations may be substantially higher in the microzone near the surface of the water directly beneath the treated vegetation.

The typical Weedar® concentrations found in the field are expected to be much less than the expected acute toxicity levels (LC_{50}) for 96-hour exposure studies. The 96-hour LC_{50} for 2,4-D for rainbow trout (*O. mykiss*) ranges from ~100 mg/L (Johnson and Finley 1980) to more than 1000 mg/L (Doe *et al.* 1988). The formulation of 2,4-D has been shown to affect toxicity, with the acid and amine forms considerably less toxic to different species of salmonids than the ester formulations (Meehan *et al.* 1974). The levels of toxicity of 2,4-D have been shown to be affected by ambient environmental pH, with the toxicity of the compound decreasing with increasing pH. This is due to the degree of dissociation of the acidic herbicide (Doe *et al.* 1988). Water hardness has also been implicated as a factor in affecting 2,4-D toxicity to salmonids. Hard water was shown to reduce the toxicity of the 2,4-D to different species of salmonids (Wan *et al.* 1991). Invertebrates have been shown to have differing sensitivities to 2,4-D (George *et al.* 1982, Sarkar 1991, and Abdelghani *et al.* 1997) and are frequently more sensitive to 2,4-D than fish.

Physiological and morphological alterations have been seen in fish exposed to 2,4-D. Common changes seen in physiological parameters are changes in enzyme activity levels (Nešković *et al.*, 1994). Exposure to 2,4-D has also been shown to cause morphological changes in gill epithelium in carp. These changes include lifting of the gill epithelium and clubbing of gill filaments, but are considered non-lethal if the fish is removed to clean water for recovery (Nešković *et al.* 1994). In field conditions this would be equivalent to swimming to an untreated area or the herbicide concentration falling off to negligible levels. Carpenter and Eaton (1983) investigated the metabolism of 2,4-D in rainbow trout after injection, and found that almost 99

percent of the compound is excreted in the urine as unchanged 2,4-D, with a half-life of only 2.4 hours. Less than 1 percent was found in the bile of treated fish, presumably as a conjugated metabolite. Similar results were shown for metabolic studies in channel catfish (*Ictalurus punctatus*) where 2,4-D was administered orally (Plakas *et al.* 1992). The responses described in the references above all occurred at considerably higher exposure concentrations than are expected to be seen in the WHCP applications in the Delta.

NMFS has queried the EPA's toxicology database and has not found any citations for sturgeon exposure to 2,4-D. Therefore, NMFS will assume that green sturgeon will be protected by the most sensitive LC_{50} values found in the database for fish exposures to 2,4-D.

Assuming a worst case situation, using the highest predicted environmental concentration (3.1 mg/L) and the lowest LC_{50} for salmonids (100 mg/L), the ambient environmental concentration of 2,4-D at the time of application is still approximately 32 times lower than the 96-hour LC_{50} for salmonids. Furthermore, the concentration of 2,4-D is expected to decrease through dilution and mixing by local water movement. Weedar® is also readily degraded in aquatic systems; its decomposition is enhanced with increased levels of nutrients, sediment loads, and dissolved organic carbon levels. Under field conditions, Weedar® is expected to have a half-life of several days to several weeks (Extoxnet 2001). The environmental fate characteristics of 2,4-D and the application rates used in the WHCP would indicate that the concentration levels of the herbicide achieved in Delta waters should be significantly below the acute toxicity levels of listed salmonids (and presumably green sturgeon) which would lead to death immediately following herbicide applications.

However, sublethal effects are of concern. As mentioned previously, these are the category of effects that are most likely to occur during this program. Sublethal effects are characterized as those that occur at concentrations that are below those that lead directly to death. Sublethal effects produce less obvious effects on behavior, biochemical and/or physiological functions and the histology of the fish. In addition, potential narcosis in exposed fish can lead to negative effects including increased predation and death as described above. Degradation of critical habitat is expected to occur due to decreases in DO, decreases in the invertebrate standing population which reduces the forage base available to the juvenile salmonids and changes in water quality, particularly ambient water temperature due to a decrease in vegetated cover. In addition, changes in the sensitivities of fish to other contaminants, particularly pesticides and other aromatic hydrocarbons, may increase the mortality of exposed fish. Furthermore, recent medical studies in humans have shown correlations with the usage of herbicides, particularly phenoxy acetic acid herbicides (*e.g.* 2,4- D) to increases in spontaneous abortions (Arbuckle *et al.* 2001) in Ontario farm populations, presence of phenoxy residues in Ontario farmers' sperm (Arbuckle *et al.* 1999), parkinsonism from glyphosate exposure (Barbosa *et al.* 2001), short term decreases in immunological indices in farmers exposed to phenoxy herbicides (Faustini *et al.* 1996) and an increased risk of non-Hodgkin lymphoma from herbicide and pesticide exposures (Lynge 1998, Hardell and Eriksson 1999, McDuffie *et al.* 2001). The epidemiological data for humans exposed to herbicides would indicate that there is sufficient concern to warrant restricted usage of the compounds in aquatic environmental settings until more extensive physiological research is conducted.

b. *Rodeo®*

Under the WHCP, Rodeo® will be applied at the rate of 0.75 to 1.0 gallon of herbicide per 100 gallons of water with an instantaneous concentration of 7,200 to 9,600 ppm from the sprayer unit nozzle (actual concentration of active ingredient is 53.8 percent therefore 3,900 ppm to 5,200 ppm). Instantaneous field concentrations for the herbicide were calculated by DBW to be 2.3 mg/L to 3.10 mg/L in 1 acre-foot of water, and 230 μg/L to 310 μg/L per 10 acre-feet of water if all of the herbicide were to enter the water and complete mixing were to occur. However, actual field concentrations are likely to be different than the theoretical concentrations. DBW believes that only 10 to 20 percent of the herbicide enters the water column after spraying the exposed foliage of the floating water hyacinth mats. The volume of herbicide that does enter the water column will only have complete mixing after an appreciable time lag as water current movements disperse the herbicides within the treatment area. Thus, herbicide concentrations may be substantially higher in the microzone near the surface of the water following the initial movement of the herbicides from the overlying water hyacinth mat into the water body beneath them.

Typical field concentrations of Rodeo® are expected to be less than the acute 96-hour LC_{50} for glyphosate, the active ingredient of the herbicide Rodeo®. However the acute toxicity levels for the formulated mixture found in Rodeo® are higher than that for glyphosate alone. This has been attributed to the addition of surfactants to the mixture. The 96-hour LC_{50} for Rodeo®, calculated as the glyphosate acid for rainbow trout and Chinook salmon ranges from 130 mg/L to 140 mg/l in soft water to 210 mg/L to 290 mg/L in hard water for rainbow trout and Chinook salmon respectively (Mitchell *et al.* 1987a). Wan *et al.* (1989) also found a correlation between water hardness and toxicity for five species of salmonids (coho, chum, Chinook, and pink salmons and rainbow trout [*Oncoryhnchus* spp]). In soft water, Chinook salmon and rainbow trout had similar sensitivities to the herbicide, 19 mg/L to 10 mg/L respectively as glyphosate, and 33 mg/L as Roundup® (a terrestrial formulation of the aquatic herbicide Rodeo® with different surfactants). However in hard water, the LC_{50} for glyphosate was 197 mg/L and 211 mg/L for rainbow trout and Chinook salmon, respectively, considerably less toxic than in soft water. Conversely, the Roundup® formulation was more toxic in hard water, with an LC_{50} equal to 14 mg/l and 17 mg/L for trout and salmon respectively. Folmar *et al.* (1979) found the 96-hour LC_{50} for several different invertebrate and fish species, including rainbow trout. Acute toxicities to rainbow trout were 8.3 mg/L for Roundup® and 140 mg/L for technical glyphosate. The toxicity for the surfactant alone was similar to that of Roundup®, 2.0 mg/L versus 8.3 mg/L for Roundup®.

Folmar *et al.* (1979) also investigated the effects of glyphosate on the reproductive success and behavior of rainbow trout. No significant effects were detected between the control fish and those exposed to the glyphosate in either their gonadal somatic index or fecundity when exposed to 2 mg/L of glyphosate for 12 hours followed by a 30-day recovery period in freshwater. The data found in Folmar *et al.* (1979) indicates that eggs of rainbow trout are less sensitive to the toxicity of Roundup® than other life stages. This is an expected result as the water hardening of the egg's chorion prevents large molecules from crossing into the interior of the egg. After hatching, toxicity increased at the yolk-sac stage and early swim up stages, but decreased in the fingerling stage, as fish grew larger. The values for the 96-hour LC_{50} exposures are as follows:

eyed eggs – 16 mg/L; sac-fry –3.4 mg/L; swim-up fry – 2.4 mg/L; fingerling (1.0 g) - 1.3 mg/L; and fingerling (2.0 g) – 8.3 mg/L. Rainbow trout also did not avoid concentrations of the isopropylamine salt of glyphosate up to 10 mg/L (Folmar 1976, Folmar *et al.* 1979). Morgan *et al.* (1991) found similar reactions of rainbow trout fry exposed to Vision®, a glyphosate based formulation with either 10 percent or 15 percent proprietary surfactant with similar function and use to Roundup®. The nominal concentration that elicited a threshold avoidance reaction from the test fish were 54 ppm for Vision-15 and 150 ppm for Vision-10, roughly two times the LC_{50} for the fish. Threshold effects for alterations in the fish's behavior where observed at 13.5 ppm for Vision-15, and 37.5 ppm for Vision-10 following 24 hours of exposure. These changes were characterized by erratic, gyrating swimming at 24 hours, with the fish eventually becoming moribund at 48 hours.

Physiological studies conducted by Mitchell *et al.* (1987b) on coho salmon showed no apparent adverse effects of exposure of up to 2.3 mg/L of Roundup® in the seawater adaptation of the fish. There were no significant differences in the biochemical and morphological parameters measured in this study between control and treated fish (hematocrit, condition factor, length or weight, or ionoregulatory gill enzymes). Similar findings were made by Janz *et al.* (1991) using the glyphosate herbicide Vision®. Their studies reported that four-hour exposures to sublethal concentrations of Vision did not appear physiologically stressful to juvenile coho salmon, as indicated by secondary stress responses (*i.e.* increased oxygen consumption, plasma glucose and lactate levels, hematocrit and leukocrit). Rainbow trout exposed for two months at concentrations up to 100 g/L of Vision® exhibited no significant effects in foraging behavior, growth, liver tumors, or gill lesions (Morgan and Kiceniuk 1992). However one study did show immunotoxicity to sublethal levels of glyphosate. At concentrations of 2.8 mg/L, El-Gendy *et al.* (1998) showed that exposure for 96-hours could significantly alter lymphocyte proliferation, humoral and cell mediated immunity and protein synthesis in tilapia for up to four weeks after exposure. It should be noted that these responses are rather gross physiological indicators and that few studies have examined cellular or molecular indices of toxicological effects.

NMFS has queried the EPA's toxicology database and has not found any citations for sturgeon exposure to glyphosate based herbicides. Therefore, NMFS will assume that green sturgeon will be protected by the most sensitive LC_{50} values found in the database for fish exposures to glyphosate based herbicides.

Assuming the worst case scenario, the highest instantaneous concentration (3.10 mg/L) and the lowest salmonid LC_{50} for Rodeo® (130 mg/L to 210 mg/L; soft water, hard water), the ambient environmental concentration of Rodeo® at the time of application is still approximately 42 to 68 times lower than the 96-hour LC_{50} for Rodeo® exposure to salmonids. Furthermore, the concentration of glyphosate is expected to decrease due to mixing and dilution in Delta waters after application (but see above also). Glyphosate will also be adsorbed to particulate matter suspended in the water and onto sediments on the bottom of the treated waterways. Bacterial degradation will remove glyphosate from the system and metabolize it to simple carbon compounds. The half-life for glyphosate in aquatic environments is on the order of days to weeks (Extoxnet 2001). The environmental fate characteristics of Rodeo® and the application rates used in the WHCP would indicate that the concentration levels of the herbicide achieved in Delta waters should be significantly below the acutely lethal toxicity levels for listed salmonids

(and presumably green sturgeon) which would lead to death immediately following herbicide applications.

As previously stated for the herbicide 2,4-D, the sublethal effects of glyphosate and the surfactants used to enhance its penetration of the plant cuticle are the most likely toxicological endpoints that will be demonstrated by salmonids and green sturgeon exposed to this herbicide application. The appearance of acute lethality following herbicide application under the WHCP is unlikely, but long term health and behavioral effects can not be ruled out based on the human medical data.

c. *Reward®*

The estimated instantaneous environmental concentration of Reward® at the application rate used in the WHCP (2.8 lbs. per acre) will be approximately 0.37 ppm diquat. The 96-hour LC_{50} for rainbow trout ranges from 11.2 mg/L (Gilderhus 1967) to 21 mg/L (Worthington and Hance 1991). The 8-hour LC_{50} for diquat dibromide is 12.3 mg/L for rainbow trout and 28.5 mg/L for Chinook salmon (Pimental 1971). However, studies by Paul *et al.* (1994) found that diquat was toxic to larval fish as low as 0.74 ppm (96-hour exposure) and would indicate that early life stages may be much more sensitive to diquat than older fish. Folmar's studies (1976) indicated that rainbow trout did not avoid diquat at concentrations up to 10 mg/L (highest concentration tested), nearly the lethal concentration for this species. The concentration of diquat in the Delta waters is expected to decrease rapidly after initial application due to the extensive adsorption of the compound to suspended particulate matter in the water column and sediment on the bottom. The half-life for diquat dibromide can be as little as 48 hours in water (Extoxnet 2001). However, diquat dibromide may persist for longer periods in the bottom sediments. Diquat residues were found 21 days after application in an artificial lake, 1 percent in the water and 19 percent adsorbed to sediments (Extoxnet 2001). Diquat that is adsorbed to particulate matter is purportedly biologically unavailable to aquatic organisms.

Assuming the worst case scenario, using the highest predicted environmental concentration (0.37 ppm) and the most sensitive LC_{50} (0.74 ppm), the instantaneous diquat concentration is still two times lower than the most sensitive LC_{50} values which are for larval fish. The instantaneous concentration is almost 77 times lower than the published LC_{50} values for Chinook and 31 times lower than those for rainbow trout are. The environmental fate characteristics of Reward® and the application rates used in the WHCP would indicate that the concentration levels of the herbicide achieved in Delta waters should be significantly below the acute toxicity levels of listed salmonids.

As mentioned previously, sublethal effects are of concern. Oxidative stress in exposed fish can be expected from the application of diquat dibromide. This reactive compound is subject to redox cycling in which highly reactive oxygen radicals are formed during the regeneration of the parent compound from the reactive intermediate metabolite. Either the reactive intermediate metabolite of the parent diquat compound, or the reactive oxygen radicals can cause deleterious effects on the organism via covalent binding to DNA or proteins thus forming adducts or oxidation of DNA, lipids or proteins within the organism (Schlenk and Di Giulio 2002). The degree to which the stress will manifest itself in the exposed organism depends on the status of

the organisms protective pathways (super oxide dismutase, glutathione reductase and catalase) and their ability to convert the reactive oxygen radicals to less potent forms.

d. *Surfactants*

Surfactants are frequently toxic in their own right. The surfactant R-11 has a 96-hour LC_{50} of 3.8 ppm for rainbow trout, making it considerably more toxic than the glyphosate it is commonly mixed with (Diamond and Durkin 1997). Curran *et al.* (2003) found that R-11 was significantly more toxic to smaller rainbow trout (0.39 g) than it was to larger fish (15.46 g) when the LC_{50} of each size was compared (5.19 ppm v. 6.57 ppm) and that EPA test criterion size (<3g) indicates that differences in fish size may cause differences in the 96-hour LC_{50} as great as 200 percent. Experimental data indicates that the surfactant Agri-Dex is approximately 300 times less toxic than R-11 (3.8 ppm v. >1000 ppm) when their 96-hour LC_{50} values are compared (Diamond and Durkin 1997). Furthermore, the surfactant R-11 has been implicated as causing endocrine disruption in fish and amphibians as one of its constituents is a nonylphenol polyethoxylate (NPE). Nonylphenols are weakly estrogenic, and have been shown to cause endocrine disruption under laboratory conditions at low doses (20 ppb) (United Kingdom Marine Special Areas of Conservation Project 2003). Exposure of male fish to these compounds, nonylphenols and octylphenols, has induced the formation of the lipoprotein vitellogenin (Jobling *et. al.* 1996, Blackburn *et. al.* 1999). Vitellogenin is a lipoprotein normally produced by females and found in the yolk of the eggs. These compounds are lipophilic and have the potential to accumulate in fatty tissues of aquatic organisms. However, the same lipophilic characteristics will also cause the compounds to be absorbed into organic biofilms surrounding particulate matter. These alkylphenols will tend to partition on to particulate matter and, to a large extent, be incorporated into the underlying sediments (Blackburn *et al.* 1999). Chronic toxicity values (No Observed Effects Concentrations) for NPEs and their metabolites have been shown to occur as low as 6 ppb in fish and 3.9 ppb for aquatic invertebrates (Environment Canada 2003). In comparison to the project's herbicides, the surfactant R-11 is more toxic and has a range of effects that present themselves in the low parts per billion concentration range.

As described in the previous sections concerning the herbicides, sublethal effects from the surfactants used in the WHCP may ultimately increase the likelihood of mortality of salmon and steelhead. Sublethal effects are characterized as those that occur at concentrations that are below those that lead directly to death. Sublethal effects may impact the fish's behavior, biochemical, and/or physiological functions, and create histological alterations of the fish's anatomy. In addition, changes in the sensitivities of fish to other contaminants (*i.e.*, chemical synergism), particularly pesticides and other aromatic hydrocarbons, may increase the mortality of exposed fish. Degradation of habitat is expected to occur due to decreases in DO level due to water hyacinth decomposition, decreases in native vegetative cover, decreases in the invertebrate standing population which reduces the forage base available to juvenile salmonids, and changes in ambient water temperature due to changes in the amount of vegetative cover.

e. Bioaccumulation of Herbicides

The high water solubility of Weedar® indicates that the active ingredient (2,4-D) is not likely to bioaccumulate in fish tissues, or undergo maternal transfer into developing ovaries and

associated eggs. Bluegills and channel catfish absorbed only 0.5 percent of radio-labeled 2,4-D during exposures to 2mg/L of the compound in laboratory studies. The amount of 2,4-D absorbed was maximal after 24 hours of exposure, and did not change significantly for the next 7 days. Bluegills administered 2,4-D via intraperitoneal injection, excreted 90 percent of the dose within 6 hours of treatment (Sikka *et al.* 1977). Rainbow trout excrete almost 99 percent of injected 2,4-D in their urine as the unchanged compound, with a half-life of 2.4 hours (Carpenter and Eaton 1983).

There is very low potential for glyphosate (Rodeo®) to bioaccumulate in the tissues of aquatic organisms due to its high water solubility. Furthermore, glyphosate is broken down by microbial actions fairly rapidly, and is subject to photodegradation in the water column. Like Weedar®, Rodeo® strongly adsorbs to particulate matter in the water column and to sediments on the bottom.

There is little bioconcentration of diquat dibromide in fish (Extoxnet 2001). A study on the metabolism and toxicokinetics of diquat dibromide in channel catfish estimated the half-life for diquat to be 35.8 hours (Schultz *et al.* 1995), indicating fairly rapid elimination, and little potential for bioaccumulation.

