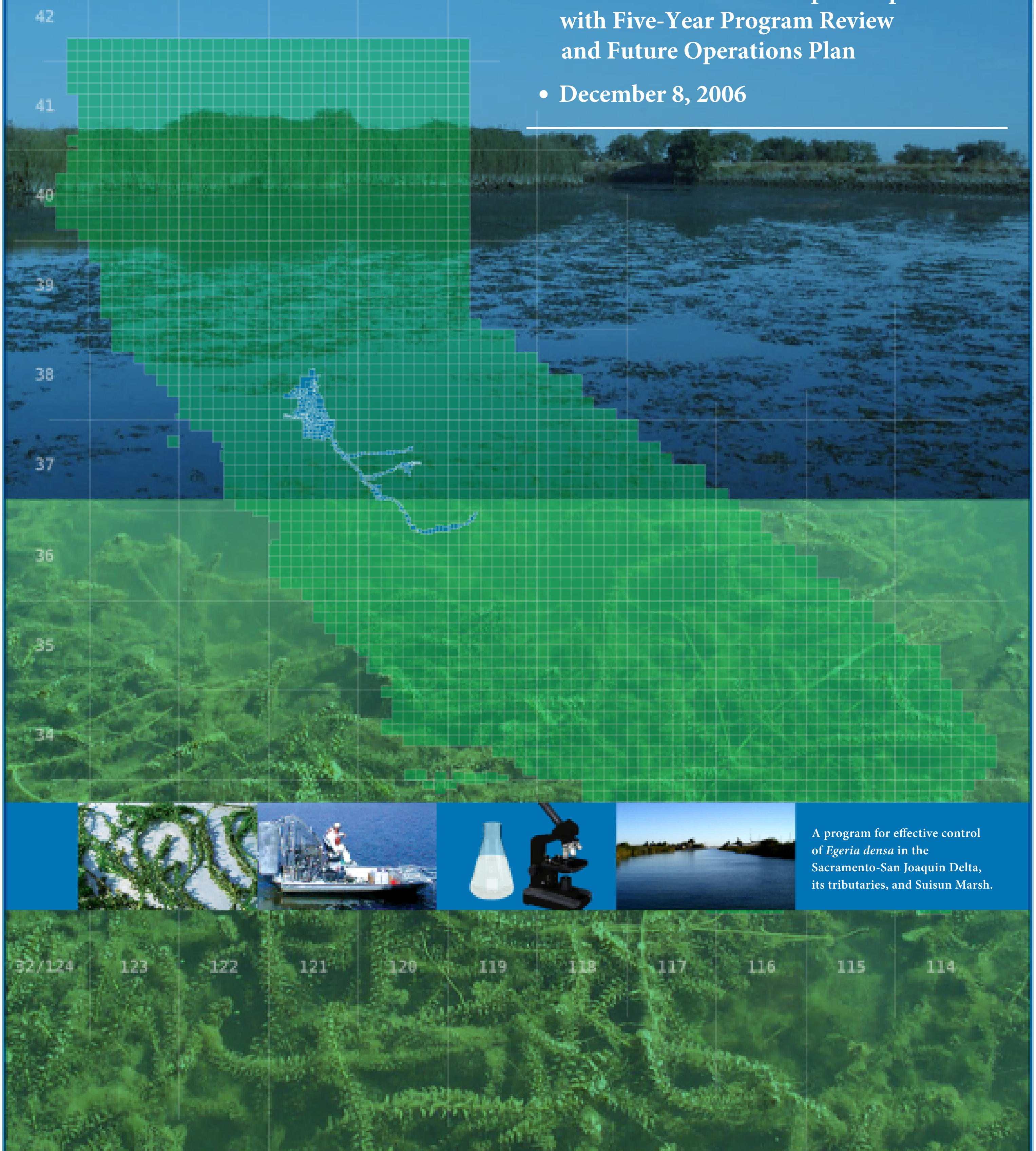
State of California
Department of Boating and Waterways
Egeria densa Control Program (EDCP)

- **Second Addendum to 2001 Environmental Impact Report with Five-Year Program Review and Future Operations Plan**
- **December 8, 2006**



A program for effective control of *Egeria densa* in the Sacramento-San Joaquin Delta, its tributaries, and Suisun Marsh.

State of California
Department of Boating and Waterways
Egeria densa Control Program (EDCP)

- Second Addendum to
2001 Environmental Impact Report
with Five-Year Program Review
and Future Operations Plan
- December 8, 2006

A program for effective control of *Egeria densa* in the Sacramento-San Joaquin Delta, its tributaries, and Suisun Marsh.

Egeria densa Control Program Second Addendum to 2001 Environmental Impact Report

with

Five-Year Program Review and Future Operations Plan

Prepared by

The State of California
Department of Boating and Waterways

David Johnson
Deputy Director

Marcia Carlock
Aquatic Weed Unit Manager

Tim Artz
Field Operations Manager

December 8, 2006

Copies of this report in hard copy form, or on compact disc, can be obtained from the California Department of Boating and Waterways. To request a copy, please contact:

Aquatic Weed Program
California Department of Boating and Waterways
2000 Evergreen Street, Suite 100
Sacramento, California 95815-3896
(916) 263-8143

A PDF version of this report also is available for viewing and downloading at the following internet address:

www.dbw.ca.gov

Table of Contents

Table of Contents

Chapters **Page**

Executive Summary ES-1

1. Introduction 1-1
   - A. DBW Rationale for Second Addendum to 2001 EIR 1-2
   - B. Five Year Program Review and Future Operations Plan 1-2
   - C. Program Efficacy Challenges and Lack of Program Environmental Impacts 1-3
   - D. The Future of *Egeria densa* in the Delta 1-5
   - E. EIR Second Addendum Certification 1-6
2. Program Operations (2001 to 2005) 2-1
   - A. Regulatory Requirements and Compliance 2-1
   - B. Areas of EDCP Treatments 2-3
   - C. Aquatic Herbicide Use 2-7
   - D. Application Methods and Techniques 2-9
   - E. Program Resources 2-11
3. *Egeria densa* Infestation and Program Efficacy (2001 to 2005) 3-1
   - A. Overview of Efficacy for the EDCP 3-1
   - B. Importance of Efficacy to EDCP Environmental Impacts 3-2
   - C. Efficacy Significance Threshold for the EDCP 3-2
   - D. The Risk of Status Quo *Egeria densa* in the EDCP Area 3-3
   - E. Measurement of Efficacy for the EDCP 3-5
   - F. Key Factors Affecting EDCP Efficacy 3-37
   - G. Optimally Effective *Egeria densa* Management by Keying Program Control to Plant Biology 3-40
   - H. Future EDCP Efforts for Efficacy Measurement and Improved Control 3-40
   - I. EDCP Efficacy Conclusions 3-41
4. Environmental Monitoring and Analysis of Potential Environmental Impacts (2001 to 2005) 4-1
   - A. Water Quality Monitoring Sites 4-4
   - B. Water Quality Monitoring Data Collections 4-4
   - C. Water Quality Monitoring Data Analysis and Results 4-6
   - D. A Third Party Environmental Assessment of the EDCP and Ongoing Delta Pelagic Organism Decline (POD) Investigations 4-30
5. Future Program Operations (2006 to 2010) 5-1
   - A. Areas of Treatment 5-1
   - B. Control Methods and Strategies 5-7

Table of Contents (continued)

C. Efficacy Monitoring 5-10
D. Environmental Monitoring 5-11
E. Program Reporting 5-12
F. Coordination with Aquatic Species Control Plans and Efforts 5-12
G. Portfolio of Focused Improvements 5-15

6. Analysis of Changes to EDCP (2006 to 2010) 6-1
A. Changes to EDCP Treatment Areas and Timing 6-1
B. Changes to EDCP Control Methods 6-5
C. Increases in Treatment Intensity 6-9
D. Summary of Potential Program Impacts 6-10

Appendices

A. EDCP CEQA Addendum Assessment A-1
A. Environmental Impact Report Background A-1
B. Context for Second Addendum to 2001 EDCP EIR A-2
C. CEQA Guidelines for Second Addendum A-3

B. EDCP DBW Sponsored Research Reports B-1
A. 2005 .... B-1
B. 2004 .... B-2
C. 2003 .... B-5
D. 1997/1998 .... B-6

C. Sonar Q Label and Material Safety Data Sheet C-1

D. Potential Impacts to Listed Fish Species or Critical Habitat D-1
A. Use of *Egeria densa* Beds by Fish D-1
B. Potential for Exposure of Special Status and Other Fish to EDCP Treatments D-3
C. Direct Impacts to Fish: Toxicity D-5
D. Direct Impacts to Fish: Bioaccumulation D-11
E. Indirect Impacts to Fish: Impacts to Habitat D-13
F. Indirect Impacts to Fish: Decrease in Abundance of Invertebrate Prey Base D-14
G. Indirect Impacts to Fish: Impacts to Essential Fish Habitat (EFH) D-20

Executive Summary

Executive Summary

In the 2001 *Egeria densa* Control Program Environmental Impact Report (2001 EDCP EIR), the California Department of Boating and Waterways (DBW) proposed a five-year program. The 2001 EDCP EIR indicated that the EDCP was not to continue program operations without meeting its intended objectives. The EDCP was required to submit supplemental environmental documentation after five years (in 2006) in order to support continued operations.[1] This Second Addendum report, prepared in 2006, following five years of operations (2001 to 2005), fully meets this environmental documentation requirement.

This Second Addendum summarizes EDCP results over the past five years (from program inception in 2001 to 2005). During this time, the EDCP has learned a great deal about program operations; *Egeria densa* infestation and program efficacy; and environmental monitoring and the potential for environmental impacts from the program.

This Second Addendum provides a vision for future EDCP operations (from 2006 to 2010). Program changes plan to include an expanded site list; increased treatment acreages; earlier system-wide treatment start dates; a Franks Tract Management Area focus; addition of Sonar Quick Release (Sonar Q); removal of Sonar Slow Release Pellet (Sonar SRP); conditional removal of mechanical harvesting; and removal of the Two-Year Komeen Research Trials.[2] This Second Addendum analyzes potential impacts of all these changes to the EDCP.

[1] From 2001 EDCP EIR, page E-3.

[2] The First Addendum to the 2001 EDCP EIR was prepared in 2003 to incorporate the use of Sonar Precision Release (Sonar PR).

Program Operations (2001 to 2005)

Aquatic herbicides dissipate rapidly, posing tremendous challenges for *Egeria densa* control in the highly tidal Delta. The EDCP has varied its control approaches and methods over the past five years. With Sonar products, the EDCP (1) used combinations of aqueous and pellet formulations; (2) treated generally between July 1st and October 15th of each year; (3) varied application concentrations throughout a treatment (e.g., constant, declining); and (4) tested different application intervals. The EDCP also used sequential treatments of Reward (Diquat) and Sonar (Fluridone) following labeled application rates and timing interval specifications.

During the past five years, the EDCP had relatively limited earlier treatment start dates (i.e., April 1st to June 30th). Treatment start date restrictions were specified in Biological Opinions from the National Oceanic and Atmospheric Administration, National Marine Fisheries Services (NOAA Fisheries); and the United States Fish and Wildlife Service (USFWS).

Research shows that optimal treatment of *Egeria densa* should occur during weak points during the lifecycle of the plant's growth. Carbohydrate reserves are lowest in April and May, and this period of time has been considered the optimal time to treat *Egeria densa*. Early treating of *Egeria densa* in the Spring is imperative for EDCP efficacy. Resource limitations and relatively modest aquatic herbicide efficacy potentials also constrained the EDCP.

EDCP treatments were conducted at 19 sites, with the largest treatment acreages being at Franks Tract, Rhode Island, Big Break Wetlands, Venice Cut, and Little Venice Island. The EDCP's annual treatment acreage averaged 466 acres per year, with a maximum of 622 acres in 2005. This treatment acreage is in contrast to the maximum permitted 1,733 acres per year specified in the 2001 EDCP EIR.

The EDCP was resource-constrained between 2001 and 2005. The 2005 Aquatic Weed Unit program budget was $6.2 million for both the EDCP and the other control program managed by the Aquatic Weed Unit, the Water Hyacinth Control Program. At times, as much as 65 percent of the annual EDCP budget was spent on environmental monitoring, regulatory compliance, and surveillance.

Egeria densa Infestation and Program Efficacy (2001 to 2005)

During the past five years, while the EDCP had "site efficacy," the EDCP did not realize measurable "program efficacy." *Egeria densa* continued to grow and spread in the Delta, with current year 2006 infestation estimated at approximately 11,500 to 14,000 acres, or about 17 to 21 percent of Delta region water acres. Untreated, *Egeria densa* may grow at an average annual compound rate of growth of more than ten percent per year.

There is no evidence that EDCP operations used more herbicides than needed for overall program control and needed to be effectual on a site-specific basis. However, there is risk to the Delta environment from the lack of EDCP program efficacy and its inability to control the spread of *Egeria densa*.

Environmental Monitoring and the Potential for Environmental Impacts (2001 to 2005)

EDCP environmental monitoring results for the past five years showed that the EDCP did not cause negative impacts to the Delta environment. Water sampling and water quality monitoring indicated (1) no degradation of Delta water quality following treatments; (2) minimal persistent concentrations of chemicals following treatments (most far below labeled rates, application concentrations, and guiding standards); (3) and less than significant adverse toxicity affects on test organisms used by EDCP contract laboratories. Third-party analyses of EDCP environmental monitoring data, conducted by the Ecological Program (IEP), Pelagic Organism Decline (POD) Workgroup, supported these conclusions.[3]

Future Program Operations (2006 to 2010)

Subject to Federal regulatory consultations and approvals in 2007, for maximum treatment flexibility and greater potential program efficacy, the EDCP plans to increase its list of treatment sites from 35 to 73; begin treating any of these sites by April 1st; and increase site-specific treatment acreages up to the full

[3] Reward (Diquat) continues to show the potential to adversely impact aquatic invertebrates and larval fish. These effects were fully considered in the 2001 EDCP EIR. To mitigate for this continuing concern, the EDCP will reduce Reward (Diquat) use in future years in favor of greater use of Sonar (Fluridone) products which have significantly less potential impacts on aquatic species than Reward (Diquat).

amount of *Egeria densa* coverage. The EDCP will create a Franks Tract Management area, treat this area intensively for the next three years, and create new environmental monitoring protocols for this area. Total EDCP treatment acreage, in a given year, plans to increase from 1,733 acres in the 2001 EDCP EIR, to a range of 3,000 to 5,000 acres[4].

EDCP treatments, at a given site, will be more aligned with unique water quality conditions, linked to prior site efficacy results, and, for Sonar, more closely adjusted using ongoing concentration measurements. The EDCP will minimize treatments not conducted at maximum labeled rates.

The DBW will allocate more of its current Aquatic Weed Unit resources to the EDCP. The DBW also, over time, will attempt to seek additional resources and funding strategies for the EDCP.

The EDCP will consider several program focused improvements. A total of 17 different improvements in the areas of program administration, environmental monitoring, field operations, and efficacy measurement are identified in this report.

The EDCP believes that stakeholder collaboration will be more critical in the future as the Delta ecosystem continues to undergo more intensive scrutiny from a variety of vested interests, including State and local departments/agencies and external organizations. Where reasonable, the EDCP will seek opportunities to align its control efforts and objectives with that of CALFED, the California Department of Fish and Game, the California Department of Water Resources, the California Department of Food and Agriculture, the California Resources Agency (Delta Vision Program), local water districts, and other weed control organizations. The EDCP also will meet future California Aquatic Invasive Species Management Plan objectives and continue to share ongoing program results with its various stakeholders.

[4] The EDCP is currently in formal consultations with NOAA Fisheries on a five-year renewal of its biological opinion (BO). Results of this 2007 consultation, and a new BO, will have a bearing on the extent to which these program changes are allowed.

Analysis of Changes to EDCP (2006 to 2010)

The EDCP concludes that the potential impacts from the various expected future program changes will not: (1) create new significant environmental effects, or (2) increase the significance of impacts documented in the 2001 EDCP EIR, and 2003 First Addendum to the EIR. Potential impacts from the EDCP will actually decrease as a result of conditionally removing mechanical harvesting; removing Komeen Research Trials; and by including offsetting beneficial program impacts, previously unrecognized. Support for these conclusions is provided in Chapter 6.

EDCP efforts may not result in successful complete vegetation restoration of Delta waterways due to the presence of other non-native invasive aquatic weeds. Other non-native species that could fill in, and grow to replace *Egeria densa* as it is controlled by the EDCP include, among others, *Myriophyllum spicatum* (Eurasian Watermilfoil) and *P. crispus* (Curlyleaf Pondweed). These non-*Egeria*, non-native, species have different growth properties that may require other control approaches and techniques than those used by the EDCP.

Successful long-term Delta restoration efforts ultimately will need to address these other non-native invasive aquatic weeds. Currently, these other non-native weeds do not fall under the scope of the EDCP. Long-term successful Delta restoration will be dependent on an as yet to be defined Delta-wide *Integrated Vegetation Management Strategy* (IVMS).

Chapter 1
Introduction

The California Department of Boating and Waterways (DBW) has operated the *Egeria densa* Control Program (EDCP) in the Sacramento-San Joaquin Delta, and its tributaries (Delta), since program inception in 2001. The EDCP was developed in order to respond to 1997 State of California legislation (Rainey, AB 2193), authorizing the program.

In the 2001 EDCP Environmental Impact Report (2001 EDCP EIR), the DBW indicated that it would (1) review EDCP operations in five years to ensure that the program was meeting its intended objectives and, (2) where necessary, prepare supplemental environmental documentation to continue program operations. The DBW has prepared this Second Addendum to the 2001 EDCP EIR (1) in response to the five-year EIR review requirement, and (2) to communicate expected future changes to program operations over the next five years.

Subject to terms stated in the forthcoming 2007 National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NOAA Fisheries), Five-Year Biological Opinion (BO), the EDCP over the next five years, from 2006 to 2010, wants to change and update program operations, including the following key items:

- Expand treatment areas to include sites within most of the legal Delta
- Focus on a newly defined Franks Tract regional management area for the first three-years (2006 to 2008)[1] of the five-year planning period
- Remove a constraint tying (1) specific treatment methods to specific sites in any given year and (2) how much of the site it will treat
- Allow earlier April 1st treatment start dates for all sites
- Incorporate the use of Sonar (Fluridone) "Q" as a potential herbicide treatment method
- Reduce overall Reward use
- Remove the Sonar (Fluridone) "Slow Release" Pellet
- Remove the limited two-year Komeen research trials from the EDCP
- Conditionally remove mechanical harvesting until viable technologies are available
- Modify future treatment strategies and approaches through adaptive management lessons-learned over the past five years.

This Second Addendum addresses new information about the EDCP that was not available at the time the 2001 EDCP EIR was prepared, including:

- Measurements of program and site efficacy
- Measurements of environmental impacts from EDCP treatments
- Results of special scientific studies commissioned by the EDCP

[1] While the DBW intends to focus treatments in the Franks Tract management area over three years (including neighboring sloughs), this does not limit the DBW from conducting treatments, as needed, in other Delta areas. Following the three-year period, treatments would not necessarily focus on the Franks Tract management area, but would be open to all Delta areas.

- Lessons-learned from five previous years of program operations.

Beyond meeting requirements for a Second Addendum to the 2001 EDCP EIR, this report serves the purposes of (1) documenting the past five-years of EDCP operations (2001 to 2005), and (2) providing a planning document for the next five-year period (2006 to 2010).

In addition to the introduction chapter *(Chapter 1),* this report includes a summary of program operations and regulatory compliance *(Chapter 2),* an evaluation of program efficacy *(Chapter 3),* and an analysis of environmental monitoring data *(Chapter 4).* The report also provides a future operating vision for the EDCP *(Chapter 5),* and an analysis of potential impacts from proposed changes to the EDCP *(Chapter 6).*

The remainder of this chapter includes the following four (4) sections:

A. DBW Rationale for Second Addendum to 2001 EIR
B. Five Year Program Review and Future Operations Plan
C. Program Efficacy Challenges and Lack of Program Environmental Impacts
D. The Future of *Egeria densa* in the Delta
E. EIR Second Addendum Certification.

A. DBW Rationale for Second Addendum to 2001 EIR

The DBW internally assessed whether to prepare a Supplemental EIR, a Subsequent EIR, or an Addendum to the 2001 EDCP EIR. CEQA environmental documentation considerations addressed by the DBW, for the EDCP, are described in **Appendix A,** EDCP CEQA Addendum Assessment.

The DBW elected to prepare this Second Addendum based on the fact that, after careful examination, the significance of environmental impacts previously stated in the 2001 EDCP EIR were not expected to increase, and no new significant environmental impacts were expected, from the proposed EDCP changes and updates in this report. The DBW has concluded that the potential for environmental impacts actually will be lessened from the expected changes and updates to the EDCP versus that originally estimated in the 2001 EDCP EIR.

B. Five Year Program Review and Future Operations Plan

The five years from 2001 to 2005 represented a developmental period for the EDCP during which time the DBW’s Aquatic Weed Unit initiated program operations; developed program procedures and protocols; obtained Federal and State permits and conducted formal consultations with regulatory agencies; developed a comprehensive environmental monitoring program; and refined various treatment strategies and approaches. Some aspects of the program’s development were based on “trial and error” efforts as would be the case with any new major invasive species control program.

No similar aquatic weed control program to the EDCP exists in the United States that involves control of *Egeria densa* in such a highly complex, tidal Delta environment. The EDCP was quickly developed from a conceptual level, to an operating level, without other best practices or model programs to learn from. The EDCP had to modify treatment vessels for Reward and Sonar applications; develop work boat herbicide pumping systems; build new aquatic herbicide injection tools; test and refine aquatic herbicide types; vary application rates and techniques based on various unique field conditions in an effort to achieve targeted herbicide concentrations; modify research vessels for environmental monitoring; and develop custom environmental monitoring protocols.

Between 2001 and 2005, EDCP treatments were conducted at 24 sites in the Delta.[2] EDCP treatments ranged from between 268 (2001) to 622 (2005) acres, or no more than 36 percent of the originally allowed treatment acreage of 1,733 acres.[3]

In response to difficult and dynamic environmental conditions present in the Delta, the DBW has adjusted its EDCP treatment approaches over time, using combinations of methods, where possible, and seeking alternative means to optimize Sonar applications. The EDCP has used combinations of Sonar (Fluridone) aqueous and Sonar pellet applications; sequential applications of Reward (Diquat) followed by Sonar, not exceeding labeled rates and providing proper intervals between the different treatment methods; and a wide array of variations for Sonar applications (e.g., biweekly applications, weekly applications, and varying application concentrations over the treatment periods).

Since program inception, the DBW has been severely resource-constrained. Up to four, two-person, field crews have been used to control *Egeria densa* in the 66,000-acre Delta region. DBW field personnel have split time throughout the year between the EDCP, and a similar DBW Delta-wide invasive species control program, the Water Hyacinth Control Program (WHCP).

A significant portion (at times up to 65 percent) of the EDCP budget over the past five years has been associated with program environmental monitoring and *Egeria densa* measurement and surveillance. The DBW has a high priority need to increase its field operation staffing to meet the demands of this ever-expanding, invasive aquatic weed. The DBW intends to seek alternative and supplemental resources and funding strategies for the EDCP.

C. Program Efficacy Challenges and Lack of Program Environmental Impacts

While the DBW has achieved many of its original program objectives between 2001 and 2005, as shown in **Table 1.1**, on the next page, the EDCP has been unable to reduce *Egeria densa* infestation acreages and the spread of *Egeria densa* to other sites in the Delta.

---

[2] The DBW has identified 369 unique DBW site identification numbers spanning the legal Delta, and its tributaries.

[3] Allowed in the 2001 EDCP EIR, and subject to NOAA Fisheries BO and U.S. Fish and Wildlife Services BO Constraints.

Egeria densa continues to grow exponentially in the Delta. Efficacy data suggests that *Egeria densa* may grow at a rate of approximately ten percent, or more, per year. At this rate, *Egeria densa* levels, untreated, could double in the Delta every seven years.

While, the EDCP has had success with site-specific efficacy, the EDCP has been challenged to realize measurable program efficacy as a result of a combination of factors, including the large size of the Delta in relation to resource, regulatory, and operational constraints. In areas where site efficacy has been realized, *Egeria densa* in some cases returns back to pre-treatment levels, but on an overall basis the EDCP has realized an approximately six percent year-to-year reduction in *Egeria densa* levels for sites treated.

Table 1.1
***Egeria densa* Control Program**
2001 EDCP EIR Objectives and Performance Measures
(2001 to 2005)

Objectives	Performance Measures (Outcomes)	Achievement 2001 to 2005
1. Limit future growth and spread of *Egeria* in the Delta	■ **Reduce total acres infested with *Egeria***	**No**
2. Improve boat and vessel navigation in the Delta	■ Reduce *Egeria* biomass at high priority navigation sites currently infested with *Egeria*	Yes (marginally)
3. Utilize the most efficacious methods available with the least environmental impacts	■ **Prevent infestation of new sites**	**No**
4. Prioritize sites so EDCP activities are focused on sites with a high degree of infestation and navigational significance	■ Produce fewer incidents of boat navigation problems	Yes (marginally)
5. Employ a combination of control methods to allow maximum flexibility		Yes
6. Improve the EDCP as more information is available on control methods used in the Delta	■ Prepare reports for regulatory agencies and the public summarizing monitoring results	Yes
7. Monitor results of the EDCP to fully understand impacts of the EDCP on the environment	■ Increase the total efficacy level of the EDCP, and of each control method over time	Yes
	■ Limit the number and significance of environmental impacts resulting from the EDCP	Yes
8. Minimize EDCP control efforts, if sufficient efficacy of *Egeria* is realized	■ Limit the number of acres treated with methods that have the potential for adverse environmental impacts	Yes
9. Minimize use of methods that could cause adverse environmental impacts	■ **Reduce the quantity of herbicides applied to the Delta over time**	**No**

Original source: 2001 *Egeria densa* Control Program Environmental Impact Report, Page 1-6.

The EDCP has used a range of different scientific researchers and methodologies to measure *Egeria densa* levels in the Delta. Prior measurement methods have included aerial photography monitoring, hyperspectral monitoring, hydroacoustic monitoring, and ground truth monitoring. Several of these methods are only in the developmental stages. The DBW expects to refine some of these methods, abandon others, and develop new methods, over the next five years, to improve its understanding of the location and quantities of *Egeria densa* in the Delta, and efficacy impacts of the EDCP.

While success with program efficacy has been difficult to achieve, a positive corollary is that the program has not caused any significant environmental impacts. Upon examination of five years of extensive environmental monitoring data collected for the EDCP between 2001 and 2005, the DBW has concluded that <u>there were no measurable negative environmental impacts from the EDCP during this time</u> (see Chapter 4).

These "no environmental impact" findings have been supported by an independent, third-party review (the Interagency Ecological Program (IEP) Pelagic Organism Decline (POD) Workgroup), who found that Sonar applications, the major aquatic herbicide used for the EDCP, are unlikely to have the potential to cause Delta ecosystem water quality impacts, and are unlikely to cause toxicity to non-target aquatic organisms. The DBW will continue to use its database of water quality and environmental monitoring data, in conjunction with efficacy measurement information, to identify ideal treatment conditions and refine its application methods.

D. The Future of *Egeria densa* in the Delta

This report was prepared at a time when other key governmental agencies (e.g., DWR and CALFED) were interested in revitalizing Delta-wide shallow water habitat; addressing the future of Franks Tract; and making concerted efforts to enhance the Delta ecosystem. Entities involved with shallow water habitat restoration efforts have suggested targeting areas away from those areas infested with *Egeria densa*, inferring that areas with *Egeria densa* cannot readily be restored. The EDCP will be coordinated with these other similar efforts so as to be considered an integral partner in these ecosystem repair and revitalization efforts.

This report also comes at a time when the future Delta ecosystem could potentially be seriously jeopardized by continued *Egeria densa* infestation. *Egeria densa* mats alter the physical bathymetry of Delta channels and act as a sponge by siphoning off and storing sediment traveling through the Delta. *Egeria densa* is not as suitable a habitat for aquatic life as native aquatic vegetation. This report details a number of ecosystem problems associated with *Egeria densa* (see Chapter 3).

Egeria densa may ultimately be shown to pose a Delta safety risk. A 2006 police report from San Joaquin County indicated that the weeds may have contributed to the drowning death of a physician in

Potato Slough. *Egeria densa* is the predominant underwater weed in the area.

The DBW has actively sponsored and commissioned scientific studies related to the use of EDCP aquatic herbicides in the Delta, and the impact of these aquatic herbicides on various special status species. A summary of these studies is referenced in Chapter 2.

These research studies suggest that aquatic herbicides used for the EDCP are relatively benign from an environmental standpoint, and the studies support findings for lack of significant environmental impacts resulting from the EDCP. The DBW has nearly exhausted virtually all potential studies related to the aquatic herbicides that it uses, only to find limited potential for any environmental impacts from these aquatic herbicides.

EDCP management has now developed a body of program operational knowledge, and is applying this knowledge, such that site-specific efficacy is increasing. DBW management expects that with (1) additional program resources, (2) a targeted Franks Tract management area focus, (3) earlier treatment start dates, and (4) more refined approaches for its application of aquatic herbicides, over the next five years from 2006 to 2010, the EDCP will be able to demonstrate some degree of measurable program efficacy.

The EDCP can not simply continue with status quo operations and expect to have a meaningful impact on *Egeria densa* levels in the Delta. Several important future changes are needed for the program. Without this adaptive management, *Egeria densa* will proliferate in the Delta, causing continual disruption to its waterways, potential safety concerns and hazards to the boating and recreational community, and further negative effects on Delta ecosystem health.

The EDCP is at a crossroads where operations adjustments are necessary for the program to realize some future measurable program efficacy. Vested EDCP stakeholders must work together to allow the EDCP greater latitude as to when, where, and how to treat *Egeria densa*, or program efficacy will be elusive.

Regulatory agencies, with authority to determine the timing, locations, and types of DBW treatments, face important decisions as to the future impact the EDCP may have on *Egeria densa* in the Delta. Absent real operations changes now, the future of *Egeria densa* may become so problematic that the State could be forced to undertake more drastic, and perhaps environmentally damaging, treatment measures to help control this weed in the Delta.

E. EIR Second Addendum Certification

The DBW, as the lead CEQA agency, read and considered the information contained in this 2006 Second Addendum to the 2001 EDCP EIR. Mr. Raynor Tsuneyoshi, DBW Director, certifies this Second Addendum.

Chapter 2
Program Operations (2001 to 2005)

Between 2001 and 2005, the EDCP has used two registered aquatic herbicides, each of which is labeled for the control of *Egeria densa* as follows:

- Reward® (Diquat dibromide), EPA Registration Number 100-1091
- Sonar, including three formulations:
  - Sonar® A.S. (liquid formulation of fluridone), EPA Registration Number 67690-4
  - Sonar® PR (precision release, granular formulation of fluridone), EPA Registration Number 67690-12
  - Sonar® SRP (slow release pellet, granular formulation of fluridone), EPA Registration Number 67690-3.[1]

This chapter identifies geographical areas the EDCP treated in the Delta, and its tributaries. The chapter describes quantities of: treatment acres, treatments, applications, gallons of aquatic herbicides used, and pounds of active ingredients applied.

Treatment locations are identified on a Delta map. A comparison between allowed and actual treatment acreages is provided. Methods and techniques used by the program are described. Also included is a description of historical program resources.

The EDCP was one of the first aquatic weed control programs in the State to obtain three important permits: (1) a biological opinion from the U.S. Fish & Wildlife Service, (2) a biological opinion from NOAA Fisheries, and (3) a National Pollutant Discharge Elimination System (NPDES) permit from the Central Valley Regional Water Quality Control Board. The EDCP operated between 2001 and 2005, subject to extensive conditions contained in these permits. Requirements and outcomes associated with these permits are discussed at the end of this chapter.

The remainder of this chapter is organized into the following five (5) sections:

A. Regulatory Requirements and Compliance
B. Areas of EDCP Treatments
C. Aquatic Herbicide Use
D. Application Methods and Techniques
E. Program Resources.

A. Regulatory Requirements and Compliance

The EDCP has operated under the three permits listed in **Exhibit 2.1,** on page 2-3. All of these permits contain specific conditions for EDCP operations, including treatment timing restrictions; operating procedures to minimize impacts from treatments; and requirements for ongoing program monitoring and reporting.

The United States Fish & Wildlife Service (USFWS) and NOAA Fisheries issued biological opinions (BOs) for the EDCP. The DBW prepared a biological assessment (BA) for the EDCP in 2001, and used the BA and the draft EDCP EIR, in its consultations with these permit agencies.

The EDCP has conducted ongoing formal “Section 7” consultations with the USFWS and NOAA Fisheries since program inception in 2001. These consultations have resulted in several

[1] Sonar SRP is no longer used by the EDCP. The EDCP intends to replace Sonar SRP by Sonar Q, subject to regulatory approvals.

updates and modifications to the BOs issued by USFWS and NOAA Fisheries.

The EDCP operates under a National Pollutant Discharge Elimination System (NPDES) permit from the Central Valley Regional Water Quality Control Board. An NPDES permit became necessary following a 2001 Ninth Circuit Court of Appeals *Headwaters, Inc. v. Talent Irrigation District* ruling that residual chemicals from an aquatic pesticide application are a “pollutant” even if their earlier use was beneficial.

The EDCP complied with all substantive conditions required in these permits**.** Primary permit requirements fulfilled by the EDCP included the following:

Plans and Protocols

- An aquatic pesticide application plan (APAP), including best management practices
- A fish passage protocol
- A pesticide application log, including information on each application

Environmental Monitoring

- A water monitoring program. A minimum of 10 percent of all treatment sites were sampled for each water type within the Delta. The EDCP collected and analyzed Delta water quality data, and the EDCP collected water samples and analyzed results of chemical residue and toxicity tests (toxicity tests were required through 2005, and now no longer required) on these water samples
- An environmental monitoring plan
- An approved monitoring protocol and sampling plan
- A quality assurance project plan (QAPP) for chemical residue and toxicity monitoring, describing procedures and protocols for data collection and analysis
- An annual report describing permit compliance and program findings and conclusions
- An annual data validation package (confirming the quality of environmental monitoring data).

The EDCP conducted ongoing formal consultations with USFWS and NOAA Fisheries, including providing these agencies with updated program information, assessments of potential program impacts, and internal and external research reports.

Between 1998 and 2005, largely in response to permit requirements, the EDCP invested heavily in scientific studies on impacts of aquatic herbicides to target organisms and special status species. A summary of the key findings and conclusions from these studies is provided in **Appendix B**.

Exhibit 2.1
***Egeria densa* Control Program**
Regulatory Permit Summary
(2001 to 2005)

Permit	Primary Permit Goals
U.S. Fish and Wildlife Service – Biological Opinion 1. 2001-2003 1-1-00-F-0234, as amended 2. 2004-2005 1-1-04-F-0148	■ Limit potential impacts to Federally threatened delta smelt, Sacramento splittail, giant garter snake, and valley elderberry longhorn beetle.
NOAA Fisheries – Biological Opinion 3. 2001 SWR-99-SA-0053 letter 4. 2002 SWR-99-SA-104 5. 2003-2005 SWR-02-SA-8279, as amended	■ Limit potential impacts to Federally Endangered Sacramento River winter-run Chinook salmon, Threatened Central Valley spring-run Chinook salmon, and Threatened Central Valley steelhead.
National Pollutant Discharge Elimination System (NPDES) Permit 6. 2001-2002 CA0084735 (Individual) 7. 2002-2003 CA990003 (General) 8. 2004-2005 CA990005 (General)	■ Minimize the extent of potential impacts to water quality in the Delta. ■ Create a water monitoring and reporting program.

B. Areas of EDCP Treatments

In the 2001 EDCP EIR, the EDCP identified 70 sites with *Egeria densa*. The EDCP indicated it would treat 35 of these 70 sites between 2001 and 2005. The EDCP determined that these 35 sites were “high priority” based on the degree of navigational impairment and importance to navigation. The remaining 35 sites were determined to be “low priority” and were not to be treated between 2001 and 2005.

The EDCP treated 19 of the 35 priority sites between 2001 and 2005, as shown in **Table 2.1,** on the next page. These sites generally covered the central Delta (shown shaded on the map in **Exhibit 2.2,** on page 2-5). These 19 priority sites correspond to 24 unique DBW site identification numbers.[2]

[2] The EDCP has divided the Delta, and its tributaries, into 369 unique site identification numbers. There may be multiple site identification numbers per priority site. For example, Franks Tract has three site identification numbers (nos. 173, 174, and 175).

Table 2.1
***Egeria densa* Control Program**
Sites and Acreage Treated
(2001 to 2005)

		Acres					
Number	**Site**	**2001**	**2002**	**2003**	**2004**	**2005**	**Total**
1	Franks Tract	75	86	178	220	160	725
2	Rhode Island	44	20	80	86	86	316
3	Big Break Wetlands	55	55	55	37	55	257
4	Venice Cut			74	55	74	203
5	Little Venice Island	74	94				168
6	Pixley Slough		11	27	27	27	92
7	Dutch Slough		11	29	25	25	90
8	White Slough		17	14	22	22	75
9	Sevenmile Slough		9	9	10	37	65
10	Disappointment Slough	20	5			35	60
11	Big Break			20	40		60
12	Sandmound Slough					38	38
13	Fourteenmile Slough					52	52
14	Middle River Bullfrog		21	14			35
15	Middle River Jones		13	17			30
16	Connection Slough		9	20			29
17	Little Potato Slough (Grindstone)			8	8	8	24
18	Middle River – Victoria			9			9
19	Big Break Marina				3	3	6
	Total Acres	268	351	554	533	622	**2,328**

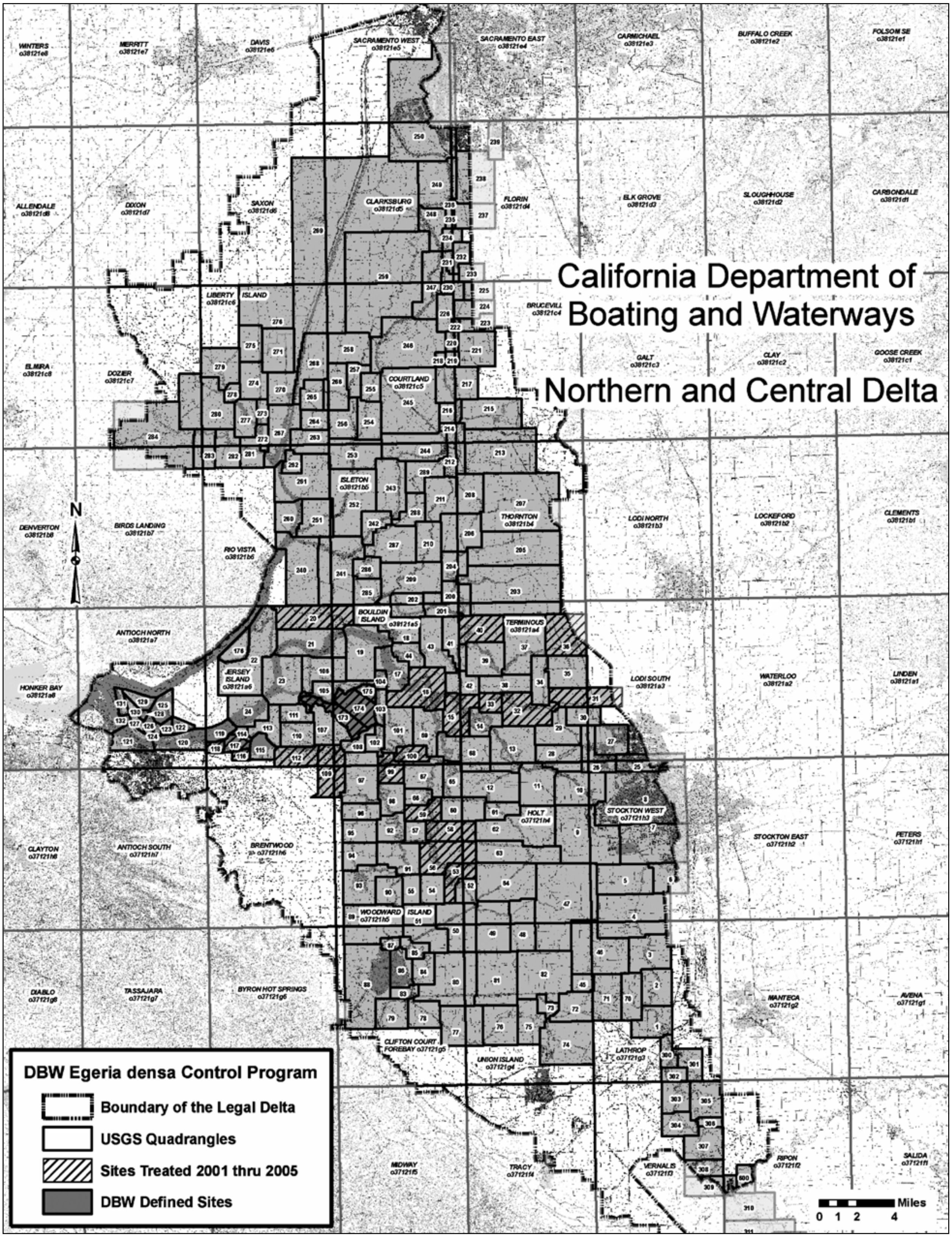
The EDCP did not treat the remaining 16 of 35 priority sites primarily due to resource constraints. Of these 16 sites, the Sherman Lake area (DBW site nos. 122 through 132) had the most *Egeria densa* present, currently estimated at 590 acres. The EDCP had difficulty treating the Sherman Lake area due to high wind and shallow water conditions.

The EDCP treated 2,328 acres in total over the five years (2001 to 2005). The five sites treated the most during this five-year period represented 72 percent of the 2,328 total treatment acres, and were as follows:

	Acreage Treated (2001 to 2005)
■ Franks Tract	725
■ Rhode Island	316
■ Big Break Wetlands	257
■ Venice Cut	203
■ Little Venice Island	168
Total	1,669

As shown in Table 2.1, EDCP annual treatment acreage more than doubled from 2001 (268 acres) to 2005 (622 acres). The 2003 to 2005 annual treatment acreage was most consistent with current program resource capabilities, and averaged 570 acres per year.

Exhibit 2.2
***Egeria densa* Control Program**
Sites Treated
(2001 to 2005)



The EDCP treated a relatively small portion of the Delta, and its tributaries. Using the maximum annual treatment acreage of 622 acres (2005), the EDCP treated approximately five (5) percent of the estimated *Egeria densa* infestation acreage in 2005 for the Delta, and its tributaries.

The EDCP treated 71 percent, or 1,653 of the 2,328 five-year treatment acreage, with Sonar (aqueous and pellet types).[3] The EDCP treated the remaining 29 percent, or 675 acres, with Reward.

Reward treatment acreage declined while Sonar treatment acreage increased over the five year period. Reward was used for over 50 percent of the 2001 treatment acreage, but just ten percent of 2005 treatment acreage. The EDCP found that Sonar provided greater efficacy potential than Reward for the particular sites treated, and the existing program conditions, between 2001 and 2005.

The EDCP fully complied with allowed treatment acreages specified in the 2001 EDCP EIR (and the 2003 addendum). For the five years, the EDCP treated 19 percent of the allowed Reward acreage and 37 percent of the allowed Sonar acreage, as shown in **Table 2.2,** right. For both Reward and Sonar combined over the five years, the EDCP treated less than one-third of the total allowed treatment acreage.

[3] Initial EDCP planning efforts separated Sonar (aqueous) from Sonar (pellet) treatment acreages. Actual results reported in this section combine Sonar (aqueous) and Sonar (pellet) results. This was necessary because a single EDCP Sonar treatment may have included both Sonar (aqueous) applications and Sonar (pellet) applications. All references to Sonar (pellet) include Sonar PR (precision release) and Sonar SRP (slow release pellet).

The EDCP made 79 treatments over the five years (2001 to 2005). A treatment almost always included multiple applications of an aquatic herbicide.[4] The EDCP made 418 applications over the five years.

Table 2.2
***Egeria densa* Control Program**
Allowed Treatment Acreage Compared with Actual Treatment Acreage
(2001 to 2005)

Reward				
Year	**Allowed Acreage**	**Actual Acreage Treated**	**Absolute Difference**	**Percent of Allowed Treated**
2001	1,224	139	(1,085)	11%
2002	1,224	168	(1,056)	14%
2003	391	158	(233)	40%
2004	391	150	(241)	38%
2005	391	60	(331)	15%
Total	**3,621**	**675**	**(2,946)**	**19%**
Sonar				
Year	**Allowed Acreage**	**Actual Acreage Treated**	**Absolute Difference**	**Percent of Allowed Treated**
2001	307	129	(178)	42%
2002	307	183	(124)	60%
2003	1,290	396	(894)	31%
2004	1,290	383	(907)	30%
2005	1,290	562	(728)	44%
Total	**4,484**	**1,653**	**(2,831)**	**37%**
Total Reward and Sonar				
Year	**Allowed Acreage**	**Actual Acreage Treated**	**Absolute Difference**	**Percent of Allowed Treated**
2001	1,531	268	(1,263)	18%
2002	1,531	351	(1,180)	23%
2003	1,681	554	(1,127)	33%
2004	1,681	533	(1,148)	32%
2005	1,681	622	(1,059)	37%
Total	**8,105**	**2,328**	**(5,777)**	**29%**

[4] Reward treatments included two applications per treatment, Sonar pellet treatments included up to eight applications per treatment, and Sonar aqueous treatments included up to 16 applications per treatment.

The EDCP determined that the ideal time to treat *Egeria densa* was between April and June of each year. Based on permit limitations and resource constraints, as shown in **Table 2.3,** on the next page, over the five years the EDCP treated just nine unique sites, or 454 acres, during this critical April through June period. No earlier-start-date treatments occurred between 2001 and 2003 due to permit restrictions. Just two sites were treated with early start dates in 2004.

In 2005, as permit conditions were modified to allow more sites with early start dates, the EDCP prioritized use of its limited resources for early-start-date treatments, treating 65 percent, or 405 acres of the 622 acres treated in total, (Table 2.1) between April and June.

Over the past five years, the EDCP has had limited ability to conduct treatments during the optimal time when treatments should be conducted. The EDCP has continued to make requests with regulatory agencies to allow earlier start dates at more sites than are currently allowed.

C. Aquatic Herbicide Use

Table 2.4, on the next page, shows the amount, in gallons or pounds of formulation, of aquatic herbicides the EDCP applied between 2001 and 2005. The 83,208 pounds of Sonar (pellet) appears large, however, Sonar (pellet) applications contain just five percent active ingredient per pound formulation.

Table 2.5, on the next page, shows the quantity of active ingredient applied, in pounds, between 2001 and 2005. Pounds of active ingredient figures allow for comparisons between aqueous aquatic herbicides (gallons formulation) and pellet aquatic herbicides (pounds formulation). Table 2.5 shows that the quantities of active ingredient used for the five years were roughly equivalent for Sonar (5,388 pounds) and Reward (5,495 pounds).

Reward use remained relatively constant over the first four years of the program, but materially declined in 2005 as the EDCP's focus shifted from use of Reward to use of Sonar. Sonar pellet use increased between 2001 and 2002, but leveled off between 2003 and 2005. Sonar aqueous use increased nearly three-fold in 2005, to 736 pounds of active ingredient, after relatively modest use between 2001 and 2004.

Reward applications for the EDCP required more than two times the amount of active ingredient per acre treated than Sonar applications. In total for the five years, Reward applications, on average for the five years (2001 to 2005), were made at 8.1 pounds active ingredient per acre, while Sonar applications, on average for the five years (2001 to 2005), were made at 3.3 pounds active ingredient per acre. This helps explain why Sonar applications accounted for 71 percent of treatment acreage but only about half of the amount of active ingredient applied. **Table 2.6,** on page 2-9, provides a time series comparison of the average quantity of active ingredient of aquatic herbicide applied per acre for each of the five years.

Table 2.3
***Egeria densa* Control Program**
Earlier-Start-Date Sonar Treatment Sites
(April, May, and June Treatments)[5]
(2001 to 2005)

Year	April – May Treatments	June Treatments
2001	None	None
2002	None	None
2003	None	None
2004	None	Pixley Slough, White Slough (total of 49 acres)
2005	Fourteenmile Slough, Pixley Slough, White Slough, Little Potato Slough, Rhode Island, Sandmound Slough, Franks Tract (total of 353 acres)[6]	Sevenmile Slough, Disappointment Slough (total of 52 acres)
Total Sites **(9 unique sites, 454 acres)**	**(7 unique sites, 353 acres)**	**(4 unique sites, 101 acres)**

Table 2.4
***Egeria densa* Control Program**
Gallons and Pounds of Aquatic Herbicide Formulation Used[7]
(2001 to 2005)

	Year					
Aquatic Herbicide	**2001**	**2002**	**2003**	**2004**	**2005**	**Total**
Reward (gallons)	801	577	495	725	150	**2,748**
Sonar – Aqueous (gallons)	0	35	32	55	184	**307**
Sonar – Pellet (pounds)	7,050	11,178	20,849	16,420	27,711	**83,208**

Table 2.5
***Egeria densa* Control Program**
Pounds of Active Ingredient Used
(2001 to 2005)

	Year					
Active Ingredient	**2001**	**2002**	**2003**	**2004**	**2005**	**Total**
Diquat[8]	1,602	1,154	989	1,450	300	**5,495**
Fluridone – Aqueous[9]	0	142	130	219	736	1,227
Fluridone – Pellet[10]	353	559	1,042	821	1,386	4,161
Fluridone - Subtotal	353	701	1,172	1,040	2,122	**5,388**
Total	1,955	1,855	2,161	2,490	2,422	**10,883**

[5] Based on permit conditions, the EDCP was not allowed to treat with Reward prior to July of each year.

[6] Treatments extended from the beginning of April through mid-May.

[7] This table shows pounds or gallon of actual formulation, in contrast to gallons of formulation diluted with water for application.

[8] Conversion from gallons formulation is based on two pounds active ingredient per gallon.

[9] Conversion from gallons formulation is based on four pounds active ingredient per gallon.

[10] Conversion from pounds formulation is based on five percent active ingredient.

Table 2.6
***Egeria densa* Control Program**
Average Pounds of Active Ingredient Used Per Acre Treated
(2001 to 2005)

Year	Diquat	Fluridone
2001	11.5	2.7
2002	6.9	3.8
2003	6.3	3.0
2004	9.7	2.7
2005	5.0	3.8

As a contact herbicide, Reward (Diquat) treatments require a more concentrated application rate than the systemic herbicide, Sonar. Reward has a target application rate of 370 ppb while Sonar treatments generally have a targeted concentration of between 10 and 40 ppb. This further explains why the pounds of active ingredient per acre are much higher for Reward than for Sonar. The EDCP will continue to evaluate the impacts of the significantly higher concentration of Reward applications compared with Sonar applications.

D. Application Methods and Techniques

Trained EDCP field operations staff applied aquatic herbicides from aluminum work boats using injection hoses and broadcast spreaders. Field crews (1) notified Agricultural Commissioners and permit agencies of planned treatments (via a Notice of Intent to Operate, or NOI); (2) followed pest control recommendations; (3) observed and measured selected field conditions prior to treating; and (4) tracked and reported herbicide use through pesticide use reporting to the California Department of Pesticide Regulation. EDCP treatments occurred during the seven months, between April and October, of a given year.

1. Reward Methods and Techniques

The EDCP typically applied Reward on a once or twice per year basis at a site. Treatment frequencies and the duration of herbicide applications for Reward (Diquat) did not change much between 2001 and 2005. The EDCP performed seven sequential treatments between 2001 and 2005, where a Reward treatment was performed and then a Sonar treatment was performed shortly thereafter (within one or two weeks).

2. Sonar Methods and Techniques

Sonar applications were generally made periodically over a six- to eight-week treatment period between 2001 and 2005. According to the label, Sonar applications are most effective when a concentration of <u>between 15 and 40 ppb</u> is maintained for a minimum of 45 days.

Pest control recommendations, prepared by a licensed pest control advisor, were used for EDCP Sonar applications. Generally, recommendations for Sonar AS targeted concentrations of <u>between 10 and 30 ppb</u>, with the most common concentration being 15 ppb. Recommendations for Sonar PR targeted concentrations of between 25 and 75 ppb, with the most common concentration being 50 ppb.

Over the past five years, the EDCP utilized a wide range of different Sonar application techniques, including using:

- Twice per week, versus weekly, Sonar AS applications over the treatment period (2003, 2004, 2005)
- Constant Sonar PR application rates throughout treatment (2001, 2002)
- Higher Sonar PR application rates in the first half of the treatment period and a reduced level of treatment in the second half of the treatment period (2002)
- Tiered application rates for Sonar PR treatments, including two applications at one level in early stages, and two applications at a lower level at later stages (used to a greater extent beginning in 2003)
- Steadily declining application rates for Sonar PR treatments (used to a greater extent beginning in 2003)
- Combinations of Sonar PR and Sonar AS with:
    - Constant application rates of Sonar AS, on a weekly basis, and constant application rates of Sonar PR on a biweekly basis (2002)
    - Constant application rates of Sonar AS, on a twice per week basis, and constant application rates of Sonar PR on a biweekly basis (2004)
    - Constant application rates of Sonar AS, on a twice per week basis, and tiered application rates (higher initially, lower later) of Sonar PR on a biweekly basis (2004, 2005)
    - Constant application rates of Sonar AS, on a twice per week basis, and two applications of Sonar PR spread evenly over the treatment period (2005)
    - Increasing application rates of Sonar AS over the treatment period and two applications of Sonar PR spread evenly over the treatment period (2005)
    - Tiered application rates (higher initially, lower later) of Sonar PR on a biweekly basis followed by a single Sonar AS application at the middle or end of the treatment (2005).

The EDCP measured concentrations of Sonar in treated waters during the six- to eight-week treatment cycle at a given site. The “FasTEST” was used to measure Sonar concentrations and was the basis for adjusting the concentrations of weekly Sonar applications throughout the treatment periods.[11]

Average fluridone concentrations based on FasTESTs are shown in **Table 2.7,** on the next page. In all cases, average Sonar concentrations over the four years were below targeted concentrations for optimal effectiveness. Combined Sonar PR and Sonar AS applications resulted in the highest average concentrations, approximately six percent greater than average Sonar AS applications. Sonar pellet applications had the lowest overall concentrations.

[11] The FasTEST is a laboratory immunoassay test (referred to as an ELIZA test) used by SePRO Corporation, the manufacturer of Sonar, to determine the concentration of fluridone in the water. The limit of detection for the FasTEST is 1.0 parts per billion (ppb). FasTESTs generally are taken on a weekly basis throughout a treatment period.

Table 2.7
***Egeria densa* Control Program**
Average Fluridone Concentrations (in parts per billion)
Based on FasTEST Results for Sonar Applications
(2002 to 2005)

	Sonar AS		Sonar PR		Sonar PR/AS		Total	
Year	(ppb)	Number of Tests	(ppb)	Number of Tests	(ppb)	Number of Tests	(ppb)	Number of Tests
2002	-	-	2.70	52	2.55	46	**2.63**	98
2003	5.49	33	1.80	39	-	-	3.49	72
2004	7.16	12	7.48	28	**9.80**	20	8.19	60
2005	5.02	23	4.72	34	**8.13**	38	**6.16**	95
Total	5.62	68	3.80	153	5.98	104	**4.88**	325

Limit of detection = 1.0 ppb.

Fluridone concentrations increased since the early years of the program as different application approaches were utilized. In 2002, average FasTEST results, for all tests, showed 2.63 ppb fluridone while in 2005 the average concentration for all tests was 6.16 ppb fluridone.