The nature of salmonid life history in the Delta also diminishes the likelihood of bioaccumulation of the herbicides applied in the WHCP. Listed species of salmonids are transitory in their use of the Delta, residing for only a few weeks to months in the Delta before emigrating to the ocean.

f. Removal of Native Submerged and Emergent Aquatic Vegetation

Native submerged and emergent vegetation may be harmed by the application of herbicides during the WHCP. However, NMFS believes that the harm to native vegetation will be temporary, as new colonizing plants take hold in the treated area. Removal of the thick mats of water hyacinth will allow light penetration to submerged plants in areas previously shaded by these mats. Likewise, the floating mats of water hyacinth will not crowd out emergent plants, which smother and abrade the native plants. Treated areas will also allow the native plants the opportunity to re-colonize these areas without competing with the water hyacinth for space and resources. During periods of juvenile salmonid migration, treated areas may not provide the necessary vegetative cover or food resources needed by the fish. Treatment protocols could possibly magnify this impact as adjacent areas could be treated within 48 hours, thereby increasing the areas devoid of aquatic vegetation or having compromised water quality. NMFS believes that these localized effects will reduce the probability of survival of juveniles emigrating through or rearing in the treatment area. Adjacent untreated acreage could be available to provide shelter and foraging for the juvenile salmonids as they move out of the treated area. However, expenditures of valuable metabolic reserves will have to be utilized for swimming to these new areas, making these reserves unavailable for other physiological needs like growth or smoltification. This shift in the utilization of metabolic energy stores has the potential to decrease the health and hence the survivability of the juvenile salmonid.

g. Declines in the Abundance of Invertebrate Food Resources

The chemical compounds proposed for use in the WHCP should not reach levels toxic to invertebrates if they are applied at the labeled rates. Regions of low DO caused by drifting mats of decaying vegetation or smothering of benthic substrate may cause a localized decrease in populations and diversity of invertebrates. This would temporarily affect salmonid and green sturgeon foraging success in treated areas. Invertebrates have limited ability to migrate out of the treatment area, and thus are more susceptible to the effects of the DO levels. Following treatment, new populations of invertebrates will re-establish themselves through larval re-colonization of the area as soon as habitat conditions are suitable for their growth. Therefore, as a result of the WHCP, portions of the critical habitats for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead will be negatively impacted until water quality is re-established in the treated areas and the native invertebrate species can re-establish themselves in sustainable populations.

VI. CUMULATIVE EFFECTS

For purposes of the ESA, cumulative effects are defined as the effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR §402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultations pursuant to section 7 of the ESA.

Non-Federal actions that may affect the action area include ongoing agricultural activities and increased urbanization. Agricultural practices in the Delta may adversely affect riparian and wetland habitats through upland modifications of the watershed that lead to increased siltation or reductions in water flow in stream channels flowing into the Delta. Unscreened agricultural diversions throughout the Delta entrain fish including juvenile salmonids. Grazing activities from dairy and cattle operations can degrade or reduce suitable critical habitat for listed salmonids by increasing erosion and sedimentation as well as introducing nitrogen, ammonia, and other nutrients into the watershed, which then flow into the receiving waters of the Delta. Stormwater and irrigation discharges related to both agricultural and urban activities contain numerous pesticides and herbicides that may adversely affect salmonid reproductive success and survival rates (Dubrovsky *et al.* 1998, 2000, Daughton 2003).

The Delta and East Bay regions, which include portions of Contra Costa, Alameda, Sacramento, San Joaquin, Solano, Stanislaus, and Yolo Counties, are expected to increase in population by nearly 3 million people by the year 2020 (California Commercial, Industrial, and Residential Real Estate Services Directory 2002). Increases in urbanization and housing developments can impact habitat by altering watershed characteristics, and changing both water use and stormwater runoff patterns. The project site is within the region controlled by San Joaquin County Council of Governments, and the cities of Brentwood, Antioch, Oakley, Lathrop, Modesto, Turlock, Merced, Fresno, and Sacramento. The General Plans for the cities of Stockton, Brentwood, Antioch, Oakley and their surrounding communities anticipate rapid growth for several decades to come, as do the other more established communities. The anticipated growth will occur along both the I-5 and US-99 transit corridors in the east, and Highway 4 in the west.

Increased urbanization also is expected to result in increased wave action and propeller wash in Delta waterways due to increased recreational boating activity. This potentially will degrade riparian and wetland habitat by eroding channel banks and mid-channel islands, thereby causing an increase in siltation and turbidity. Wakes and propeller wash also churn up benthic sediments thereby potentially resuspending contaminated sediments and degrading areas of submerged vegetation. This in turn would reduce habitat quality for the invertebrate forage base required for the survival of juvenile salmonids. Increased recreational boat operation in the Delta is anticipated to result in more contamination from the operation of engines on powered craft entering the water bodies of the Delta. In addition to recreational boating, commercial vessel traffic is expected to increase with the redevelopment plans of the Port. Portions of this redevelopment plan have already been analyzed by NMFS for the West Complex (formerly Rough and Ready Island) but the redevelopment of the East Complex, which currently does not have a Federal action associated with it, will also increase vessel traffic as the Port becomes more modernized. Commercial vessel traffic is expected to create substantial entrainment of aquatic organisms through ship propellers as the vessels transit the shipping channel from Suisun Bay to the Port and back again. In addition, the hydrodynamics of the vessel traffic in the confines of the channel will create sediment resuspension, and localized zones of high turbulence and shear forces. These physical effects are expected to adversely affect aquatic organisms, including both listed salmonids and North American green sturgeon resulting in death or injury.

VII. INTEGRATION AND SYNTHESIS

The degree to which Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead may be impacted by the WHCP is a function of their presence within the action area. The proposed period of implementation of the WHCP is from April 1 through November 30, which will overlap with more than half of the migration periods for the two Chinook salmon listed ESUs and the Central Valley steelhead DPS. The period of greatest overlap with the presence of listed juvenile salmonids in the Delta is during the higher flow periods of spring (*e.g.*, from April through June) and fall (*e.g.*, October 1 through November 30). North American green sturgeon are anticipated to be year round residents within the Delta portion of the action area and therefore will be present for the entire application season in the Delta region (April through October 15). The upstream reaches of the San Joaquin River from Mossdale to Hills Ferry are expected to potentially have listed Central Valley steelhead present during the April through June period, based on water temperature profiles and emigration patterns. The upper reaches of the Tuolumne and Merced Rivers above their confluences with the San Joaquin River but below the first impassable barrier (La Grange Dam or Merced Falls Dam respectively) may have juvenile Central Valley steelhead present year round based on the cooler temperatures available below the dams and the life history of steelhead. However, water conditions that favor steelhead residency (*i.e.* faster flows and cooler water temperatures) do not favor water hyacinth infestations. Infestations in these reaches are typically off channel sloughs or isolated water bodies set off from the main channel by receding water levels.

Based on the foregoing analysis, NMFS anticipates that applications of Reward®, Weedar®, or Rodeo® to the waters of the Delta and its tributaries during the WHCP treatment seasons in an

effort to control water hyacinth will not result in acute lethal effects to listed salmonids, unless fish are present in the immediate area during or immediately after the herbicide is applied. Nonetheless, there is a potential for loss of a certain fraction of the migrating population that is exposed to the toxicants. Although fish should not be present in the cores of water hyacinth mats, they may be present along the periphery of the mats, utilizing them for cover from overhead predators. Thus, fish may be exposed to lethal or sublethal concentrations of herbicides that are applied to the margins of the mat or to herbicides present in the water column directly below the mat or flowing out of the area of application.

The most important impacts of the WHCP are expected to occur to juvenile salmonids and green sturgeon, and include sublethal effects and effects to habitat. As stated in Rand (1995), sublethal effects to listed salmonids can be expected to take the form of behavioral, physiological, biochemical, or histological changes in the exposed fish. These changes may not be immediately lethal, but can cause fish to exhibit impaired behaviors (*e.g.*, narcosis) or eventually develop a lesser level of physical health, thus reducing their chances of survival as compared to unexposed fish. Possible consequences include loss of equilibrium, reduced swimming ability, and impaired predator avoidance behavior, which could lead to increased predation risk or reduced foraging ability. Chemical synergism between the WHCP herbicides and other contaminants in the Delta could occur and exacerbate these effects.

The WHCP is expected to result in several temporary degraded habitat conditions. These are expected to include physical disturbance, elevation of water temperature caused by reduced shading, reduction of DO levels resulting from decaying water hyacinth, reduction in the invertebrate forage base for juvenile salmonids and green sturgeon, and reduction of native vegetation which juvenile salmonids may utilize for cover. Even though juvenile salmonids should be able to leave or avoid areas of degraded habitat, they may need to expend valuable metabolic energy to do so. This could result in depleted energy stores that could have been used for other physiological needs, such as growth or smoltification.

As stated previously in the project description, the WHCP proposes to treat 367 possible sites for water hyacinth infestation (see Table 3). These sites range between one to two miles in length. Treatment sites are located throughout the Delta, including portions of the Sacramento River, Steamboat Slough, and Sutter Slough, as well as most of the San Joaquin River watershed between the first dam on each tributary and its confluence downstream with the mainstem of the San Joaquin River and then north along the mainstem of the river to the Delta. Over the last 3 years approximately 2,500 acres were treated annually. The geographical coverage of the WHCP overlaps with the known migration corridors for all three listed salmonids as well as the fall/late fall run of Chinook salmon in the Central Valley. However, DBW has a limited number of spray boats (*i.e.*, in 2002, four full time and three part time crews and boats were used) that can be active on any given weekday. Therefore, only a fraction of the 367 sites can be treated in any given day, and not all sites treated may be within areas expected to support salmonids. Each crew is capable of treating at a maximum 50 acres per a day if conditions are optimal and they work overtime. However, due to environmental and logistical constraints, the treatment acreage is frequently less. In addition to the low number and area of coverage of daily sites for the treatment program, only the waters near the periphery of the water hyacinth mat will have elevated herbicide concentrations capable of having toxicological effects on the fish. Even

though the interior of the mat will have similar elevated concentrations of herbicides following treatment, it is unlikely that any salmonids will be present within the interior due to its low ambient DO levels. Therefore the total area of Delta waters likely to have negative effects on fish during the period of elevated concentrations is far smaller than 50 acres on any given treatment day. As a result, NMFS reasons that very few listed salmonids will be present within areas of toxicological effect. The duration of elevated herbicidal concentrations in the peripheral waters will depend on the rate of mixing that occurs and the subsequent dilution of the herbicide applied to the mat as well as other physical conditions such as adsorption to suspended matter in the water column and water hardness. The dilution of applied herbicides will occur over a period of minutes to hours, dependent on current velocity, tidal stage, and local water quality. These parameters will invariably change on both a spatial and temporal scale in the described action area. Therefore, NMFS expects that areas with elevated herbicide concentrations will be both small and transient in nature, resulting in low levels of exposure to salmonids migrating through the action area and transitory impacts on critical habitat. Degraded habitat conditions eventually will be attenuated as DO levels increase and invertebrates recolonize treated areas. In addition, the removal of water hyacinth eventually may improve habitat conditions for juvenile salmonids if water flow improves and native vegetation colonizes the treated areas, creating shaded habitat. Similarly, it is not anticipated that individual green sturgeons will congregate in application areas in high enough numbers to represent a significant proportion of the population, but rather will be dispersed throughout the channels of the Delta.

NMFS, in previous consultations with DBW and the USDA-ARS, has given guidance for avoidance of listed fish based on temporal and spatial parameters. NMFS has concluded that certain sections of the project area can be treated with minimal potential for exposing listed salmonids and the proposed green sturgeon starting as early as April 1 of the treatment season. These early start dates allow boat crews from DBW to start control measures early in the water hyacinth's growth cycle. The sections that were chosen by NMFS for early start dates have habitats that are unsuitable for salmonids either due to a lack of circulation (eastside sloughs) or physical barriers to prevent salmonid migration into the application area (South Delta region between temporary barriers after the installation of the Head of Old River Barrier). Early applications in the San Joaquin River watershed are based on hydrologic connections between off channel sloughs and ponds and the main channel and the ambient water temperatures in the system. When there is a lack of hydrologic connection between the off channel water bodies and the main water channel, then NMFS believes that any hyporheic flow between the two bodies will be insufficient to carry herbicides between the two water bodies through the gravel and underlying substrate. When water temperatures have become sufficiently elevated to preclude the presence of listed salmonids (greater than 70 °F for seven consecutive days and after May 15) then herbicide treatments may be applied in the main channels of the San Joaquin River and its tributaries. DBW has incorporated these guidelines into its application protocol as described in the project description (see section II (C)(5) of this biological opinion).

While there will be negative impacts to a proportion of the listed salmonid populations that are within the immediate vicinity of a herbicidal application at the moment of application or immediately following it, the exact proportion of each ESU affected by the application is difficult to determine since the density of migrating fish and the timing of migration can vary annually and within seasons based on a myriad of factors. However, as discussed above, only a

small segment of each listed salmonid race is expected to be actually exposed to concentrations sufficiently elevated to have a negative impact on the individual fish. Effects of primary concern are sublethal, as few or no fish are likely to be directly killed during herbicide application. Sublethal effects such as behavioral changes (*e.g.*, swimming, feeding, attraction, avoidance, and predator-prey interactions), physiological changes (*e.g.*, growth, reproduction, and development), biochemical changes (*e.g.*, blood enzyme and ion levels), and histological changes (*e.g.*, degenerative necrosis of the liver, kidneys, and gill lamellae) are expected in the fish that are exposed to areas of elevated herbicide and surfactant concentrations. However, based on the low likelihood of fish exposure to these levels and the small numbers of salmonids likely affected, this level of impact is not expected to detectably reduce the numbers, reproduction, or distribution of the cohorts affected during each year of treatment. Likewise, green sturgeon are not anticipated to spend any length of time in the localized areas of herbicide applications for water hyacinth control. Green sturgeon are expected to rear primarily in the deeper channels and holes of the Delta with transient foraging movements onto the shallow flats during favorable tides. As previously stated, NMFS could not find any data on herbicide exposure to sturgeon species in the EPA database. Therefore, NMFS will assume that the sturgeon will be no more sensitive than the most sensitive fish species available in the database and based on the current analysis would not show signs of acute toxicity from the herbicide concentrations present in the WHCP.

Critical habitat for Sacramento River winter-run Chinook salmon in the project area is not expected to be adversely modified. The majority of the critical habitat in the project area for this ESU is in the Sacramento River, Steamboat, Cache, and Sutter Sloughs. Although some treatment areas will be in the Sacramento River side of the Delta, WHCP operations will be primarily to the south of these waterways in the central and south Delta regions as well as in the San Joaquin River watershed. Critical habitat for the Central Valley spring-run Chinook salmon ESU includes waterways in the central Delta (North Fork Mokelumne River and Georgiana Slough) and waterways in the northern portion of the Delta. The critical habitat for the Central Valley steelhead DPS includes all waters of the Delta that are accessible to anadromous fish, and habitat below the high water line (*i.e.* tidal flats, commonly inundated riparian zones, *etc.*). Critical habitats for Sacramento River winter-run and Central Valley spring-run Chinook salmon and Central Valley steelhead are not expected to be permanently affected in an adverse manner, but rather on a temporary basis following herbicide treatment. The degraded habitat conditions eventually will be attenuated as DO levels increase and invertebrates recolonize treated areas. The removal of water hyacinth eventually may improve habitat conditions for juvenile salmonids if water flow improves and native vegetation colonizes the treated areas, creating shaded habitat and diverse foraging opportunities for juvenile salmon. Therefore, the EDCP is not expected to appreciably reduce the conservation value of designated critical habitat for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, or Central Valley steelhead. No critical habitat has been proposed for green sturgeon at this time.

VIII. CONCLUSION

A. Formal Consultation

After reviewing the best available scientific and commercial information, the current status of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead, the environmental baseline, the effects of the proposed WHCP, and the cumulative effects, it is NMFS' biological opinion that the WHCP, as proposed, is not likely to jeopardize the continued existence of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, or Central Valley steelhead, or result in the destruction or adverse modification of the designated critical habitat for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, or Central Valley steelhead.

B. Conference Consultation

After reviewing the best available scientific and commercial information, the current status of the southern DPS of North American green sturgeon, the environmental baseline, the effects of the proposed WHCP, and the cumulative effects, it is NMFS' biological opinion that the WHCP, as proposed, is not likely to jeopardize the continued existence of the southern DPS of North American green sturgeon.

IX. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS as an act which kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this incidental take statement (ITS).

The measures described below are non-discretionary and must be undertaken by the USDA-ARS so that they become binding conditions of any grant or permit issued to DBW or their agents, as appropriate, for the exemption in section 7(o)(2) to apply. The USDA-ARS has a continuing duty to regulate the activity covered in this ITS. If the USDA-ARS: (1) fails to assume and implement the terms and conditions of the ITS; and/or (2) fails to require the DBW or its agents to adhere to the terms and conditions of the ITS through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the USDA-ARS and its agents must report the progress of the action and its impact on the species to NMFS as specified in this ITS (50 CFR §402.14[i][3]).

While some measures described below are expected and intended to avoid, minimize, or monitor the take of North American green sturgeon, the prohibitions against taking of listed species in section 9 of the ESA do not apply to proposed North American green sturgeon unless and until

the species is listed. However, NMFS advises the USDA-ARS to consider implementing the following reasonable and prudent measures for proposed North American green sturgeon. If this conference opinion for North American green sturgeon is adopted as a biological opinion following a listing, the measures for North American green sturgeon, with their implementing terms and conditions, will be nondiscretionary.

A. Amount or Extent of Take

NMFS anticipates that the proposed WHCP will result in the incidental take of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and North American green sturgeon.

The incidental take is expected to be in the form of death, injury, harassment, and harm from sources such as herbicide exposure, behavioral modifications, increased susceptibility to contaminants in the aquatic system, and depleted DO. Direct take of salmonids from the DBW's activities (*e.g.*, exposure to herbicide applications) is expected to occur primarily to listed salmonids and only during the months of April and May, when listed salmonids are most likely to be present in the Delta. Take from extended changes to the action area (*e.g.*, reductions in forage base species and changes in plant communities) are expected to affect listed salmonids from November 1 through May 31, which includes the entire period when individuals from one or more of the listed ESUs or DPSs may be expected to occur in the action area.

North American green sturgeon are known to spawn only in the Sacramento River drainage. Therefore, NMFS assumes that adverse effects to green sturgeon are most likely to occur in the lowermost portions of the Sacramento and San Joaquin River channels during the application season. Green sturgeon are expected to occur in the action area year-round, although it is anticipated that the highest densities will occur from April through October. Therefore, take from project activities is most likely to occur from April through October during the proposed work window. The occupation of benthic habitat by green sturgeon is expected to increase their vulnerability to water quality changes due to decaying vegetation as compared to listed salmonids.

The numbers of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and North American green sturgeon taken will be difficult to quantify because dead, injured, or impaired individuals will be difficult to detect and recover. Take is expected to include:

1. All Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead fry and juveniles, as well as all North American green sturgeon killed from exposure to lethal and sublethal concentrations of diquat, glyphosate, 2,4-D or surfactants applied to waters of the Delta and the San Joaquin River basins.

2. All Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead fry and juveniles, as well as all North American green sturgeon harmed, harassed, or killed from altered habitat conditions, increased

predation levels, and reductions in health as a result of chemical herbicide exposure or activities resulting from the implementation of the WHCP.

B. Effect of the Take

In the accompanying biological and conference opinion, NMFS determined that the level of anticipated take will not result in jeopardy to the species or destruction or adverse modification of designated or proposed critical habitat.