For the 325 tests performed, the average FasTEST concentration was 4.88 ppb, roughly half of the lower bound target of 10 ppb. In 2004 and 2005, through use of Sonar PR/AS in combination, average FasTEST results approached the lower bound 10 ppb target at 9.8 ppb and 8.1 ppb respectively.

Combinations of Sonar PR and Sonar AS were the most effective at maintaining the highest fluridone concentrations based on FasTEST results over the treatment period. The EDCP established an ongoing ambient fluridone concentration using a pellet version of Sonar (Sonar PR, or Sonar Q), and subsequently "bumped up" the concentration of fluridone with biweekly or weekly Sonar AS applications.

However, combinations of treatment methods were more expensive than Sonar AS-only treatments. For some sites, Sonar AS-only treatments provided nearly similar concentrations to pellet/aqueous applications, so the EDCP must continually weigh the costs and benefits of combined Sonar treatments with Sonar AS treatments alone.

E. Program Resources

Between 2001 and 2005, funding for the EDCP came from Harbors and Watercraft Funds (made up of boat registration and gas tax funds). The DBW Aquatic Weed Program over the past five years had a fixed amount of program funding for its two aquatic weed control programs, the EDCP and the Water Hyacinth Control Program (WHCP).

The total DBW Aquatic Weed Program budget for 2001 through 2005 is shown in **Table 2.8,** on the next page. Program cost components are discussed below.

Program Staffing Costs

Program staffing costs have been about 25 percent of the combined program budgets. In the past five years, based on resource constraints, the DBW has had staffing of between 18 to 23 personnel in total, including 6 to 7 environmental scientists/administration personnel, and 12 to 16 field operations personnel. EDCP personnel and other resources from 2001 to 2005 are shown in **Table 2.9,** right.

EDCP field treatments were highly labor intensive. Sonar treatments required field staff to visit a site on a twice per week, or weekly, basis for up to eight weeks, with each treatment taking potentially up to several hours. Sonar pellet treatments often required two boats on-site, including a primary boat to conduct the application, and a secondary boat to hold additional pellets the primary boat was unable to store. Reward treatments required field staff to visit a site just twice, with each application taking potentially up to several hours.

Environmental Monitoring, Regulatory Compliance, and Surveillance Costs

Program environmental monitoring and surveillance between 2001 and 2005 for the two programs amounted to approximately $3 million per year on average, or as much as 40 percent of the combined program budgets.[12]

Table 2.8
Department of Boating and Waterways Aquatic Weed Program Budget (Both EDCP and WHCP) (2001 to 2005)

Year	Total Budget (in millions $)
2001	$7.9
2002	6.8
2003	7.0
2004	7.0
2005	6.2

Table 2.9
Department of Boating and Waterways Aquatic Weed Program Resources (Both EDCP and WHCP) (2001 to 2005)

Year	Total Program Staff	Field Operations Boats	Field Operation Crews[13]
2001	23	16	8
2002	23	16	8
2003	18	12	6
2004	18	12	6
2005	18	12	6

Environmental monitoring and regulatory compliance costs included (1) chemical residue laboratory analyses at the California Department of Food and Agriculture; (2) toxicity laboratory analyses at the California Department of Fish and Game; (3) water quality and water sample data collection; and (4) special commissioned scientific research studies largely requested by regulatory agencies. Surveillance costs included contracted aerial mapping analyses, hyperspectral analyses, and hydroacoustic analyses. In some years, the combined costs for environmental

[12] Over $1 million in toxicity monitoring costs was eliminated in 2006 as toxicity monitoring was no longer required for the EDCP.

[13] Each crew had access to two boats (one airboat and one aluminum work boat). Each field crew had two staff (one specialist and one technician).

monitoring and regulatory compliance and surveillance reached as high as sixty-five (65) percent of the EDCP (only) budget.

Aquatic Herbicide Costs

Aquatic herbicide purchases between 2001 and 2005 were limited to an average of approximately $1.5 million per year, or approximately 20 percent of the combined program budgets. Aquatic herbicide costs alone restricts the acreage the EDCP can treat in a given year.

For the EDCP, Sonar costs have been approximately $1,000 per treated acre. Reward costs have been similar to Sonar costs at between $750 and $1,000 per treated acre. Were the DBW to use the entire current aquatic herbicide program budget for the EDCP alone, the estimated maximum annual acreage the EDCP could treat would be 1,500 acres ($1.5 million / $1,000/acre).

Other Costs

Other costs were about 15 percent of total combined program costs and included the following costs: (1) equipment purchases, (2) general office expenses, (3) facility rentals, (4) fuel, (5) parts/supplies, and (6) miscellaneous costs.

Chapter 3
Egeria densa Infestation and Program Efficacy (2001 to 2005)

Chapter 3 – *Egeria densa* Infestation and Program Efficacy (2001 to 2005)

This chapter discusses efficacy of the EDCP over the last five years, 2001 to 2005. This chapter is organized into the following nine (9) sections as follows:

A. Overview of Efficacy for the EDCP
B. Importance of Efficacy to EDCP Environmental Impacts
C. Efficacy Significance Threshold for the EDCP
D. The Risk of Status Quo *Egeria densa* in the EDCP Area
E. Measurement of Efficacy for the EDCP
F. Key Factors Affecting EDCP Efficacy
G. Optimally Effective *Egeria densa* Management by Keying Program Control to Plant Biology
H. Future EDCP Efforts for Efficacy Measurement and Improved Control
I. EDCP Efficacy Conclusions.

References are provided at the end of this chapter in lieu of footnotes used in the other chapters.

A. Overview of Efficacy for the EDCP

Efficacy can be defined as the power or capability to produce a desired result. Efficacy in the context of the EDCP relates to the EDCP's effectiveness to control *Egeria densa* infestation levels.

The EDCP is designed as a control program, not an eradication program. Thus the goal of the EDCP is to limit the spread of *Egeria densa*, not to completely eliminate the non-native, aquatic invasive plant species.

Efficacy can be a measure of the EDCP's chemically based treatment success to control *Egeria densa*. Program success can be defined both (1) absolutely (diminished total *Egeria densa* acreage and/or biomass within program boundaries overtime) and (2) relatively (site or event treatment control effectiveness at a point in time). The EDCP's boundaries are the Sacramento-San Joaquin Delta, its tributaries, and Suisun Marsh (Delta region).

There are several possible means (visual, aerial mapping, hyperspectral analyses, hydroacoustic analyses, etc.) to measure EDCP efficacy, and there are many different possible units (acreage, percentage ground coverage, percentage plant biovolume, etc.) of EDCP efficacy measurement. Efficacy is concerned with both (1) the extent to which the EDCP achieves its desired control result (program efficacy) and (2) with the extent to which a specific chemical treatment achieves its intended control result (site efficacy).

Efficacy can also be an indicator of conditions effecting EDCP success. These conditions include the different chemical controls and formulations; how and when the chemicals are applied; and the unique ambient and environmental conditions existing before, during, and after treatment application.

Egeria densa poses significant challenges in terms of quantifying its infestation levels in the Delta region because it is primarily underneath the water's surface. *Egeria densa* is often times mixed with other underwater plants and hidden under algae.

Control of *Egeria densa,* a submerged, aquatic, invasive plant species, has never been attempted before world-wide situated in such a large and complex, tidal estuary as the Delta region. The Delta is part of the largest U.S. estuary system on the West Coast.

A challenge for EDCP program efficacy is the inability to have a true side-by-side "control test" of the entire program area without any EDCP treatment actions in order to say what would have happened to *Egeria densa* without the program. Because of this limiting factor, and combined with the large number of dynamic and complex variables in the Delta region environment, there will always be some uncertainty regarding EDCP "program" efficacy.

B. Importance of Efficacy to EDCP Environmental Impacts

There is a close and critical relationship between EDCP efficacy and EDCP potential physical environmental impacts to the land, air, water, flora, and fauna. This relationship includes issues of (1) measuring EDCP efficacy; (2) controlling for factors that improve efficacy; and (3) conclusions about program efficacy over time, and site efficacy at a point in time.

The higher the EDCP's efficacy, the less chemical herbicides that will need to be utilized in the Delta region for a given level of control, and hence the less potential significant physical environmental impacts from the EDCP. A sufficient EDCP efficacy is important to ensuring (1) the EDCP's success and (2) that the EDCP does not cause significant impacts to the program environment.

C. Efficacy Significance Threshold for the EDCP

Efficacy is not specifically listed as one of the standard named effects that are considered significant under national and State of California environmental law. However, because of the unique nature and design of this EDCP, and because of the EDCP's desire to help further reduce the perceived significance of program environmental impacts, efficacy has been added to the list of effects that may be considered significant.

For purposes of this EDCP, EIR Addendum, the DBW needed to define an EDCP efficacy significance threshold. The EDCP efficacy significance threshold is defined as follows: **Impacts to the program physical environment (as defined by the Legislative program control boundaries) are potentially significant when EDCP operations use more chemical herbicides than are (1) needed for overall program control, or (2) needed to be effectual on a site-specific basis.** Program control is defined as containing (not eradicating) *Egeria densa* infestation levels to no more than the best current acreage infestation estimates (as identified below), and hopefully diminishing this infestation acreage through on-going annual maintenance control efforts.

This significance threshold is defined based on the fact that *Egeria densa* has continued to expand significantly over the past five years (2001 to 2006) in the Delta region program control area. It is also assumed that *Egeria densa* will continue to expand in the future.

Egeria densa was first identified in the Delta approximately 40 years ago, in the mid 1960s. It is commonly believed that *Egeria densa* was first introduced by someone cleaning an aquarium and discarding the plant into the Delta.[1]

Some of the first recorded complaints by boaters in the Delta about *Egeria densa* mats impeding navigation are circa 1988. The initial infestation appeared limited to a relatively small area.[2] Today, thousands of Delta acres remain at risk of *Egeria densa* infestation.

The 1997 State of California legislation eventually authorizing the *Egeria densa* control program (that materialized a few years later) declared that growth of *Egeria densa* had occurred at an "unprecedented level" and that the resulting accumulation of *Egeria densa* obstructs navigation, impairs other recreational uses of waterways, has potential for damaging manmade facilities, and may threaten the health and stability of fisheries and other ecosystems within the Delta region.

A corollary to the above efficacy threshold of significance (that emphasizes the importance of EDCP efficacy), is that **if the EDCP is relatively ineffective, or in the extreme has no control impact (and assuming no adverse environmental impacts from the use of ineffectual *Egeria densa* chemical herbicides), then there is a risk that impacts to the project physical environment are potentially significant when EDCP operations fail to control *Egeria densa*, and infestation levels threaten the health and stability of fisheries and other ecosystems within the Delta region.**

There is a unique beneficial impact to the EDCP over the status quo, "no program" environment. The EDCP has significant physical environmental benefits that override some targeted potential significant physical environmental impact program effects.

D. The Risk of Status Quo *Egeria densa* in the EDCP Area

Egeria densa has spread since it was first introduced to the Delta several decades ago. Factors that have caused *Egeria densa* to spread through the Delta include ideal weather and hydrologic conditions, and the lack of natural controls (e.g., competing species, herbivores, and pathogens).

True to its name, *Egeria densa* grows in subsurface mats that can be several feet thick. It is commonly cited that aquatic invasive species, such as *Egeria densa*, can threaten the (1) diversity and abundance of native species and natural communities by crowding them out; (2) ecological stability and water quality of infested waters; and (3) commercial, agricultural, and recreational activities dependent on these waters.[3]

Egeria densa acts like a filter in that it collects sediments and particles in the water. In areas where *Egeria densa* has formed dense stands, the water is slowed and organic and inorganic materials that are normally transported throughout the Delta and upper San Francisco Bay become entrapped and settle. The result is localized, heavy organic loading of shallow sloughs.[4]

Egeria densa changes the architecture of shallow water ecosystems, forming walls between deepwater and inter-tidal habitat. Impenetrable mats of *Egeria densa* can force fish such as salmon and Delta smelt into more open waterways, where food resources may be scarce and where fish are more vulnerable to predators.

Simenstad and others (2000) observed that invasion of *Egeria densa*, and the distinctive fish fauna that exploits the habitat it creates, essentially makes it impossible to restore pre-development habitat conditions in areas where the plant is abundant. *Egeria densa* habitat does support some native fish but such habitat does not appear to be utilized extensively by the species of greatest concern in the Delta, including anadromous salmonids, splittail, and delta smelt.

Although *Egeria densa* does not grow in the intertidal zone of tidal wetlands, it does grow in the nearshore subtidal areas and can hinder movements of fish moving between subtidal open water and tidal wetlands.[5] All these considerations raise concerns that shallow water habitat restoration efforts (for example by agencies such as CALFED and the CDFG) may not be successfully accomplished in areas where *Egeria densa* is present.

Dense mats of *Egeria densa* that form in the Delta are a hazard and nuisance because they can:

- Eliminate or hinder boat and vessel navigation
- Disrupt recreational activities such as water skiing, fishing, and swimming
- Clog agricultural irrigation intakes
- Slow water conveyance, requiring increased energy costs to pump water
- Compete with native plant communities
- Create anoxic (low oxygen) conditions with decomposition
- Upset the balance of the aquatic environment.

The **economic** consequences of *Egeria densa* impacts in the Delta region can be substantial, including: (1) decreased productivity of fisheries by impeding migration of anadromous and pelagic fish, (2) impairment of recreational boating uses by (i) obstructing waterways, forcing boaters to stop frequently to clear propellers, (ii) creating difficult bottom conditions for anchoring, and (iii) in more extreme cases preventing passage of large and small vessels, (3) interference with agricultural infrastructure such as irrigation pumps, (4) impeding water flows, entrapping sediments, and clogging municipal water intakes, (5) diminished real property values, and (6) the expenditure of tens of millions of dollars over time to alleviate its impacts.[6]

In 2006, *Egeria densa* may have been a contributing factor to the drowning death of a physician in Potato Slough, San Joaquin County. The physician was trying to rescue another person struggling in the water and the physician drowned.

E. Measurement of Efficacy for the EDCP

A fundamental on-going need for the EDCP is to develop a credible, accurate, large scale, and cost-effective monitoring method to measure the baseline extent of *Egeria densa* infestation, and to measure maintenance control treatment efficacy over time. The EDCP monitoring methods need to be non-intrusive, repeatable, and show consistent and reliable results over time.

The EDCP monitoring initiatives are continuously evolving. The EDCP is perfecting methodologies for helping to make informed decisions for managing the extent and spread of *Egeria densa*.

The EDCP has in the past, and is currently continually investing in different efficacy data collection and analysis methodologies. The EDCP efficacy data are based on several different collection methodologies, including surveys by ground, motor vessel, and air.

Primary sources of efficacy and infestation information include: (1) "ground-truth" anecdotal information from program stakeholders (such as recreational boaters and fishermen; marina owners in the area; and Delta region residents), (2) "ground truth" professional field observations from DBW field crews and other State and Federal regulatory agencies operating in the Delta region (such as the U.S. Fish and Wildlife Service, California Department of Fish and Game, California Department of Water Resources, etc.), (3) DBW treatment area information for the EDCP (4) San Francisco State University (aerial mapping analysis), (5) University of California, Davis (hyperspectral analysis), and (6) ReMetrix (hydroacoustic analysis). **Figure 3.1**, on the next page, depicts the various sources of EDCP infestation and efficacy data to-date.

Observations from program stakeholders and professionals in the field indicate that *Egeria densa*'s presence in the Delta region has not diminished over the past five years. *Egeria densa* continues to grow and infest the Delta region. A description of efficacy measurement efforts is provided below.

1. EDCP Water Area

Water acreage in the EDCP Delta region is relevant to measure as it provides a denominator to measure the percentage of *Egeria densa* acreage against. There are few current estimates of land and water acreage for the EDCP Delta region. The California Department of Water Resources Delta Atlas is a commonly sited reference for "legal Delta" geographical acreage.[7]

Table 3.1, on the next page, shows estimated land and water acreage for the "legal Delta". The legal Delta is comprised of portions of six counties (Alameda, Contra Costa, Sacramento, San Joaquin, Solano, and Yolo); with the five Cities of Antioch, Brentwood, Isleton, Pittsburg, and Tracy entirely with the legal Delta; and the three Cities of Sacramento, Stockton, and West Sacramento partly within the legal Delta.

Figure 3.1
***Egeria densa* Control Program**
Infestation and Efficacy Measurement Sources
(2001 to 2005)

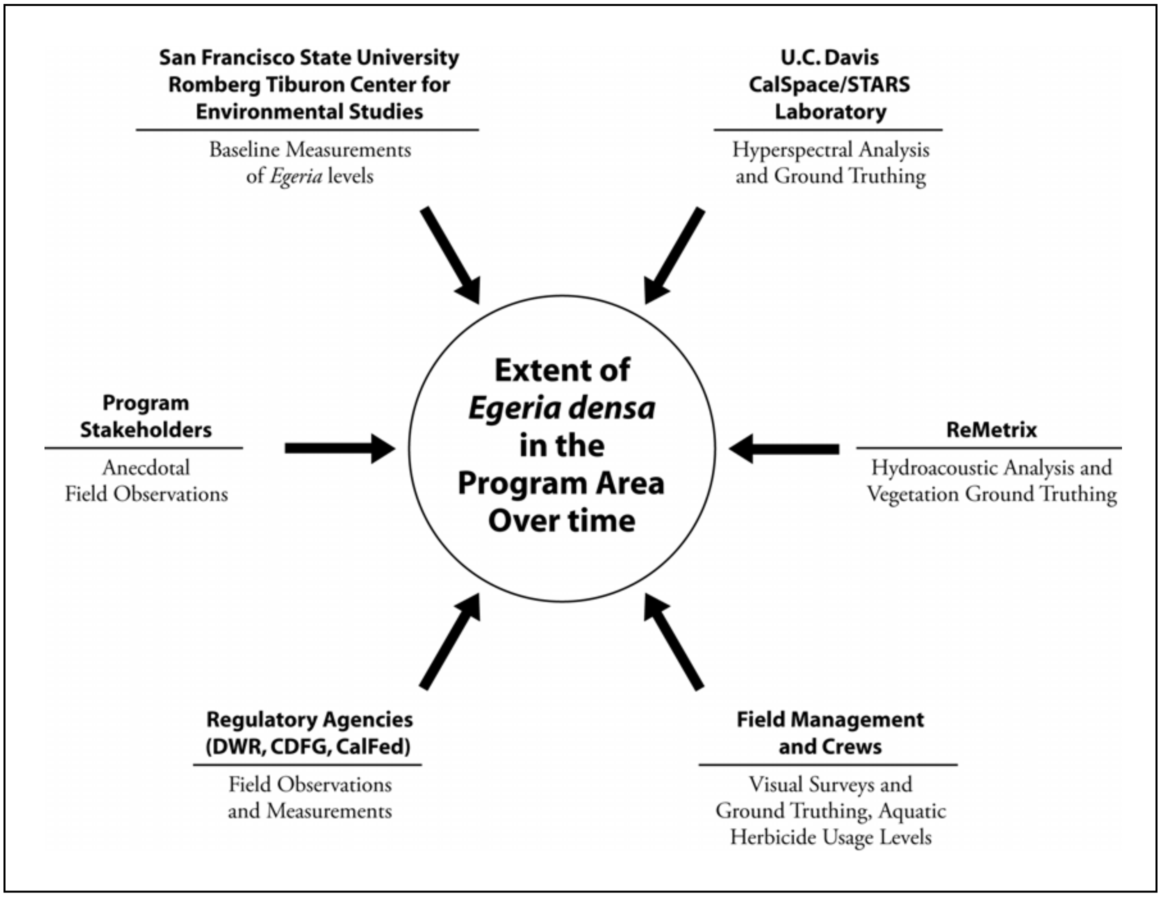


Table 3.1
***Egeria densa* Control Program**
Legal Delta Geographical Acreage

Area (1991)	Acres	Percent
Agriculture	538,000	73
Undeveloped	75,000	10
Cities and Towns	64,000	9
Water Surface	**61,000**	**8**
Total Land and Water	**738,000**	100

Source: California Department of Water Resources, Sacramento-San Joaquin Delta Atlas, Revised 1995, Table 7, Page 91.

Table 3.1 shows 738,000 acres of land and water estimated for the legal Delta, with ninety-two percent of this total area being land. A large part of this land is below sea level, as the land relies on more than 1,100 miles of levees for protection against flooding along the hundreds of miles of interlaced waterways.

The vast majority (73 percent) of the legal Delta is agricultural land. The next largest legal Delta sub-area (10 percent of total land and water area) is “undeveloped land”, primarily natural plant vegetation.

It is estimated by the California Department of Water Resources that there are 61,000 acres of water surface area in the legal Delta (eight percent of the total land and water acres). This legal definition of Delta water acreage is smaller than the EDCP's Delta region water acreage estimate, because the EDCP's area includes the legal Delta, plus tributaries to the Sacramento and San Joaquin Rivers (such as the Tuolumne and Merced Rivers) and Suisun Marsh. The EDCP Delta region boundaries are essentially the legal Delta plus a small narrow and irregular shaped area South of the legal Delta.

The DBW Geographical Information System (GIS) Unit has developed high level estimates of land and water acreage for 369 unique DBW site numbers comprising an estimate of the EDCP Delta region. For these 369 DBW site numbers it is estimated that there are 66,986 acres of water and 790,342 acres of land.

Table 3.2, above right, shows these DBW land and water estimates for the EDCP Delta region. These DBW figures also estimate that 8 percent of the Delta region area is water (identical to the Delta Atlas estimate). The EDCP Delta region area (land and water) is 16 percent larger than the legal Delta area (857,328 acres versus 738,000 acres).

Exhibit 3.1, following this page, provides a cross-walk of the unique DBW site numbers, with the priority site numbers, identified in the March 2001, *Final Environmental Impact Report for the EDCP*. Exhibit 3.1 also provides estimated total water, and total water and land, acres for these DBW site numbers that comprise the priority sites identified in 2001.

Table 3.2
***Egeria densa* Control Program**
Delta Region Geographical Acreage

Area	Acres	Percent
Land	790,342	92
Water	**66,986**	**8**
Total Land and Water	**857,328**	100

Source: California Department of Boating and Waterways, Geographical Information Systems Unit high level estimate using U.S. Geological Survey quadrangle maps, California Department of Fish and Game draft vegetation maps, and U.S. Bureau of Reclamation water layer information.

Exhibit 3.1 shows that there were 15,571 acres of water within the DBW's original 35 primary priority sites. The 70 EDCP sites delineated in 2001 (primary and secondary sits) comprised 26,819 water acres.

Exhibit 3.2, on page 3-16, consolidates the DBW site numbers for the 70 EDCP sites delineated in 2001. Exhibit 3.2 shows that the water intensive priority sites out of the 35 primary priority sites in 2001 were Franks Tract, Big Break, Sherman Lake, and Donlon Island. Water acreage comprised 14 percent of the respective land and water acres for the 35 priority sites. This exhibit also shows that water acreage comprised 10 percent of the respective land and water acres for the 70 EDCP sites.

2. DBW Field Treatment Areas for the EDCP

Past and future growth, and spread, of *Egeria densa* in the Delta region is uncertain. *Egeria densa's* rate of growth and spread varies greatly from year-to-year, depending on environmental conditions and treatment efficacy. Thousands of acres of the EDCP

Exhibit 3.1
***Egeria densa* Control Program**
Cross-walk of DBW Site Numbers with Priority Site Numbers
(Original 2001 EIR Priority Site Classifications and Definitions) **Page 1 of 8**

Priority Site Number	Site Name	DBW Site Number	Description	Estimated Total Water Acres	Estimated Total Water & Land Acres
1	Franks Tract	173	A large, open, and shallow water body in the west Delta.	726.80	1,373.28
1	Franks Tract	174	A large, open, and shallow water body in the west Delta.	1,513.91	1,733.16
1	Franks Tract	175	A large, open, and shallow water body in the west Delta.	378.93	432.27
2	Venice Cut	16	A narrow channel centrally located in the Delta on the south side of Venice Island and east of Empire Tract. This site includes Priority Site No. 27-DBW Site No. 16.	841.36	3,480.31
3	Big Break I	115	A large, open, and shallow water body in the west Delta. This site does not have flow through capacity.	669.18	1,032.38
4	Sherman Lake	123	A large, open, and shallow water body in the west Delta.	146.73	290.30
4	Sherman Lake	124	A large, open, and shallow water body in the west Delta.	64.90	189.75
4	Sherman Lake	125	A large, open, and shallow water body in the west Delta.	856.34	1,011.26
4	Sherman Lake	126	A large, open, and shallow water body in the west Delta.	153.00	365.07
4	Sherman Lake	127	A large, open, and shallow water body in the west Delta.	74.59	295.97
4	Sherman Lake	128	A large, open, and shallow water body in the west Delta.	64.11	125.28
4	Sherman Lake	129	A large, open, and shallow water body in the west Delta.	203.47	670.04
4	Sherman Lake	130	A large, open, and shallow water body in the west Delta.	28.34	281.41
4	Sherman Lake	131	A large, open, and shallow water body in the west Delta.	217.94	432.72
4	Sherman Lake	132	A large, open, and shallow water body in the west Delta.	107.58	142.38
5	Rock Slough	97	A heavily infested slough running from the south end of Sandmound Slough to Old River, south of Holland Tract.	126.54	3,168.06
6	White Slough	36	A slough on the north of Empire Tract and King Island, running from Little Potato Slough to Telephone Cut.	177.67	3,092.07
6	White Slough	37	A slough on the north of Empire Tract and King Island, running from Little Potato Slough to Telephone Cut.	150.40	4,093.66

Exhibit 3.1 (continued)
***Egeria densa* Control Program**
Cross-walk of DBW Site Numbers with Priority Site Numbers
(Original 2001 EIR Priority Site Classifications and Definitions) **Page 2 of 8**

Priority Site Number	Site Name	DBW Site Number	Description	Estimated Total Water Acres	Estimated Total Water & Land Acres
6	White Slough	39	A slough on the north of Empire Tract and King Island, running from Little Potato Slough to Telephone Cut.	192.21	2,356.42
7	Fisherman's Cut	106	A cut directly north of False River at the west side of Franks Tract to the San Joaquin River.	88.50	2,175.66
8	Taylor Slough	110	A slough on the west end of Franks Tract running around Bethal Island and south to Dutch Slough. Frequently used to access Franks Tract from marinas along Dutch Slough.	92.38	1,489.08
8	Taylor Slough	111	A slough on the west end of Franks Tract running around Bethal Island and south to Dutch Slough. Frequently used to access Franks Tract from marinas along Dutch Slough.	75.39	984.23
9	Sandmound Slough	108	A slough on the west side of Holland Tract from Quimby Island to Rock Slough.	148.52	772.46
9	Sandmound Slough	109	A slough on the west side of Holland Tract from Quimby Island to Rock Slough.	199.39	2,534.96
10	Piper Slough	107	A slough on the southwest corner of Franks Tract connecting to Sandmound Slough.	168.38	2,051.75
11	Latham Slough	65	A slough on the west side of McDonald Island off of Middle River in the central portion of the Delta.	394.53	1,198.29
11	Latham Slough	68	A slough on the west side of McDonald Island off of Middle River in the central portion of the Delta.	254.67	2,980.37
11	Latham Slough	69	A slough on the west side of McDonald Island off of Middle River in the central portion of the Delta.	277.19	2,086.17
12	Disappointment Slough	32	A slough south of Empire Tract and King Island, running from the Stockton Deep Water Channel to Pixley Slough.	253.34	2,715.86
12	Disappointment Slough	33	A slough south of Empire Tract and King Island, running from the Stockton Deep Water Channel to Pixley Slough.	124.60	817.38
13	Old River Del's	78	The portion of Old River south of Clifton Court Forebay near Del's Boat Harbor.	48.11	1,609.55
13	Old River Del's	79	The portion of Old River south of Clifton Court Forebay near Del's Boat Harbor.	68.08	1,775.18
14	Old River Connection	100	The north most portion of Old River where it meets Connection Slough on the north side of Bacon Island.	225.30	926.14

Exhibit 3.1 (continued)
***Egeria densa* Control Program**
Cross-walk of DBW Site Numbers with Priority Site Numbers
(Original 2001 EIR Priority Site Classifications and Definitions)