C. Reasonable and Prudent Measures

Reasonable and Prudent Measures (RPMs) are non-discretionary measures to minimize take that may or may not already be part of the description of the proposed action. They must be implemented as binding conditions for the exemption in section 7(o)(2) to apply. The USDA-ARS has the continuing duty to regulate the activities covered in this incidental take statement. If the USDA-ARS fails to adhere to the terms and conditions of the incidental take statement, or fails to retain the oversight of its contractor(s) to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

NMFS believes that the following RPMs are necessary and appropriate to minimize take of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead resulting from implementation of the action. These reasonable and prudent measures would also minimize adverse effects on designated critical habitat for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead. Implementation of these actions will also serve to avoid or minimize adverse effects upon North American green sturgeon, should they be eventually listed, by the actions of the WHCP.

1. Measures shall be taken to reduce impacts to juvenile Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and North American green sturgeon from chemical control treatment and/or monitoring activities.

2. Measures shall be taken to reduce the impact of DBW's WHCP boating operations on Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central valley steelhead, and North American green sturgeon.

3. Measures shall be taken by DBW to monitor the operations of the WHCP and the ambient Delta hydrologic conditions.

4. Pending the listing of the southern population of North American green sturgeon, the USDA-ARS and their agents will implement additional measures to avoid, minimize, and monitor incidental take of North American green sturgeon from the actions of the WHCP.

D. Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, the USDA-ARS must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. **Measures shall be taken to reduce impacts to juvenile Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and North American green sturgeon from chemical control treatment and/or monitoring activities.**

   a. Restrictions to the timing and places of herbicide applications shall comply with the guidelines indicated in the project description for the WHCP as presented in section II (C)(5) of this biological opinion.

   b. Any winter-run Chinook salmon, spring-run Chinook salmon, and steelhead trout mortalities found at or in the vicinity of a treatment site (*i.e.*, within 400 meters) shall be collected, fork length measured and the body placed in a whirl-pak bag. The bag will be labeled with the time, date, location of capture, and a description of the near-shore habitat type and water conditions and frozen. NMFS, Sacramento office shall be notified as soon as possible of any mortalities at 916-930-3600 and a representative of NMFS will collect the frozen specimen.

   c. DBW staff and their assigned agents must follow all Federal and State laws applicable to the use of the herbicides and any adjuvants and apply them in a manner consistent with the product labeling, the current NPDES General Permit if granted, the Description of the Proposed Action, and determinations from the California Department of Pesticide Regulation.

   d. The use of the adjuvant R-11 shall be reduced to minimize its toxic effects on aquatic organisms where practicable. The less toxic adjuvant, Agri-Dex, shall be used in its place. R-11 may be used in the following defined areas during the appropriate application windows. Within the sites on the San Joaquin River south of the intersection of Merced, Madera, and Fresno Counties (sites 900 to 929), R-11 may be used as an adjuvant between June 1 and October 15. Within the Stone Lakes/Beach Lakes area (sites 221-239), R-11 may be used as an adjuvant between June 1 and October 15. R-11 may not be used as an adjuvant elsewhere in the WHCP application areas.

   e. Fish passage shall not be blocked within treatment areas. Protocols shall be followed to ensure that WHCP operations do not inhibit passage of fish in each area scheduled for treatment or exceed limitations on contiguous treated acreage.

   f. The DBW will provide a copy of each week's Notice of Intent to Jeffrey Stuart, Fishery Biologist, Protected Resources Division, 650 Capitol Mall, Suite 8-300, Sacramento, CA 95814, by the Friday prior to the treatment week. This

notification will include the sites scheduled for treatment and a contact person for those sites.

g. Jeffrey Stuart will be the appointed NMFS representative on the Water Hyacinth Task Force (Task Force), and provide technical assistance to the Task Force along with carrying out the duties of a Task Force member. As part of the WHCP Task Force, the NMFS representative will be active in guiding decisions on prioritizing treatment sites in regards to the presence of salmonids.

2. **Measures shall be taken to reduce the impact of DBW's WHCP boating operations on the designated critical habitat of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead.**

a. USDA-ARS and DBW shall comply with the receiving water limitations of the General Permit issued for the WHCP in regards to oils, greases, waxes, floating material, or suspended material derived from the operation of program vessels or application activities.

b. The USDA-ARS and DBW shall ensure that any mixing of chemicals, or disinfecting and cleaning of any equipment shall be done in strict accordance with the operational protocols of the WHCP and that all equipment is in working order prior to engaging in application activities, including the operation of the program's vessels.

c. Operation of program vessels in shallow water habitats shall be done in a manner that causes the least amount of disturbance to the habitat. Operational procedures for vessels in these habitats should minimize boat wakes and propeller wash.

d. Operation of program vessels shall avoid or minimize to the greatest practicable extent dislodging portions of existing water hyacinth mats that can drift into other areas. This will avoid or minimize new infestations of the weed due to drifting fragments.

3. **Measures shall be taken by DBW to monitor the operations of the WHCP and the ambient Delta hydrologic conditions.**

a. The USDA-ARS shall ensure that the DBW follows a comprehensive monitoring plan designed to collect project operational information. The monitoring plan shall adhere to the requirements of the General Permit and have at a minimum those water quality criteria stated in Attachment B of the permit, *i.e.* data on water temperatures, DO, pH, turbidity, water hardness, electrical conductivity, and chemical concentrations in the application areas as well as other criteria stated in the attachment. Chemical concentrations (including both herbicides and adjuvants) shall have at a minimum, a pre- and post-application water sample taken at the furthest down current site of the application zone. Additional tests, if required by other Federal and State agencies, shall be conducted and the

information made available to NMFS. The results of this monitoring program will be used to determine if the DBW is affecting Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, or Central Valley steelhead to an extent not previously considered.

b. The USDA-ARS, in coordination with the DBW, shall provide bimonthly (*i.e.*, every other month) monitoring reports of the hydrologic conditions and the amounts of chemical discharges to Jeffrey Stuart, NMFS, Sacramento Field Office. These reports shall also include information on the following parameters:

i. Pre-treatment and post-treatment measurements on chemical residues, pH and turbidity levels as well as water temperatures and DO concentrations at selected sites in the Delta. These sites shall be reflective of the different water types found in the range of application sites and will be determined by DBW as part of their NPDES permit conditions.

ii. Receiving water temperatures and DO levels and resultant changes in those conditions resulting from WHCP operations during each month.

iii. Amounts, types, and dates of application of herbicides and adjuvants applied at each site.

iv. Visual assessment of pre- and post-treatment conditions of treated sites to determine the efficacy of treatment and any effects of chemical drift on downstream habitats immediately adjacent to the treated sites.

v. Operational status of equipment and vessels, including repairs and spraying equipment calibrations as needed.

c. The USDA-ARS, in coordination with the DBW, shall summarize the above bimonthly reports into an annual report of the DBW project operations, monitoring measurements and Delta hydrological conditions for the previous treatment year for submission to NMFS by January 31 of each year. The annual report of DBW operations shall also include:

i. A description of the total number of winter-run and spring-run chinook salmon or steelhead observed taken, the manner of take, and the dates and locations of take, the condition of the Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, or Central Valley steelhead taken, the disposition of fish taken in the event of mortality and a brief narrative of the circumstances surrounding the take of the fish. This report shall be sent to the address given below.

ii. Listed salmonids or other fish species that are observed to be behaving in an erratic manner shall be reported (see Appendix A).

d. All bimonthly reports and the annual report shall be submitted by mail or Fax to:

NMFS Sacramento Field Office
Attn: Supervisor
650 Capitol Mall, Suite 8-300
Sacramento, California 95814
Fax: (916)930-3629

4. **Pending the listing of the southern population of North American green sturgeon, the USDA-ARS and their agents will implement additional measures to avoid, minimize, and monitor incidental take of North American green sturgeon from the actions of the WHCP.**

a. The USDA-ARS will monitor the take of green sturgeon, and record such information for their reports to NMFS required under term and condition 3(C), above.

b. If necessary, USDA-ARS and DBW will coordinate with NMFS to alter herbicide application plans to avoid or minimize take of green sturgeon if field observations indicate that take is occurring.

X. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on a listed species or critical habitat or regarding the development of pertinent information.

1. The USDA-ARS and DBW should support anadromous salmonid monitoring programs throughout the Delta to improve the understanding of migration and habitat utilization by salmonids in the Delta region.

2. The USDA-ARS and DBW should support and promote aquatic and riparian habitat restoration within the Delta region, and encourage practices that avoid or minimize negative impacts to salmon and steelhead.

3. NMFS recommends that the USDA-ARS encourage alternate non-chemical controls of water hyacinth and other non-native invasive vegetation in the Delta and its tributaries, in conjunction with a re-vegetation program with native plants in the Delta.

4. NMFS recommends that the USDA-ARS and DBW increase public awareness of the potential threats to proper ecosystem function by exotic species introductions such as water hyacinth.

5. NMFS recommends that the USDA-ARS and DBW pro-actively promote state legislation that takes steps to curb the importation and marketing of water hyacinth, and prevent future exotic species introductions into the state.

In order for NMFS to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, NMFS requests notification of the implementation of any conservation recommendations.

XI. REINITIATION OF CONSULTATION

This concludes formal consultation on the actions outlined in the November 14, 2005 BA from the USDA-ARS and the DBW. This biological opinion is valid for the project described for the years 2006 through 2010. As provided for in 50 CFR§402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of taking specified in any incidental take statement is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the agency action is subsequently modified in a manner that causes an affect to the listed species that was not considered in the biological opinion; or, (4) a new species is listed or critical habitat is designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, formal consultation shall be reinitiated immediately.

XII. REFERENCES

Abdelghani, A.A., Tchounwou, P.B., A.C. Anderson, H. Sujono, L.R. Heyer, and A. Monkiedje. 1997. Toxicity of single and chemical mixtures of Roundup, Garlon-3A, 2,4-D and Syndets Surfactant to channel catfish (*Ictalurus punctatus*), bluegill Sunfish (*Lepomis macrochirus*), and crawfish (*Procambarus spp.*). Environmental Toxicology and Water Quality 12: 237-243.

Adams, P.B., C.B. Grimes, J.E. Hightower, S.T. Lindley, and M.L. Moser. 2002. Status review for North American green sturgeon, *Acipenser medirostris*. National Marine Fisheries Service, Southwest Fisheries Science Center, Santa Cruz, California. 49 pages.

Alderdice, D.F., and F.P.J. Velsen. 1978. Relation between temperature and incubation time for eggs of Chinook salmon (*Oncorhynchus tshawytscha*). Journal of the Fisheries Research Board of Canada 35(1):69-75.

Allen, M.A., and T.J. Hassler. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates. (Pacific Southwest), Chinook salmon. U.S. Fish and Wildlife Report 82 (11.49). April 1986.

Anderson, L.W.J. 1982. Experimental application of 2,4-D Dichlorophenoxy acetic acid (2,4-D) for the control of water hyacinth in the delta. United States Dept. of Agriculture, Agricultural Research Service. Davis, California. 17 pages.

Arbuckle, T.E., S.M. Schrader, D. Cole, J.C. Hall, C.M. Bancej, L.A. Turner, and P. Claman. 1999. 2,4-Dichlorophenoxyacetic acid residues in semen of Ontario farmers. Reproductive Toxicology Nov-Dec 13(6): 421-429.

Arbuckle, T.E., Z. Lin, and L.S. Mery. 2001. An exploratory analysis of the effect of pesticide exposure on the risk of spontaneous abortion in an Ontario farm population. Environmental Health Perspectives Aug 109(8): 851-857.

Ayers and Associates. 2001. Two-dimensional modeling and analysis of spawning bed mobilization, lower American River. Prepared for the U.S. Army Corps of Engineers, Sacramento District Office.

Bailey, R.G. and M.R. Litterick. 1993. The Macroinvertebrate fauna of water hyacinth fringes in the Sudd swamps (River Nile, southern Sudan). Hydrobiologia 250:97-103.

Barbosa, E.R., M.D. Leiros da Costa, L.A. Bacheschi, M. Scaff, and C.C. Leite. 2001. Parkonsonism after glycine-derivative exposure. Movement Disorders 16(3):565-568.

Barnhart, R.A. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest), steelhead. U.S. Fish and Wildlife Service, Biological Report 82 (11.60). 21 pages.

California Department of Fish and Game. 2003. Memorandum to Madelyn Martinez (NMFS) regarding steelhead populations in the San Joaquin River basin. 4 pages.

California Department of Fish and Game. 2004a. Sacramento River winter-run Chinook salmon 2002-2003 biennial report. Prepared for the California Fish and Game Commission. Habitat Conservation Division, Native Anadromous Fish and Watershed Branch. Sacramento, 22 pages.

California Department of Fish and Game. 2004b. Sacramento River spring-run Chinook salmon 2002-2003 biennial report. Prepared for the California Fish and Game Commission. Habitat Conservation Division, Native Anadromous Fish and Watershed Branch. Sacramento, 35 pages.

California Department of Fish and Game. 2004c. Freshwater Sport Fishing Regulations 2004-2006. California Fish and Commission and Department of Fish and Game, Sacramento, California, 64 pages.

California Department of Water Resources. 2002. Suisun Marsh Salinity Control Gates salmon passage evaluation report. Environmental Services Office, Sacramento, 19 pages.

California Regional Water Quality Control Board-Central Valley Region. 1998. Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins, fourth edition. Available: http://www.swrcb.ca.gov/~CRWQCB5/home.html

California Regional Water Quality Control Board-Central Valley Region. 2001. Draft staff report on recommended changes to California's Clean Water Act, section 303(d) list. Available: http://www.swrcb.ca.gov/CRWQCB5/tmdl/

California Resources Agency. 1989. Upper Sacramento River fisheries and riparian management plan. Prepared by an Advisory Council established by SB1086, authored by State Senator Jim Nielson. 157 pages.

Calkins, R.D., W.F. Durand, and W.H. Rich. 1940. Report of the Board of Consultants on the fish problem of the upper Sacramento River. Stanford University, Stanford, CA, 34 pages.

Carpenter, L.A. and D.L. Eaton. 1983. The disposition of 2, 4-Dichlorophenoxy acetic acid in rainbow trout. Archives of Environental Contamination and Toxicology 12:169-173.

Chambers, J. 1956. Fish passage development and evaluation program. Progress Report No. 5. U.S. Army Corps of Engineers, North Pacific Division, Portland, OR.

Chapman, D.W., and T.C. Bjornn. 1969. Distribution of salmon in streams, with special reference to food and feeding. *In* T. G. Northcote (editor), Symposium on salmon and trout in streams, pages 153-176. University of British Columbia, Institute of Fisheries, Vancouver.

Clark, G.H. 1929. Sacramento-San Joaquin salmon (*Oncorhynchus tshawytscha*) fishery of California. Calif. Div. of Fish and Game, Fish Bull. No.17:73.

Cohen, A.N., and P.B. Moyle. 2004. Summary of data and analyses indicating that exotic species have impaired the beneficial uses of certain California waters: a report submitted to the State Water Resources Control Board on June 14, 2004. 25 pages.

Conomos, T.J., R.E. Smith, and J.W. Gartner. 1985. Environmental settings of San Francisco Bay. Hydrobiologia 129: 1-12.

Cordone, A.J., and D.W. Kelley. 1961. The influences of inorganic sediment on the aquatic life of streams. California Fish and Game 47:89-228.

Cramer, S.P. 2005. Stanislaus River rotary screw trap monitoring data. Available at: http://spcramer.com/spcramer.html

Cramer, S.P., and D.B. Demko. 1997. The status of late-fall and spring Chinook salmon in the Sacramento River Basin regarding the Endangered Species Act. S.P. Cramer and Associates. Gresham, OR.

Curran, C.A., J.M Grassley, and C.E. Grue. 2003. Toxicity of R-11 Surfactant to juvenile rainbow trout: does size matter? Program and abstracts: 12th Annual Meeting of the Pacific Northwest Chapter of the Society of Experimental Toxicology and Chemistry (PNW-Setac).

Daughton, C.G. 2003. Cradle-to-cradle stewardship of drugs for minimizing their environmental disposition while promoting human health. I. Rationale for and avenue toward a green pharmacy. Environmental Health Perspectives 111:757-774.

Decato, R.J. 1978. Evaluation of the Glenn-Colusa Irrigation District fish screen. California Department of Fish and Game, Anadromous Fisheries Branch Administrative Report No. 78-20.

Demko, D.B., C. Gemperle, A. Phillips, and S.P. Cramer. 2000. Outmigrant trapping of juvenile salmonids in the lower Stanislaus River, Caswell State Park site, 1999. Prepared for U.S. Fish and Wildlife Service. Prepared by S.P. Cramer and Associates, Inc. Gresham, OR. 146 pages plus appendices.

Deng, X., J.P. Van Eenennaam, and S.I. Doroshov. 2002. Comparison of early life stages and growth of green sturgeon and white sturgeon. Pages 237-248 *in* W. Van Winkle, P.J. Anders, D.H. Secor, and D.A. Dixon, editors. Biology, management, and protection of North American sturgeon. American Fisheries Society, Symposium 28, Bethesda, Maryland.

Diamond, G.L. and P.R. Durkin. 1997. Effects of surfactants on the toxicity of glyphosate, with specific reference to Rodeo. Prepared by Syracuse Environmental Research Associates for the Animal and Plant Health Inspection Service (APHIS). Report Number SERA TR 97-206-1b.

Di Giulo, R.T., W.H. Benson, B..M. Sanders, and P.A. Van Veld. 1995. Biochemical Mechanisms: Metabolism, Adaptation, and Toxicity Rand, G.M. (editor): Fundamentals of Aquatic Toxicology: Effects, Environmental Fate, and Risk Assessment, Second Edition. Taylor and Francis, 1995. pages 523-560.

Doe, K.G., W.R. Ernst, W.R. Parker, G.R. Julien, and P.A. Hennigar. 1988. Influence of pH on the acute sublethality of fenitrothion, 2,4-D, and aminocarb and some ph-altered sublethal effects of aminocarb on rainbow trout (*Salmo gairdneri*). Canadian Journal of Fisheries and Aquatic Sciences 45: 287-293.

Dubrovsky, N.M., C.R. Kratzer, L.R. Brown, J.M. Gronberg, and K.R. Burow. 2000. Water quality in the San Joaquin-Tulare basins, California, 1992-95. U.S. Geological Survey Circular 1159.

Dubrovsky, N.M., D.L. Knifong, P.D. Dileanis, L.R. Brown, J.T. May, V. Connor, and C.N. Alpers. 1998. Water quality in the Sacramento River basin. U.S. Geological Survey Circular 1215.

Dunford, W.E. 1975. Space and food utilization by salmonids in marsh habitats in the Fraser River Estuary. M.S. Thesis. University of British Colombia, Vancouver, B.C., 81 pages.

Ecobichon, D.J. 1996. Toxic effects of Pesticides *In*: Casarett & Doull's Toxicology: The Basic Science of Poisons, Fifth Edition. Curtiss D. Klassen, editor. McGraw Hill. New York. Pp. 643-690.

Edwards, G.W., K.A.F. Urquhart, and T.L. Tillman. 1996. Adult salmon migration monitoring, Suisun Marsh Salinity Control Gates, September-November 1994. Technical Report 50. Interagency Ecological Program for the San Francisco Bay/Delta Estuary, 27 pages.

El-Gendy, K.S., N.M. Aly, and A.H. El-Sebae. 1998. Effects of edifenphos and glyphosate on the immune response and protein biosynthesis of boltifish (*Tilapia nilotica*). Journal of Environmental Sciences and Health B 33(2): 135-149.

Emmett, R.L., S.L. Stone, S.A. Hinton, and M.E. Monaco. 1991. Distribution and abundance of fishes and invertebrates in West coast estuaries, Volume II: Species life history summaries. ELMR Report No. 8. NOAA/NOS Strategic Environmental Assessments Division, Rockville, MD, 329 pages.

Environmental Science Associates. November, 2003. Draft Environmental Impact Report: Port of Stockton, West Complex Development Plan. Volumes 1 and 2. Environmental Science Associates, Sacramento, CA.

Environment Canada. 2003. Priority substances Assessment Program, existing substances evaluation. Assessment Report – Nonylphenol and its ethoxylates. Available at: http://www.ec.gc.ca/substances/ese/eng/psap/final/npe.cfm

Erickson, D.L., J.A. North, J.E. Hightower, J. Weber, L. Lauck. 2002. Movement and habitat use of green sturgeon *Acipenser medirostris* in the Rogue River, Oregon, USA. Journal of Applied Ichthyology 18:565-569.

Everest, F.H. 1973. Ecology and management of summer steelhead in the Rogue River. Oregon State Game Commission. Fishery Research Report 7. 48 pages.

Extoxnet. 1993. Extension Toxicology Network, Toxicology Briefs. A Pesticide Information Profile of the Cooperative Extension Offices of Cornell University, Oregon State University, University of Idaho, University of California, Davis and the Institute for Environmental Toxicology at the University of Michigan. Found at **http://pmep.cce.cornell.edu/profiles/extoxnet/dienchlor-glyphosate/diquat-ext.html**

Extoxnet. 1996. Extension Toxicology Network, Toxicology Briefs. A Pesticide Information Profile of the Cooperative Extension Offices of Cornell University, Oregon State University, University of Idaho, University of California, Davis and the Institute for Environmental Toxicology at the University of Michigan. Found at **http://ace.orst.edu/info/extoxnet/pips/diquatdi.html**.

Extoxnet. 2001. Extension Toxicology Network, Toxicology Briefs. A Pesticide Information Profile of the Cooperative Extension Offices of Cornell University, Oregon State University, University of Idaho, University of California, Davis and the Institute for Environmental Toxicology at the University of Michigan. Found at: http://pmep.cce.cornell.edu/profiles/extoxnet/dienchlor-glyphosate/diquat-ex.html.

Faustini, A. L. Settimi, R. Pacifici, V. Fano, P. Zuccaro, and F. Forastiere. 1996. Immunological changes among farmers exposed to phenoxy herbicides: preliminary observations. *Occup. Environ. Med.* Sept. 53(9): 583-585.

Fisher, F.W. 1994. Past and present status of Central Valley Chinook salmon. Conservation Biology 8:870-873.

Folmar, L.C. 1976. Overt avoidance of rainbow trout fry to nine herbicides. Bulletin of Environmental Contamination and Toxicology 15(5): 509-514.

Folmar, L.C., H.O. Sanders, and A.M. Julin. 1979. Toxicity of the herbicide glyphosate and several of its formulations to fish and aquatic invertebrates. Archives of Environmental Contamination and Toxicology 8:279-278.

Fry, D.H. 1961. King salmon spawning stocks of the California Central Valley, 1940-1959. California Fish and Game 47:55-71.

Gadomski, D.M. and M.J. Parsely. 2005. Effects of turbidity, light level, and cover on predation of white sturgeon larvae by prickly sculpins. Transactions of the American Fisheries Society 134:369-374.

Garcia, A. 1989. The impacts of squawfish predation on juvenile Chinook salmon at Red Bluff Diversion Dam and other locations in the Sacramento River. U.S. Fish and Wildlife Service Report No. AFF/FAO-89-05.

George, J.P., H.G. Hingorani, and K.S. Rao. 1982. Herbicide toxicity to fish food organisms. Environmental Pollution (Series. A) 28: 183-188.

Gilderhus, P.A. 1967. Effects of Diquat on bluegills and their food organisms. Progressive Fish Culturist 29(2): 67-74.

Gingras, M. 1997. Mark/recapture experiments at Clifton Court Forebay to estimate pre-screen loss of juvenile fishes: 1976-1993. Interagency Ecological Program Technical Report No. 55.

Goals Project. 1999. Baylands ecosystem habitat goals: A report of habitat recommendations prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. U.S. Environmental Protection Agency, San Francisco. San Francisco Bay Regional Water Quality Control Board, Oakland, CA.

Good, T.P., R.S. Waples, and P. Adams (editors). 2005. Updated status of federally listed ESU of West Coast salmon and steelhead. U.S. Department of Commerce, NOAA Technical Memo. NMFS-NWFSC-66, 598 p.

Gopal, B. and K.P. Sharma, 1981. Water-Hyacinth (*Eichhornia crassippes*): the most troublesome weed in the world. Hindasia publishers, Delhi, India.

Goyer, R.A. 1996. Toxic effects of metals. *In* C.D. Klassen (editor), Casarett & Doull's toxicology: the basic science of poisons, fifth edition, pages 691-736. McGraw Hill. New York, NY.

Hallock, R.J. 1989. Upper Sacramento River steelhead (*Oncorhynchus mykiss)* 1952-1988. Prepared for the U.S. Fish and Wildlife Service. California Department of Fish and Game, Sacramento, CA.

Hallock, R.J., and F.W. Fisher. 1985. Status of winter-run Chinook salmon, *Oncorhynchus tshawytscha*, in the Sacramento River. Report to the California Department of Fish and Game, Anadromous Fisheries Branch, Sacramento, CA.

Hallock, R.J., R.F. Elwell, and D.H. Fry, Jr. 1970. Migrations of adult king salmon, *Oncorhynchus tshawytscha*, in the San Joaquin Delta. California Fish and Game 151. Sacramento. 92 p.

Hallock, R.J., W.F. Van Woert, and L. Shapavalov. 1961. An evaluation of stocking hatchery-reared steelhead rainbow trout (*Salmo gairdneri gairdneri*) in the Sacramento River system. California Fish and Game 114:73.

Hardell, L. and M. Eriksson. 1999. A case-control study of non-Hodgkin lymphoma and exposure to pesticides. *Cancer* March 15 85(6): 1353-1360.

Hare, S.R., N.J. Mantua, and R.C. Frances. 1999. Inverse production regimes: Alaska and west coast Pacific salmon. Fisheries 24(1):6-14.

Hartzler, R. 2001. Glyphosate –A Review. Iowa State University, Extension Agronomy. Found at **http://www.weeds.edu/mgmt/2001/glyphosate%20review.html**.

Healey, M.C. 1980. Utilization of the Nanaimo River estuary by juvenile Chinook salmon *(Oncorhynchus tshawytscha)*. Fishery Bulletin 77:653-668.

Healey, M.C. 1982. Juvenile Pacific salmon in estuaries: the life support system. *In* V.S. Kennedy (editor), Estuarine Comparisons, pages 315-341. Academic Press. New York, N.Y.

Healey, M.C. 1991. Life history of Chinook salmon. *In* C. Groot and L. Margolis (editors), Pacific Salmon Life Histories, pages 213-393. Univ. of British Columbia Press, Vancouver, British Columbia.

Herren, J.R., and S.S. Kawasaki. 2001. Inventory of water diversions in four geographic areas in California's Central Valley. *In* R.L. Brown (editor), Contributions to the Biology of Central Valley Salmonids, Volume 2, Pages 343-355. California Fish and Game, Fish Bulletin 179.

Hill, B., E. Young, and D.J. Oh. 2002. 2,4-Dichlorophenoxyacetic Acid Degradation Pathway Map. University of Minnesota.
Found at http://umbbd.ahc.umn.edu/2,4-d/2,4-d_map.html.

Holm, L.G., D.L. Plucket, J.V. Pancho, and J.P. Herberger, 1977. The World's worst weeds; Distribution and biology. Honolulu, University Press of Hawaii.

Ingersoll, C.G. 1995. Sediment tests. *In* G.M. Rand (editor), Fundamentals of aquatic toxicology: effects, environmental fate, and risk assessment, second edition, pages 231-255. Taylor and Francis, Bristol, Pennsylvania.

Interagency Ecological Program Steelhead Project Work Team. 1999. Monitoring, assessment, and research on Central Valley steelhead: Status of knowledge, review existing programs, and assessment needs. In Comprehensive Monitoring, Assessment, and Research Program Plan, Technical Appendices VII-11.

Janz, D.M., A.P. Farrell, J.D. Morgan, and G.A. Vigers. 1991. Acute stress responses of juvenile coho salmon (*Oncorhynchus kisutch)* to sublethal concentrations of Garlon 4®, garlon 3A® and Vision® herbicides. Environmental Toxicology and Chemistry 10: 81-90.

Jobling, S., D. Sheahan, J.A. Osborne, P. Matthiessen, and J.P. Sumpter. 1996. Inhibition of testicular growth in rainbow trout (*Oncorhynchus mykiss*) exposed to estrogenic akylphenolic chemicals. *Environmental Toxicology and Chemistry*. 15:1993-2002.

Johnson, W.W. and M.T. Finely. 1980. Handbook of Acute toxicity of Chemicals to Fish and Aquatic Invertebrates, Resource Publications 137. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. 10-38.

Keller, E.A., and F.J. Swanson. 1979. Effects of large organic material on channel form and fluvial processes. Earth Surface Processes 4:361-380.

Kjelson, M.A., P.F. Raquel, and F.W. Fisher. 1981. Influences of freshwater inflow on Chinook salmon (*Oncorhynchus tshawytscha*) in the Sacramento-San Joaquin Estuary. *In* R.D. Cross and D.L. Williams (editors), Proceedings of the National Symposium on Freshwater Inflow to Estuaries, pages 88-108. U.S. Fish and Wildlife Service, FWS/OBS-81-04.

Kjelson, M.A., P.F. Raquel, and F.W. Fisher. 1982. Life history of fall-run juvenile Chinook salmon (*Oncorhynchus tshawytscha*) in the Sacramento-San Joaquin estuary, California. *In* V.S. Kennedy (editor), Estuarine comparisons, pages 393-411. Academic Press, New York, NY.

Kynard, B., E. Parker, and T. Parker. 2005. Behavior of early life intervals of Klamath River green sturgeon, *Acipenser medirostris*, with note on body color. Environmental Biology of Fishes 72:85-97.

Levings, C.D. 1982. Short term use of low-tide refugia in a sand flat by juvenile chinook, (*Oncorhynchus tshawytscha*), Fraser River estuary. Canadian Technical Reports of Fisheries and Aquatic Sciences, Number 1111. 7 pages.

Levings, C.D., C.D. McAllister, and B.D. Chang. 1986. Differential use of the Campbell River estuary, British Columbia, by wild and hatchery-reared juvenile Chinook salmon (*Oncorhynchus tshawytscha*). Canadian Journal of Fisheries and Aquatic Sciences 43:1386-1397.

Levy, D.A., and T.G. Northcote. 1982. Juvenile salmon residency in a marsh area of the Fraser River estuary. Canadian Journal of Fisheries and Aquatic Sciences 39:270-276.

Lindley, S.T., R. Schick, B.P. May, J.J. Anderson, S. Greene, C. Hanson, A. Low, D. McEwan, R.B. MacFarlane, C. Swanson, and J.G. Williams. 2004. Population structure of threatened and endangered Chinook salmon ESU in California's Central Valley basin. Public review draft. NMFS Southwest Science Center. Santa Cruz, CA.

Lynge, E. 1998. Cancer incidence in Danish phenoxy herbicide workers, 1947-1993. *Environ. Health. Perspect.* Apr 106 Suppl. 2:683-686.

MacFarlane, B.R., and E.C. Norton. 2002. Physiological ecology of juvenile Chinook salmon at the southern end of their distribution, the San Francisco Estuary and Gulf of Farallones, California. California Department of Fish and Game, Fish Bulletin 100:244-257.

Manguin, S., D.R. Roberts, R.G. Andre, E. Rejmankova, and S. Hakre, (1996). Characterization of *Anopheles darlingi* (Diptera: Culicidae) Larval Habitats in Belize, Central America. Journal of Medical Entomology 33(2): 205-211.

Mantua, N.J., and S.R. Hare. 2002. The Pacific decadal oscillation. Journal of Oceanography. 58:35-44.

Martin, C.D., P.D. Gaines, and R.R. Johnson. 2001. Estimating the abundance of Sacramento River juvenile winter Chinook salmon with comparisons to adult escapement. Red Bluff Research Pumping Plant Report Series, Volume 5. U.S. Fish and Wildlife Service. Red Bluff, CA.

Maslin, P., M Lennox, and W. McKinney. 1997. Intermittent streams as rearing habitat for Sacramento River Chinook salmon (*Oncorhynchus tshawytscha*). California State University, Chico, Department of Biological Sciences. 89 pages.

Matthews, K.R. and N.H. Berg. 1997. Rainbow trout responses to water temperature and dissolved oxygen stress in two southern California stream pools. Journal of Fish Biology. 50:50-67.

Mayfield, R.B. and J.J. Cech, Jr. 2004. Temperature Effects on green sturgeon bioenergetics. Transactions of the American Fisheries Society 133:961-970.

McDonald, J. 1960. The behavior of Pacific salmon fry during the downstream migration to freshwater and saltwater nursery areas. Journal of the Fisheries Research Board of Canada 17:655-676.

McDuffie, H.H., P. Pahwa, J.R. McLaughlin, J.J. Spinelli, S. Fincham, J.A. Dosman, D. Robson, L.F. Skinnider, and N.W. Choi. 2001. Non-Hodgkin's lymphoma and specific pesticide exposures in men: cross-Canada study of pesticides and health. *Cancer Epidemiol. Biomarkers Prev.* Nov 10(11): 1155-1163.

McEwan, D. 2001. Central Valley steelhead. *In* R .L. Brown (editor), Contributions to the Biology of Central Valley Salmonids, Volume 1, pages 1-44. California Department of Fish and Game, Fish Bulletin 179.

McEwan, D., and T.A. Jackson. 1996. Steelhead Restoration and Management Plan for California. California. Department of Fish and Game, Sacramento, California, 234 pages.

McGill, R.R. Jr. 1987. Land use changes in the Sacramento River riparian zone, Redding to Colusa. A third update: 1982-1987. Department of Water Resources, Northern District, 19 pages.

Meehan, W.R. 1991. Introduction and overview. *In* W.R. Meehan (editor), Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 19, pages 1-16. American Fisheries Society, Bethesda, MD.

Meehan, W.R., L.A. Norris, and H.S. Sears. 1974. Toxicity of various formulations of 2,4-D to salmonids in Southeast Alaska. Journal of the Fisheries Research Board of Canada. **31**: 480-485.

Meehan, W.R., and T.C. Bjornn. 1991. Salmonid distributions and life histories. *In* W.R. Meehan (editor), Influences of forest and rangeland management on salmonid fishes and their habitats, pages 47-82. American Fisheries Society Special Publication 19. American Fisheries Society, Bethesda, MD.

Meyers, R.P. (1992). Residential Encroachment on Wetlands. Proceedings of the California Mosquito Vector Control Association 60: 17-20.

Michny, F., and M. Hampton. 1984. Sacramento River Chico Landing to Red Bluff project, 1984, Juvenile salmon study. U.S. Fish and Wildlife Service, Division of Ecological Services. Sacramento, CA.

Mitchell, D.G., P.M. Chapman, and T.J. Long. 1987a. Acute toxicity of Roundup® and Rodeo® herbicides to rainbow trout, Chinook, and coho salmon. Bulletin of Environmental Contamination and Toxicology 39: 1028-1035.

Mitchell, D.G., P.M. Chapman, and T.J. Long. 1987b. Seawater challenge testing of coho salmon smolts following exposure to Roundup® herbicide. Environmental Toxicology and Chemistry 6:875-878.

Mitchell, D.S. 1976. The growth and management of *Eichhornia crassipes* and *Salviniai* spp. in their native environment and in alien situations. *In*: Varsheny, C.K. and J. Rzoska, editors, Aquatic Weeds in Southeast Asia. The Hague: Dr. W. Junk b.v., Publishers.

Monroe, M., J. Kelly, and N. Lisowski. 1992. State of the estuary, a report of the conditions and problems in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. June 1992. 269 pages.

Morgan, J.D., G.A. Vigers, A.P. Farrell, D.M. Janz, and J.F. Manville. 1991. Acute avoidance reactions and behavioral responses of juvenile rainbow trout (*Oncorhynchus mykiss*) to

Garlon 4® and Garlon 3A® and Vision® herbicides. Environmental Toxicology and Chemistry 10: 73-79.

Morgan, M.J. and J.W. Kiceniuk. 1992. Response of rainbow trout to a two month exposure to Vision®, a glyphosate herbicide. Bulletin of Environmental Contamination and Toxicology 48:772-780.

Mount, J.F. 1995. California Rivers and Streams: The conflict between fluvial process and land use. University of California Press, Berkeley.

Moyle, P.B., J.E. Williams, and E.D. Wikramanayake. 1989. Fish species of special concern of California. Final report submitted to State of California Resources Agency. October 1989.

Moyle, P.B., P.J. Foley, and R.M. Yoshiyama. 1992. Status of green sturgeon, *Acipenser medirostris*, in California. Final report submitted to National Marine Fisheries Service, Terminal Island, California. 11 pages. University of California, Davis, California.

Moyle, P.B., R.A. Daniels, B. Herbold, and D.M. Baltz. 1986. Patterns in distribution and abundance of a non-coevolved assemblage of estuarine fishes in California. Fishery Bulletin 84:105-117.

Murty, A.S. 1986. Toxicity of Pesticides to Fish. Boca Raton, FL. CRC Press.

Myers, J.M., R.G. Kope, G.L. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grant, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status review of Chinook salmon from Washington, Idaho, Oregon, and California. U.S. Department Of Commerce, NOAA Tech Memo. NMFS-NWFSC-35, 443p.

Myrick, C.A, and Cech J.J. 2000. Growth and thermal biology of Feather River steelhead under constant and cyclical temperatures. Department of Wildlife, Fish, and Conservation Biology, University of California. Davis, California.

Myrick, C.A. 1998. Temperature, genetic, and ration effects on juvenile rainbow trout (*Oncorhynchus mykiss*) bioenergetics. Ph.D. dissertation. University of California. Davis. 165 pages.

National Marine Fisheries Service and California Department of Fish and Game. 2001. Final report on anadromous salmon fish hatcheries in California. Prepared by Joint Hatchery Review Committee. June 27, 2001.

National Marine Fisheries Service. 1996. Making Endangered Species Act determinations of effect for individual or group actions at the watershed scale. Prepared by NMFS, Environmental and Technical Services Branch, Habitat Conservation Branch. 31pages.

National Marine Fisheries Service. 1997. National Marine Fisheries Service Proposed Recovery Plan for the Sacramento River Winter-run Chinook Salmon. NMFS, Southwest Region, Long Beach, California, 217 pages with goals and appendices.

National Marine Fisheries Service. 1998. Status Review of Chinook Salmon from Washington, Idaho, Oregon, and California. U.S. Department of Commerce, NOAA Tech. Memo. NMFS-NWFSC-35. 443 pages.

National Marine Fisheries Service. 2003. Preliminary conclusions regarding the updated status of listed ESU of West Coast salmon and steelhead. Draft report February 2003. West Coast Salmon Biological Review Team. U.S. Department of Commerce, National Marine Fisheries Service-Northwest Fisheries Science Center.