Priority Site Number	Site Name	DBW Site Number	Description	Estimated Total Water Acres	Estimated Total Water & Land Acres
15	Middle River Bullfrog	58	The portion of Middle River next to Bullfrog Landing and Marina, west of the Lower Jones Tract and South of Mildred Island.	128.43	1,872.67
15	Middle River Bullfrog	59	The portion of Middle River next to Bullfrog Landing and Marina, west of the Lower Jones Tract and South of Mildred Island.	191.23	1,226.05
16	Middle River Jones	56	The portion of Middle River on the west side of Upper Jones Tract and South to Woodward Canal.	146.90	2,776.83
17	Fourteenmile Slough	25	A slough east of the Stockton Deep Water Channel on the north side of Lower Roberts Island beginning near Windmill Cove Marina.	45.17	2,007.08
17	Fourteenmile Slough	26	A slough east of the Stockton Deep Water Channel on the north side of Lower Roberts Island beginning near Windmill Cove Marina.	162.92	1,861.86
17	Fourteenmile Slough	27	A slough east of the Stockton Deep Water Channel on the north side of Lower Roberts Island beginning near Windmill Cove Marina.	52.13	1,791.56
17	Fourteenmile Slough	28	A slough east of the Stockton Deep Water Channel on the north side of Lower Roberts Island beginning near Windmill Cove Marina.	96.98	2,002.38
18	Middle River Victoria	52	The portion of Middle River between Woodward Canal and Union Point east of Victoria Island.	89.37	943.20
18	Middle River Victoria	53	The portion of Middle River between Woodward Canal and Union Point east of Victoria Island.	107.43	1,373.12
19	Donlon Island	122	A heavily infested island on the east side of Sherman Island bordering the San Joaquin River.	232.23	466.36
20	Rhode Island	99	An island on the northwest side of Bacon Island bordering Holland Tract along Old River.	253.75	1,268.28
21	Big Break Wetlands	118	A heavily infested area on the westernmost side of Big Break.	103.85	379.90
21	Big Break Wetlands	117	A heavily infested area on the westernmost side of Big Break.	549.36	624.95
22	Big Break Marina	116	A heavily infested area on the southwest corner of Big Break.	179.48	349.25
23	Sevenmile Slough	20	A slough on the west portion of the treatment area, north of Webb Tract.	63.88	3,310.48

Exhibit 3.1 (continued)
***Egeria densa* Control Program**
Cross-walk of DBW Site Numbers with Priority Site Numbers
(Original 2001 EIR Priority Site Classifications and Definitions)

Priority Site Number	Site Name	DBW Site Number	Description	Estimated Total Water Acres	Estimated Total Water & Land Acres
24	Dutch Slough	112	A heavily traveled slough running from the east side of Big Break to Sandmound Slough through Bethal Island.	174.70	1,599.21
24	Dutch Slough	113	A heavily traveled slough running from the east side of Big Break to Sandmound Slough through Bethal Island.	104.65	1,371.54
24	Dutch Slough	114	A heavily traveled slough running from the east side of Big Break to Sandmound Slough through Bethal Island.	83.29	299.25
25	Little Potato Slough (Grindstone)	40	A slough connecting Potato Slough with Whites Slough beginning at the intersection of Venice Island and Empire Tract.	105.41	2,210.72
25	Little Potato Slough (Grindstone)	41	A slough connecting Potato Slough with Whites Slough beginning at the intersection of Venice Island and Empire Tract.	127.55	1,636.67
25	Little Potato Slough (Grindstone)	42	A slough connecting Potato Slough with Whites Slough beginning at the intersection of Venice Island and Empire Tract.	100.74	1,267.90
26	Turner Empire Cut	12	A cut intersecting Latham Slough at Mildred Island with the Stockton Deep Water Channel, north of Lower Jones Tract and Roberts Island.	117.27	3,049.20
26	Turner Empire Cut	60	A cut intersecting Latham Slough at Mildred Island with the Stockton Deep Water Channel, north of Lower Jones Tract and Roberts Island.	144.12	1,905.46
27	Little Venice Island	15	A small island bordered by Mandeville Island to the west, Medford Island to the east and Venice Cut to the north.	455.70	2,253.77
27	Little Venice Island	16	A small island bordered by Mandeville Island to the west, Medford Island to the east and Venice Cut to the north. This site is included in Priority Site No. 2-DBW Site No. 16.	0.00	0.00
28	Coney Island	84	An island on the east side of Clifton Court Forebay.	49.14	1,152.98
28	Coney Island	85	An island on the east side of Clifton Court Forebay.	60.76	804.85
28	Coney Island	86	An island on the east side of Clifton Court Forebay.	939.12	1,477.75
29	Hog Island	13	An island east of McDonald Island, bordering the Stockton Deep Water Channel and Hog Cut.	407.07	3,513.07
30	Pixley Slough	31	A slough on the eastern side of the Delta, south of Bishop Tract beginning at Paradise Point Marina.	82.82	2,435.82

Exhibit 3.1 (continued)
***Egeria densa* Control Program**
Cross-walk of DBW Site Numbers with Priority Site Numbers
(Original 2001 EIR Priority Site Classifications and Definitions) **Page 5 of 8**

Priority Site Number	Site Name	DBW Site Number	Description	Estimated Total Water Acres	Estimated Total Water & Land Acres
31	Bacon Island	56	Areas around Bacon Island, a large centrally located island in the Delta. This site is included in Priority Site Nos. 57-59, 66-67, 92, and 98-100.	0.00	0.00
32	Paradise Cut	72	A cut on the southern portion of the Delta, on the south side of Stewart Tract intersecting Old River (not readily navigable).	109.93	1,946.44
33	Bishop Telephone Cut	34	Bishop is located on the east side of the Delta, running along the west side of Bishop Tract and including Telephone Cut.	81.63	1,522.26
33	Bishop Telephone Cut	35	Bishop is located on the east side of the Delta, running along the west side of Bishop Tract and including Telephone Cut.	72.56	2,346.06
34	Old River Orwood	91	The portion of Old River bordering Orwood Island.	177.14	2,221.80
34	Old River Orwood	92	The portion of Old River bordering Orwood Island.	202.04	1,404.42
35	Potato Slough	43	A slough north of Venice Island between the Stockton Deep Water Channel and Little Potato Slough.	210.17	2,425.94
35	Potato Slough	44	A slough north of Venice Island between the Stockton Deep Water Channel and Little Potato Slough.	249.91	1,137.55
			Subtotal of Sites Nos. 1-35	**15,571**	108,920
36	Beaver Slough	207	A slough on the northern portion of the treatment area, intersecting the South Mokelumne River and the north side of Brack Tract.	134.61	8,175.44
37	Sycamore Slough	203	A slough on the northern portion of the treatment area, intersecting the South Mokelumne River and the south side of Brack Tract.	294.91	8,469.73
38	Hog Slough	205	A slough on the northern portion of the treatment area, intersecting the South Mokelumne River and the middle portion of Brack Tract.	113.26	5,442.78
39	Ward Island	14		289.55	1,302.32
40	Whiskey Slough	61	A slough south of the intersection of Turner and Empire Cuts and north of Trapper Slough.	62.15	1,042.88
40	Whiskey Slough	62	A slough south of the intersection of Turner and Empire Cuts and north of Trapper Slough.	68.56	4,406.10

Exhibit 3.1 (continued)
***Egeria densa* Control Program**
Cross-walk of DBW Site Numbers with Priority Site Numbers
(Original 2001 EIR Priority Site Classifications and Definitions)

Priority Site Number	Site Name	DBW Site Number	Description	Estimated Total Water Acres	Estimated Total Water & Land Acres
41	Indian Slough (includes Discovery Bay)	93	A slough north of Discovery Bay that intersects with Old River.	804.07	2,614.36
42	South Mokelumne	204		103.12	1,301.09
42	South Mokelumne	206		75.91	2,713.22
42	South Mokelumne	208		67.55	1,927.46
43	Old River Main	89	The portion of Old River north of Clifton Ct. Forebay and south of Woodward Canal.	114.68	3,997.79
43	Old River Main	90	The portion of Old River north of Clifton Ct. Forebay and south of Woodward Canal.	98.93	1,426.81
44	North Mokelumne	209		241.52	3,669.98
44	North Mokelumne	210		107.53	1,874.74
45	3 Mile Slough	22		704.40	5,202.55
46	San Joaquin Bradford	23		849.78	3,452.58
47	Quimby Island	101	The portion of Old River to the east of Quimby Island running from Franks Tract to Connection Slough.	328.27	2,252.00
48	Hayes Reach	17		850.66	1,874.58
49	Middle River Mildred	66	The portion of Middle River between Connection Slough and the south side of Mildred Island.	123.52	797.60
49	Middle River Mildred	67	The portion of Middle River between Connection Slough and the south side of Mildred Island.	729.45	2,223.02
50	Antioch	121	The portion of the San Joaquin River north of the Antioch Marina.	731.99	1,656.31
51	Topeka Santa Fe	57		53.27	876.59
52	Old River Holland	98	The north portion of Old River where it meets Rhode Island on the southwest side of Holland Tract.	217.37	1,430.39
53	Werner Dredger Cut	94	A cut running from Rock Slough to Discovery Bay west of Old River.	38.87	1,578.81
53	Werner Dredger Cut	95	A cut running from Rock Slough to Discovery Bay west of Old River.	38.71	1,439.25
53	Werner Dredger Cut	96	A cut running from Rock Slough to Discovery Bay west of Old River.	50.41	1,160.28
54	Victoria Canal	50	A canal northeast of Clifton Ct. Forebay running from Coney Island to Union Point.	119.63	3,119.29

Exhibit 3.1 (continued)
***Egeria densa* Control Program**
Cross-walk of DBW Site Numbers with Priority Site Numbers
(Original 2001 EIR Priority Site Classifications and Definitions)

Priority Site Number	Site Name	DBW Site Number	Description	Estimated Total Water Acres	Estimated Total Water & Land Acres
54	Victoria Canal	51	A canal northeast of Clifton Ct. Forebay running from Coney Island to Union Point.	75.02	2,881.51
55	Burns French Camp	9		364.79	5,893.94
56	Woodward Canal	54	A canal east of Discovery Bay between Old River and Middle River.	47.49	1,328.05
56	Woodward Canal	55	A canal east of Discovery Bay between Old River and Middle River.	38.72	971.92
57	Grant Line Canal	80	A canal southeast of Clifton Ct. Forebay from Old River to Doughty Cut.	170.48	4,621.46
57	Grant Line Canal	81	A canal southeast of Clifton Ct. Forebay from Old River to Doughty Cut.	106.23	4,023.63
58	Trapper Slough	64		42.36	4,133.28
59	Lost Slough	215	A slough east of Snodgrass Slough north of the Mokelumne River.	130.55	3,275.14
60	Snodgrass Slough	214	A long slough in the north portion of the Delta from the Walnut Grove area up to Lambert Road (Stone Lakes).	77.30	733.81
60	Snodgrass Slough	216	A long slough in the north portion of the Delta from the Walnut Grove area up to Lambert Road (Stone Lakes).	67.43	849.39
60	Snodgrass Slough	217	A long slough in the north portion of the Delta from the Walnut Grove area up to Lambert Road (Stone Lakes).	126.63	2,680.15
60	Snodgrass Slough	218	A long slough in the north portion of the Delta from the Walnut Grove area up to Lambert Road (Stone Lakes).	18.51	286.81
60	Snodgrass Slough	219	A long slough in the north portion of the Delta from the Walnut Grove area up to Lambert Road (Stone Lakes).	14.54	355.16
60	Snodgrass Slough	220	A long slough in the north portion of the Delta from the Walnut Grove area up to Lambert Road (Stone Lakes).	40.32	480.56
60	Snodgrass Slough	221	A long slough in the north portion of the Delta from the Walnut Grove area up to Lambert Road (Stone Lakes).	8.79	2,358.11
61	Middle River Union	45	The portion of Middle River running southeast of Union Point along the east side of Union Island.	9.77	701.38
61	Middle River Union	46	The portion of Middle River running southeast of Union Point along the east side of Union Island.	32.13	4,682.50

Exhibit 3.1 (continued)
***Egeria densa* Control Program**
Cross-walk of DBW Site Numbers with Priority Site Numbers
(Original 2001 EIR Priority Site Classifications and Definitions)

Priority Site Number	Site Name	DBW Site Number	Description	Estimated Total Water Acres	Estimated Total Water & Land Acres
61	Middle River Union	47	The portion of Middle River running southeast of Union Point along the east side of Union Island.	50.94	8,440.50
61	Middle River Union	48	The portion of Middle River running southeast of Union Point along the east side of Union Island.	24.64	2,392.13
61	Middle River Union	49	The portion of Middle River running southeast of Union Point along the east side of Union Island.	39.76	3,141.81
62	Depue Ox Bow	305		35.13	2,146.50
63	River Club Ox Bow	306		90.74	452.38
64	Five Mile Slough	27	This site is included in Priority Site No. 17-DBW Site No. 27.	0.00	0.00
65	San Joaquin Roberts	2		88.93	2,059.45
65	San Joaquin Roberts	3		109.97	2,694.54
65	San Joaquin Roberts	4		76.41	5,685.05
65	San Joaquin Roberts	5		57.56	3,057.63
66	Stockton Channel	10		294.25	3,052.67
66	Stockton Channel	11		217.12	2,644.98
67	San Andreas Shoal	19		888.20	3,487.96
68	San Joaquin Mossdale	1		116.97	2,074.35
69	Tom Paine Slough	74		167.60	4,204.28
70	Circle Lake	300		205.59	842.91
			Subtotal of Priority Site Numbers 36 to 70[b)]	**11,248**	162,062
			Total of all Priority Site Numbers 1 to 70[b)]	**26,819**	270,981

[a)] Source: Acreage estimated by the DBW GIS Unit using U.S. Geological Survey quadrangle maps, California Department of Fish and Game draft vegetation maps, and U.S. Bureau of Reclamation water layer information.. There are 369 different priority site numbers that cross-walk with a unique defined DBW Site Number.

[b)] It is estimated by the DBW that there are 51,727 acres of water and 529,396 acres of water and land within the DBW's defined Northern sites that include approximately DBW Priority Sites 1 to 300.

Exhibit 3.2
***Egeria densa* Control Program**
Estimated Total Surface Acreage at Each Site by Priority Site Numbers **Page 1 of 3**

Priority Site Number	Site Name	DBW Site Numbers	Estimated Total Water Acres	Estimated Total Water & Land Acres	Percentage Water Area of Total Water & Land Acres
1	**Franks Tract**	173, 174, 175	2,619.64	3,538.71	**74%**
2	Venice Cut	16	841.36	3,480.31	24%
3	**Big Break I**	115	669.18	1,032.38	**65%**
4	**Sherman Lake**	123, 124, 125, 126, 127, 128, 129, 130, 131, 132	1,917.00	3,804.18	**50%**
5	Rock Slough	97	126.54	3,168.06	4%
6	White Slough	36, 37, 39	520.28	9,542.15	5%
7	Fisherman's Cut	106	88.50	2,175.66	4%
8	Taylor Slough	110, 111	167.77	2,473.31	7%
9	Sandmound Slough	108, 109	347.91	3,307.42	11%
10	Piper Slough	107	168.38	2,051.75	8%
11	Latham Slough	65, 68, 69	926.39	6,264.83	15%
12	Disappointment Slough	32, 33	377.94	3,533.24	11%
13	Old River Del's	78, 79	116.19	3,384.73	3%
14	Old River Connection	100	225.30	926.14	24%
15	Middle River Bullfrog	58, 59	319.66	3,098.72	10%
16	Middle River Jones	56	146.90	2,776.83	5%
17	Fourteenmile Slough	25, 26, 27, 28	357.20	7,662.88	5%
18	Middle River Victoria	52, 53	196.80	2,316.32	8%
19	**Donlon Island**	122	232.23	466.36	**50%**
20	Rhode Island	99	253.75	1,268.28	20%
21	**Big Break Wetlands**	117, 118	653.21	1,004.85	**65%**
22	**Big Break Marina**	116	179.48	349.25	**51%**
23	Sevenmile Slough	20	63.88	3,310.48	2%
24	Dutch Slough	112, 113, 114	362.64	3,270.00	11%
25	Little Potato Slough (Grindstone)	40, 41, 42	333.70	5,115.29	7%
26	Turner Empire Cut	12, 60	261.39	4,954.66	5%
27	Little Venice Island	15, 16	455.70	2,253.77	20%
28	Coney Island	84, 85, 86	1,049.02	3,435.58	31%
29	Hog Island	13	407.07	3,513.07	12%
30	Pixley Slough	31	82.82	2,435.82	3%
31	Bacon Island	56	0.00	0.00	0%

Exhibit 3.2 (continued)
***Egeria densa* Control Program**
Estimated Total Surface Acreage at Each Site by Priority Site Numbers **Page 2 of 3**

Priority Site Number	Site Name	DBW Site Numbers	Estimated Total Water Acres	Estimated Total Water & Land Acres	Percentage Water Area of Total Water & Land Acres
32	Paradise Cut	72	109.93	1,946.44	6%
33	Bishop Telephone Cut	34, 35	154.19	3,868.32	4%
34	Old River Orwood	91, 92	379.18	3,626.22	10%
35	Potato Slough	43, 44	460.08	3,563.49	13%
Subtotal of Priority Sites 1 to 35			15,571	108,920	**14%**
36	Beaver Slough	207	134.61	8,175.44	2%
37	Sycamore Slough	203	294.91	8,469.73	3%
38	Hog Slough	205	113.26	5,442.78	2%
39	Ward Island	14	289.55	1,302.32	22%
40	Whiskey Slough	61, 62	130.71	5,448.98	2%
41	Indian Slough (includes Discovery Bay)	93	804.07	2,614.36	31%
42	South Mokelumne	204, 206, 208	246.58	5,941.77	4%
43	Old River Main	89, 90	213.61	5,424.60	4%
44	North Mokelumne	209, 210	349.05	5,544.72	6%
45	3 Mile Slough	22	704.40	5,202.55	14%
46	San Joaquin Bradford	23	849.78	3,452.58	25%
47	Quimby Island	101	328.27	2,252.00	15%
48	Hayes Reach	17	850.66	1,874.58	45%
49	Middle River Mildred	66, 67	852.97	3,020.62	28%
50	Antioch	121	731.99	1,656.31	44%
51	Topeka Santa Fe	57	53.27	876.59	6%
52	Old River Holland	98	217.37	1,430.39	15%
53	Werner Dredger Cut	94, 95, 96	127.99	4,178.34	3%
54	Victoria Canal	50, 51	194.65	6,000.80	3%
55	Burns French Camp	9	364.79	5,893.94	6%
56	Woodward Canal	54, 55	86.21	2,299.97	4%
57	Grant Line Canal	80, 81	276.71	8,645.09	3%
58	Trapper Slough	64	42.36	4,133.28	1%
59	Lost Slough	215	130.55	3,275.14	4%
60	Snodgrass Slough	214, 216, 217, 218, 219, 220, 221	353.52	7,743.99	5%
61	Middle River Union	45, 46, 47, 48, 49	157.24	19,358.32	1%

Exhibit 3.2 (continued)
***Egeria densa* Control Program**
Estimated Total Surface Acreage at Each Site by Priority Site Numbers **Page 3 of 3**

Priority Site Number	Site Name	DBW Site Numbers	Estimated Total Water Acres	Estimated Total Water & Land Acres	Percentage Water Area of Total Water & Land Acres
62	Depue Ox Bow	305	35.13	2,146.50	2%
63	River Club Ox Bow	306	90.74	452.38	20%
64	Five Mile Slough	27	0.00	0.00	0%
65	San Joaquin Roberts	2, 3, 4, 5	332.87	13,496.67	2%
66	Stockton Channel	10, 11	511.37	5,697.65	9%
67	San Andreas Shoal	19	888.20	3,487.96	25%
68	San Joaquin Mossdale	1	116.97	2,074.35	6%
69	Tom Paine Slough	74	167.60	4,204.28	4%
70	Circle Lake	300	205.59	842.91	24%
Subtotal of Priority Sites 36 to 70			11,248	162,062	**7%**
Total of Priority Sites 1 to 70			26,819	270,981	**10%**

Source: Exhibit 3-1 (consolidated)

Delta region remain at risk to *Egeria densa* as much of the Delta ecosystem consists of freshwater areas less than ten feet deep, an aquatic habitat in which *Egeria densa* thrives.

No one definitive efficacy and infestation quantification data measurement set are available for the EDCP. Efficacy measurement is an area of great challenge for the EDCP. By examining a range of partial, or incomplete, available EDCP efficacy data sources one can make inferences about change over time in *Egeria densa* infestation levels in the Delta region.

Prior EDCP treated sites and acreage treated can be some indicator, or a proxy, for the extent of *Egeria densa* in the Delta region. This proxy is a minimum estimate of *Egeria densa* acreage under the assumption that if this acreage was treated, then *Egeria densa* existed at least to these acreage levels. This assumption is also reasonable because (1) the EDCP is resource constrained by treatment crews and chemical budgets, (2) the EDCP has not begun to treat all of the possible sites within its jurisdiction, and (3) the EDCP is a control effort, not an eradication program.

An examination of DBW's Annual reports for the five years, 2001 through 2005, provides some information for this treatment area proxy.[8 9 10 11 12] **Table 3.3**, above right, shows the number of sites treated, and the acreage treated by the EDCP for each of the five years, 2001 through 2005.

Table 3.3
***Egeria densa* Control Program Sites and Acreage Treated (2001 to 2005)**

Application Year	Number of Sites Treated (Fluridone, Diquat, & Combination Treatments)	Acreage Treated in Total
2001	5	268
2002	12	351
2003	14	554
2004	11	533
2005	**13**	**622**

Source: DBW pesticide use data reporting.

Total acreage treated includes some multiple treatments throughout the treatment season at the same site. Thus these acreage estimates are not necessarily a precise geographic acreage estimate, but rather an acreage estimate of *Egeria densa,* and some reoccurring *Egeria densa,* during the same treatment season.

Table 3.3 shows that while the number of EDCP treated sites has generally remained essentially constant at 11 to 14 sites each year (except for the first year 2001, and not always the same sites each year), the amount of *Egeria densa* acreage treated has grown significantly, approximately 90 percent over the three years from 2002 to 2005, or at an average annual compound rate of growth of 24 percent. Table 3.3 provides evidence that *Egeria densa* has not been controlled, and that it is still spreading rapidly over time.

Other DBW documentation shows that over the five-year, 2001 to 2005 EDCP treatment period, a total of 24 different DBW site numbers have been treated in total (versus 19 named sites), out of a potential of 369 unique DBW site numbers.

Though *Egeria densa* may be most everywhere in the Delta region, it is concentrated in the Central Delta, particularly in Franks Tract and Big Break.

3. San Francisco State University Aerial Mapping Analysis for the EDCP

Researchers at San Francisco State University, over a period of years, under contract to the DBW, estimated *Egeria densa* acreage in the Delta region[13 14 15 16]. These aerial mapping estimates started in 1997, and were also performed in 1999, and 2000.

The air photo estimates were based on color infrared aerial photography flown by airplane at various times. The air photos were scan-digitized, and color-separated to create 3-band digital imagery at a nominal 2-meter spatial resolution (each pixel was equal to 2 meters x 2 meters on the ground). Periodic ground surveys were used in interpreting the imagery, but these ground surveys were not extensive.

At the time of these various air photo studies, the ground surveys indicated that other submerged aquatic plants (included in the *Egeria densa* acreage estimates) comprised less than five percent of the submergent species in the Delta region. Today, DBW field crews estimate that this percentage may be much greater (as high as 30 percent or more) likely because as *Egeria densa* has been treated over time, other submerged species have filled-in.

The first two year air photo estimates (1997 and 1999) had more limitations than later year estimates in 2000. The 2000 year estimates were generally considered more accurate than either the 1997 or 1999 estimates.

Changing sun angles; tide levels; water currents; wind conditions and surface waves; and turbidity all effect spectral response patterns. All the aerial photo estimates have numerous caveats and disclaimers indicating that these *Egeria densa* acreage measurements are “rough estimates”.

Exhibit 3.3, following this page, provides estimated *Egeria densa* surface acreage determined by the San Francisco State University aerial mapping analyses. These *Egeria densa* acreage estimates are generally by the priority site numbers originally delineated in the March 2001, *Final Environmental Impact Report, for the EDCP*.

There was some lack of consistency between the site definitions used by San Francisco State University and those which are reported in Exhibit 3.3 by the DBW priority site numbers. This inconsistency is considered to have a minor impact on bottom-line reported results (as the San Francisco State site definitions were relatively consistent over-time).

Exhibit 3.3 data show that San Francisco State University estimated relative stability in total *Egeria densa* acreage over the two year period between 1997 and 1999 (a slight eight percent decrease), but more than a thirty (30) percent increase (4,501 acres to 5,959 acres) in *Egeria densa* acreage for the 70 sites over the three year period, 1997 to 2000.