National Marine Fisheries Service. 2005a. Green sturgeon (*Acipenser medirostris*) status review update, February 2005. Biological review team, Santa Cruz Laboratory, Southwest Fisheries Science Center. 31 pages.

National Marine Fisheries Service. 2005b. Biological Opinion for the Port of Stockton, West Complex Dredging Project. File Number 151422SWR2003SA9009;9010:JSS. Issued July 19, 2005.

Nešković, N.K., V. Karan, I. Elezović, V. Poleksić and M. Budimir. 1994. Toxic effects of 2,4-D herbicide on fish. Journal of Environmental Sciences and Health B29(2): 265-279.

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

Nickelson, T.E., J.W. Nicholas, A.M. McGie, R.B. Lindsay, D.L. Bottom, R.J. Kaiser, and S.E. Jacobs. 1992. Status of anadromous salmonids in Oregon coastal basins. Oregon Department of Fish and Wildlife, Research Development Section and Ocean Salmon Management, 83 pages

Nobriga, M., and P. Cadrett. 2003. Differences among hatchery and wild steelhead: evidence from Delta fish monitoring programs. Interagency Ecological Program for the San Francisco Estuary Newsletter 14:3:30-38.

Orsi, J. 1967. Predation study report, 1966-1967. California Department of Fish and Game

Pacific Fishery Management Council. 2004. Review of 2003 Ocean Salmon Fisheries. Available: www.pcouncil.org

Paul, E.A., H.A. Simonin, J. Symula, and R.W. Bauer. 1994. The toxicity of diquat, endothall, and fluridone to the early life stages of fish. Journal of Freshwater Ecology 9(3): 229-239.

Phillips, R.W., and H.J. Campbell. 1961. The embryonic survival of coho salmon and steelhead trout as influenced by some environmental conditions in gravel beds. Annual Report to Pacific Marine Fisheries Commission 14:60-73.

Pickard, A., A. Grover, and F. Hall. 1982. An evaluation of predator composition at three locations on the Sacramento River. Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary. Technical Report No. 2, 20 pages.

Pimental, D. 1971. Ecological effects of pesticides on nontarget species. Executive office of the President's office of Science and technology, U.S. Government printing Office, Washington D.C.

Piper, R.G., McElwain, I.B., Orme, L.E., McCraren, J.P. Fowler, L.G., and J.R. Leonard. 1982. Fish Hatchery Management. U.S. Department of Interior, U.S. Fish and Wildlife Service. 517 pages.

Plakas, S.M., L. Khoo, and M.G. Barron. 1992. 2,4-Dichlorophenoxyaceitic acid disposition after oral administration in channel catfish. J. Agric. Food Chem. 40: 1236-1239.

Prokpovich, N., A. Storm, and C. Tennis, 1985. Toxic Trace metals in water hyacinth in the Sacramento-San Joaquin delta, California. Tech Notes. Bull. Assoc. Eng. Geol. 352-358.

Radtke, L.D. 1966. Distribution of smelt, juvenile sturgeon, and starry flounder in the Sacramento-San Joaquin delta, Part II. Pages115-119. *In*: S.L. Turner and D.W. Kelley (eds.), California Fish and Game Bulletin 136.

Rand, G.M., P.G. Wells, and L.S. McCarty. 1995. Introduction to aquatic toxicology. *In* G.M. Rand (editor), Fundamentals of aquatic toxicology: effects, environmental fate, and risk assessment, second edition, pages 3-66. Taylor and Francis. Bristol, Pennsylvania.

Reiser, D.W., and T.C. Bjornn. 1979. Habitat requirements of anadromous salmonids. *In* W.R. Meehan, editor. Influence of Forest and Rangeland Management on Anadromous Fish Habitat in the Western United States and Canada. USDA, Forest Service General Technical Report PNW-96.

Rich, A.A. 1997. Testimony of Alice A. Rich, Ph.D., regarding water rights applications for the Delta Wetlands Project, proposed by Delta Wetlands Properties for Water Storage on Webb Tract, Bacon Island, Bouldin Island, and Holland Tract in Contra Costa and San Joaquin Counties. July 1997. California Department of Fish and Game Exhibit CDFG-7. Submitted to State Water Resources Control Board.

Robison, G.E., and Beschta, R.L. 1990. Identifying trees in riparian areas that can provide coarse woody debris to streams. Forest Service 36:790-801.

Rodriguez, A.D., R.H Rodriguez, R.A. Meza, , J.E. Hernandez, , E Rejmankova, H.M Savage, D.R Roberts, K.O. Pope, and L. Legters (1993). Dynamics of Population densities and

Vegetation Associations of *Anopheles albimanus* larvae in a Coastal Area of Southern Chiapas, Mexico. Journal of the American Mosquito Control Association 9(1):46-57.

Ross, M.A. and D.J. Childs. 196. Herbicide –mode- of Action. Cooperative Extension Service, Purdue University. Found at: **www.agcom.purdue.edu./AgCom/Pubs/WS-23.html**.

Rutter, C. 1904. Natural history of the quinnat salmon. Investigations on Sacramento River, 1896-1901. Bull. U.S. Fish Comm. 22:65-141.

Sarkar, S.K. 1991. Effects of the herbicide 2,4-D on the bottom fauna of fish ponds. The Progressive Fish Culturist 53: 161-165.

Savage, H.M., E.Remankova,, J.I. Arredondo-Jimenezc, D.R. Roberts, and M.H. Rodriguez, (1990). Limnological and Botanical Characterization of Larval Habitats for Two Primary Malarial Vectors, *Anopheles albimanus* and *Anopheles pseudopunctipennis*, in Coastal Areas of Chiapas State, Mexico. Journal of the American Mosquito Control Association. 6(4):612-620.

Schlenk, D. and R.T. Di Giulio. 2002. Biochemical Responses as Indicators of Aquatic Ecosystem Health. Pages 13-42 *in* S.M. Adams, editor. Biological Indicators of aquatic ecosystem stress. American Fisheries Society, Bethesda, Maryland.

Schultz, I.R., W.L. Hayton and B.H. Kemmenoe 1995. Disposition and toxicokinetics of diquat in channel catfish. *Aquatic Toxicology* 33(3-4): 297-310.

Shapovalov, L. and A.C. Taft. 1954. The life histories of the steelhead rainbow trout (*Salmo gairdneri gairdneri)* and silver salmon (*Oncorhynchus kisutch*) with special reference to Waddell Creek, California, and recommendations regarding their management. California Department of Fish and Game, Fish Bulletin 98, 375 pages.

Shelton, J. M. 1995. The hatching of Chinook salmon eggs under simulated stream conditions. Progressive Fish-Culturist 17:20-35.

Shirvell, C.S. 1990. Role of instream rootwads as juvenile coho salmon (*Oncorhynchus kisutch*) and steelhead trout (*O. mykiss*) cover habitat under varying streamflows. Canadian Journal of Fisheries and Aquatic Sciences 47:852-860.

Sikka, H.C., H.T. Appleton, et al. 1977. Uptake and metabolism of dimethyamine salt of 2,4-dichlorophenoxyacetic acid by fish. Journal of Agriculture and Food Chemistry 25(5):1030-1033.

Slater, D.W. 1963. Winter-run Chinook salmon in the Sacramento River, California, with notes on water temperature requirements at spawning. U.S. Fish and Wildlife Service, Special Science Report Fisheries 461:9.

Smith, A.K. 1973. Development and application of spawning velocity and depth criteria for Oregon salmonids. Transactions of the American Fisheries Society 10:312-316.

Snider, B. 2001. Evaluation of effects of flow fluctuations on the anadromous fish populations in the lower American River. California Department of Fish and Game, Habitat Conservation Division. Stream Evaluation Program. Tech. Reports No. 1 and 2 with appendices 1-3. Sacramento, California.

Sommer, T.R., M.L. Nobriga, W.C. Harrell, W. Batham, and W.J. Kimmerer. 2001. Floodplain rearing of juvenile Chinook salmon: evidence of enhanced growth and survival. Canadian Journal of Fisheries and Aquatic Sciences 58:325-333.

Staley, J.R. 1975. American River steelhead (*Salmo gairdnerii gairdnerii*) management,1956-1974. California Department of Fish and Game, Region 2, Inland Fisheries, Anadromous Branch, Administrative Report No. 76-2.

Stevens, D.E. 1961. Food habits of striped bass, *Roccus saxatilis* (Walbaum) in the Rio Vista area of Sacramento River. Master's Thesis. University of California. Berkeley, California.

Stone, L. 1874. Report of operations during 1872 at the U.S. salmon-hatching establishment on the McCloud River, and on the California Salmonidae generally; with a list of specimens collected. Report to U.S. Commissioner of Fisheries for 1872-1873, 2:168-215.

Thompson, K. 1972. Determining stream flows for fish life. *In* Proceedings, Instream Flow Requirement Workshop, pages 31-50. Pacific Northwest River Basin Commission, Vancouver, Washington.

Tillman, T.L., G.W. Edwards, and K.A.F. Urquhart. 1996. Adult salmon migration during the various operational phases of Suisun Marsh Salinity Control Gates in Montezuma Slough: August-October 1993. Agreement to California Department of Water Resources, Ecological Services Office by California Department of Fish and Game, Bay-Delta and Special Water Projects Division, 25 pages.

Toft, J.D. 2000. Community effects of the non-indigenous aquatic plant water hyacinth (*Eichhornia crassipes*) in the Sacramento/San Joaquin Delta, California. University of Washington.

UK Marine SACS Project (United Kingdom Marine Special Areas of Conservation Project. 2003. Report on Surfactants. Available at: http://www.ukmarinesac.org.uk/activities/water-quality/wq8_46.htm

U.S. Army Corps of Engineers. 1985. State Design Memorandum Water Hyacinth Sacramento-San Joaquin Delta, California. U. S. Army Corps of Engineers.

U.S. Bureau of Reclamation and Orange Cove Irrigation District. 1999. Draft Environmental Assessment/Initial Study for Mill Creek Anadromous Fish Adaptive Management Enhancement Plan. August 1999.

U.S. Bureau of Reclamation. 2004. Long-term Central Valley Project and State Water Project Operating Criteria and Plan. Biological Assessment for ESA section 7(a)(2) consultation. Mid-Pacific Region. Sacramento, California.

U.S. Department of Agriculture, Forest Service. 2002. 2,4-D Pesticide Fact Sheet. Found at **http://www.fs.fed.us/foresthealth/pesticide/24d.html**.

U.S. Department of Interior. 1999. Final Programmatic Environmental Impact Statement for the Central Valley Project Improvement Act. October 1999. Technical Appendix, 10 volumes.

U.S. Environmental Protection Agency. 1994. Methods for measuring the toxicity and bioaccumulation of sediment associated contaminants with freshwater invertebrates. EPA 600-R-94-024. Duluth, Minnesota.

U.S. Fish and Wildlife Service. 1995. Sacramento-San Joaquin Delta Native Fishes Recovery Plan. Portland, OR.

U.S. Fish and Wildlife Service. 2001a. Abundance and seasonal, spatial, and diel distribution patterns of juvenile salmonids passing the Red Bluff Diversion Dam, Sacramento River. Draft Progress Report for Red Bluff Research Pumping Plant, Vol.14. Prepared by Philip Gaines and Craig Martin for the U.S. Bureau of Reclamation. Red Bluff, CA.

U.S. Fish and Wildlife Service. 2001b. Abundance and survival of juvenile Chinook salmon in the Sacramento-San Joaquin Estuary: 1997 and 1998. Annual progress report. 131 pages.

U.S. Fish and Wildlife Service. 2003a. Flow-habitat relationships for steelhead and fall, late-fall, and winter-run Chinook salmon spawning in the Sacramento River between Keswick Dam and Battle Creek. Sacramento, CA. 76 pages.

U.S. Fish and Wildlife Service. 2003b. Abundance and survival of juvenile Chinook salmon in the Sacramento-San Joaquin Estuary: 1999. Annual progress report. 70 pages.

U.S. Fish and Wildlife Service. 2004. Draft adult spring Chinook salmon monitoring in Clear Creek, California, 1999-2002. Prepared by J.M. Newton and M.R. Brown. Red Bluff, CA.

Van Eenennaam, J.P., J. Linares-Casenave, X. Deng, and S.I. Doroshov. 2005. Effect of incubation temperature on green sturgeon embryos, *Acipenser medirostris*. Environmental Biology of Fishes 72:145-154.

Van Eenennaam, J.P., M.A.H. Webb, X. Deng, S.I. Doroshov, R.B. Mayfield, J.J. Cech, Jr., D.C. Hillemeir and T.E. Willson. 2001. Artificial spawning and larval rearing of Klamath River green sturgeon. Transactions of the American Fisheries Society 130:159-165.

Van Woert, W. 1964. Mill Creek counting station. Office memorandum to Eldon Hughes, May 25, 1964. California Department of Fish and Game, Water Projects Branch, Contract Services Section.

Vogel, D.A., and K.R. Marine. 1991. Guide to upper Sacramento River Chinook salmon life history. Prepared for the U.S. Bureau of Reclamation, Central Valley Project, 55 pages.

Vogel, D.A., K.R. Marine, and J.G. Smith. 1988. Fish passage action program for Red Bluff Diversion Dam. Final report on fishery investigations. Report No. FR1/FAO-88-19. U.S. Fish and Wildlife Service, Northern Central Valley Fishery Resource Office. Red Bluff, CA.

Waples, R.S. 1991. Pacific Salmon, *Oncorhynchus spp.*, and the definition of "species" under the Endangered Species Act. Marine Fisheries Review 53:11-21.

Wan, M.T., R.G. Watts, and D.J. Moul. 1991. Acute toxicity to juvenile Pacific Northwest Salmonids of Bascid Blue NB755 and its mixture with formulated products of 2,4-D, Glyphosate, and triclopyr. Bulletin of Environmental Toxicology 47: 471-478.

Ward, P.D., T.R. Reynolds, and C.E. Garman. 2003. Butte Creek spring-run Chinook salmon *Oncorhynchus tshawytscha*, pre-spawn mortality evaluation. California Department of Fish and Game, Inland Fisheries, Administrative Report No. 2004-5. Chico, CA.

Waters, T.F. 1995. Sediment in streams: sources, biological effects, and control. American Fisheries Society Monograph 7

Wolverton, B.C. and R.C. McDonald. 1976. Water Hyacinth (*Eichhornia crassipes*) productivity and harvesting studies. *Econ. Botany* 33:1-10.

Worthingcton, C.R. and R.J. Hance (editors) 1991. The Pesticide Manual- A World Compendium, 9th Edition. Great Britain: British Crop Protection Council. 1141 pages.

Wright, D. A., and D. J. Phillips. 1988. Chesapeake and San Francisco Bays: A study in contrasts and parallels. Marine Pollution Bulletin 19 (9): 405-413.

Yoshiyama, R.M., E.R. Gerstung, F.W. Fisher, and P.B. Moyle. 1996. Historical and present distribution of Chinook salmon in the Central Valley Drainage of California. *In* Sierra Nevada Ecosystem Project, Final Report to Congress, Volume III. Assessments, Commissioned Reports, and Background Information. Centers for Water and Wildland Resources, University of California. Davis, California.

Yoshiyama, R.M., E.R. Gerstung, F.W. Fisher, and P.B. Moyle. 2001. Historical and present distribution of Chinook salmon in the Central Valley Drainage of California. *In* R.L. Brown (editor), Contributions to the Biology of Central Valley Salmonids, pages 71-176. California Department of Fish and Game, Fish Bulletin 179, Volume 1.

Yoshiyama, R.M., F.W. Fisher, and P.B. Moyle. 1998. Historical abundance and decline of Chinook salmon in the Central Valley region of California. North American Journal of Fisheries Management 18:487-521.

Appendix A: Tables

Table 2:
Chemical Usage and Acreage Treated during the 2003 through 2005 Treatment Seasons

2003	2,4 - D		Glyphosate		R-11	Agri-dex
Month	Gallons	Acres	Gallons	Acres	Gallons	
April	0	0	0	0	0	0
May	42.69	42.69	90.7	121.16	40.33	0
June	78.08	80.61	105.91	141.96	55.32	0
July	430.45	433.18	38.73	51.83	124.8	0
August	428.75	430.78	46.63	63.19	111.34	0
September	479.78	481.45	49.02	66.64	126.51	0
October	259.37	259.87	35.81	47.74	60.57	0
November	0	0	0	0	0	0
Total	1719.12	1728.58	366.8	492.52	518.87	0

2004	2,4 - D		Glyphosate		R-11	Agri-dex
Month	Gallons	Acres	Gallons	Acres	Gallons	
April	20.5	20.5	136.7	183.65	0	39.77
May	24.86	24.86	109.84	147.17	0	38.14
June	65.77	67.44	92.3	124.37	0	48.01
July	464.12	471.12	47.45	66.17	0	154.78
August	577.57	585.09	36.03	49.15	0	181.91
September	572.31	579.21	53.38	72.88	0	178
October	323.05	328.32	36.85	49.75	0	103.29
November	14.25	14.92	4.28	5.92	0	7.03
Total	2062.43	2091.46	516.83	699.06	0	750.93

2005	2,4 - D		Glyphosate		R-11	Agri-dex
Month	Gallons	Acres	Gallons	Acres	Gallons	
April	26.5	26.5	49.3	65.44	0	24.8
May	17.25	17.25	44.5	59.23	0	23
June	68	68	62.13	82.69	0	50.13
July	549.16	553.56	0.76	0.97	0	188.16
August	600.93	604.93	44.15	58.82	0	229.04
September	401.03	403.03	17.6	23.41	0	143.99
October	240.5	243.83	0.1	0.13	0	77.1
November	0	0	0	0	0	0
Total	1903.37	1917.1	218.54	290.69	0	736.22

Table 3: WHCP Treatment Sites

County	Location	Site Number(s)	Water Type
San Joaquin	San Joaquin River	1,2,3,4,5,	Tidal
San Joaquin	French Camp Slouogh, Walker Slough	6	Tidal
San Joaquin	San Joaquin River	7	Tidal
San Joaquin	Mormon Slough, San Joaquin River Deep Water Ship Channel	8	Tidal
San Joaquin	Burns Cutoff	9	Tidal
San Joaquin	Buckley Cove, San Joaquin River Deep Water Ship Channel	10	Tidal
San Joaquin	Black Slough, Black Slough Landing, 14 Mile Slough, San Joaquin River	11	Tidal
San Joaquin	Turner Cut	12	Tidal
San Joaquin	Heypress Reach, Hog Island Cut, San Joaquin River Deep Water Ship Channel, 21 Mile Slough	13	Tidal
San Joaquin	San Joaquin River	14	Tidal
San Joaquin	Empire Tract Slough	15	Tidal
San Joaquin	Mandeville Cut, Mandeville Reach, San Joaquin River Deep Water Ship Channel, 3 River Reach, Venice Cut, Venice Reach	16	Tidal
San Joaquin	Potato Slough	17	Tidal
San Joaquin	Mokelumne River	18	Tidal
Contra Costa	San Joaquin River	19	Tidal
Sacramento	San Joaquin River, 7-Mile Cut	20	Tidal
Contra Costa	San Joaquin River	21	Tidal
Sacramento	Sacramento River, 3-Mile Slough	22	Tidal
Sacramento	Lake Natoma	none	Slow Moving
Contra Costa, Sacramento	False River, San Joaquin River	23	Tidal
Contra Costa, Sacramento	San Joaquin River	24	Tidal
San Joaquin	14 Mile Slough	25	Tidal
San Joaquin	14 Mile Slough	26,28,29	Tidal
San Joaquin	5 Mile Slough	27	Tidal
San Joaquin	Mosher Slough	30	Tidal
San Joaquin	Bear Creek, Disappointment Slough, Pixley Slough	31	Tidal
San Joaquin	Disappointment Slough	32,33	Tidal
San Joaquin	Bishop Cut	34	Tidal
San Joaquin	Telephone Cut	35	Tidal
San Joaquin	White Slough	36,37,39	Tidal
San Joaquin	Bishop Cut	38	Tidal
San Joaquin	Little Potato Slough	40,41	Tidal
San Joaquin	Little Connection Slough	42	Tidal
San Joaquin	Potato Slough	43,44	Tidal
San Joaquin	Middle River	45,46,47,48,49,52,53,56,58,59,66,67,68	Tidal
San Joaquin	North Canal, Victoria Canal	50,51	Tidal
San Joaquin	North Victoria Canal, Woodard Canal	54,55	Tidal
San Joaquin	Railroad Cut	57	Tidal
San Joaquin	Empire Cut	60	Tidal