Exhibit 3.3
***Egeria densa* Control Program**
Estimated *Egeria densa* Surface Acreage at Each Site by Priority Site Numbers **Page 1 of 3**

Priority Site Number	Site Name	Estimated Total Water Acres	Estimated 1997 *Egeria densa* Acres	Percentage *Egeria densa* Acres of Water Acres in 1997	Estimated 1999 *Egeria densa* Acres	Percentage *Egeria densa* Acres of Water Acres in 1999	Estimated 2000 *Egeria densa* Acres	Percentage *Egeria densa* Acres of Water Acres in 2000
1	Franks Tract	2,619.64	1,039	40%	718	27%	1,697	65%
2	Venice Cut	841.36	141	17%	147	17%	119	14%
3	Big Break I	669.18	563	84%	293	44%	724	108%
4	Sherman Lake	1,917.00	370	19%	648	34%	590	31%
5	Rock Slough	126.54	35	28%	37	29%	39	31%
6	White Slough	520.28	105	20%	129	25%	159	31%
7	Fisherman's Cut	88.50	13	15%	21	24%	34	38%
8	Taylor Slough	167.77	24	14%	11	7%	38	23%
9	Sandmound Slough	347.91	53	15%	58	17%	53	15%
10	Piper Slough	168.38	23	14%	19	11%	26	15%
11	Latham Slough	926.39	104	11%	90	10%	73	8%
12	Disappointment Slough	377.94	126	33%	86	23%	123	33%
13	Old River Del's	116.19	23	20%	24	21%	67	58%
14	Old River Connection	225.30	37	16%	39	17%	52	23%
15	Middle River Bullfrog	319.66	57	18%	49	15%	63	20%
16	Middle River Jones	146.90	38	26%	20	14%	47	32%
17	Fourteenmile Slough	357.20	52	15%	35	10%	62	17%
18	Middle River Victoria	196.80	25	13%	20	10%	69	35%
19	Donlon Island	232.23	89	38%	111	48%	100	43%
20	Rhode Island	253.75	88	35%	86	34%	94	37%
21	Big Break Wetlands	653.21	27	4%	55	8%	55	8%
22	Big Break Marina	179.48	2	1%	3	2%	5	3%
23	Sevenmile Slough	63.88	20	31%	13	20%	14	22%
24	Dutch Slough	362.64	63	17%	44	12%	18	5%
25	Little Potato Slough (Grindstone)	333.70	30	9%	31	9%	45	13%
26	Turner Empire Cut	261.39	27	10%	14	5%	24	9%
27	Little Venice Island	455.70	103	23%	87	19%	93	20%
28	Coney Island	1,049.02	72	7%	55	5%	116	11%
29	Hog Island	407.07	51	13%	20	5%	33	8%
30	Pixley Slough	82.82	27	33%	11	13%	46	56%
31	Bacon Island	0.00	30	0%	39	0%	46	0%

Exhibit 3.3 (continued)
***Egeria densa* Control Program**
Estimated *Egeria densa* Surface Acreage at Each Site by Priority Site Numbers **Page 2 of 3**

Priority Site Number	Site Name	Estimated Total Water Acres	Estimated 1997 *Egeria densa* Acres	Percentage *Egeria densa* Acres of Water Acres in 1997	Estimated 1999 *Egeria densa* Acres	Percentage *Egeria densa* Acres of Water Acres in 1999	Estimated 2000 *Egeria densa* Acres	Percentage *Egeria densa* Acres of Water Acres in 2000
32	Paradise Cut	109.93	18	16%	0	0%	0	0%
33	Bishop Telephone Cut	154.19	20	13%	28	18%	64	42%
34	Old River Orwood	379.18	90	24%	62	16%	83	22%
35	Potato Slough	460.08	37	8%	48	10%	36	8%
Subtotal of Priority Sites 1 to 35		15,571	**3,622**	**23%**	3,151	20%	**4,907**	**32%**
36	Beaver Slough	134.61	0	0%	0	0%	1	1%
37	Sycamore Slough	294.91	30	10%	23	8%	44	15%
38	Hog Slough	113.26	15	13%	4	4%	8	7%
39	Ward Island	289.55	64	22%	102	35%	158	55%
40	Whiskey Slough	130.71	21	16%	9	7%	23	18%
41	Indian Slough	804.07	92	11%	15	2%	31	4%
42	South Mokelumne	246.58	69	28%	104	42%	131	53%
43	Old River Main	213.61	55	26%	53	25%	105	49%
44	North Mokelumne	349.05	51	15%	51	15%	58	17%
45	3 Mile Slough	704.40	48	7%	38	5%	22	3%
46	San Joaquin Bradford	849.78	24	3%	51	6%	25	3%
47	Quimby Island	328.27	99	30%	103	31%	90	27%
48	Hayes Reach	850.66	27	3%	33	4%	31	4%
49	Middle River Mildred	852.97	29	3%	26	3%	20	2%
50	Antioch	731.99	43	6%	124	17%	21	3%
51	Topeka Santa Fe	53.27	16	30%	20	38%	32	60%
52	Old River Holland	217.37	19	9%	23	11%	19	9%
53	Werner Dredger Cut	127.99	25	20%	27	21%	47	37%
54	Victoria Canal	194.65	34	17%	19	10%	57	29%
55	Burns French Camp	364.79	10	3%	0	0%	2	1%
56	Woodward Canal	86.21	15	17%	18	21%	32	37%
57	Grant Line Canal	276.71	9	3%	10	4%	13	5%
58	Trapper Slough	42.36	22	52%	0	0%	0	0%
59	Lost Slough	130.55	0	0%	61	47%	30	23%

Exhibit 3.3 (continued)
***Egeria densa* Control Program**
Estimated *Egeria densa* Surface Acreage at Each Site by Priority Site Numbers **Page 3 of 3**

Priority Site Number	Site Name	Estimated Total Water Acres	Estimated 1997 *Egeria densa* Acres	Percentage *Egeria densa* Acres of Water Acres in 1997	Estimated 1999 *Egeria densa* Acres	Percentage *Egeria densa* Acres of Water Acres in 1999	Estimated 2000 *Egeria densa* Acres	Percentage *Egeria densa* Acres of Water Acres in 2000
60	Snodgrass Slough	353.52	0	0%	17	5%	24	7%
61	Middle River Union	157.24	0	0%	4	3%	0	0%
62	Depue Ox Bow	35.13	0	0%	0	0%	1	3%
63	River Club Ox Bow	90.74	0	0%	-	0%	-	-
64	Five Mile Slough	0.00	0	0%	0	0%	0	0%
65	San Joaquin Roberts	332.87	0	0%	0	0%	0	0%
66	Stockton Channel	511.37	40	8%	15	3%	10	2%
67	San Andreas Shoal	888.20	19	2%	32	4%	17	2%
68	San Joaquin Mossdale	116.97	3	3%	0	0%	0	0%
69	Tom Paine Slough	167.60	0	0%	6	4%	0	0%
70	Circle Lake	205.59	0	0%	0	0%	0	0%
Subtotal of Priority Sites 36 to 70		11,248	**879**	**8%**	988	9%	**1,052**	**9%**
Total of Priority Sites 1 to 70		26,819	**4,501**	**17%**	4,139	15%	**5,959**	**22%**

Source: References number 13 through 16.

Exhibit 3.3 data also show that the percentage *Egeria densa* acres of site total water acres, increased from 23 percent in 1997 for the 35 highest priority sites, to 32 percent in 2000. Overall for the 70 priority sites, the percentage *Egeria densa* acres increased from 17 percent in 1997, to 22 percent in 2000.

Just four sites (Franks Tract, Sherman Lake, Big Break I, and Ward Island) were responsible for 78 percent of the net acreage increase between 1997 and 2000, recognizing that some sites increased *Egeria densa* acreage and some sites decreased *Egeria densa* acreage. Franks Tract *Egeria densa* increased by 658 acres, Sherman Lake's *Egeria densa* increased by 220 acres, Big Break I's *Egeria densa* increased by 161 acres, and Ward Island's *Egeria densa* increased by 94 acres. These four sites had increased *Egeria densa* acreage of 1,133 acres out of the total 1,458 *Egeria densa* acreage increase over the three year period.

The San Francisco State aerial mapping analyses demonstrated some key findings. *Egeria densa* grew at a rapid rate during this analyzed time period (1997 to 2000). Much of the measured growth in *Egeria densa* during this analyzed time period was concentrated in a handful of key priority sites.

Franks Tract alone, comprised over 28 percent of the measured *Egeria densa* acreage in 2000, while Big Break and Sherman Lake combined, comprised another 22 percent of the *Egeria densa* acreage. In total, just these three (3) sites accounted for over 50 percent of the total measured *Egeria densa* acreage in 2000. This concentration finding is consistent with the resource constrained operational reality that the EDCP has focused on a finite number of sites each year reflecting the *Egeria densa* "hot spot" priorities at the time.

Exhibit 3.3, along with Table 3.2, provide quantitative information from which to make range projections of *Egeria densa* acreage for the Delta region. **Table 3.4**, following this page, provides 2006 year estimates of *Egeria densa* acres for the Delta region, using year 2000 aerial mapping data.

Assuming the 40,167 acre remaining Delta region (after subtracting out the 70, 2001 EIR priority sites) is covered nine (9) percent by *Egeria densa* (the same percentage as the second 35, 2001 priority sites), then there were an estimated 9,574 total acres of *Egeria densa* in the Delta region in 2000. If this *Egeria densa* grew at an average annual compound rate of growth of 9.8 percent (the actual average annual compound rate of growth from 1997 through 2000 for all the 70 sites), then from 2000 through 2006 with assumed *Egeria densa growth,* there are estimated 14,057 acres of *Egeria densa* in the Delta region in 2006.

The actual average annual compound rate of growth from 1997 through 2000 for only the second 35, 2001 EIR priority sites, was 6.17 percent. If one assumes that *Egeria densa* grew at one-half (4.9 percent) the 9.8 percent rate of growth from 2000 through 2006, then there are estimated 11,555 acres of

Table 3.4
***Egeria densa* Control Program**
2006 Estimates of *Egeria densa* Acres for Delta Region Using 2000 Aerial Mapping Data

Year 2000	**Water Acres**	***Egeria densa* Acres**	**Percentage *Egeria densa* Acres of Water Acres**
First 35, 2001 EIR Priority Sites	15,571	4,907	32%
Second, 35 2001 EIR Priority Sites	11,248	1,052	**9%**
Total 70, 2001 EIR Priority Sites	26,819	5,959	22%
Delta region	66,986		
Less 70, 2001 EIR Priority Sites	-26,819	5,959	22%
Remaining Delta region	40,167	3,615	**9%**
Total *Egeria densa* Acreage Estimate for Delta region in **2000** Assuming 9 Percent *Egeria densa* Coverage for Remaining 299 Sites (369-70)	66,986	**9,574**	14%

Year 2006			
Average Annual Compound Rate of *Egeria densa* Growth from 1997 through 2000 for 70 Key Sites	**9.8%**		
Total *Egeria densa* Acreage Estimate for Delta region in **2006** Assuming Continued 9.8 Percent Compound Rate of Growth of *Egeria densa* from 2000 through 2006 for just the 70 Key Sites and the Remaining 299 Sites Stayed the Same	26,819	5,959 x (1+.098)E6 = **10,442**	39%
	40,167	3,615	9%
	66,986	**14,057**	21%
Total *Egeria densa* Acreage Estimate for Delta region in **2006** Assuming **4.9 Percent** Compound Rate of Growth of *Egeria densa* from 2000 through 2006 for just the 70 Key Sites and the Remaining 299 Sites Stayed the Same	26,819	5,959 x (1+.049)E6= **7,940**	30%
	40,167	3,615	9%
	66,986	**11,555**	17%

Source: Table 3.2 and Exhibit 3.3.

Egeria densa in the Delta region in 2006.

Using the 2000 aerial mapping data it can be reasonably estimated that there are anywhere from approximately 11,500 to 14,000 acres of *Egeria densa* in the Delta region for 2006. These range estimates have *Egeria densa* comprising anywhere from 17 to 21 percent of the Delta region water acres.

4. University of California at Davis Hyperspectral Analysis for the EDCP

Scientists at the University of California, Davis, under contract to the DBW, have more recently attempted to estimate *Egeria densa* and Water Hyacinth acreage in the Delta region using hyperspectral remote sensing analysis (differentiated from aerial photography and satellite imagery analyses).[17] [18] [19] [20] Hyperspectral remote sensing uses airborne sensors to gather reflected radiation data from the *Egeria densa* ground target.

This hyperspectral pilot research project first started in 2003, and analysis efforts were then continued for three years, 2004 through 2006. In each year the U.C. Davis methodology was continually refined by improving field and laboratory procedures for greater *Egeria densa* measurement consistency and accuracy.

The hyperspectral analyses were based on airborne, remotely sensed hyperspectral imagery (HyMap) for the Delta region, acquired from a private contractor (HyVista Corporation). HyMap contained data for over 126 spectral bands.

For 2005, 149 flight lines were acquired with a nominal ground resolution of 3-meters (each pixel was equal to 3 meters x 3 meters on the ground). Field work was conducted to obtain ground reference data for six different target plant species *(Egeria densa*, water hyacinth, pennywort, water primrose, tule, and cattail).

Hyperspectral remote sensing analysis (using sampled visible, near-infrared, and short-wave-infrared spectrums) has potential advantages over the prior used aerial photography analysis, or a potential alternative satellite imagery analysis. Aerial photography has high spatial resolution (2 meters), but only three band spectral resolution. Satellite imagery has low spatial resolution (10 to 100 meters), and only 4 to 7 spectral resolution bands. The large (hyperspectral) degree of spectral resolution over that obtainable from either aerial photography, or satellite imagery, can be potentially useful for *Egeria densa* identification, and to distinguish *Egeria densa* from other native species.

Hyperspectral remote sensors collect image data in dozens, or hundreds, of narrow adjacent spectral bands. These measurements make it possible to derive a continuous spectrum for each image cell. The data files are huge in these hyperspectral *Egeria densa* analyses. After adjustments for sensor, atmospheric, and terrain effects are applied, these image spectra can be compared with field and laboratory reflectance spectra in order to recognize and map *Egeria densa*.

Hyperspectral analyses have courser spatial resolution by 50 percent over that of the aerial photo analyses (2 meter resolution to 3 meter resolution). Also, hyperspectral analyses require a highly trained and reliable team of staff personnel to interpret the images consistently over time. Hyperspectral analysis is a much more expensive technology than any previously used by the DBW to measure *Egeria densa*.

Hyperspectral images contain a wealth of potential useful data. However, accurately interpreting these hyperspectral data requires a large amount of complex analytical decision rules, mathematical algorithms, and analyses; professional judgment; and correct understanding of the *Egeria densa* water properties and environment. Remote sensing has demonstrated success in accurately identifying terrestrial vegetation but it is much more exploratory in its development for identifying aquatic vegetation, especially submerged weeds.

It is relatively easy to have *Egeria densa* confused with submerged algae or water sedimentation in the hyperspectral analyses. DBW field workers have noted a high correlation between the presence of *Egeria densa* and algae. Most recent hyperspectral estimates of *Egeria densa* now include identified underwater algae on the surface of presumed *Egeria densa* underneath.

It can be somewhat judgmental generating the various overlay analytical masks required in the hyperspectral decision tree elimination analyses, such as even the definition to be used for the water mask. One earlier definition of water in the hyperspectral estimates was quite liberal, including saturated marsh lands in addition to navigable waters. Most recently, the hyperspectral estimates re-estimated water acreage excluding tule islands, riparian zones, and periodic flooded lands and soils.

There is the hyperspectral judgment of whether to include just individual pixel counts for the measure of *Egeria densa*, or to perform polygon smoothing to estimate *Egeria densa* contiguous patches. The most recent hyperspectral estimates of *Egeria densa* include the use of smoothing in the *Egeria densa* measurements when the space between the pixels cannot be identified as tule weeds.

The hyperspectral analyses for *Egeria densa* measurement are only in the developmental research stage. The U.C. Davis researchers will continue to work to improve identification and measurement of *Egeria densa* using hyperspectral analyses.

5. ReMetrix Hydroacoustic Analysis for the EDCP

Researchers at ReMetrix, LLC (Carmel, Indiana), under contract since 2002 to the DBW, have attempted to estimate efficacy for the EDCP on a site-specific basis using hydroacoustic vegetation monitoring assessments (see endnotes [21 22 23 24]). Hydroacoustic surveys are a relatively recently developed form of submersed aquatic vegetation assessments. This sound wave methodology was developed through research by the U.S. Army Engineer Research and Development Center in 1995. The research tool has been incorporated into a commercially available, scientific monitoring system for portable, digital, acoustic data collection. This monitoring system is sold by BioSonics, Inc. (Seattle, Washington).

Hydroacoustic signals (not affected by water clarity) from a digital echo-sounder are reflected back to a ReMetrix research vessel when the signal encounters a material density change in the water column. The monitoring instrument is constantly calibrated to address specific monitoring and vegetation conditions. The digital echo-sounder is directly linked to a geographical positioning system (GPS) instrument through a laptop computer and accompanying software.

In addition to hydroacoustic vegetation data collection, ReMetrix also performs vegetation point sampling. With point sampling, the submerged *Egeria densa* plant community is assessed by use of a pole-mounted thatch rake on a ReMetrix research vessel along with underwater cameras, in parallel with the hydroacoustic assessments. This point sampling is necessary to help calibrate *Egeria densa* from other submerged aquatic vegetation. Hydroacoustic and vegetation point sampling was performed pre-treatment and post-treatment, at a number of treatment sites for 2003, 2004, 2005, and 2006.

Several EDCP sample measurement parameters are calculated by ReMetrix. These parameters include percent of bottom covered in vegetation (biocover), and plant "biovolume". Plant biovolume is defined by ReMetrix as a combination of *Egeria densa* biocover and *Egeria densa* height information that thus estimates the percentage of a water body occupied by submersed *Egeria densa* vegetation.

The ReMetrix research is continuously evolving for the EDCP. Due to the Delta's complex, daily tidal fluctuations, water levels are constantly changing during the course of hydroacoustic collection dates for a given monitoring site. Accurate measurement of tidal levels is critical when using a biovolume (percentage of volume metric), as large changes in site water levels can be material enough to override the ability to accurately measure biovolume. Changes in water level at each site often necessitate the need for normalizations by ReMetrix of their field monitoring data. ReMetrix takes efforts to perform it data collection at consistent tide levels so that meaningful time-series comparisons can be made.

Transect spacing for the ReMetrix field monitoring varied depending on the year, site, budget, and time-line of the particular ReMetrix sampling effort. Repeatable transects were laid out based on the overall size and geometry of each study plot.

Field data collection and computer data analyses are large resource effort for this type of *Egeria densa* efficacy monitoring, thus limiting the hydroacoustic monitoring to a relatively small number of sites, a relatively small amount of acreage as compared to the Delta region, and a limited number of control sites with which to compare to the sampled treatment sites. However, this ReMetrix sampling effort is substantial relative to the number of sites and acreage treated. The ReMetrix biocover and biovolume estimates require extensive detailed data modeling along with numerous assumptions using complex computer software.

In the future, ReMetrix will continue with their annual EDCP monitoring. They will incorporate more statistical inference testing by developing better use of paired control versus treatment sites; and they will expand their unique *Egeria densa* monitoring measures to include an acreage estimate of *Egeria densa* by sampled DBW site. ReMetrix also is interested in further examining (1) salinity levels, water flows, and sedimentation measures at each monitored site, to help guide program chemical treatment efficacy, and (2) after-treatment ecological restoration issues involving shallow water habitat and the other plant species that grow in to replace *Egeria densa*.

At a September 6, 2006, DBW briefing by a lead ReMetrix researcher, Mr. Scott Ruch (who has spent thousands of hours in the Delta performing *Egeria densa* field monitoring over the past several years), the following EDCP efficacy observations were made:

- Delta-wide, there is stability or an increase in coverage of *Egeria densa* infestation overtime, with no noticeable declines in infestation
- As *Egeria densa* is selectively "killed-off" there is evidence of pond weed filling in were *Egeria densa* used to be
- The April early EDCP start dates are very important to EDCP site efficacy, especially for use of the Sonar (fluridone) herbicide
- The site-specific EDCP treatments are targeting *Egeria densa* and not affecting non-targeted plant species.

The ReMetrix hydroacoustic analyses provide the best evidence to-date of site efficacy from the EDCP. **Exhibit 3.4**, beginning on the next page, presents ReMetrix mean biovolume treatment data for 2004 and 2005 for 13 unique DBW sites. The exhibit also presents similar control data for 2 unique DBW sites.

Data from Exhibit 3.4 show that for 23 different possibilities at a EDCP treatment site (treated with Sonar (fluridone) aqueous or pellet forms, and/or Reward (Diquat) herbicides) in either 2004 or 2005, mean biovolume for *Egeria densa* declined from pre-treatment, to the end of treatment cycle period, for the treatment boundary in the respective year, for 20 (eighty-seven percent) of the 23 sites.

Data from Exhibit 3.4 also show that for four (4) control (non-treatment) sites mean biovolume increased for 3 of 4 (seventy-five percent) control sites from the beginning of the year period to the end of the year period, for the respective year.

Exhibit 3.5, on page 3-36, summarizes usable time-series (2004 and 2005) biovolume data for 9 treatment sites and 1 control site. These data are probably the most compelling site efficacy data to-date for the EDCP because they show *Egeria densa* results for the same site over-time.

Exhibit 3.5 shows the following important EDCP efficacy metrics:

- For the 2004 treatment season, the EDCP had efficacy for 9 of the 9 treated time-series sites. This efficacy amounted to a large 41 percent initial decline in total biovolume
- For the untreated, winter growing season from 2004 to 2005, 8 of the 9 sites had an increase in biovolume, and total biovolume came back with a large 55 percent increase.
- For the 2005 treatment season, the EDCP had efficacy for 7 of the 9 treated time-series sites. This efficacy amounted to another large 39 percent decline in total biovolume.

Exhibit 3.4
***Egeria densa* Control Program**
ReMetrix Estimates of Biovolumes by Sample Site
(2004 to 2005)

1. Big Break Marina 117 (2004)

Treatment Product(s): Sonar AS

Date	Treatment Cycle	Treatment Boundary (in Acres)	Total Area (in Acres)	Mean Biovolumes: Treatment Boundary	Mean Biovolumes: Total Area
July 16, 2004	Pre-Treatment	3	5	32.9%	37.2%
September 4, 2004	60 days	3	5	14.9%	16.4%
November 13, 2004	90 days	3	5	7.2%	6.9%

Big Break Marina 117 (2005)

Treatment Product(s): Sonar AS

Date	Treatment Cycle	Fluridone Treatment Area (in Acres)	Total Study Area (in Acres)	Mean Biovolumes: Treatment Boundary	Mean Biovolumes: Total Area
June 30, 2005	Pre-Treatment	3	6	22.1%	22.5%
September 29, 2005	90 days	3	6	13.4%	22.2%

2. Big Break Wetlands 118 (2004)

Treatment Product(s): Sonar PR, Sonar AS

Date	Treatment Cycle	Treatment Boundary (in Acres)	Total Area (in Acres)	Mean Biovolumes: Treatment Boundary
July 8, 2004	Pre-Treatment	55	N/A	41.0%
September 10, 2004	60 days	55	N/A	42.9%
October 30, 2004	90 days	55	N/A	41.3%
November 23, 2004	120 days	55	N/A	27.3%

Big Break Wetlands 118 (2005)

Treatment Product(s): Sonar PR

Date	Treatment Cycle	Fluridone Treatment Area (in Acres)	Total Study Area (in Acres)	Mean Biovolumes: Treatment Boundary
July 1, 2005	Pre-Treatment	55	N/A	60.7%
September 30, 2005	90 days	55	N/A	54.0%
November 13, 2005	120 days	55	N/A	53.2%

3. Dutch Slough 112 (2004)

Treatment Product(s): Sonar PR

Date	Treatment Cycle	Treatment Boundary (in Acres)	Total Area (in Acres)	Mean Biovolumes: Treatment Boundary
June 28, 2004	Pre-Treatment	26	N/A	50.5%
August 10, 2004	28 days	26	N/A	49.0%
October 28, 2004	90 days	26	N/A	41.7%

Dutch Slough 112 (2005)

Treatment Product(s): Sonar PR

Date	Treatment Cycle	Fluridone Treatment Area (in Acres)	Total Study Area (in Acres)	Mean Biovolumes: Treatment Boundary	Mean Biovolumes: Total Area
June 29, 2005	Pre-Treatment	25	23	35.0%	34.5%
September 28, 2005	90 days	25	23	45.6%	45.2%

Exhibit 3.4
***Egeria densa* Control Program**
ReMetrix Estimates of Biovolumes by Sample Site
(2004 to 2005)

4. Franks Tract 173 (2004)

Treatment Product(s): Diquat, Sonar PR

				Mean Biovolumes		
Date	**Treatment Cycle**	**Treatment Boundary (in Acres)**	**Total Area (in Acres)**	**Treatment Boundary**	**Non-Treatment Area**	**Total Area**
July 1, 2004	Pre-Treatment	140	235	54.6%	65.0%	58.8%
August 6, 2004	28 days	140	235	22.4%	35.4%	27.3%
October 8, 2004	90 days	140	235	19.6%	17.6%	18.7%

Franks Tract 173a (2005)

Treatment Product(s): Sonar PR, Diquat

					Mean Biovolumes			
Date	**Treatment Cycle**	**Fluridone Treatment Area (in Acres)**	**Diquat Treatment Area (in Acres)**	**Total Study Area (in Acres)**	**Fluridone Treatment Boundary**	**Non-Fluridone Treatment Boundary**	**Diquat Treatment Boundary**	**Total Area**
April 17, 2005	Pre-Treatment	N/A	N/A	467	38.9%	41.5%	40.5%	40.7%
May 22, 2005	60 days	140	N/A	467	47.8%	61.0%	64.5%	57.0%
July 16, 2005	90 days	140	N/A	467	24.1%	43.4%	48.0%	37.6%
August 15, 2005	120 days	140	N/A	467	50.8%	69.3%	73.6%	63.7%
September 16, 2005	150 days	140	20	467	34.8%	44.9%	41.9%	41.8%
October 14, 2005	180 days	140	20	467	40.3%	45.8%	39.8%	43.9%
November 22, 2005	210 days	140	20	467	37.0%	42.2%	25.9%	39.9%

5. Little Potato Slough - Grindstone 40 (2004)

Treatment Product(s): Sonar AS

				Mean Biovolumes	
Date	**Treatment Cycle**	**Treatment Boundary (in Acres)**	**Total Area (in Acres)**	**Treatment Boundary**	**Total Area**
July 9, 2004	Pre-Treatment	6	8	32.4%	24.0%
September 8, 2004	60 days	6	8	11.7%	9.0%
October 24, 2004	90 days	6	8	13.2%	9.8%

Little Potato Grindstone 40 (2005)

Treatment Product(s): Sonar AS

				Mean Biovolumes	
Date	**Treatment Cycle**	**Fluridone Treatment Area (in Acres)**	**Total Study Area (in Acres)**	**Fluridone Treatment Boundary**	**Total Area**
April 13, 2005	Pre-Treatment	4.5	8	47.5%	39.6%
May 27, 2005	60 days	4.5	8	N/A	N/A
August 1, 2005	90 days	4.5	8	13.9%	15.8%

Exhibit 3.4
***Egeria densa* Control Program**
ReMetrix Estimates of Biovolumes by Sample Site
(2004 to 2005)

6. Pixley Slough/Bear Creek 31 (2004)

Treatment Product(s): Sonar AS

Date	Treatment Cycle	Treatment Boundary (in Acres)	Total Area (in Acres)	Mean Biovolumes: Treatment Boundary
June 25, 2004	Pre-Treatment	27	N/A	45.9%
August 30, 2004	60 days	27	N/A	10.3%
September 26, 2004	90 days	27	N/A	7.5%

Pixley Slough/Bear Creek 31 (2005)

Treatment Product(s): Sonar AS

Date	Treatment Cycle	Fluridone Treatment Area (in Acres)	Total Study Area (in Acres)	Mean Biovolumes: Treatment Boundary
April 6, 2005	Pre-Treatment	27	N/A	21.3%
May 19, 2005	60 days	27	N/A	5.4%
July 28, 2005	90 days	27	N/A	27.2%
October 13, 2005	180 days	27	N/A	N/A

7. Rhode Island 99 (2004)

Treatment Product(s): Diquat, Sonar PR

Date	Treatment Cycle	Diquat Treatment Site (in Acres)	Treatment Boundary (in Acres)	Total Area (in Acres)	Mean Biovolumes: Treatment Boundary
June 30, 2004	Pre-Treatment	20	66	N/A	90.3%
August 9, 2004	28 days	20	66	N/A	85.5%
October 12, 2004	90 days	20	66	N/A	76.9%

Rhode Island 99 (2005)

Treatment Product(s): Sonar PR, Diquat

					Mean Biovolumes		
Date	Treatment Cycle	Fluridone Treatment Area (in Acres)	Diquat Treatment Area (in Acres)	Total Study Area (in Acres)	Fluridone Treatment Boundary	Diquat Treatment Boundary	Total Area
April 8, 2005	Pre-Treatment	N/A	N/A	60	79.3%	84.3%	78.8%
May 26, 2005	60 days	60	N/A	N/A	N/A	N/A	N/A
July 13, 2005	90 days	60	N/A	N/A	54.1%	45.3%	54.1%
August 12, 2005	120 days	60	N/A	N/A	66.5%	59.5%	66.9%
September 11, 2005	150 days	60	20	N/A	66.0%	61.9%	66.0%
October 11, 2005	180 days	60	20	N/A	51.3%	41.5%	51.2%

Exhibit 3.4
***Egeria densa* Control Program**
ReMetrix Estimates of Biovolumes by Sample Site
(2004 to 2005)

8. Venice Cut 16 (2004)

Treatment Product(s): Sonar PR

Date	Treatment Cycle	Treatment Boundary (in Acres)	Total Area (in Acres)	Mean Biovolumes: Treatment Boundary	Mean Biovolumes: Non-Treatment Area	Mean Biovolumes: Total Area
July 7, 2004	Pre-Treatment	55	79	34.5%	16.0%	27.0%
September 9, 2004	60 days	55	79	34.6%	34.7%	34.7%
October 26, 2004	90 days	55	79	33.4%	36.1%	34.3%

Venice Cut 16 (2005)

Treatment Product(s): Sonar PR

Date	Treatment Cycle	Fluridone Treatment Area (in Acres)	Total Study Area (in Acres)	Mean Biovolumes: Treatment Boundary	Mean Biovolumes: Total Area
July 5, 2005	Pre-Treatment	88	128	44.8%	33.0%
September 6, 2005	60 days	88	128	N/A	N/A
October 2, 2005	90 days	88	128	21.5%	15.9%
November 10, 2005	120 days	88	128	6.8%	5.1%