County	Location	Site Number(s)	Water Type
San Joaquin	Whiskey Slough	61,62,63	Tidal
San Joaquin	Trapper Slough	64	Tidal
San Joaquin	Latham Slough	65	Tidal
San Joaquin	Connection Slough, Middle River	69	Tidal
San Joaquin	Old River	70,71	Tidal
San Joaquin	Old River, Paradise Cut	72	Tidal
San Joaquin	Old River, Paradise Cut, Salmon Slough	73	Tidal
San Joaquin	Sugar Cut, Tom Paine Slough	74	Tidal
San Joaquin	Old River	75,76,77,78,79,83,84,85,87,89,90,91,92,98,99	Tidal
San Joaquin	Fabian & Bell Canal, Grant Line Canal	80,81,82	Tidal
Contra Costa	Italian Slough	88	Tidal
Contra Costa	Indian Slough	93	Tidal
Contra Costa	Warner Dredge Cut	94,95,96	Tidal
Contra Costa	Rock Slough	97	Tidal
San Joaquin	Connection Slough, Old River	100	Tidal
San Joaquin	Old River	101	Tidal
Contra Costa	Sheep Slough	102	Tidal
Contra Costa, San Joaquin	Old River	103,104	Tidal
Contra Costa	False River,	105	Tidal
Contra Costa	Fisherman's Cut	106	Tidal
Contra Costa	Piper Slough	107	Tidal
Contra Costa	Roosevelt Cut, Sand Mound Slough	108	Tidal
Contra Costa	Sand Mound Slough	109	Tidal
Contra Costa	Taylor Slough	110,111	Tidal
Contra Costa	Dutch Slough, Emerson Slough	112	Tidal
Contra Costa	Dutch Slough	113, 114	Tidal
Contra Costa	Big Break	115,116,117,118	Tidal
Contra Costa, Sacramento	San Joaquin River	119,120,121	Tidal
Sacramento	Sherman Lake	**132**	Tidal
Contra Costa	Frank's Tract	**173, 174, 175**	Tidal
Solano	Sacramento River, Decker Isalnd	176	Tidal
San Joaquin	South Mokelumne River	200, 201, 202, 204, 206, 208	Tidal
San Joaquin	Sycamore Slough	203	Tidal
San Joaquin	Hog Slough	205	Tidal
San Joaquin	Beaver Slough	207	Tidal
Sacramento, San Joaquin	North Mokelumne River	209, 210,211,2113	Tidal
Sacramento, San Joaquin	Snodgrass Slough, Delta Cross Channel	**212**	To Be Determined
Sacramento	Snodgrass Slough	214, 215, 216,217, 218, 219	Tidal
Sacramento	Stone Lakes	220, 221, 222, 223, 224, 225, 226, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239	Tidal

Table 3: WHCP Treatment Sites

County	Location	Site Number(s)	Water Type
Sacramento, Solano	Sacramento River	**240**	To Be Determined
Sacramento	Sacramento River	**241, 242, 243, 244, 245**	To Be Determined
Sacramento, Yolo	Sacramento River	**246, 247, 248, 249, 250**	To Be Determined
Sacramento, Solano	Steamboat Slough	**251, 252, 253**	To Be Determined
Sacramento	Steamboat Slough	**254, 255**	To Be Determined
Sacramento, Solano	Sutter Slough	**256, 257**	To Be Determined
Sacramento	Sutter Slough	**258,259**	To Be Determined
Soalno, Sacramento	Cache Slough	**260**	To Be Determined
Solano	Cache Slough	**261, 272, 277, 278, 280**	To Be Determined
Solano	Miner Slough	**262, 263,264, 265, 266**	To Be Determined
Solano	Prospect Lsough	**267**	To Be Determined
Solano, Yolo	Sacramento Deep Water Ship Channel	**268**	To Be Determined
Solano	Tox Drain, Liberty	**270**	To Be Determined
Solano, Yolo	Tox Drain, Liberty	**271**	To Be Determined
Solano	Shag Slough	**273, 274**	To Be Determined
Solano, Yolo	Shag Slough	**275, 276**	To Be Determined
Solano	Hass Slough, Duck Slough	**279**	To Be Determined
Solano	Lindsey Slough	**281, 282, 283, 284**	To Be Determined
Sacramento	Georgiana Slough	**285, 286, 287, 288, 289**	To Be Determined
San Joaquin	San Joaquin River	300, 302, 303, 304, 305, 306, 307, 308, 309	Fast or Slow Moving
San Joaquin	Wethall Slough	301	Fast or Slow Moving
Stanislaus	San Joaquin River	310, 313, 314, 316, 318, 319, 320, 321, 322, 323	Fast or Slow Moving
Stanislaus	Brush Lake	316	Fast or Slow Moving
Stanislaus	Finnegan Cut, San Joaquin River	311, 312	Fast or Slow Moving
Stanislaus	Laird Slough	315	Fast or Slow Moving
Stanislaus	Del Puerto Creek, San Joaquin River	317	Fast or Slow Moving
Stanislaus	Lake Ramona	320	Fast or Slow Moving
Merced, Stanislaus	San Joaquin River	324, 325	Fast or Slow Moving

Table 3: WHCP Treatment Sites

County	Location	Site Number(s)	Water Type
Merced	San Joaquin River	401, 403, 414, 415, 417, 418, 419, 421,422, 423, 424, 425, 426, 427	Fast or Slow Moving
Merced	Snag Slough, San Joaquin River	402	Fast or Slow Moving
Merced	Salt Slough	405, 406, 407, 408, 409, 410, 412, 413	Fast or Slow Moving
Merced	Poso Slough	414A	Fast or Slow Moving
Merced	Mud Slough	411	Fast or Slow Moving
Merced	Bear Creek, Bravel Slough	416	Fast or Slow Moving
Merced	San Joaquin River	**420**	To Be Determined
Merced	Merced River	500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 517, 518, 519, 520, 521, 522, 523, 524, 526, 527, 530, 532	Fast or Slow Moving
Merced	Ingalsbe Slough, Hope Town Slough	516	Fast or Slow Moving
Merced	Ingalsbe Slough	525	Fast or Slow Moving
Merced	Merced River, North Canal	528, 529	Fast or Slow Moving
Merced	Main Canal	531, 533, 537	Fast or Slow Moving
Merced	Main Canal, Canal Creek	534, 535	Fast or Slow Moving
Merced	Main Canal, Parkinson Creek	536	Fast or Slow Moving
Stanislaus	Stanislaus River	600	Fast or Slow Moving
Stanislaus	Toulumne River	700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718	Fast or Slow Moving
Fresno	San Joaquin River	900, 901, 902, 903, 904, 905, 909, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929	Fast or Slow Moving
Fresno, Madera	Firebaugh	**906, 907, 908**	To Be Determined
Fresno	San Joaquin River, Mendota Pool	910	Fast or Slow Moving
Fresno	Fresno Slough	910A, 910B	Fast or Slow Moving

Table 3: WHCP Treatment Sites
Bold Numbers are new treatment sites as of 2003.

Table 6:

Monthly Occurrences of Dissolved Oxygen Depressions below the 5mg/L Criteria in the Stockton Deepwater Ship Channel (Rough and Ready Island DO monitoring site) Water Years 2000 to 2004

	Water Year					
Month	**2000-01**	**2001-02**	**2002-03**	**2003-04**	**2004-05**	**Monthly Sum**
September	0	26**	30**	16**	30**	102
October	0	0	7	0	4	11
November	0	0	12	0	3	15
December	6	4*	13	2	13	38
January	3	4	19	7	0	33
February	0	25	28	13	0	66
March	0	7	9	0	0	16
April	0	4	4	0	0	8
May	2*	0	2	4	0	8
Yearly Sum	11	70	124	42	50	**Total=297**

* = Suspect Data – potentially faulty DO meter readings

** = Wind driven and photosynthetic daily variations in DO level; very low night-time DO levels, high late afternoon levels

Table 7. Salmon and Steelhead monitoring programs in the Sacramento - San Joaquin River basins, and Suisun Marsh.

Geographic Region	Species	Watershed	Methods	Geographic Area Covered	Monitoring Parameters	Monitoring Period	Implementing Agency
Central Valley	***Chinook salmon, Steelhead***	Sacramento River	Scale and otolith collection	Coleman National Hatchery, Sacramento River and tributaries	Scale and otolith microstructure analysis	Year-round	CDFG
		Sacramento River and San Joaquin River	Central Valley angler survey	Sacramento and San Joaquin rivers and tributaries downstream to Carquinez	In-river harvest	8 or 9 times per month, year-round	CDFG
		Sacramento River	Rotary screw trap	Upper Sacramento River at Balls Ferry and Deschutes Road Bridge	Juvenile emigration timing and abundance	Year round	CDFG
		Sacramento River	Rotary screw trap	Upper Sacramento River at RBDD	Juvenile emigration timing and abundance	Year round	FWS
		Sacramento River	Ladder counts	Upper Sacramento River at RBDD	Escapement estimates, population size	Variable, May - Jul	FWS
		Sacramento River	Beach seining	Sacramento River, Caldwell Park to Delta	Spatial and temporal distribution	Bi-weekly or monthly, year-round	FWS
		Sacramento River	Beach seining, snorkel survey, habitat mapping	Upper Sacramento River from Battle Creek to Caldwell Park	Evaluate rearing habitat	Random, year-round	CDFG
		Sacramento River	Rotary screw trap	Lower Sacramento River at Knight's Landing	Juvenile emigration and post-spawner adult steelhead migration	Year-round	CDFG
		Sacramento-San Joaquin basin	Kodiak/Midwater trawling	Sacramento River at Sacramento, Chipps Island, San Joaquin River at Mossdale	Juvenile outmigration	Variable, year-round	FWS
		Sacramento-San Joaquin Delta	Kodiak trawling	Various locations in the Delta	Presence and movement of juvenile salmonids	Daily, Apr - Jun	IEP
		Sacramento-San Joaquin Delta	Kodiak trawling	Jersey Point	Mark and recapture studies on juvenile salmonids	Daily, Apr - Jun	Hanson Environmental Consultants
Central Valley	***Chinook salmon, Steelhead, Continued***	Sacramento-San Joaquin Delta	Salvage sampling	CVP and SWP south Delta pumps	Estimate salvage and loss of juvenile salmonids	Daily	USBR/CDFG

Geographic Region	Species	Watershed	Methods	Geographic Area Covered	Monitoring Parameters	Monitoring Period	Implementing Agency
		Battle Creek	Rotary screw trap	Above and below Coleman Hatchery barrier	Juvenile emigration	Daily, year-round	FWS
		Battle Creek	Weir trap, carcass counts, snorkel/ kayak survey	Battle Creek	Escapement, migration patterns, demographics	Variable, year-round	FWS
		Clear Creek	Rotary screw trap	Lower Clear Creek	Juvenile emigration	Daily, mid Dec- Jun	FWS
		Feather River	Rotary screw trap, Beach seining, Snorkel survey	Feather River	Juvenile emigration and rearing, population estimates	Daily, Dec - Jun	DWR
		Yuba River	Rotary screw trap	lower Yuba River	Life history evaluation, juvenile abundance, timing of emergence and migration, health index	Daily, Oct - Jun	CDFG
		Feather River	Ladder at hatchery	FRH	Survival and spawning success of hatchery fish (spring-run Chinook salmon), determine wild vs. hatchery adults (steelhead)	Variable, Apr - Jun	DWR, CDFG
		Mokelumne River	Habitat typing	Lower Mokelumne River between Camanche Dam and Cosumnes River confluence	Habitat use evaluation as part of limiting factors analysis	Various, when river conditions allow	EBMUD
		Mokelumne River	Redd surveys	Lower Mokelumne River between Camanche Dam and Hwy 26 bridge	Escapement estimate	Twice monthly, Oct 1- Jan 1	EBMUD
		Mokelumne River	Rotary screw trap, mark/recapture	Mokelumne River, below Woodbridge Dam	Juvenile emigration and survival	Daily, Dec- Jul	EBMUD
		Mokelumne River	Angler survey	Lower Mokelumne River below Camanche Dam to Lake Lodi	In-river harvest rates	Various, year-round	EBMUD
Central Valley	***Chinook salmon, Steelhead, Continued***	Mokelumne River	Beach seining, electrofishing	Lower Mokelumne	Distribution and habitat use	Various locations at various times throughout the year	EBMUD
		Mokelumne River	Video monitoring	Woodbridge Dam	Adult migration timing, population estimates	Daily, Aug - Mar	EBMUD

Geographic Region	Species	Watershed	Methods	Geographic Area Covered	Monitoring Parameters	Monitoring Period	Implementing Agency
		Calaveras River	Adult weir, snorkel survey, electrofishing	Lower Calaveras River	Population estimate, migration timing, emigration timing	Variable, year-round	Fishery Foundation
		Stanislaus River	Rotary screw trap	lower Stanislaus River at Oakdale and Caswell State Park	Juvenile outmigration	Daily, Jan - Jun, dependent on flow	S.P. Cramer
		San Joaquin River basin	Fyke nets, snorkel surveys, hook and line survey, beach seining, electrofishing	Stanislaus, Tuolumne, Merced, and mainstem San Joaquin rivers	Presence and distribution, habitat use, and abundance	Variable, Mar- Jul	CDFG
	Central Valley Steelhead	Sacramento River	Angler Survey	RBDD to Redding	In-river harvest	Random Days, Jul 15 - Mar 15	CDFG
		Battle Creek	Hatchery counts	CNFH	Returns to hatchery	Daily, Jul 1 - Mar 31	FWS
		Clear Creek	Snorkel survey, redd counts	Clear Creek	Juvenile and spawning adult habitat use	Variable, dependent on river conditions	FWS
		Mill Creek, Antelope Creek, Beegum Creek	Spawning survey - snorkel and foot	Upper Mill, Antelope, and Beegum Creeks	Spawning habitat availability and use	Random days when conditions allow, Feb - Apr	CDFG
		Mill Creek, Deer Creek, Antelope Creek	Physical habitat survey	Upper Mill, Deer, and Antelope Creeks	Physical habitat conditions	Variable	USFS
		Dry Creek	Rotary screw trap	Miner and Secret Ravine's confluence	Downstream movement of emigrating juveniles and post-spawner adults	Daily, Nov- Apr	CDFG
		Dry Creek	Habitat survey, snorkel survey, PIT tagging study	Dry Creek, Miner and Secret Ravine's	Habitat availability and use	Variable	CDFG
Central Valley	***Central Valley Steelhead Continued***	Battle Creek	Otolith analysis	CNFH	Determine anadromy or freshwater residency of fish returning to hatchery	Variable, dependent on return timing	FWS
		Feather River	Hatchery coded wire tagging	FRH	Return rate, straying rate, and survival	Daily, Jul - Apr	DWR

Geographic Region	Species	Watershed	Methods	Geographic Area Covered	Monitoring Parameters	Monitoring Period	Implementing Agency
		Feather River	Snorkel survey	Feather River	Escapement estimates	Monthly, Mar to Aug (upper river), once annually (entire river)	DWR
		Yuba River	Adult trap	lower Yuba River	Life history, run composition, origin, age determination	Year-round	Jones and Stokes
		American River	Rotary screw trap	Lower American River, Watt Ave. Bridge	Juvenile emigration	Daily, Oct- Jun	CDFG
		American River	Beach seine, snorkel survey, electrofishing	American River, Nimbus Dam to Paradise Beach	Emergence timing, juvenile habitat use, population estimates	Variable	CDFG
		American River	Redd surveys	American River, Nimbus Dam to Paradise Beach	Escapement estimates	Once, Feb - Mar	CDFG, BOR
		Mokelumne River	Electrofishing, gastric lavage	Lower Mokelumne River	Diet analysis as part of limiting factor analysis	Variable	EBMUD
		Mokelumne River	Electrofishing, hatchery returns	Lower Mokelumne River, Mokelumne River hatchery	O. Mykiss genetic analysis to compare hatchery returning steelhead to residents	Variable	EBMUD
		Calaveras River	Rotary screw trap, pit tagging, beach seining, electrofishing	lower Calaveras River	Population estimate, migration patterns, life history	Variable, year-round	S.P. Cramer
		San Joaquin River basin	Fyke nets, snorkel survey, hook and line survey, beach seining, electrofishing, fish traps/weirs	Stanislaus, Tuolumne, Merced, and mainstem San Joaquin rivers	Presence, origin, distribution, habitat use, migration timing, and abundance	Variable, Jun - Apr	CDFG
		Merced River	Rotary screw trap	Lower Merced River	Juvenile oumigration	Variable, Jan-Jun	Natural Resource Scientists, Inc.
Central Valley	***Central Valley Steelhead Continued***	Central Valley-wide	Carcass survey, hook and line survey, electrofishing, traps, nets	Upper Sacramento, Yuba, Mokelumne, Calaveras, Tuolumne, Feather, Cosumnes, and Stanislaus Rivers, and Mill, Deer, Battle, and Clear Creeks	Occurrence and distribution of *O. Mykiss*	Variable, year-round	CDFG

Geographic Region	Species	Watershed	Methods	Geographic Area Covered	Monitoring Parameters	Monitoring Period	Implementing Agency
		Central Valley - wide	Scale and otolith sampling	Coleman NFH, Feather, Nimbus, Mokelumne River hatcheries	Stock identification, juvenile residence time, adult age structure, hatchery contribution	Variable upon availability	CDFG
		Central Valley - wide	Hatchery marking	All Central Valley Hatcheries	Hatchery contribution	Variable	FWS, CDFG
	Sacramento River Winter-run Chinook salmon	Sacramento River	Aerial redd counts	Keswick Dam to Princeton	Number and proportion of reds above and below RBDD	Weekly, May 1-July 15	CDFG
		Sacramento River	Carcass survey	Keswick Dam to RBDD	In-river spawning escapement	Weekly, Apr 15-Aug 15	FWS, CDFG
		Battle Creek	Hatchery marking	Colemen National Fish Hatchery	Hatchery contribution	Variable	FWS, CDFG
		Sacramento River	Ladder counts	RBDD	Run-size above RBDD	Daily, Mar 30- Jun 30	FWS
		Pacific Ocean	Ocean Harvest	California ports south of Point Arena	Ocean landings	May 1- Sept 30 (commercial), Feb 15 - Nov 15 (sport)	CDFG
	Central Valley Spring-run Chinook salmon	Mill, Deer, Antelope, Cottonwood, Butte, Big Chico Creeks	Rotary screw trap, snorkel survey, electrofishing, beach seining	upper Mill, Deer, Antelope, Cottonwood, Butte, and Big Chico creeks	Life history assessment, presence, adult escapement estimates	Variable, year-round	CDFG
		Feather River	Fyke trapping, angling, radio tagging	Feather River	Adult migration and holding behavior	Variable, Apr-June	DWR
		Yuba River	Fish trap	lower Yuba River, Daguerre Point Dam	Timing and duration of migration, population estimate	Daily, Jan - Dec	CDFG
Suisun Marsh	***Chinook salmon***	Suisun Marsh	Otter trawling, beach seining	Suisun Marsh	Relative population estimates and habitat use	Monthly, year-round	UC Davis
		Suisun Marsh	Gill netting	Suisun Marsh Salinity Control Gates	Fish passage	Variable, Jun - Dec	CDFG