9. White Slough 36 (2004)

Treatment Product(s): Sonar PR, Sonar AS

Date	Treatment Cycle	Treatment Boundary (in Acres)	Total Area (in Acres)	Mean Biovolumes: Treatment Boundary
June 23, 2004	Pre-Treatment	25	N/A	35.6%
August 28, 2004	60 days	25	N/A	20.1%
September 25, 2004	90 days	25	N/A	27.8%
November 4, 2004	120 days	25	N/A	18.7%

White Slough 36 (2005)

Treatment Product(s): Sonar PR, Sonar AS

Date	Treatment Cycle	Fluridone Treatment Area (in Acres)	Total Study Area (in Acres)	Mean Biovolumes: Treatment Boundary	Mean Biovolumes: Total Area
April 7, 2005	Pre-Treatment	22	24	23.4%	28.3%
May 20, 2005	60 days	22	24	17.4%	18.5%
July 27, 2005	90 days	22	24	0.04%	0.05%
October 13, 2005	180 days	22	24	4.2%	4.8%

Exhibit 3.4
***Egeria densa* Control Program**
ReMetrix Estimates of Biovolumes by Sample Site
(2004 to 2005)

10. Disappointment Slough 32b Control (2004)

Treatment Product(s): Control

Date	Treatment Cycle	Treatment Boundary (in Acres)	Total Area (in Acres)	Mean Biovolumes
				Treatment Boundary
June 24, 2004	Pre-Treatment	32	N/A	32.8%
August 31, 2004	60 days	32	N/A	49.3%
September 27, 2004	90 days	32	N/A	44.0%

Disappointment Slough 32b (2005)

Treatment Product(s): Sonar AS, Sonar PR

Date	Treatment Cycle	Fluridone Treatment Area (in Acres)	Total Study Area (in Acres)	Mean Biovolumes	
				Treatment Boundary	Total Area
May 31, 2005	Pre-Treatment	26	32	57.4%	53.3%
August 27, 2005	60 days	26	32	18.5%	14.8%
September 27, 2005	90 days	26	32	11.2%	9.3%

Disappointment Slough 32c Control (2005)

Treatment Product(s): Control

Date	Treatment Cycle	Control Area (in Acres)	Mean Biovolumes
			Control Area
May 31, 2005	Pre-BioVolume	15	33.7%
August 27, 2005	60 days	15	11.9%
September 27, 2005	90 days	15	7.4%

11. Latham Slough Five Fingers 68 Control (2004)

Treatment Product(s): Control

Date	Treatment Cycle	Treatment Boundary (in Acres)	Total Area (in Acres)	Mean Biovolumes
				Treatment Boundary
August 11, 2004	Pre-Treatment	22	N/A	29.0%
September 24, 2004	28 days	22	N/A	23.9%
October 22, 2004	60 days	22	N/A	29.8%
November 11, 2004	120 days	22	N/A	33.0%

Latham Slough Five Fingers 68 Control (2005)

Treatment Product(s): Control

Date	Treatment Cycle	Control Area (in Acres)	Mean Biovolumes
			Control Area
July 31, 2005	Pre-BioVolume/ Pre-Health	22	32.6%
October 1, 2005	90 days	22	29.0%
November 11, 2005	120 days	22	39.5%

12. Franks Tract 175 (2004)

Treatment Product(s): Diquat

Date	Treatment Cycle	Treatment Boundary (in Acres)	Total Area (in Acres)	Mean Biovolumes		
				Treatment Boundary	Non-Treatment Area	Total Area
August 13, 2004	Pre-Treatment	20	67	54.6%	51.0%	51.5%
August 27, 2004	14 days	20	67	54.3%	54.2%	52.8%
September 22, 2004	28 days	20	67	53.5%	60.0%	56.5%
November 2, 2004	60 days	20	67	23.2%	28.1%	25.8%

Exhibit 3.4
***Egeria densa* Control Program**
ReMetrix Estimates of Biovolumes by Sample Site
(2004 to 2005)

13. Fourteenmile Slough 26 (2005)

Treatment Product(s): Sonar PR, Sonar AS

Date	Treatment Cycle	Fluridone Treatment Area (in Acres)	Total Study Area (in Acres)	Mean Biovolumes: Treatment Boundary
April 20, 2005	Pre-Treatment	52	N/A	32.0%
May 27, 2005	60 days	52	N/A	29.6%
July 29, 2005	90 days	52	N/A	4.2%
August 24, 2005	120 days	52	N/A	N/A
September 12, 2005	150 days	52	N/A	0.004%
October 12, 2005	180 days	52	N/A	0.003%

14. Sandmound Slough 109 (2005)

Treatment Product(s): Sonar PR

				Mean Biovolumes	
Date	Treatment Cycle	Fluridone Treatment Area (in Acres)	Total Study Area (in Acres)	Treatment Boundary	Total Area
April 16, 2005	Pre-Treatment	38	37	63.8%	64.8%
May 26, 2005	60 days	38	37	N/A	N/A
July 15, 2005	90 days	38	37	8.7%	9.5%
August 14, 2005	120 days	38	37	4.0%	4.9%
November 15, 2005	210 days	38	37	1.7%	2.2%

15. Disappointment Slough 32a (2005)

Treatment Product(s): Sonar AS, Sonar PR

				Mean Biovolumes	
Date	Treatment Cycle	Fluridone Treatment Area (in Acres)	Total Study Area (in Acres)	Treatment Boundary	Total Area
May 31, 2005	Pre-Treatment	35	34	36.0%	34.8%
August 27, 2005	60 days	35	34	9.9%	9.5%
September 27, 2005	90 days	35	34	5.3%	10.4%

Source: Chapter 3 references number 20 and 21.

Exhibit 3.5
***Egeria densa* Control Program**
Time-Series Biovolume ReMetrix Efficacy Metrics

Number of Time-Series Treatment Sites	DBW Treated Site Number	Pre-Treatment 2004	End of Treatment 2004	Pre-Treatment 2005	End of Treatment 2005	2004 Treatment, Pre 2004 to Post 2004	2004 to 2005 Growth, Post 2004 to Pre 2005	2005 Treatment, Pre 2005 to Post 2005	1 year Program and Growth, Post 2004 to Post 2005
1.	117-Big Break Marina	32.9	7.2	22.1	13.4	-25.70	14.90	-8.70	6.2
2.	118-Big Break Wetlands	41	27.3	60.7	53.2	-13.70	33.40	-7.50	25.9
3.	112-Dutch Slough	50.5	41.7	35	45.6	-8.80	-6.70	10.6	3.9
4.	173-Franks Tract	54.6	19.6	40.5	25.9	-35.00	20.90	-14.60	6.3
5.	40-Little Potato Slough	32.4	13.2	47.5	13.9	-19.20	34.30	-33.60	0.7
6.	31-Pixley Slough	45.9	7.5	21.3	27.2	-38.40	13.80	5.9	19.7
7.	99-Rhode Island	90.3	76.9	84.3	41.5	-13.40	7.40	-42.80	-35.4
8.	16-Venice Cut	34.5	33.4	44.8	6.8	-1.10	11.40	-38.00	-26.6
9.	36-White Slough	35.6	18.7	23.4	4.2	-16.90	4.70	-19.20	-14.5
Number of Sites That Declined Biovolume of 9 Treated Sites						9	1	7	3
Total Biovolume for 9 Treated Sites		417.7	245.5	379.6	231.7				
Percentage Biovolume Change						-41%	55%	-39%	**-6%**

Number of Time-Series Control Sites	DBW Control Site Number								
1.	68-Latham Slough	29	33	32.6	39.5	4	-0.4	6.9	6.5
Number of Sites That Declined Biovolume of 1 Control Site						0	1	0	0
Total Biovolume for 1 Control Site		29	33	32.6	39.5				
Percentage Biovolume Change						14%	-1%	21%	**20%**

Source: Exhibit 3.4.

- For the one year combined treatment and growing cycle, from the end of the 2004 treatment season, to the end of the 2005 treatment season, the EDCP had efficacy for only 3 of the 9 treated time-series sites. This efficacy however, amounted to a small 6 percent overall decline in total biovolume.
- For the one control site, biovolume grew 14 percent in 2004, and 21 percent in 2005, during the respective treatment seasons. At the control site biovolume remained nearly constant during the winter growing season. For a total one-year period, biovolume grew 20 percent at the control site.

Exhibit 3.5 data show that *Egeria densa,* untreated, has a high potential growth rate. From a biovolume standpoint, *Egeria densa,* untreated, can grow 20 percent or more, a year. These data also show that *Egeria densa* even in the winter can still grow back quite quickly after it is effectively treated.

The one-year, 21 percent increase in biovolume at the control site may not translate into a one-for-one, annual percentage increase in *Egeria densa* acreage. The percentage increase in untreated *Egeria densa* acreage could be somewhat less than this 20 percent figure, as biovolume is a function of both *Egeria densa* biocover and *Egeria densa* height information.

Exhibit 3.5 data are obviously limited in size and scope. Also, the time-series treatment boundaries, and control site boundaries, may not be exactly comparable in all instances. In spite of these data limitations, Exhibit 3.5 information provides a valuable inference for EDCP site efficacy.

The data show that the EDCP can have site-specific control efficacy and prevent *Egeria densa* from multiplying further, albeit efficacy may be a single digit percentage reduction over a year's growing time.

F. Key Factors Affecting EDCP Efficacy

Egeria densa's growth is affected by nutrient status, light intensity, day length, temperature, turbidity, salinity, and rate of water flow. The plant inhabits acidic to alkaline waters and is highly susceptible to iron deficiencies. *Egeria densa* prefers slowly moving shallow waters.

Efficacy as an indicator of conditions effecting EDCP success is a challenging aspect of the overall EDCP. There are a large number of dynamic and complex variables in the Delta region environment that contribute to program efficacy. Some of these numerous changing and interacting variables before treatment, during treatment, and after treatment include the following:

- Weather/Seasons
  - Drought weather conditions, on-season and off-season
  - Temperature during growing cycles
  - Light intensity
- Water Quality
  - Salinity levels
  - Sedimentation and turbidity levels
  - Dissolved oxygen levels
- Water Quantity
  - Water flows, on-season and off-season
  - Tidal periods

- Existing Aquatic Conditions
  - Other aquatic plant species
- Treatments
  - Chemical types and formulations
  - Applications
  - Start dates.

Below we address some of the key environmental conditions that effect efficacy.

1. Weather/Seasonal *Egeria densa* Factors

It has been generally observed for, the EDCP, that in drought years, *Egeria densa* appears to grow more quickly, while in years with heavy precipitation, it appears to grow more slowly. Over the past five years, the EDCP has generally experienced some mixture of both types of climate conditions.

Egeria densa appears to grow in spurts, with the fastest growth likely occurring during periods of drought. Anecdotally, the DBW believes that *Egeria densa* growth was stimulated during previous (i.e. 2001 to 2003) by low water periods in Northern California.

In colder regions, *Egeria densa* is reported to senesce, or decrease in biomass through sloughing and decay of tips and branches. However, a recent study reported that *Egeria densa* senescence was not observed in Oregon and California, likely due to milder temperature variations.[25] Observations on *Egeria densa* growth in the Delta, combined with year-over-year bio-volume estimates reported by ReMetrix, would support the conclusion that *Egeria densa* in the Delta is likely not senescing to any great degree.

Pennington and Sytsma found that the maximum photosynthetic rate for *Egeria densa* in the Delta was observed during summer when the surface water temperature was 25° C while the minimum photosynthetic rate was observed in January when the surface water temperature was 9.2° C.[26]

Maximum *Egeria densa* growth rates in the Delta were measured in April 2003 (0.7 cm d -1) and April 2004 (0.3 cm d -1).[27] The Delta provides *Egeria densa* with ideal temperature conditions for growth.[28]

2. Temperature *Egeria densa* Factors

Growth of *Egeria densa* is rapid during summer, with increasing temperatures. However, *Egeria densa* is less tolerant of extreme high temperatures than other plant species.

Growth typically begins when water temperatures reach 10° C and continues until temperatures reach a maximum of 32° C, at which point the plant's biomass decreases. Ideal temperatures for *Egeria densa* growth range between 10° and 25° C. Temperature variations appear to have a larger affect on *Egeria densa* growth than does light intensity in the Delta.[29]

3. Light Intensity and Water Depth *Egeria densa* Factors

Light is a primary factor affecting the growth and distribution of submersed aquatic plants. *Egeria densa* grows best under low light.[30] Higher light causes discoloration and damage to the plant's chlorophyll.

Egeria densa has a low light requirement. High light intensities cause discoloration and damage to the chlorophyll within about two weeks.[31] Pennington and Sytsma found that *Egeria densa* in the Delta is capable of adapting to low light.[32]

Egeria densa prefers the red light spectra, which is more prevalent on the water surface. The weed is killed, or suffers, under the blue or green light spectra, which penetrate deeper into the water. This may explain why the plant rarely establishes itself greater than 20 feet below the water surface.[33, 34]

Observations by EDCP personnel confirm that *Egeria densa* is not present in deeper Delta waterways (e.g., Sacramento River, Stockton Deep Water Channel). However, much of the Delta is shallow, ranging from six to 12 feet deep in most areas, and as a result provides optimal light conditions for robust *Egeria densa* growth.

4. Turbidity *Egeria densa* Factors

Turbid water is likely to favor rather than inhibit *Egeria densa* growth.[35] Turbid waters can affect growth of *Egeria densa*.

At a depth of 1.85 meters, *Egeria densa* has been observed to have its highest growth rate with turbidity between 9 and 15 grams per cubic meter of suspended solids (SS). The *Egeria densa* relative growth rates declined significantly as turbidity increased to 39 grams per cubic meter SS.

The highest observed shoot elongation occurs between 10 and 20 grams per cubic meter SS with a maximum rate recorded at 15 grams per cubic meter SS in summer. At higher turbidity levels, both biomass and shoot length decline markedly, while at lower levels *Egeria densa* showed reduced shoot elongation, but greater biomass and branching.[36]

5. Salinity *Egeria densa* Factors

Both *Egeria densa* root formation and growth decline with salinity.[37] Abrupt changes in *Egeria densa* density in the Western Delta at the periphery of the distribution of the plant are likely attributable to salinity excursions.[38]

Native submerged aquatic plants likely are adapted to higher salinity levels than *Egeria densa*.[39] This determination is based on the fact that plant species that have evolved under conditions of periodically increased salinity have adaptations that increase their tolerance to salinity.[40]

Egeria densa is a fresh water macrophyte and salinity can impact its growth. Field observations in Chile, where the plant is endemic, report that *Egeria densa* had the greatest biomass where salinities ranged from zero to 1.2 percent. The plant's biomass was an order of magnitude lower at salinities of up to five percent and was not found at salinities greater than five percent. Salinity tolerance may be lower in areas like the Delta, where the plant can only propagate asexually, due to the lack of genetic diversity.[41]

A DBW solicited experiment showed a decline in root formation and growth with increased salinity levels (0, 3, 6 ppt tested). The study concluded that abrupt changes in *Egeria densa* density in the Western Delta, at the periphery of the distribution of the plant, are likely attributable to salinity excursions.[42]

G. Optimally Effective *Egeria densa* Management by Keying Program Control to Plant Biology

Research shows that optimal treatment of *Egeria densa* should occur during “weak points” in the lifecycle of the plant’s growth. Carbohydrate reserves are lowest in April and May, and this period of time has been considered the optimal time to treat *Egeria densa.*[43]

Pennington and Sytsma found maximum *Egeria densa* growth rates in the Delta in April.[44] From this they concluded that rapid Spring growth suggests early season systemic herbicide application. A four-month study of *Egeria densa* in portions of the Delta suggest that the maximum density of the plant occurs in June.[45]

Pennington found that plants studied in Newport, Oregon, and in the Delta did not senesce or exhibit winter-type growth.[46] All of these findings suggest that early treating of *Egeria densa* in the Spring is imperative to EDCP efficacy.

H. Future EDCP Efforts for Efficacy Measurement and Improved Control

The EDCP will continuously seek more effective chemical and non-chemical treatment alternatives and applications. To help further reduce the perceived significance of program environmental impacts, and to improve program efficacy, the EDCP will move towards more targeted EDCP treatments (e.g., fine tuning of treatment type(s) and formulations; and where, when, and how much), as this knowledge becomes available. Mapping water flows at key treatment sites may result in better site efficacy for particularly challenging treatment sites.

Key to EDCP success is to continuously improve EDCP program and site efficacy itself, and to accurately measure efficacy. The EDCP needs more cost-effective and practical methods to reliably measure program efficacy.

Due to resource limitations and past funding priorities, the DBW has not been able to conduct systematic on-site field surveys to assess *Egeria densa* infestation. By conducting ground and water field surveys, the DBW could triangulate on its current high level estimates of *Egeria densa* infestation.

Field surveys could be performed by tying DBW systematic field observations to DBW digitized maps, that are in turn linked to a geographic information system (GIS). This methodology would need to be developed, piloted, and tested. If this field survey method proved practical, field surveys could be conducted over the next five years when DBW field crews were not conducting actual treatments. Benefits of these systematic, digitized map field surveys include:

- Ground truthing aerial mapping, hyperspectral, and hydroacoustic analyses
- Identifying areas of infestation at each site, and its priority for posing navigation problems
- Reprioritizing treatment sites
- Helping to determine the most appropriate control method for a given site
- Maximizing the use of DBW field crews during periods when treatments are not occurring.

I. EDCP Efficacy Conclusions

There is no evidence that the EDCP operations currently use more chemical herbicides than are (1) needed for overall program control, or (2) needed to be effectual on a site-specific basis. EDCP data-to-date show that *Egeria densa*, from a program standpoint is spreading, in the Delta region. There are no noticeable declines in *Egeria densa* infestation for the Delta region.

While there is no evidence for significant environmental impacts from the EDCP, there is risk to the Delta environment from the lack of EDCP program efficacy, and its inability to control the spread of *Egeria densa,* with resultant threats to the health and stability of fisheries and other ecosystems in the Delta region.

While eight (8) percent of the Delta region is water, *Egeria densa* is estimated to comprise 17 to 21 percent of the Delta region water acres. It is estimated for 2006 that there are approximately 11,500 acres to 14,000 acres of *Egeria densa* in the Delta region. This acreage estimate is up from approximately 8,000 *Egeria densa* acres in 1997, 9 years ago.

Untreated, *Egeria densa* may grow at an average annual compound rate of growth of approximately 10 to 20 percent a year. At a 10 percent average annual compound rate of growth, *Egeria densa* doubles every 7 years. It is not expected at this time that *Egeria densa* will be eradicated from the California Delta.

On a site-specific basis, data show that the EDCP can be somewhat efficacious using the present herbicide treatments of Sonar (fluridone) and Reward (Diquat). The initial site-specific *Egeria densa* decline can be quite dramatic (approximately 39 to 41 percent reduction for 9 sites), though *Egeria densa* “grow-back” at the same treated site can also be significant (a 55 percent increase for 9 sites). The net site reduction in *Egeria densa* for a one year combined site treatment and growing cycle can be relatively modest (approximately 6 percent), though in the direction of a positive net decline in *Egeria densa*.

The EDCP has not achieved direct program efficacy as *Egeria densa* has not been contained in the Delta region. The EDCP has shown its ability to have success for site-specific efficacy.

The lack of significant environmental impacts from the EDCP are largely a mirror image of the relatively selective net site-specific efficacy. The absence of residual treatment chemicals at the treated sites (and hence lack of adverse environmental impacts) is associated with this level of selective site efficacy.

Overall, the EDCP is likely restraining *Egeria densa* from spreading even more that it already has, but the EDCP is "not keeping up" with the Delta-wide *Egeria densa* infestation. The EDCP site efficacy, and lack of program efficacy, are largely because of (1) the inability of the EDCP to obtain, from applicable permitting agencies, an early start date for system-wide treatment beginning April 1st of each year, versus the current allowed system-wide start date of July 1st, (2) the relatively limited effective treatment tools available (Fluridone and Diquat herbicides) for the EDCP, (3) EDCP resource constraints, and (4) the limited size of treatment areas allowed within a site (e.g., 140 acres within the large 3,000 acre Franks Tract area) as specified in the 2001 EDCP EIR.

The EDCP has tried on numerous occasions to obtain system-wide early start dates for this program from Federal regulatory agencies and has been limited in many cases. It has gotten to the point that applicable permitting agencies need to take into account risk to the Delta region ecosystem of *Egeria densa* infestation and how detrimental delayed treatment start dates are to EDCP success, especially in light of no evidence of significant environmental impacts from the EDCP.

The herbicide Komeen has been demonstrated in research trials to have *Egeria densa* site efficacy, but its perceived significant environmental impacts, along with its uncertain long-term potential fate in the Delta, have effectively removed this herbicide as a tool for EDCP treatment options. Currently, the EDCP has only two herbicide tools remaining, Sonar (fluridone) and Reward (Diquat), that appear less efficacious than Komeen, but are also arguably relatively benign from an environmental standpoint.

Program resource constraints result in the inability to treat (1) enough Delta sites in total, (2) intensively enough those sites that are treated, and (3) bigger portions of, or all of, the sites that are treated. The EDCP has been relatively resource constrained from inception, especially in comparison to the Delta-wide *Egeria densa* infestation challenge. The EDCP will need significantly more direct field personnel (both spray applicators and environmental specialists), and treatment herbicides, than are currently budgeted for in order to achieve program efficacy, especially with the current mix of Sonar (Fluridone) and Reward (Diquat) herbicides, and the absence of system-wide early treatment start dates.

The EDCP EIR in 2001 stated that the DBW re-visit status of the EDCP in five years to determine whether the program was meeting its intended goals and objectives. Today, in 2006, the EDCP has demonstrated that it can achieve <u>site</u> efficacy, but that under current resource allocation constraints that perhaps were more geared to Komeen efficacy, not Fluridone and Diquat efficacy, the EDCP cannot, and likely will not, achieve <u>program</u> efficacy.[47]

In 2001 the EDCP was given a five-year review period, now in 2006 it is recommended that the EDCP be provided five more years for demonstration, but with a planned almost doubling of current field resource commitments. In 2011, the EDCP should be revisited for program efficacy. At that time the EDCP should be discontinued as we know it, if it cannot demonstrate some measurable program efficacy with a more critical mass of field resources.

Now is a juncture for policy makers to consider the future of the EDCP going forward. The status quo program level of resources is inadequate for the task at hand, and the program should either voluntarily "sunset" now, or "be geared up" to a more critical mass resource commitment so the program could have an opportunity for Delta-wide program efficacy and success.

* * * * *

Just as the Brazilian waterweed *Egeria densa* means "a mythical water nymph" in Latin, EDCP efficacy can be difficult to achieve, identify, and measure. The DBW will continuously adapt to improve efficacy of the EDCP.

[1] California Department of Fish and Game, California Aquatic Invasive Species Management Plan, Draft, Page 63, August 21, 2006.

[2] Ibid., Page 63.

[3] Pimentel, D., and L. Lach, R. Zuniga, and D. Morrison, Environmental and Economic Costs of Non-indigenous Species in the United States, Bioscience 50: Pages 53-65, 2000.

[4] Lars W.J. Anderson, "*Egeria* Invades the Sacramento-San Joaquin Delta," Aquatic Nuisance Species Digest, Volume 3, No. 4, (1999).

[5] Larry R. Brown, "A Summary of the San Francisco Tidal Wetlands Restoration Series", San Francisco Estuary and Watershed Science, Page 4, 2003.

[6] California Department of Fish and Game, California Aquatic Invasive Species Management Plan, Draft, Pages 16 and 63, August 21, 2006.

[7] California Department of Water Resources, Sacramento-San Joaquin Delta Atlas, Revised 1995.

[8] California Department of Boating and Waterways (DBW), *Egeria densa* Control Program, Annual Report for the 2001 Application Season.

[9] California Department of Boating and Waterways (DBW), *Egeria densa* Control Program, Annual Report for the 2002 Application Season.

[10] California Department of Boating and Waterways (DBW), *Egeria densa* Control Program, Annual Report for the 2003 Application Season.

[11] California Department of Boating and Waterways (DBW), *Egeria densa* Control Program, Annual Report for the 2004 Application Season.

[12] California Department of Boating and Waterways (DBW), *Egeria densa* Control Program, Annual Report for the 2005 Application Season.

[13] Foschi, Patricia G., "Estimating *Egeria densa* Acreage and Density in the Sacramento-San Joaquin Delta DBW Priority Sites", San Francisco State University, 1997.

[14] Foschi, Patricia G., "Interpretation of *Egeria densa* Percent Coverage from Color IR Aerial Film Positives, San Francisco State University, 2000.

[15] Foschi, Patricia G. and Huan Liu, "Active Learning for Detecting a Spectrally Variable Subject in Color Infrared Imagery", San Francisco State University, 2001.

[16] Foschi, Patricia G., Gary Fields, and Huan Liu, "Detecting a Spectrally Variable Subject in Color Infrared Imagery Using Data-Mining and Knowledge-Engine Methods", San Francisco State University, 2004.

[17] Ustin, Susan and Melinda Mulitsch, "Mapping Invasive Plant Species in the Sacramento-San Joaquin Delta Region Using Hyperspectual Imagery, University of California, Davis, 2003.

[18] Ustin, Susan, "Mapping Invasive Plant Species in the Sacramento-San Joaquin Delta Region Using Hyperspectual Imagery, University of California, Davis, 2004.

[19] Ustin, Susan, "Mapping Invasive Plant Species in the Sacramento-San Joaquin Delta Region Using Hyperspectual Imagery, University of California, Davis, 2005.

[20] Ustin, Susan, "Mapping Invasive Plant Species in the Sacramento Jan Joaquin River Delta Using Hyperspectual Imagery, University of California, Davis, 2006.

[21] ReMetrix, LLC, "Bathymetric Survey of Franks Tract State Recreation Area, Contra Costa County, California", 2002.

[22] ReMetrix, LLC, "2004 Monitoring Aquatic Herbicide Treatment Efficacy on *Egera densa,* Sacramento-San Joaquin Delta, California", December 2004.

[23] ReMetrix, LLC, "2005 Monitoring Aquatic Herbicide Treatment Efficacy on *Egera densa,* Sacramento-San Joaquin Delta, California", January 2006.

[24] ReMetrix, LLC, "2003 to 2005 Monitoring Aquatic Herbicide Treatment Efficacy on *Egeria densa,* Sacramento-San Joaquin Delta, California", September 2006.

[25] Toni Pennington, *Egeria Densa Research* (Portland State University - Center for Lakes and Reservoirs, accessed July 2006); available from http://www.clr.pdx.edu/people/pennington/index.html.

[26] Ibid, 2005.

[27] www.clr.pdx.edu/people/pennington/index.html.

[28] Ibid, 2005.

[29] Steven Obrebski and Robin Booth, *Experimental Studies of the Effects of Temperature, Salinity and Light Intensity on Growth of Egeria Densa* (Romberg Tiburon Center - San Francisco State University, 2003).

[30] *Egeria Densa Weed Information* [Web Page] (California Department of Food and Agriculture (CDFA), accessed July 2006); available from http://www.cdfa.ca.gov/phpps/ipc/weedinfo/hydrilla.htm.

[31] California Invasive Species Plant Council, http://ucce.ucdavis.edu/datastore/detailreport.cfm?usernumber=43&surveynumber=182

[32] Pennington and Sytsma, Productivity and growth rates of Egeria densa in the Sacramento-San Joaquin Delta, California," Center for Lakes and Reservoirs, Portland State University, 2005.

[33] California Invasive Species Plant Council.

[34] *Egeria Densa Informational Page* (accessed).

[35] CISPC website.

[36] Chris C. Tanner, John S. Clayton, and Rohan D. S. Wells, "Effects of Suspended Solids on the Establishment and Growth of *Egeria densa*," *Aquatic Botany* 45, no. 4 (1993).

[37] Obrebski and Booth, *Experimental Studies of the Effects of Temperature, Salinity, and Light Intensity on Growth of Egeria densa*. Romberg Tiburon Center, San Francisco State University, 2003.

[38] Ibid, page 8.

[39] Kimmerer, Boyer, Marvin-DiPasquale, Nobriga, Sereno, Thompson, E*cological Consequences of Elevated Salinity in the Sacramento-San Joaquin Delta (proposal submitted to CALFED Science Program)*. 2005 (Kimmerer, et. Al 2005), 9.