Appendix B: Figures

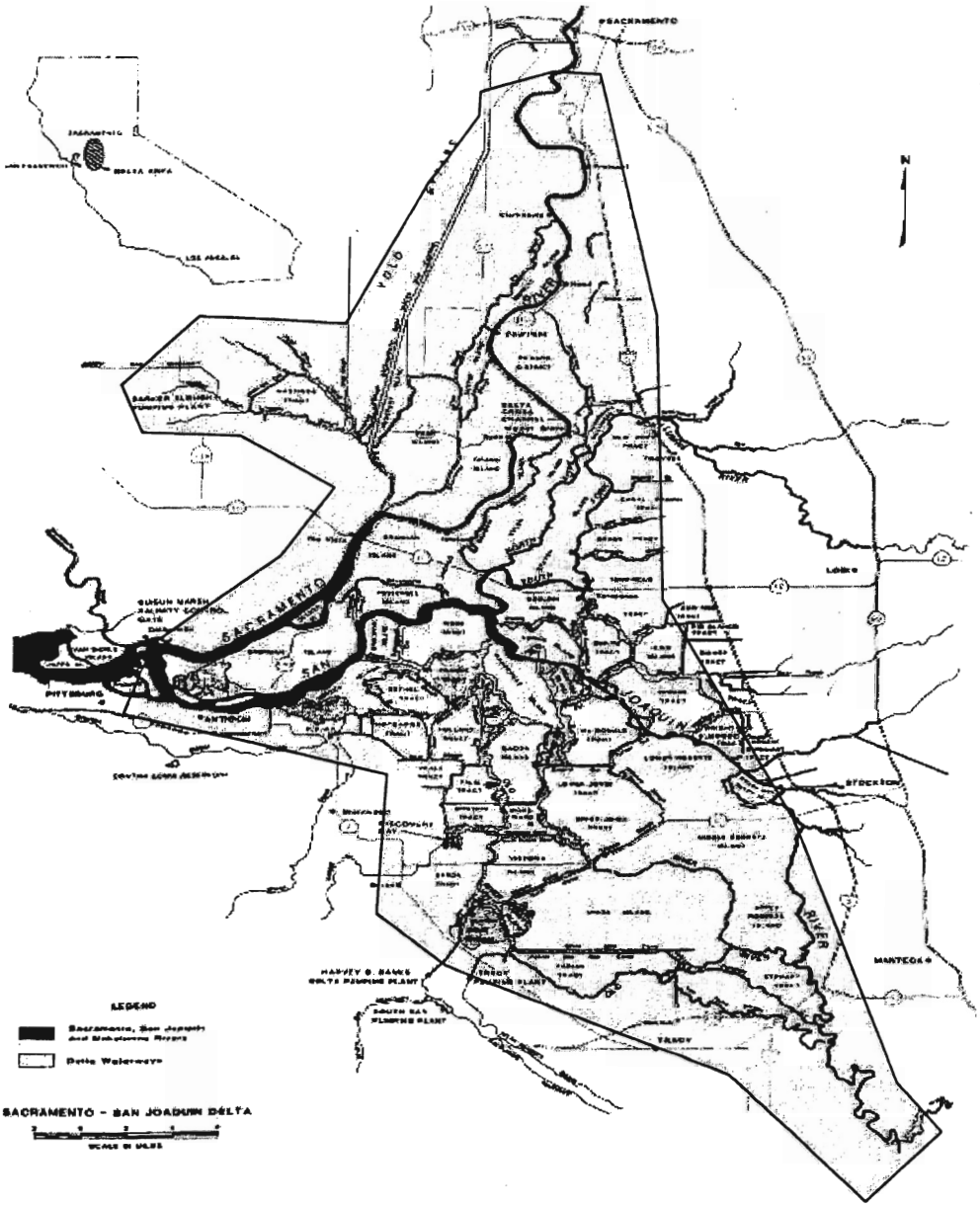
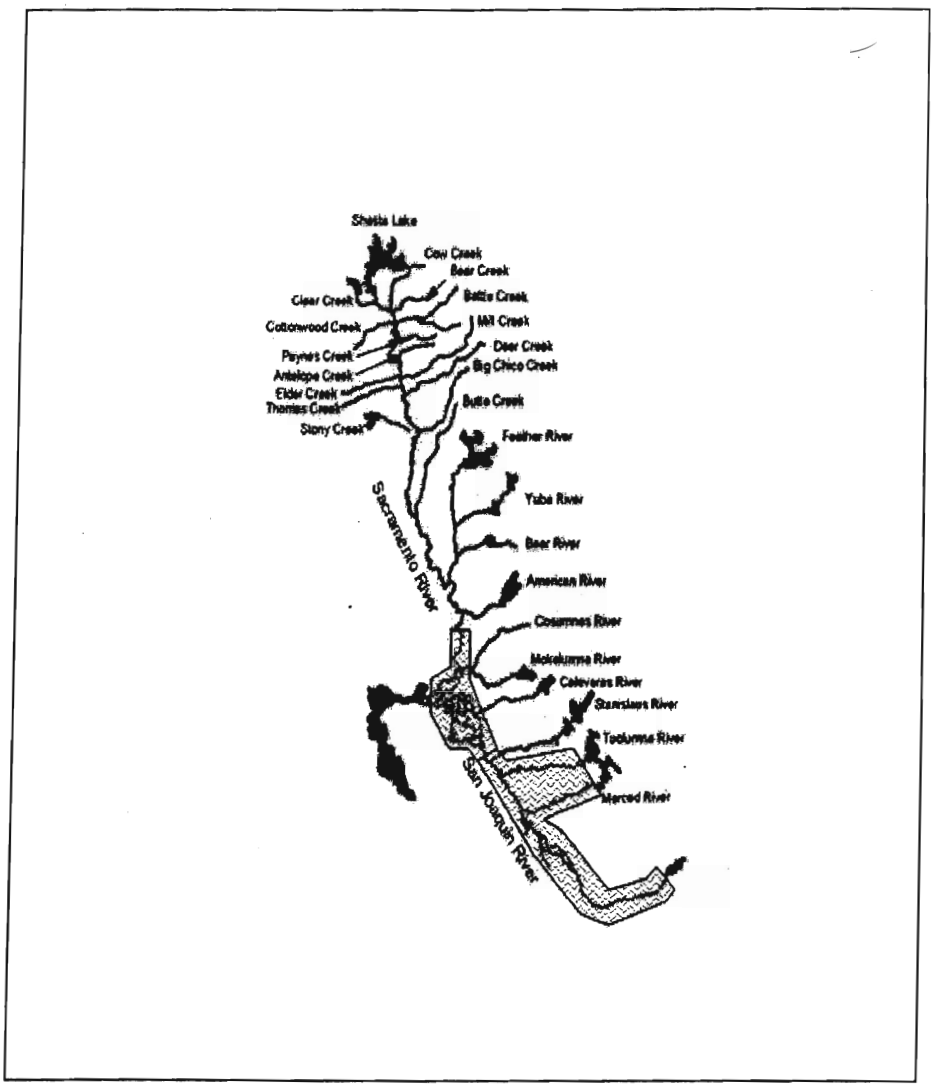


Figure 1A: Generalized Water Hyacinth Treatment Boundaries in the Legal Delta. Treatment boundaries are not to exact geographic locale.

Figure 1b: Generalized Water Hyacinth Boundaries in the San Joaquin Valley



Shaded areas indicate generalized areas of herbicide applications for the WHCP.

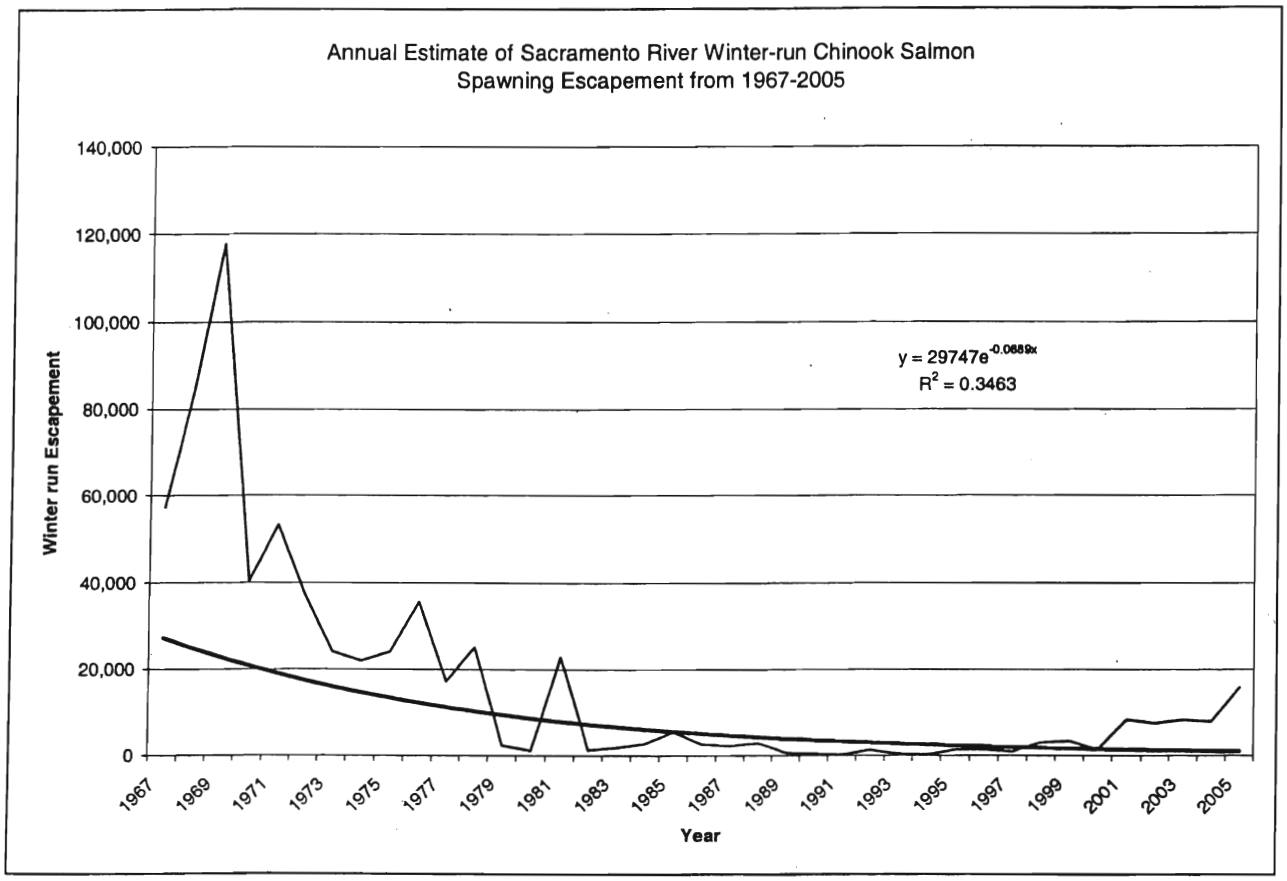


Figure 2:
Annual estimated Sacramento River winter-run Chinook salmon escapement population.
Sources: PFMC 2002, DFG 2004a, NMFS 1997
Trendline for figure 2 is an exponential function: $Y=29,747e^{-0.0889x}$, $R^2=0.3463$.

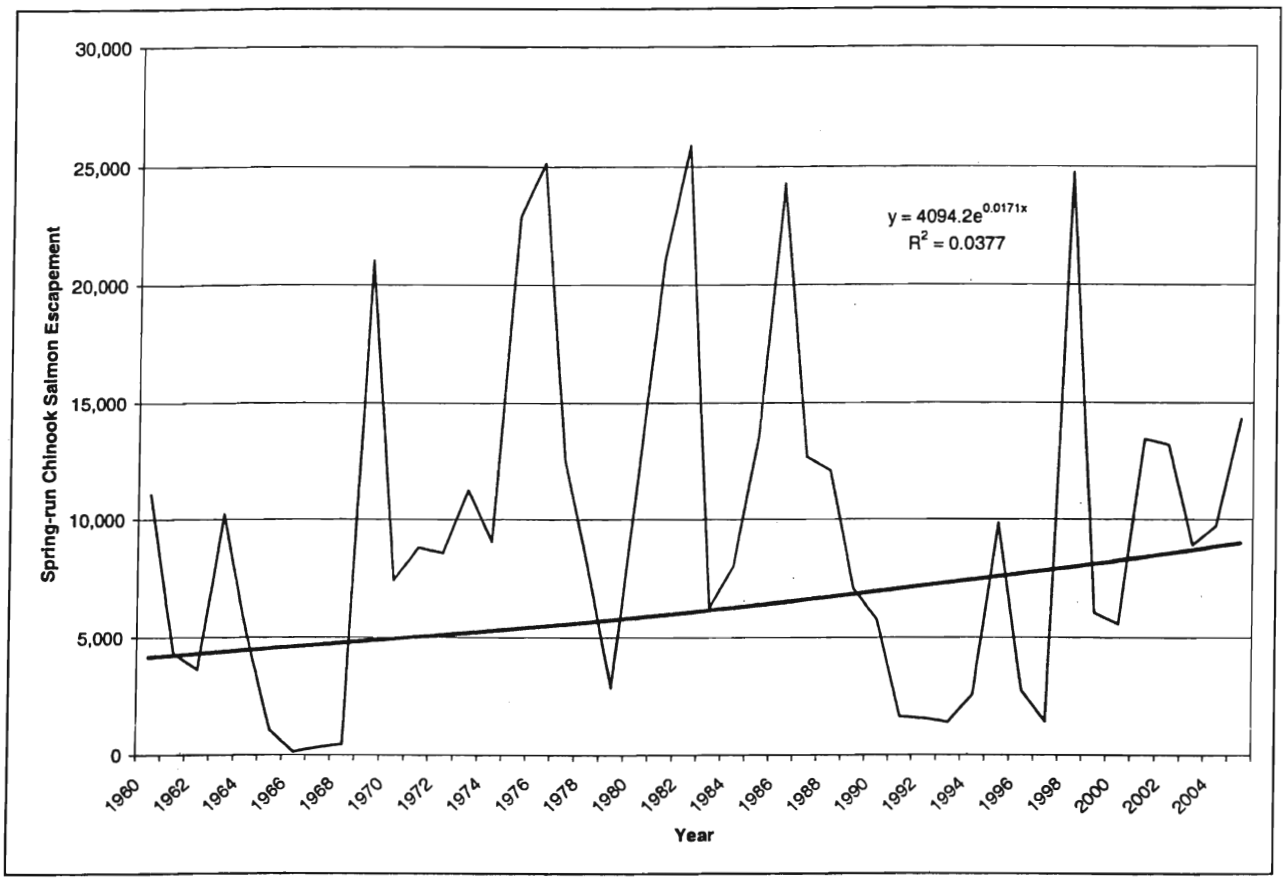
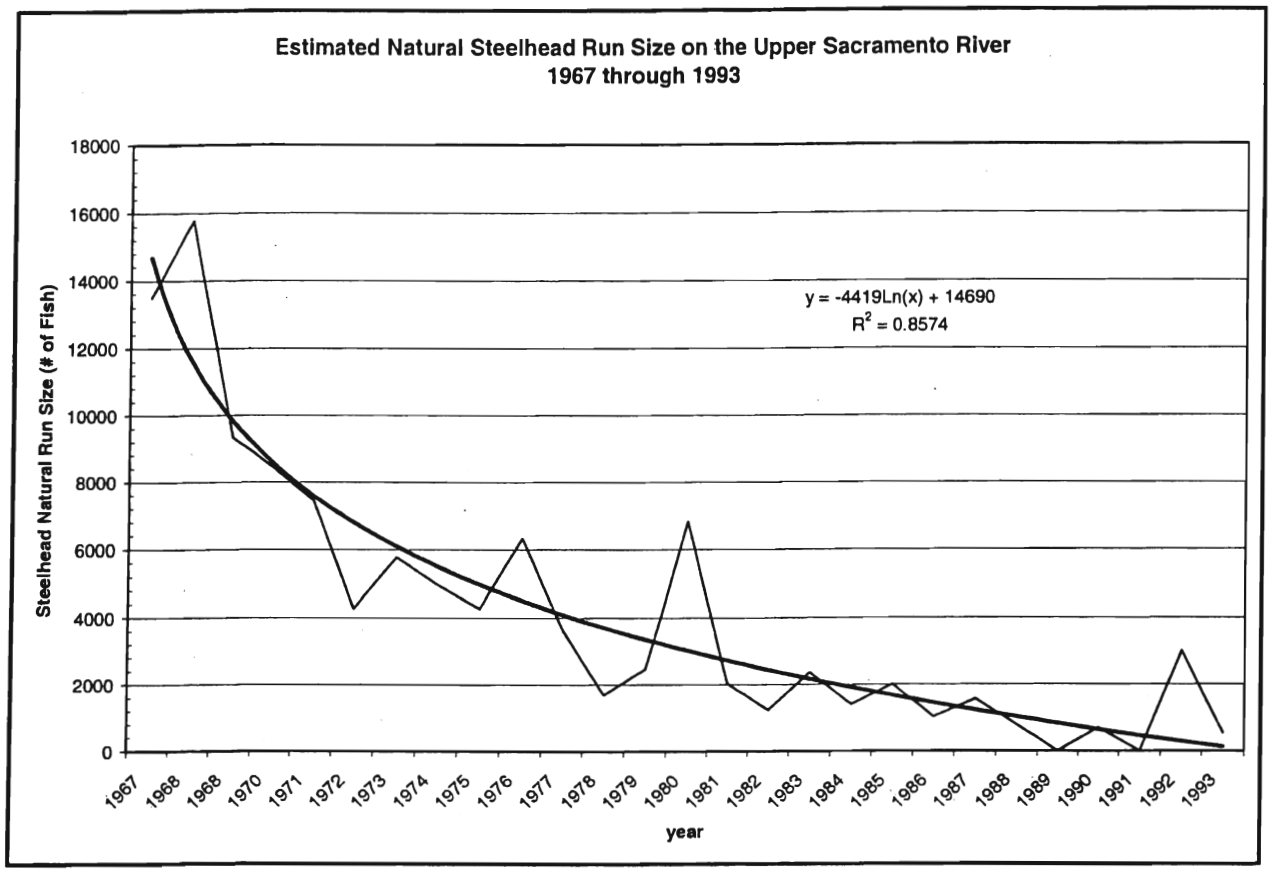


Figure 3:
Annual estimated Central Valley spring-run Chinook salmon escapement population for the Sacramento River watershed for years 1967 through 2003.
Sources: PFMC 2002, DFG 2004b, Yoshiyama 1998.
Trendline for figure 3 is an exponential function: $Y= 4094.2\ e^{0.0171}$, $R^2 = 0.0377$.



Note: Steelhead escapement surveys at RBDD ended in 1993

Figure 4:
Estimated Central Valley natural steelhead escapement population in the upper Sacramento River based on RBDD counts.
Source: McEwan and Jackson 1996.
Trendline for Figure 4 is a logarithmic function: $Y= -4419 \text{ Ln}(x) + 14690$ $R^2= 0.8574$

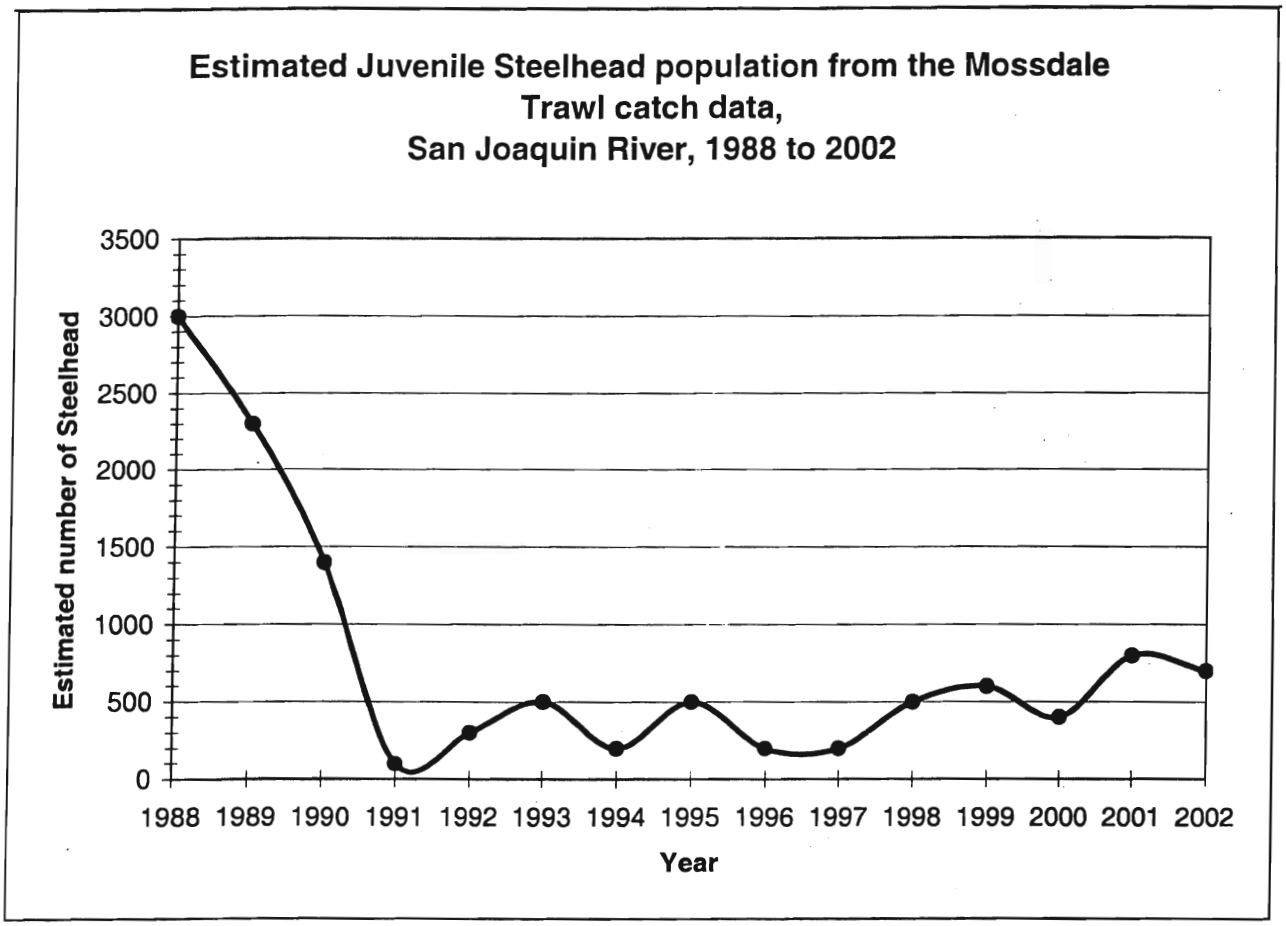


Figure 5:
Estimated number of juvenile Central Valley steelhead derived from the Mossdale trawl surveys on the San Joaquin River from 1988 to 2002.
Source: Marston (DFG), 2003.

Enclosure 2

Magnuson-Stevens Fishery Conservation and Management Act

ESSENTIAL FISH HABITAT CONSERVATION RECOMMENDATIONS

I. IDENTIFICATION OF ESSENTIAL FISH HABITAT

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended (U.S.C. 180 *et seq.*), requires that Essential Fish Habitat (EFH) be identified and described in Federal fishery management plans (FMPs). Federal action agencies must consult with NOAA's National Marine Fisheries Service (NMFS) on any activity which they fund, permit, or carry out that may adversely affect EFH. NMFS is required to provide EFH conservation and enhancement recommendations to the Federal action agencies.

EFH is defined as those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purposes of interpreting the definition of EFH, "waters" includes aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means habitat required to support a sustainable fishery and a healthy ecosystem; and, "spawning, breeding, feeding, or growth to maturity" covers all habitat types used by a species throughout its life cycle. The proposed project site is within the region identified as EFH for Pacific salmon in Amendment 14 of the Pacific Salmon FMP and for starry flounder (*Platichthys stellatus*) and English sole (*Parophrys vetulus*) in Amendment 11 to the Pacific Coast Groundfish FMP.

The Pacific Fishery Management Council (PFMC) has identified and described EFH, Adverse Impacts and Recommended Conservation Measures for salmon in Amendment 14 to the Pacific Coast Salmon FMP (PFMC 1999). Freshwater EFH for Pacific salmon in the California Central Valley includes waters currently or historically accessible to salmon within the Central Valley ecosystem as described in Myers *et al.* (1998), and includes the San Joaquin Delta (Delta) hydrologic unit (*i.e.*, number 18040003), Suisun Bay hydrologic unit (18050001) and the Lower Sacramento hydrologic unit (18020109). Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), Central Valley spring-run Chinook salmon (*O. tshawytscha*), and Central Valley fall-/late fall-run Chinook salmon (*O. tshawytscha*) are species managed under the Salmon Plan that occur in the Delta, Suisun Bay, and Lower Sacramento units.

Factors limiting salmon populations in the Delta include periodic reversed flows due to high water exports (drawing juveniles into large diversion pumps), loss of fish into unscreened agricultural diversions, predation by introduced species, and reduction in the quality and quantity of rearing habitat due to channelization, pollution, riprapping, *etc.* (Dettman *et al.* 1987;

California Advisory Committee on Salmon and Steelhead Trout 1988, Kondolf *et al.* 1996a, 1996b). Factors affecting salmon populations in Suisun Bay include heavy industrialization within its watershed and discharge of wastewater effluents into the bay. Loss of vital wetland habitat along the fringes of the bay reduce rearing habitat and diminish the functional processes that wetlands provide for the bay ecosystem.

A. Life History and Habitat Requirements

1. Pacific Salmon

General life history information for Central Valley Chinook salmon is summarized below. Information on Sacramento River winter-run and Central Valley spring-run Chinook salmon life histories is summarized in the preceding biological opinion for the proposed project (Enclosure 1). Further detailed information on Chinook salmon Evolutionarily Significant Units (ESU) are available in the NMFS status review of Chinook salmon from Washington, Idaho, Oregon, and California (Myers *et al.* 1998), and the NMFS proposed rule for listing several ESU of Chinook salmon (63 FR 11482).

Adult Central Valley fall-run Chinook salmon enter the Sacramento and San Joaquin Rivers from July through December and spawn from October through December while adult Central Valley late fall-run Chinook salmon enter the Sacramento and San Joaquin Rivers from October to April and spawn from January to April (U.S. Fish and Wildlife Service [FWS] 1998). Chinook salmon spawning generally occurs in clean loose gravel in swift, relatively shallow riffles or along the edges of fast runs (NMFS 1997).

Egg incubation occurs from October through March (Reynolds *et al.* 1993). Shortly after emergence from their gravel nests, most fry disperse downstream towards the Delta and into the San Francisco Bay and its estuarine waters (Kjelson *et al.* 1982). The remaining fry hide in the gravel or station in calm, shallow waters with bank cover such as tree roots, logs, and submerged or overhead vegetation. These juveniles feed and grow from January through mid-May, and emigrate to the Delta and estuary from mid-March through mid-June (Lister and Genoe 1970). As they grow, the juveniles associate with coarser substrates along the stream margin or farther from shore (Healey 1991). Along the emigration route, submerged and overhead cover in the form of rocks, aquatic and riparian vegetation, logs, and undercut banks provide habitat for food organisms, shade, and protect juveniles and smolts from predation. These smolts generally spend a very short time in the Delta and estuary before entry into the ocean. Whether entering the Delta or estuary as fry or juveniles, Central Valley Chinook salmon depend on passage through the Delta for access to the ocean.

2. Starry Flounder

The starry flounder is a flatfish found throughout the eastern Pacific Ocean, from the Santa Ynez River in California to the Bering and Chukchi Seas in Alaska, and eastwards to Bathurst inlet in Arctic Canada. Adults are found in marine waters to a depth of 375 meters. Spawning takes place during the fall and winter months in marine to polyhaline waters. The adults spawn in

shallow coastal waters near river mouths and sloughs, and the juveniles are found almost exclusively in estuaries. The juveniles often migrate up freshwater rivers, but are estuarine dependent. Eggs are broadcast spawned and the buoyant eggs drift with wind and tidal currents. Juveniles gradually settle to the bottom after undergoing metamorphosis from a pelagic larva to a demersal juvenile by the end of April. Juveniles feed mainly on small crustaceans, barnacle larvae, cladocerans, clams and dipteran larvae. Juveniles are extremely dependent on the condition of the estuary for their health. Polluted estuaries and wetlands decrease the survival rate for juvenile starry flounder. Juvenile starry flounder also have a tendency to accumulate many of the anthropogenic contaminants found in the environment.

3. English Sole

The English sole is a flatfish found from Mexico to Alaska. It is the most abundant flatfish in Puget Sound, Washington and is abundant in the San Francisco Bay estuary system. Adults are found in nearshore environments. English sole generally spawn during late fall to early spring at depths of 50 to 70 meters over soft mud bottoms. Eggs are initially buoyant, then begin to sink just prior to hatching. Incubation may last only a couple of days to a week depending on temperature. Newly hatched larvae are bilaterally symmetrical and float near the surface. Wind and tidal currents carry the larvae into bays and estuaries where the larvae undergo metamorphosis into the demersal juvenile. The young depend heavily on the intertidal areas, estuaries, and shallow near-shore waters for food and shelter. Juvenile English sole primarily feed on small crustaceans (*i.e.* copepods and amphipods) and on polychaete worms in these rearing areas. Polluted estuaries and wetlands decrease the survival rate for juvenile English soles. The juveniles also have a tendency to accumulate many of the contaminants found in their environment and this exposure manifests itself as tumors, sores, and reproductive failures.

II. PROPOSED ACTION

The proposed action is described in section II (*Description of the Proposed Action*) of the preceding biological opinion for endangered Sacramento River winter-run Chinook salmon, threatened Central Valley spring-run Chinook salmon, and Central Valley steelhead (*O. mykiss*), the proposed threatened southern population of North American green sturgeon, and critical habitat for winter-run Chinook salmon, spring-run Chinook salmon, and Central Valley steelhead (Enclosure 1).

III. EFFECTS OF THE PROJECT ACTION

The effects of the proposed action on salmonid habitat (*i.e.,* for winter, spring and fall/late fall-run Chinook salmon) are described at length in section V (*Effects of the Action*) of the preceding biological opinion, and generally are expected to apply to Pacific salmon EFH. The general contaminant effects on the quality of EFH for the two species of flatfish are expected to be similar to those for green sturgeon due to their benthic life history. Benthic dwelling flatfish will have direct contact with contaminated sediment and will ingest sediment as well as benthic

invertebrates during their foraging activities. Both the starry flounder and the English sole will spend more time as juveniles rearing in the action area than the Chinook salmon smolts. Therefore, these fish species will have a greater duration of exposure to the contaminants of concern than the juvenile Chinook salmon, leading to greater levels of adverse effects to the individual organisms.

IV. CONCLUSION

Based on the best available information, NMFS believes that the proposed Water Hyacinth Control Program may adversely affect EFH for Pacific salmon and groundfish during its five year term of operations (2006 to 2010).

V. EFH CONSERVATION RECOMMENDATIONS

NMFS recommends that the reasonable and prudent measures 1, 2, and 3 from the biological opinion, with their associated terms and conditions, be adopted as EFH Conservation Recommendations for EFH in the action area. In addition, certain other conservation measures need to be implemented in the project area, as addressed in Appendix A of Amendment 14 to the Pacific Coast Salmon Plan (PFMC 1999). NMFS anticipates that implementing those conservation measures intended to minimize disturbance and sediment and pollutant inputs to waterways would benefit groundfish as well.

Riparian Habitat Management–In order to prevent adverse effects to riparian corridors, the U.S. Department of Agriculture-Agricultural Research Service (USDA-ARS) should:

- Maintain riparian management zones of appropriate width in the San Joaquin River system and Delta that influence EFH;
- Reduce erosion and runoff into waterways within the project area; and
- Minimize the use of chemical treatments within the riparian management zone to manage nuisance vegetation along the levee banks and reclamation district's irrigation drain.

Bank Stabilization–The installation of riprap or other streambank stabilization devices can reduce or eliminate the development of side channels, functioning riparian and floodplain areas and off channel sloughs. In order to minimize these impacts, the USDA-ARS should:

- Use vegetative methods of bank erosion control whenever feasible. Hard bank protection should be a last resort when all other options have been explored and deemed unacceptable;
- Determine the cumulative effects of existing and proposed bio-engineered or bank hardening projects on salmon EFH, including prey species before planning new bank stabilization projects; and

- Develop plans that minimize alterations or disturbance of the bank and existing riparian vegetation.

Conservation Measures for Construction/Urbanization–Activities associated with urbanization (*e.g.*, building construction, utility installation, road and bridge building, and storm water discharge) can significantly alter the land surface, soil, vegetation, and hydrology and subsequently adversely impact salmon EFH through habitat loss or modification. In order to minimize these impacts, the USDA-ARS and the applicant should:

- Plan development sites to minimize clearing and grading;

- Use Best Management Practices in building as well as road construction and maintenance operations such as avoiding ground disturbing activities during the wet season, minimizing the time disturbed lands are left exposed, using erosion prevention and sediment control methods, minimizing vegetation disturbance, maintaining buffers of vegetation around wetlands, streams and drainage ways, and avoid building activities in areas of steep slopes with highly erodible soils. Use methods such as sediment ponds, sediment traps, or other facilities designed to slow water runoff and trap sediment and nutrients; and

- Where feasible, reduce impervious surfaces.

Wastewater/Pollutant Discharges–Water quality essential to salmon and their habitat can be altered when pollutants are introduced through surface runoff, through direct discharges of pollutants into the water, when deposited pollutants are resuspended (*e.g.*, from dredging or ship traffic), and when flow is altered. Indirect sources of water pollution in salmon habitat includes run-off from streets, yards, and construction sites. In order to minimize these impacts, the USDA-ARS and the applicant should:

- Monitor water quality discharge following National Pollution Discharge Elimination System requirements from all discharge points;

- For those waters that are listed under Clean Water Act section 303 (d) criteria (*e.g.*, the Delta), work with State and Federal agencies to establish total maximum daily loads and develop appropriate management plans to attain management goals; and

- Establish and update, as necessary, pollution prevention plans, spill control practices, and spill control equipment for the handling and transport of toxic substances in salmon EFH (*e.g.*, oil and fuel, organic solvents, raw cement residue, sanitary wastes, *etc.*). Consider bonds or other damage compensation mechanisms to cover clean-up, restoration, and mitigation costs.

VI. STATUTORY REQUIREMENTS

Section 305 (b) 4(B) of the MSA requires that the Federal lead agency provide NMFS with a detailed written response within 30 days, and 10 days in advance of any action, to the EFH conservation recommendations, including a description of measures adopted by the lead agency for avoiding, minimizing, or mitigating the impact of the project on EFH (50 CFR §600.920[j]). In the case of a response that is inconsistent with our recommendations, the Corps must explain its reasons for not following the recommendations, including the scientific justification for any disagreement with NMFS over the anticipated effects of the proposed action and the measures needed to avoid, minimize, or mitigate such effects.

VII. LITERATURE CITED

California Advisory Committee on Salmon and Steelhead Trout. 1998. Restoring the balance. California Department of Fish and Game, Inland Fisheries Division, Sacramento, California, 84 pages.

Dettman, D.H., D.W. Kelley, and W.T. Mitchell. 1987. The influence of flow on Central Valley salmon. Prepared by the California Department of Water Resources. Revised July 1987. 66 pages.

Healey, M.C. 1991. Life history of Chinook salmon. *In* C. Groot and L. Margolis (editors) Pacific salmon life histories, pages 213-393. University of British Columbia Pres, Vancouver, British Columbia.

Kjelson, M.A., P.F. Raquel, and F.W. Fisher. 1982. Life history of fall-run juvenile Chinook salmon, *Oncorhynchus tshawytscha*, in the Sacramento-San Joaquin estuary, California. *In* V.S. Kennedy (editor), Estuarine comparisons, pages 213-393. Academic Press, New York, New York.

Kondolf, G.M., J C. Vick, and T.M. Ramirez. 1996a. Salmon spawning habitat rehabilitation in the Merced, Tuolumne, and Stanislaus Rivers, California: an evaluation of project planning and performance. University of California Water Resources Center Report No. 90, ISBN 1-887192-04-2, 147 pages.

Kondolf, G.M., J.C. Vick, and T.M. Ramirez. 1996b. Salmon spawning habitat on the Merced River, California: An evaluation of project planning and performance. Transactions of the American Fisheries Society 125:899-912.

Lister, D.B., and H.S. Genoe. 1970. Stream habitat utilization by cohabiting underyearlings of Chinook (*Oncorhynchus tshawytscha*) and coho (*O. kisutch*) salmon in the Big Qualicum River, British Columbia. Journal of the Fisheries Research Board of Canada 27:1215-1224.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grant, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status review of Chinook salmon from Washington, Idaho, Oregon, and California. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-35, 443 pages.

National Marine Fisheries Service. 1997. Proposed recovery plan for the Sacramento River winter-run Chinook salmon. National Marine Fisheries Service, Southwest Region, Long Beach, California, 288 pages plus appendices.

Pacific Fishery Management Council. 1999. Description and identification of essential fish habitat, adverse impacts and recommended conservation measures for salmon.

Amendment 14 to the Pacific Coast Salmon Plan, Appendix A. Pacific Fisheries Management Council, Portland, Oregon.

Reynolds, F.L., T.J. Mills, R. Benthin, and A. Low. 1993. Restoring Central Valley streams: A plan for action. California Department of Fish and Game, Sacramento, California, 129 pages.

U.S. Fish and Wildlife Service. 1998. Central Valley Project Improvement Act tributary production enhancement report. Draft report to Congress on the feasibility, cost, and desirability of implementing measures pursuant to subsections 3406(e)(3) and (e)(6) of the Central Valley Project Improvement Act. U.S. Fish and Wildlife Service, Central Valley Fish and Wildlife Restoration Program Office, Sacramento, California.