[40] Ishigawa, S., and Naoki, K. *Differential Tolerance of to Artemisia Species Growing in Contrasting Coastal Habitats*. Ecol. Research 15 (2000): 241-247.

[41] Boyer Kimmerer, Marvin-DiPasquale, Nobriga, Sereno. Thompson, "Ecological Consequences of Elevated Salinity in the Sacramento−San Joaquin Delta," (CALFED Science Program, 2005).

[42] Steven Obrebski and Robin Booth, *Experimental Studies of the Effects of Temperature, Salinity and Light Intensity on Growth of Egeria Densa* (Romberg Tiburon Center - San Francisco State University, 2003).

---

[43] Getsinger, 1982.

[44] Pennington and Sytsma presentation, 2005.

[45] Obrebski et al, 2000.

[46] Pennington and Sytsma presentation, 2005.

[47] Komeen was never used as part of the EDCP from 2001 to 2005. Komeen was only used for very limited research trials, occurring two days in 2002, and two days in 2003. Komeen's use has been removed entirely from the EDCP.

Chapter 4
Environmental Monitoring and Analysis of Potential Environmental Impacts (2001 to 2005)

Chapter 4 – Environmental Monitoring and Analysis of Potential Environmental Impacts (2001 to 2005)

The following chapter provides an analysis of EDCP water monitoring, chemical residue, and toxicity results for the five years, from 2001 to 2005. Where possible, statistical tests are used to make inferences about the analytical results.

Included are findings related to levels of chemicals in the water following EDCP aquatic herbicide applications and the toxicity of EDCP aquatic herbicides to three standard test organisms (water flea, fathead minnow, and algae). Also included is a discussion of the impacts of EDCP applications on Delta water quality and whether the EDCP has complied with labeled rates, maximum contaminant levels, and various water quality requirements specified in the Basin Plan.

The end of this chapter provides a third party environmental assessment of the EDCP. There also is a discussion of the ongoing Delta Pelagic Organism Decline (POD) investigations.

EDCP water quality data, and water sample collection, is documented in **Exhibit 4.1**, on the following page. DBW research vessels, with environmental scientists, collect water quality data using a combination of a Hydrolab DataSonde, TSCE Trimble, and Hydroplus software on a Rugged laptop computer. The water quality data also are copied to hard copy forms which are used as backup in case electronic transfer of the data is compromised. Water quality data is downloaded into the DBW's ArcSDE database.

Environmental scientists collect water samples and transport them to State contract laboratories for analysis. During the five-year period that is the focus of this report, the California Department of Food and Agriculture (CDFA) conducted analysis of chemical residue and the California Department of Fish & Game (CDFG) conducted toxicity testing. The resulting laboratory analysis reports were provided in Microsoft Excel spreadsheets to the DBW (in some cases these are hard copy reports while in others they are electronic). The DBW provided summaries of this laboratory data in its annual reports, which have been submitted to the NMFS in each of the past five years.

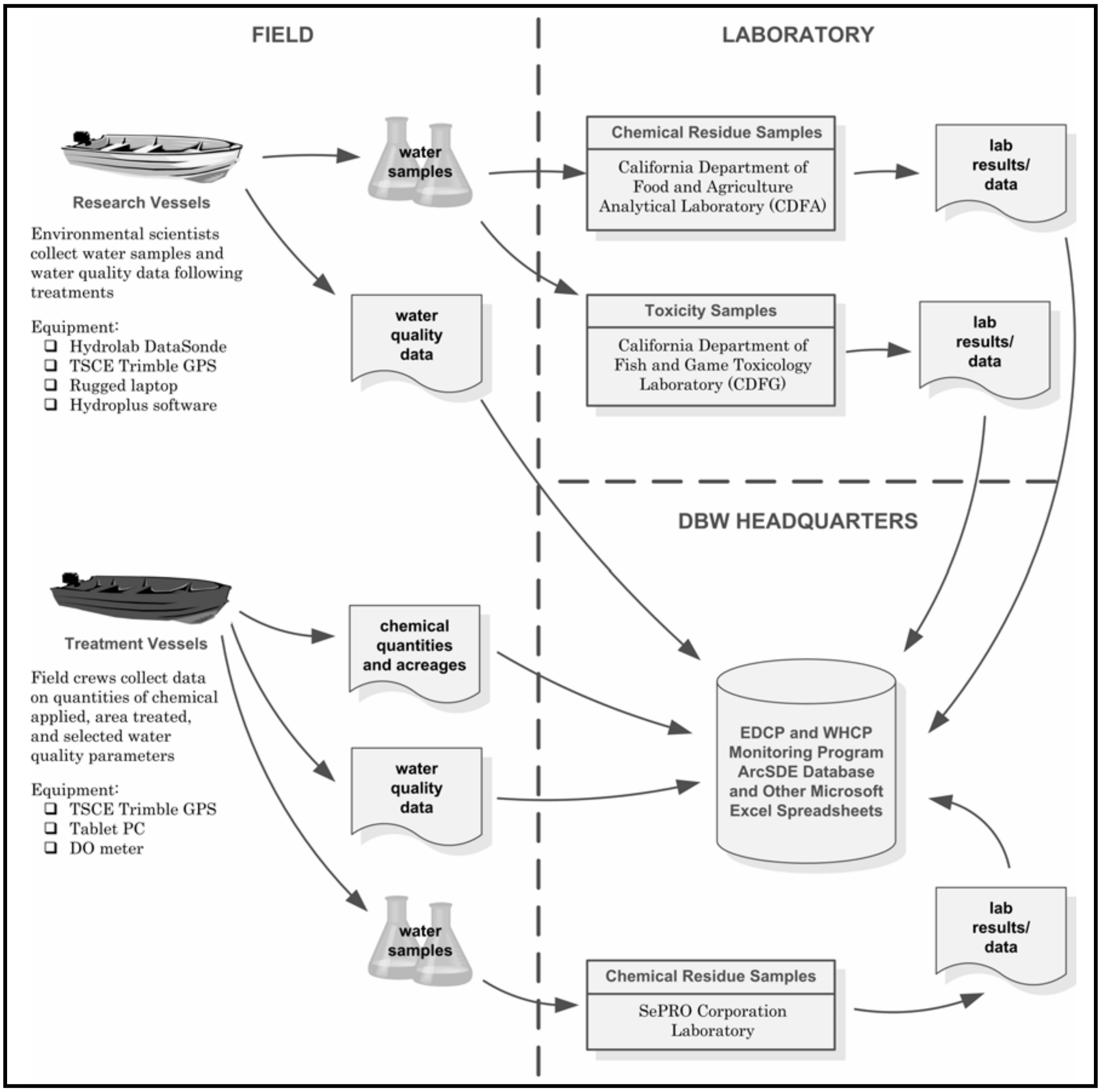
Field treatment crews collect water samples intermittently throughout Sonar treatments. These water samples are analyzed by SePRO Corporation laboratories for ppb concentrations. These treatment water samplings are referred to as the “FasTEST”. These water sample test results are used to adjust application concentrations throughout the Sonar treatments.

Findings from this five-year (2001 to 2005) analysis are as follows:

General Findings

- The DBW completed 46 sampling events, 333 visual inspections, and collected over 600 water quality data sets; 308 chemical residue samples; and 137 toxicity samples.
- No statistical evidence exists that water quality was degraded significantly as a result of the EDCP treatments.
- The EDCP did not have a significant or consistent adverse affect on test organisms used for toxicity testing.

Exhibit 4.1
Egeria densa **Control Program**
Water Quality Data and Water Sample Collection



- In general, there was no correlation between the level of a Delta water quality parameter and the tendency for detectable chemical residue or toxicity to an aquatic test organism.
- There was no distinct correlation between detectable chemical residue and toxicity to laboratory test organisms.
- Thirteen (13) of 204, or six percent, of post-treatment diquat and fluridone samples had chemical residues in excess of applicable standards. All 13 cases were for diquat.
- For most cases, the EDCP met Basin Plan requirements for dissolved oxygen levels prior to, and after, treatment; changes in pH after treatment; and turbidity changes after treatment.
- Dissolved oxygen levels were not decreasing following EDCP treatments, but were actually shown to increase.
- A total of 28 of 45, or 62 percent, of algae samples run on pre-treatment samples showed an adverse affect, suggesting that Delta water alone could adversely affect this aquatic test organism.

Diquat

- The mean post-treatment diquat residue concentration was 15.90 ppb. For the few cases when diquat concentrations exceeded the standard and toxicity tests were performed there was an adverse affect to water flea (8 tests). However, for the 44 cases where toxicity tests where performed for diquat samples with concentrations below applicable standards, water flea impacts were not significant.
- For 107 post-treatment samples, the EDCP exceed the maximum labeled rate on one occasion for Reward (diquat) (in 2001).
- For diquat applications, it appears there was a correlation between high pH and higher chemical residue levels. For fluridone applications, it appears there was a correlation between higher turbidity and higher chemical residue levels.

Fluridone

- No post-treatment fluridone samples had chemical residues in excess of standards. The mean residue post-treatment residue concentration was 4.7 ppb for fluridone liquid, 0.91 ppb for fluridone pellet, and 1.67 for fluridone pellet/aqueous combination treatments.
- For 97 post treatment samples, in no case did the EDCP exceed the maximum labeled rate for Sonar (fluridone).
- In cases where fluridone concentrations were detected, the number of samples with toxicity tests performed was small and so inferences regarding its toxicity could not be made statistically. However, toxicity results for cases with fluridone detection did not differ materially from toxicity results for cases where fluridone was not detected in the water.

* * * * *

The remainder of this chapter includes the following four (4) sections:

A. Water Quality Monitoring Sites

B. Water Quality Monitoring Data Collections
C. Water Quality Monitoring Data Analysis and Results
D. A Third Party Environmental Assessment of the EDCP and Delta Pelagic Organism Decline Investigations.

A. Water Quality Monitoring Sites

During the five-year period, 2001 through 2005, the DBW monitored water quality at fourteen (14) sites. Water quality data and water samples were obtained for 46 individual sampling events. Each sampling event consisted of a series of water quality data collections and water samples obtained prior to treatment, and after treatment, plus additional water quality data collected during follow-up visual inspections (generally at one-week intervals).

These treatment sites, and the number of sampling events at a site each year, are shown in **Table 4.1**, below.

B. Water Quality Monitoring Data Collections

A sampling event includes one and only one site (e.g., Franks Tract), with water quality measured before, and after, treatment. In general, the DBW conducted at least one follow-up visit, and as many as seven, following treatment. For each sampling event, DBW environmental scientists, on-board research vessels equipped with

Table 4.1
***Egeria densa* Control Program**
Water Monitoring Sampling Events Each Year

Site [a]	2001	2002	2003	2004	2005	Total
1. Little Venice Island (two sites)	1	2			1	**4**
2. Sevenmile Slough			1			**1**
3. Pixley Slough		1	1	1	1	**4**
4. Disappointment Slough (two sites)	1	1				**2**
5. Bacon Island		1	1			**2**
6. Middle River Bullfrog			1			**1**
7. Rhode Island	2	2	2	2	2	**10**
8. Old River Connection		1				**1**
9. Dutch Slough		2	2			**4**
10. Big Break Wetlands	1	1	1		1	**4**
11. Franks Tract (two sites)	4	3	2	2	2	**13**
Number of Sample Events	**9**	**14**	**11**	**5**	**7**	**46**
Number of Treatments	**8**	**25**	**19**	**21**	**21**	**94**[b]
Percentage of Treatments Sampled	**100%**	**56%**	**58%**	**24%**	**33%**	**49%**
Number of Sites Sampled	**5**	**9**	**8**	**3**	**5**	**11**
Number of Sites Treated	**5**	**12**	**14**	**11**	**13**	**19**
Percentage of Treated Sites Sampled	**100%**	**75%**	**57%**	**27%**	**38%**	**58%**

(a) Three of the sites share a name with another site.
(b) There can be multiple applications per treatment. The EDCP made 418 applications over the five-year period. **The EDCP had sampling events for 46, or 11 percent of these applications.**

Water Quality Monitoring Data

1. Dissolved oxygen (DO, mg/L)
2. pH
3. Salinity (ppm)
4. Specific conductance (mS/cm)
5. Temperature (°C)
6. Turbidity (NTU, Nephelometric Turbidity Unit)
7. Water depth (feet)

monitoring equipment, collected seven water quality parameters **(see side bar above)** at each of three sample stations (or locations):

- Within the treatment area
- Downstream from the treatment area
- At a control (or background) location, which generally was upstream from the treatment area.

DBW environmental scientists also collected additional water quality monitoring data in subsequent follow-up visual inspections at the same three site locations. The number of follow-up visits made to measure post-treatment water quality ranged from none to seven. The time period for each follow-up visit was generally one week after the prior follow-up visit, but varied from the same day as the prior visit, to several weeks after the prior visit.

For each sampling event, the DBW also collected water samples before treatment, immediately after treatment (e.g., the same day), and approximately weekly for three weeks after treatment from each of the three sample stations.[1]

[1] Both the time period between each water sample collection, and the number of water samples collected after treatment, varied over the course of the EDCP.

The DBW then transported these water samples to State contract laboratories for analysis. The laboratories determined the concentration of the aquatic herbicide in a water sample and determined whether the water sample had an adverse affect on aquatic laboratory test organisms survival, growth, and reproduction. Laboratories provided DBW the results of these chemical residue and toxicity tests.

In summary, test results are available for one more of the following tests for each water sample collected at each site location:

- Chemical residue
  - Quantity of target chemical recovered (in ppb)
    - Percent recovery of surrogate
- Toxicity to *Ceriodaphnia dubia* (water flea)
    - Adverse affect on survival significance (N or Y)
    - Adverse affect on progeny (reproduction) significance (N or Y)
- Toxicity to *Pimephales promeles* (fathead minnow)
    - Adverse affect on survival significance (N or Y)
    - Adverse affect on growth significance (N or Y)
- Toxicity to *Selenastrum capricornutum* (algae)
    - Adverse affect on growth significance (N or Y).

The seven water quality parameters, the two chemical residue measures, and the five toxicity measures, collected from 2001 through 2005, are the data analyzed to determine the environmental impact of the five-year EDCP, 2001 through 2005.

C. Water Quality Monitoring Data Analysis and Results

1. Water Quality Before and After Aquatic Herbicide Treatment

In general, there was no statistical evidence that water quality degraded significantly as a result of aquatic herbicide treatments. Statistical tests performed at the 95 percent confidence level showed that, with exceptions noted, measured levels for each of five water quality parameters after treatment did not differ from their levels before treatment. There was no statistical evidence that water quality degraded immediately after treatment or for up to two months after treatment.

The following five water quality measures were examined before, and after, a treatment:

- Dissolved oxygen (DO)
- Turbidity
- pH
- Conductivity
- Salinity.

The DBW collected these data during follow-up visits it made to each treatment site. The DBW made each visit approximately one to two weeks after the prior visit. The DBW generally made three, but made as many as seven follow-up visits to the same site for a treatment, and collected water quality data inside the treatment area and downstream from the treatment area.

The value of each of the five water quality parameters <u>inside the treatment area</u> prior to treatment was compared with each of the following measures taken inside the treatment area:

- First post-treatment follow-up visit
- Second post-treatment follow-up visit
- Third post-treatment follow-up visit
- Fourth post-treatment follow-up visit
- Fifth post-treatment follow-up visit.

This resulted in 25 separate paired comparisons (5 water quality parameters X 5 follow-up visits). Each pair consisted of from six to as many as 45 water quality data points. Most sites had at least one follow-up visit, so there were more of these paired comparisons. Few sites had five follow-up visits, resulting in the fewest number of paired comparisons.

A similar set of comparisons also was made for pre and post treatment water quality conditions <u>downstream from the treatment area</u>. Again, 25 sets of paired comparisons were made.

The paired difference t-test was utilized, using a two-tailed test at a 95 percent confidence level (Type I error, or α, was set at 0.05 for this and all testing in this report). The "pairs" analyzed consisted of a water quality parameter (e.g., pH) measured before treatment and that same parameter measured after treatment at the same site, at the same location (e.g., inside the treatment area). The null hypothesis, H_0, for these tests was that there was no difference in the level of each water quality parameter between water samples collected before treatment, and those collected after treatment.

Stated formally:

H_0: $\mu_d = 0$

where μ_d is the average of all differences of measurements before and after treatment for a single water quality parameter, at the same location (e.g., inside the treatment area) during the same sequential follow-up visit (e.g., second visit).

Forty-one of the 50 paired comparisons showed no statistically significant change in the water quality parameter. The remaining nine showed a statistically significant change. In all nine cases, the value of the water quality parameter measured <u>increased</u> from the level measured before treatment. **Table 4.2**, on the following page, identifies the results from these nine comparisons.

The first of the nine comparisons summarized above shows that dissolved oxygen inside the treatment area at the time DBW collected the first sample after treatment increased. The average increase was 1.32 mg/L. As an example of the statistical tests performed on all 50 sets of paired differences, the resulting statistics for this first conclusion are shown in **Table 4.3**, on the following page.

Where there was a demonstrated change in dissolved oxygen, <u>it appears that DO increased after treatment</u>. All other water quality parameters held equal, an increase in DO is not necessarily considered a degradation of water quality. Changes in pH, conductivity, and salinity also were increases, in those cases found to have a statistically significant change.

The DBW conducted 341 visual inspections during the period, 2001 through 2005, to collect additional water quality samples. **Table 4.4**, on the following page, shows the number of visual inspections conducted each year to collect water quality data. The number of follow-up inspections generally are proportional to the number of sampling events (treatments) that occurred during the period for each aquatic herbicide.

2. Water Quality Levels and Chemical Residue Concentration

Generally, there was no statistically significant linear relationship between water quality parameters and detectable chemical residue. In other words, there was no tendency of detectable chemical residue concentration to increase linearly with increasing levels of an individual water quality parameter, nor was there a tendency of residue concentration to decrease with increasing levels of an individual water quality parameter. There were two exceptions, which are explained below.

Table 4.2
***Egeria densa* Control Program**
Water Quality Parameters that Changed After Treatment

Water Quality Parameter	Inside or Downstream	Number of Samples	Follow-up Visit	Change
Dissolved oxygen	Inside	45	1st visit	+1.32 mg/L
Dissolved oxygen	Inside	34	3rd visit	+1.73 mg/L
Dissolved oxygen	Inside	28	4th visit	+1.79 mg/L
Dissolved oxygen	Downstream	43	1st visit	+0.71 mg/L
pH	Inside	32	3rd visit	+0.18
Conductivity	Downstream	32	3rd visit	+0.13 µmhos/cm
Conductivity	Downstream	18	5th visit	+0.16 µmhos/cm
Salinity	Downstream	32	3rd visit	+0.07 ppm
Salinity	Downstream	18	5th visit	+0.08 ppm

Table 4.3
***Egeria densa* Control Program**
Results of Paired Difference t Test for Dissolved Oxygen Measured
Inside the Treatment Area Before and Immediately After Treatment

Statistic	Before Treatment	After Treatment
1. Mean	7.280	8.604
2. Variance	4.750	5.799
3. Observations	45	45
4. Pearson correlation	-0.01354	
5. Hypothesized mean difference	0	
6. Degrees of freedom	44	
7. t statistic	**-2.71821**	
8. P(T<=t) one-tail	0.004677	
9. t Critical one-tail	1.68023	
10. P(T<=t) two-tail	0.009354	
11. t Critical two-tail	**2.01537**	

Table 4.4
***Egeria densa* Control Program**
Visual Inspections Conducted Each Year

Herbicide	2001	2002	2003	2004	2005	Total	Sample Events
Diquat	60	76	64	8	2	**210**	**20**
Fluridone liquid	0	0	10	6	1	**17**	**2**
Fluridone pellet	20	17	46	14	5	**103**	**10**
Fluridone aqueous/pellet	0	11	0	0	0	**11**	**2**
Total	**80**	**104**	**120**	**28**	**8**	**341**	**34**

To determine whether there was a linear correlation,[2] an analysis was made of those water samples that were tested for both chemical residue and at least one of five water quality parameters: DO, turbidity, pH, conductivity, or salinity. The analysis excluded samples with no detectable residue in order to determine if there was a linear correlation between detected residue and water quality. However, had these samples with no detectable residue been included in the analysis, the results would have been more conclusive – no linear correlation between residue concentrations and any of five water quality parameters.

The analysis required an estimate of the linear correlation coefficient, ρ, which for this analysis is the extent of the relationship between a single water quality parameter (e.g., pH) and chemical residue levels. The estimate of this parameter, obtained from the sample data, is represented by the symbol *r*. If there was a perfect linear relationship between a water quality parameter and residue level, *r* would equal 1. If there were no linear relationship, then *r* would equal 0. The DBW tested the null hypothesis that ρ = 0. That is, unless the data showed otherwise, the DBW assumed there was no tendency of residue levels to change with changes in water quality.

The alternative hypothesis is that ρ <> 0, which would result in rejecting the null hypothesis. The statistical tests required a 95 percent confidence level (α =0.05). That is, the probability that the null hypothesis is rejected when in fact it is true is five (5) percent.

The analysis of diquat treatment water samples is provided in **Table 4.5**, below. The null hypothesis was rejected in the case of pH. The linear relationship between pH and diquat residue concentration, if there is one, was very weak, as indicated by the value of *r*.

The analysis of fluridone treatment water samples is presented in **Table 4.6**, below. The null hypothesis was rejected in the case of turbidity. The linear

Table 4.5
***Egeria densa* Control Program**
Correlation between Water Quality Levels and Diquat Residue Concentration

Water Quality Parameter (number of samples)	Accept or Reject Null Hypothesis (at 95% confidence level)
DO (84)	Accept
Turbidity (76)	Accept
pH (44)	Reject (*r*=0.13)
Conductivity (76)	Accept
Salinity (80)	Accept

Table 4.6
***Egeria densa* Control Program**
Correlation between Water Quality and Fluridone Residue Levels

Water Quality Parameter (number of samples)	Accept or Reject Null Hypothesis (at 95% confidence level)
DO (80)	Accept
Turbidity (80)	Reject (*r*=0.80)
pH (80)	Accept
Conductivity (80)	Accept
Salinity (80)	Accept

[2] In this discussion of EDCP environmental impacts, any statistical test performed to determine correlations between results was one to determine "linear" correlation. Other correlations may exist (e.g., curvilinear, quadratic, multi-variate), but these alternatives were not tested. When the term "correlation" or "relationship" is used in this discussion, it is intended to mean "linear correlation", unless otherwise stated so.

relationship between turbidity and fluridone residue may be significant, as indicated by the value of *r*.

If there appears to be some linear correlation, as measured by *r*, a linear correlation may still not actually exist. The linear relationship may be spurious, meaning it may not be linear and in fact be much more complex. For example, the relationship could actually be curvilinear, but still show high r values across a narrow range of water quality values. Additional statistical tests would be needed to be more satisfied with the assumption of some linear correlation. These other tests include inspecting a graph of the two variables, evaluating the line of best fit between the two variables, and plotting the residuals from a linear regression.[3] Also, there are many other characteristics of Delta water that may or may not influence residue levels.

3. Water Quality Levels and Toxicity

Generally, there was no statistically significant relationship between water quality parameters and a greater likelihood of adverse effects to laboratory aquatic test organisms. In other words, the physical and/or chemical characteristics of the water body (e.g., DO, pH, salinity) did not appear to alter the toxicity of the herbicide to a selected test organism. There was one exception, which is explained below.

The DBW delivered water samples collected before and after herbicide treatments to State of California laboratories. These laboratories conducted toxicity tests under specified laboratory conditions on selected aquatic test organisms. These studies determined if the treated, downstream, and control water samples affected the survival, growth, and reproduction of aquatic test organisms. The laboratories returned results of these tests to the DBW. The types of aquatic test organisms and the test results returned for each are presented in **Table 4.7**, below.

Table 4.7
***Egeria densa* Control Program**
Toxicology Tests

Aquatic Test Organism	Adverse Effects (No or Yes)
Ceriodaphinia dubia (water flea)	■ Survival ■ Progeny (reproduction)
Pimephales promelas (fathead minnow)	■ Survival ■ Growth
Selenastrum capriocornutum (algae)	■ Growth

The data file received from the laboratories contained a number of fields that described each test, including a field that indicated whether the sampled water had an adverse effect or not. If there was no adverse affect on the test organism, the laboratory indicated so with a "N." If there was an adverse affect, the laboratory indicated so with a "Y". For example, if the laboratory determined that there was no statistically significant adverse affect on the

[3] For this analysis of water quality and chemical residues, residuals would be the difference between the actual chemical residue concentration (parts per billion) of each sample and the chemical residue concentration that would be predicted from the linear regression equation for a given value of a water quality parameter. In the best case, the residuals would not be in any discernable pattern when plotted on a graph. A discernable pattern would indicate that there may not be a linear relationship, that an outlier in the data influenced the line of best fit, or that there were other variables impacting chemical residue concentrations.

reproduction of the water flea, then the field for “progeny” significance contained an “N.”

There were 124 water samples with results from at least one of the toxicity tests. These samples were collected prior to and after the herbicide treatment, from inside the treatment area and downstream from the treatment area. Of these 124 water samples:

- 101 water samples had results from all five tests (5 tests)
- 4 water samples had results from just water flea and fathead minnow tests (4 tests)
- 1 water sample had results from water flea and algae tests (3 tests)
- 18 water samples had results from just water flea tests (2 tests).

In order to determine if water body characteristics impact toxicity results, the DBW required an indicator of relative toxicity for each of the 124 samples that could be compared with each of the sample’s water quality parameters. The “toxicity indicator” chosen was the percent of tests performed on the sample that had an adverse affect on a test organism. The indicator for each water sample is calculated as:

$$\frac{\text{Number of “Y” s}}{\text{Number of Tests}}$$

For example, if five toxicity tests were performed on a water sample, and three of them had adverse affects, then the “toxicity indicator” for the individual water sample would be 60 percent. This indicator was calculated for each of the 124 water samples.

The statistical test used to determine whether physical and/or chemical characteristics of the water body (e.g., DO, pH, salinity) alter the toxicity of the herbicide was estimating the linear correlation coefficient, ρ, using the sample data. This sample estimate, *r*, was made for each of five water quality parameters and the toxicity indicator. The null hypothesis was that there is no correlation (H_0: $\rho = 0$). The alternate hypothesis was that there is a correlation (H_a: $\rho \neq 0$). A 95 percent confidence level was required for each statistical test.

The analysis of water quality and toxicity results is presented in **Table 4.8**, on the following page. In general, there did not appear to be a linear correlation between individual water quality parameters and the water’s toxicity. The one exception to this conclusion was the pH of water samples collected from fluridone treatment sites. The null hypothesis was rejected in the case of pH. There appeared to be a linear relationship between pH and the number of adverse affects. If there were no linear correlation (the null hypothesis),

Table 4.8
***Egeria densa* Control Program**
Correlation between Water Quality and Toxicity Results [a]

Water Quality Parameter (total number of samples) [a]	Accept or Reject Null Hypothesis (at 95% confidence level)		
	All Samples	Diquat Samples	Fluridone Samples
DO (124)	Accept	Accept	Accept
Turbidity (124)	Accept	Accept	Accept
pH (122)	Reject (r=0.19)	Accept	Reject (r=0.38)
Conductivity (120)	Accept	Accept	Accept
Salinity (120)	Accept	Accept	Accept

(a) The 124 water samples were collected before and after treatment, from inside the treatment area and downstream from the treatment area.

(b) Measures of all five water quality parameters were not available for some of the 124 samples. Therefore, the number of samples used for the analysis of an individual water quality parameter can be less than 124.

the probability of getting $r = 0.19$ is less than five percent. Therefore, the null hypothesis was rejected. However, because r is relatively low, the relationship, if it is linear, was not strong.

Examining results by the aquatic herbicide used provides the source of the correlation. In the case of water collected from sites treated with fluridone, there was evidence that the water's pH was correlated positively with the toxicity results. Fluridone water samples with a higher pH tended to have a larger proportion of adverse toxicity results. In the case of water taken from sites treated with diquat, there was no statistical evidence that any of the five water quality characteristics are correlated, either positively or negatively, with toxicity results.

4. Chemical Residue

The frequency of samples with detectable residue exceeding allowable levels was low. There were 204 post treatment water samples collected and analyzed for chemical residue concentration. Of these, 13 exceeded allowable contaminant levels for residual chemical. All 13 were from sites treated with Reward (diquat). The Basin Plan[4] established the maximum contaminant level (MCL)[5] for diquat at 20 parts per billion (ppb). Eleven of these 13 samples were collected from inside the treatment area, and the other two were downstream from the treatment area.

Exhibit 4.2, on the following page, provides information about these 13 diquat samples. Toxicity results from these 13 samples were mixed.

- Eight of the samples had tests conducted to determine toxicity to water flea. Seven of these samples had adverse affects on both survival and reproduction of the test organism. The eighth sample had no adverse effect. This eighth sample also had

[4] The California Regional Water Quality Control Board, Central Valley Region, adopted the Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins.

[5] Maximum contaminant level (MCL) is the highest level of a contaminant that is allowed in drinking water.

Exhibit 4.2
***Egeria densa* Control Program**
Test Results of Water Samples that Exceeded Specified Chemical Residue Concentration Levels
Diquat maximum contaminant level (MCL): 20 ppb
Fluridone maximum label rate: 40 ppb

							Toxicity Test Results					Water Quality Test Results	
							Ceriodaphinia dubia (Water flea)		*Pimephales promelas* (Fathead minnow)		*Selenastrum capriocornutum* (Algae)		
Sample	Sample Date	DBW Site Identification Number	Chemical	Sample Station	Sample Interval	Chemical Residue (ppb)	Survival Significant (y/n)	Progeny Significant (y/n)	Survival Significant (y/n)	Growth Significant (y/n)	Growth Significant (y/n)	Dissolved Oxygen	Turbidity (NTU)
1	9/24/01	E099-092401-2	Diquat	1A	post	207.30						7.21	42.0
2	10/1/01	E032-100101-2	Diquat	1A	post	159.69						8.92	53.9
3	10/1/01	E032-100101-4	Diquat	1B	post	922.43						10.00	12.5
4	10/3/01	E173-100301-2	Diquat	1A	post	201.13						9.86	20.1
5	10/11/01	E173-101101-2	Diquat	1A	post	396.20						12.84	
6	9/19/02	E100-091902-3	Diquat	2A	post	77.00	Y	Y	N	Y	N	10.35	21.4
7	7/15/03	E099-071503-2	Diquat	2A	post	60.00	Y	Y	N	N	Y	9.15	5.1
8	9/11/03	E058-091103-6	Diquat	2A	post	110.00	Y	Y	N	N	Y	8.82	3.8
9	7/1/04	E173-070104-8	Diquat	2A	post	2270.00	Y	Y				8.14	13.8
10	7/1/04	E173-070704-8	Diquat	2B	post	170.00	Y	Y				8.23	18.2
11	7/7/04	E099-070704-8	Diquat	2A	post	140.00	Y	Y				8.54	11.6
12	8/31/05	E099-083105-8	Diquat	2A	post	40.00	N	N				11.71	3.4
13	9/6/05	E173-090605-8	Diquat	2A	post	390.00	Y	Y				11.70	2.7

the lowest concentration of diquat, measured at 40 ppb.

- Three of the samples also had tests conducted to determine toxicity to two other test organisms: fathead minnow and algae. None had an adverse affect on minnow survival, while one of the three had an adverse affect on minnow growth. Two of the three had an adverse affect on algae growth.

None of the 97 post-treatment fluridone samples analyzed exceeded the maximum label rate of 150 ppb for fluridone.[6] The maximum concentration of fluridone detected in any of the 97 water samples from fluridone-treated sites was 42.4 ppb. This occurred in a sample taken on August 12, 2004, from Pixley Slough, which had been treated with Sonar AS. The next highest detected fluridone concentration was 9.9 ppb, less than one-quarter the concentration detected at Pixley Slough. Of the 33 samples with detected fluridone residue, 29 had detected residue that was less than or equal to the 5 ppb considered the maximum beneficial use protective water quality limit. The remaining 64 samples from fluridone-treated sites had no detectable chemical residue.

During the five years, 2001 through 2005, the DBW treated targeted sites with Reward (diquat) or with Sonar (fluridone). The DBW applied fluridone in one of three formulations, each with different release rates:

- Sonar AS liquid
- Sonar Precision Release pellet
- Sonar Slow Release pellet.

[6] There is no published MCL for fluridone. The maximum residue limit for municipal drinking water is 560 ppb.

The DBW collected 204 post-treatment water samples from inside the treatment area and downstream from the treatment area that it then delivered to State laboratories to test for chemical residue. These post-treatment samples were obtained at intervals that ranged from the day of treatment to several weeks later. A single site, then, could have had more than one sample collected and analyzed for chemical residue. A profile of water samples collected and analyzed by State laboratories is provided in **Table 4.9**, on the following page.

The three most common time intervals, and residue test results from each, are summarized as follows:

- The first post-treatment water sample for a site generally was collected within one week of the treatment, most often on the same day within two to three hours of the treatment. **Table 4.10**, on the following page, identifies the chemical residue characteristics of these water samples. All of the samples with residues exceeding maximum contaminant levels (MCL) are those collected in this first post treatment sample. Further, 11 of these 13 samples were from water collected within the treatment area.
- One week following the initial sample (in some cases, more than one week), a second post-treatment sample from the site was collected. **Table 4.11**, on the following page, identifies the residue characteristics of these water samples. The maximum detected

Table 4.9
***Egeria densa* Control Program**
Post-Treatment Water Samples Collected for Residue Analysis from Inside Treatment Area and Downstream from Treatment Area

Chemical	Number of Samples		Percent of Samples		Minimum Detected Residue (ppb)	Maximum Detected Residue (ppb)	Mean Residue (ppb) [(a)]	Median Residue (ppb) [(a)]	Samples Exceeding Limit
	Tested	Number Detected Residue	Number Detected Residue	Detected Residue (ppb)					
Diquat	107	56	52.3%	47.7%	0.75	922.43	15.90	0.50	13
Fluridone liquid	16	7	43.8	56.2	1.10	42.40	4.66	1.50	0
Fluridone pellet	61	44	72.1	27.9	0.93	4.00	0.91	0.50	0
Fluridone aqueous/pellet combined	20	13	65.0	35.0	1.70	9.90	1.67	0.50	0
Totals	**204**	**120**	**58.8%**	**41.2%**					**13**

[(a)] Excludes data outlier of 922 ppb. Non-detected samples were given a value of 0.50 ppb, one half of difference between 0 ppb and the 1.0 ppb limit of detection.

Table 4.10
***Egeria densa* Control Program**
First Set of Post-Treatment Water Samples Collected for Residue Analysis from Inside Treatment Area and Downstream from Treatment Area

Chemical	Number of Samples		Percent of Samples		Minimum Detected Residue (ppb)	Maximum Detected Residue (ppb)	Samples Exceeding Limit
	Tested	No Detected Residue	No Detected Residue	Detected Residue (ppb)			
Diquat	57	19	33.3%	66.7%	0.75	922.43	13
Fluridone liquid	6	6	100.0	0.0	2.70	42.40	0
Fluridone pellet	18	12	66.7	33.3	0.93	3.80	0
Fluridone aqueous/pellet combined	8	3	37.5	62.5	2.50	9.90	0
Totals	**89**	**40**	**44.9%**	**55.1%**			**13**

Table 4.11
***Egeria densa* Control Program**
Second Set of Post-Treatment Water Samples Collected for Residue Analysis from Inside Treatment Area and Downstream from Treatment Area

Chemical	Number of Samples		Percent of Samples		Minimum Detected Residue (ppb)	Maximum Detected Residue (ppb)	Samples Exceeding Limit
	Tested	No Detected Residue	No Detected Residue	Detected Residue (ppb)			
Diquat	37	33	89.2%	10.8%	0.80	10.00	0
Fluridone liquid	6	3	50.0	50.0	1.10	2.60	0
Fluridone pellet	17	12	70.6	29.4	1.00	4.00	0
Fluridone aqueous/pellet combined	6	4	66.7	33.3	1.70	2.20	0
Totals	**66**	**52**	**78.8%**	**21.2%**			**0**

Table 4.12
***Egeria densa* Control Program**
Third Set of Post-Treatment Water Samples Collected for Residue Analysis from Inside Treatment Area and Downstream from Treatment Area

Chemical	Number of Samples		Percent of Samples		Minimum Detected Residue (ppb)	Maximum Detected Residue (ppb)	Samples Exceeding Limit
	Tested	No Detected Residue	No Detected Residue	Detected Residue (ppb)			
Diquat	4	4	100.0%	0.0%	0.00	0.00	0
Fluridone liquid	2	2	100.0	0.0	0.00	0.00	0
Fluridone pellet	16	12	75.0	25.0	1.10	2.40	0
Fluridone aqueous/pellet combined	6	6	100.0	0.0	0.00	0.00	0
Totals	**28**	**24**	**85.7%**	**14.3%**			**0**

diquat concentration for these second round of collections was 10.00 ppb, about one-half of the MCL. Of the 37 diquat samples, 33 had no detected residue. For the remaining four samples, the lowest concentration found was less than 1 ppb. The variability (or range) of fluridone concentrations appeared to be relatively small across all of these samples, and the measured fluridone concentration never exceeded 4.00 ppb.

- One week following the second sample (in some cases, more than one week), a third post-treatment sample was collected. **Table 4.12**, above, identifies the residue characteristics of these water samples.

5. Chemical Residue and Toxicity

Results from examining the impact of detectable chemical residue on laboratory test organisms differ by the chemical herbicide and the concentration detected. There was not always a distinct correlation between chemical concentration and toxicity to laboratory test organisms. There were water samples with detectable residue that did not impact the organisms, while there were water samples with no detectable residue that did impact the test organisms.

Table 4.13, on the following page, summarizes the findings. A discussion follows the table.

There were 204 post-treatment water samples collected from inside or downstream from the treatment area that were examined for chemical residue. Of these, 74 also were sent to State laboratories that conducted at least one of the five toxicity tests. A profile of these 74 samples and their impact on test organism survival, growth, and reproduction, are provided in **Exhibit 4.3**, on page 4-18.

Approximately one-half of the 107 diquat samples were delivered to laboratories that performed toxicity tests, while approximately one-fifth of the 97 fluridone samples were tested for toxicity. Therefore, there was more toxicity information available about diquat treatments then there was for fluridone treatments.

Table 4.13
***Egeria densa* Control Program**
Correlation between Residue Levels and Toxicology Test Results

Residue Level	Adverse Affect on Test Organisms
Exceeds allowable residue levels	■ Diquat: There appeared to be a correlation between samples with detectable diquat residue above the maximum contaminant level (MCL) of 20 ppb and positive toxicity results. Of the 107 water samples that were tested for diquat residue, 13 exceeded the MCL of 20 ppb. Eight of these 13 were tested for toxicity to water flea. Seven of these eight tests resulted in water flea survival rates and progeny counts that were significantly low. ■ Fluridone: No fluridone samples exceeded the label rate of 150 ppb, or the targeted maximum field concentration of 40 ppb for moving water.
Detected, but below allowable level	■ Diquat: Results were mixed. Adverse affects on some test organisms did occur, but not consistently. For example, 45 percent of the algae toxicity tests performed on these diquat water samples were positive. However, these same samples had a much lower adverse affect on water flea survival and reproduction, and an even lower impact on fathead minnow survival and growth. ■ Fluridone: Results appeared to vary by the fluridone formulation. None of the fluridone samples impacted water flea survival. While none of the fluridone liquid samples impacted fathead minnow survival or growth, 4 of the 8 fluridone pellet samples did. While both fluridone liquid samples tested did impact algae growth, 3 of the 6 fluridone pellet samples impacted algae growth. Only one sample of fluridone aqueous/pellet combination was tested for toxicity to all three organisms. The only adverse affect determined for this sample was on water flea reproduction.
Not detected	■ Diquat: Fifteen samples without any detected diquat residue were tested for adverse affect on fathead minnows and algae, and a number of these samples did impact these organisms. Something other than diquat caused the adverse affect. None of samples had an adverse affect on water flea survival or reproduction. ■ Fluridone: Seven samples without any detected fluridone residue were tested for adverse affect on fathead minnows and algae, and a number of these samples did impact these organisms. Something other than fluridone caused the adverse affect.

There were 13 diquat samples that contained residue exceeding the MCL. All 13 were the first sample taken after treatment, and 11 of these were from inside the treatment area. State laboratories tested eight of these 13 samples for adverse affects on water flea, and tested three of the 13 for adverse affects on the fathead minnow and algae. Seven of the eight samples impacted water flea survival and reproduction. Six of these water samples came from inside the treatment area, the seventh from a downstream location. Finally, two of the three tested with algae had an adverse affect on algae growth.

Of the 38 diquat samples with detectable residue below MCL, up to 25 were tested for their impacts on laboratory test organisms. The proportion of the samples tested that impacted water flea and fathead minnow survival, growth, and reproduction was much lower than the impact of the 13 samples exceeding MCL. The two diquat samples that did impact water flea survival had concentrations of 10.17 and 4.20 ppb, significantly lower than the MCL. Thirteen of the 25 samples with concentrations greater than 4.20 ppb did not impact water flea survival.

Four of the 25 diquat samples with detectable residue below MCL had an adverse impact on water flea reproduction. These four samples had concentrations ranging from 4.20 ppb to 12.30 ppb. Three of them came from inside the treatment area. Eleven of the 25 diquat samples had concentrations greater than

Exhibit 4.3
***Egeria densa* Control Program**
Frequency of Post Treatment Water Samples with Positive Toxicology Test Results

		Percent of Toxicity Tests Performed that Indicated an Adverse Affect							
		Water Flea			Fathead Minnow			Algae	
Chemical and Detected Residue	Number of Samples	Number Tested	Surv. Sign.	Progeny Sign.	Number Tested	Surv. Sign.	Growth Sign.	Number Tested	Growth Sign.
Diquat									
Above Limit	13	8	87.5%	87.5%	3	0.0%	33.3%	3	66.7%
Below Limit	38	25	8.0%	16.0%	23	4.3%	8.7%	22	45.5%
Not Detected	56	19	0.0%	0.0%	15	0.0%	13.3%	15	60.0%
Fluridone Liquid									
Above Limit	0	0	--	--	0	--	--	0	--
Below Limit	9	2	0.0%	0.0%	2	0.0%	0.0%	2	100.0%
Not Detected	7	0	--	--	0	--	--	0	--
Fluridone Pellet									
Above Limit	0	0	--	--	0	--	--	0	--
Below Limit	17	8	0.0%	12.5%	8	37.5%	12.5%	6	50.0%
Not Detected	44	7	0.0%	14.3%	7	28.6%	28.6%	7	71.4%
Fluridone/Aqueous Combined									
Above Limit	0	0	--	--	0	--	--	0	--
Below Limit	7	3	0.0%	0.0%	3	0.0%	33.3%	3	0.0%
Not Detected	13	1	0.0%	100.0%	1	0.0%	0.0%	1	0.0%
Total	**204**	**73**			**62**				

4.20 ppb and did not impact water flea reproduction.

Diquat samples with concentrations below MCL appeared to have a relatively lower impact on fathead minnow survival and growth. A single sample from the 23 samples tested impacted minnow survival, and had a concentration of 7.3 ppb. This single sample did not adversely affect minnow growth. Eight of the 23 diquat samples had concentrations greater than 7.3 ppb, and did not adversely affect minnow survival.

The diquat samples with no detectable residue had no impact on water fleas or on fathead minnow survival. However, 2 of the 15 samples with no detectable diquat residue had an adverse impact on minnow growth, and 9 of the 15 had an adverse impact on algae growth. These adverse affects could not be attributable to diquat. None of the 97 fluridone samples had concentrations above the label rate of 150 ppb, or the targeted maximum field concentration of 40 ppb for moving water. Thirty-three of the 97 samples had detectable concentrations below the label rate, and the remaining 64 samples had no detectable fluridone residue.

State laboratories tested water flea toxicity of 13 of the 33 fluridone samples with detectable residue. None had any adverse affect on water flea survival. One of the 13 samples had an impact on water flea reproduction. The fluridone concentration of this sample was 1.1 ppb. Eleven of the 13 samples tested had concentrations higher than 1.1 ppb, but had no impact on water flea reproduction.

State laboratories also tested fat head minnow toxicity of 13 of the 33 fluridone samples with detectable residue. None had any adverse affect on water flea survival. Three of the 13 had an adverse impact on fathead minnow survival. All three of these had fluridone concentrations less than or equal to 2 ppb. Seven of the 13 fluridone samples tested had concentrations greater than 2 ppb but had no impact on minnow survival. Two of the 13 samples had an impact on minnow growth. The fluridone concentration of these samples was 2.00 ppb and 5.00 ppb.

The eight fluridone samples with no detectable residue that were tested had no impact on water flea survival. However, one of the eight samples had an adverse affect on water flea reproduction, two of the samples had an adverse affect on minnow survival and growth, and five had an adverse affect on algae growth. These adverse affects could not be attributable to fluridone.

The fluridone used by DBW was: liquid, pellet, and combination aqueous/pellet. The number of samples tested for toxicity for each of these three types was small, varying between one and eight samples for a particular test organism. As a result, it was difficult to conclude statistically how chemical concentration and toxicity results varied by fluridone formulation.

The information provided in the discussion above focused on water samples collected inside the treatment area and downstream from the treatment area that then were tested for toxicity to laboratory test organisms. The DBW also colleted a third, control sample at the same time it collected the other two samples. Over the five-year period, the

DBW collected and performed chemical residue tests on 308 samples, representing the 46 sampling events.

Of the 308 samples tested for residue, 205, or 67 percent had no detectable residue. Of these 205 samples with no detectable residue, 81 were tested for adverse affects on water flea survival, 69 were tested for impacts on fathead minnow survival, and 68 were tested for impacts on algae growth.

Table 4.14, below, summarizes results of three toxicity tests on water samples with no detectable chemical residue. These samples had no adverse affect on water flea survival. Five samples had an adverse affect on fathead minnow growth, while 45 had an adverse affect on algae growth. <u>Two-thirds of the water samples with no detectable chemical residue had an adverse affect on algae growth</u>. One or more other contaminants in the water may be the source of the adverse affect, but it is not known what the contaminant(s) is.

One explanation for the results above is that ambient Delta water conditions have some influence on the toxicology results, in particularly on algae growth. Another explanation is that the algae test organism is extremely sensitive to the laboratory testing conditions. It brings into question the reliability, accuracy, and effectiveness of monitoring the EDCP environmental impacts using toxicology tests on algae.

6. Chemical Residue and Toxicity Trends at Treatment Sites

During the five-year period 2001 through 2005, the DBW obtained chemical residue tests on 308 water samples collected from the 14 geographically-distinct sites (three of these 14 sites share a common name). Of the 308 water samples collected, 42 samples were the first samples collected from inside the treatment area after treatment and tested for chemical residue. **Table 4.15**, on the next page, provides a summary of the average chemical concentration of herbicide for each site, measured from these 42 samples.

Immediately after treatment, the DBW collected an initial water sample from inside the treatment area. At four of the Diquat-treated sites, the chemical was not detected in the first post-treatment water sample collected from inside the treatment area.

Table 4.14
***Egeria densa* Control Program**
Non-Detected Residue Water Samples Adverse Affects on Test Organisms

Chemical	Water Flea Survival		Fathead Minnow Survival		Algae Growth	
	# Tested	# Adverse	# Tested	# Adverse	# Tested	# Adverse
Diquat	53	0	41	2	41	26
Fluridone liquid	2	0	2	0	2	1
Fluridone pellet	21	0	24	3	20	15
Fluridone aqueous/pellet combined	5	0	5	0	5	3
Totals	**81**	**0**	**69**	**5**	**68**	45

Table 4.15
***Egeria densa* Control Program**
Average Chemical Concentrations (ppb) of First Post-Treatment Samples Collected Inside Treatment Areas

Site Number	Name	Diquat	Fluridone Liquid	Fluridone Pellet	Fluridone Aqueous/Pellet Combined
15	Little Venice Island	0.00		0.93	
16	Venice Cut			0.00	
20	Sevenmile Slough	0.00			
31	Pixley Slough		16.00		9.90
32	Disappointment Slough	9.94			
33	Disappointment Slough	0.00			
56	Bacon Island	8.60			
58	Middle River Bullfrog	110.00			
99	Rhode Island	37.53		3.55	0.00
100	Old River Connection	77.00			
112	Dutch Slough	5.50		1.40	
118	Big Break Wetlands			0.00	5.00
173	Franks Tract	112.32		1.65	2.50
175	Franks Tract	12.35			

On four occasions, fluridone was not detected in the first post-treatment water sample collected from inside the treatment area. For example, site # 118, Big Break Wetlands, was treated in 2001, 2003, and 2005 with fluridone pellet, which may have occurred over several weeks. Immediately after the last in the series of these fluridone treatments, the DBW collected an initial water sample from inside the treatment area for the 2003 and 2005 treatments. Neither of these two post-treatment samples contained detectable levels of fluridone. It is unclear how soon after each annual treatment that each of these initial collections was made.

Of the 42 samples obtained after treatment and tested for chemical residue, 33 also were tested for toxicity to test organisms. These samples, which were obtained from within the treatment area, were subjected to toxicology tests on one, two, or three of the test organisms. An indicator of the relative level of toxicity used in an earlier analysis was calculated from the tests. For example, if five toxicity tests were performed on a water sample, and three of them had adverse affects, then the "toxicity indicator" for the individual water sample would be 60 percent.

Table 4.16, on the following page, provides a summary of the relative toxicity of water samples collected immediately after treatment from inside the treatment area.

Table 4.16
***Egeria densa* Control Program**
Relative Toxicity of First Post-Treatment Samples Collected Inside Treatment Areas

Site Number	Name	Diquat	Fluridone Liquid	Fluridone Pellet	Fluridone Aqueous/Pellet
15	Little Venice Island	20%		25%	
16	Venice Cut				
20	Sevenmile Slough	20%			
31	Pixley Slough		20%		0%
32	Disappointment Slough	0%			
33	Disappointment Slough	0%			
56	Bacon Island	20%			
58	Middle River Bullfrog	60%			
99	Rhode Island	29%		20%	
100	Old River Connection	60%			
112	Dutch Slough	33%		20%	
118	Big Break Wetlands			20%	20%
173	Franks Tract	44%		20%	
175	Franks Tract	10%			

There was some consistency of relative toxicity across the sites, for all years. At approximately one-half of the sites displayed above, one-fifth of the toxicology tests performed adversely impacted test organisms, meaning four-fifths of the water samples from these sites had no adverse affect on the test organisms.

At two sites, Middle River Bullfrog and Old River Connection, the relative toxicity was 60 percent, meaning three of five test results showed adverse affects on a test organism. This was the maximum relative toxicity from any sampling event for all five years of the EDCP. During the five-year EDCP, there were a total of 112 water samples collected on which all five toxicology tests were performed. None of these 112 had all five nor four of the five test results come back positive (positive result is one that showed an adverse impact on the test organism). A further discussion of toxicology test results is provided in following subsection.

7. Toxicity

During the five-year EDCP test program, the DBW collected 137 pre-treatment and post-treatment water samples and delivered these to State laboratories that conducted toxicology tests. Based on and examination of toxicology test results from these water samples, it appears that <u>the EDCP did not have a significant or consistent adverse affect on the test organisms used by the laboratories</u>.

The State laboratories conducted toxicity tests under specified laboratory conditions on specific indicator organisms. These tests were designed to demonstrate statistically (at a 95 percent confidence level) whether the water sample had an insignificant or significant adverse affect on a test organism's survival, growth, and/ or reproduction. For an EDCP water sample, the laboratories indicated (with a "N" or "Y") whether the sample had a statistically significant adverse affect on the organism. This indicator was provided for the following tests:

- Water flea (*Ceriodaphinia dubia*) survival
- Water flea reproduction
- Fathead minnow (*Pimephales promelas*) survival
- Fathead minnow growth
- Algae (*Selenastrum capriocornutum*) growth.

During the five-year EDCP, the DBW requested toxicity tests on 137 water samples prior to and after treatment, and in multiple locations (inside the treatment area, downstream, and at a control area). All five toxicity tests were not performed on every one of these water samples. The frequency of toxicity tests performed is provided below:

- All five tests performed 112 samples
- Four of five tests performed 6 samples
- Three of five tests performed 1 sample
- Two of five tests performed 18 samples
- One of five tests performed 0 samples.

Of the water samples that the DBW collected after treatment, 29 that were collected from within the treatment area had all five toxicity tests performed. **Table 4.17**, below, provides a summary of the toxicology test results from these 29 post-treatment water samples on which all five toxicology tests were performed.

None of the 29 post-treatment samples on which all five tests were performed had significant impacts on more than three of the five toxicity tests. The EDCP did not appear to have a significant and consistent adverse affect on all organisms used to test toxicity.

Table 4.17
***Egeria densa* Control Program**
Relative Toxicology of Water Samples Collected within the Treatment Area that had All Five Toxicology Tests Performed

Number of Toxicology Results Deemed Significant [(a)]	Number of Water Samples	Aquatic Herbicide			
		Diquat	Fluridone Liquid	Fluridone Pellet	Fluridone Aq/Pellet
All five	**0**	0	0	0	0
Four of five	**0**	0	0	0	0
Three of five	**4**	4	0	0	0
Two of five	**2**	1	0	1	0
One of five	**15**	8	1	5	1
None of the five	**8**	6	0	1	1
Total	**29**	**19**	**1**	**7**	**2**

(a) The State laboratories indicated whether a water sample had a significant adverse affect on a test organism. For the 112 water samples summarized in this table, the tests performed resulted in five separate indicators of significance: (1) water flea survival, (2) water flea reproduction, (3) fathead minnow survival, (4) fathead minnow growth, and (5) algae growth.

Eight of the 19 water samples from diquat-treated areas had an adverse affect demonstrated on one of the five toxicity tests. The organism impacted in seven of these eight was algae growth. These seven samples had no statistically significant impact on water flea survival, water flea reproduction, fathead minnow survival, or fathead minnow growth.

In addition, three of the seven diquat samples that did impact algae growth actually had no diquat residue detected. The toxicity tests performed on algae are difficult to interpret because of the toxicity results obtained from water samples that had no detected diquat residue.

The use of fluridone pellets as an herbicide has the same results pattern as the use of diquat. Five of the seven water samples collected from areas treated with fluridone pellets had an adverse affect demonstrated on one of the five toxicity tests. The organism impacted in four of these five was algae growth. These four samples had no statistically significant impact on water flea survival, water flea reproduction, fathead minnow survival, or fathead minnow growth. One of the four samples that impacted algae growth had no detected fluridone residue.

8. Ambient Delta Water Conditions

The DBW collected, and had toxicity tests performed on, up to 53 water samples prior to treatment. These samples were collected from inside the area that was later treated, downstream from this planned treatment area, and at a control location (generally, upstream). These water samples generally reflected ambient Delta water conditions at a site prior to treatment. A summary of the toxicity test results from these pre-treatment water samples are provided in **Table 4.18**, below.

Table 4.18
***Egeria densa* Control Program**
Test Results for Ambient Delta Water Samples

Toxicity Test	Number Tested	No Adverse Affect	Adverse Affect
1. Water flea survival	53	53	0
2. Water flea reproduction	53	47	6
3. Fathead minnow survival	45	41	4
4. Fathead minnow growth	45	43	2
5. Algae growth	45	15	28

If ambient Delta water conditions pose an environmental risk, the table above indicates that it could adversely affect the aquatic test organism algae. None of the 28 water samples that impacted algae growth contained detectable residues of the EDCP herbicide. The average dissolved oxygen of these 28 samples was 7.23 mg/L, and the average pH was 7.8. The variability of these two water quality parameters among the 28 samples was relatively small.[7] The average turbidity was 52.8 NTUs. The variability of this measure was relatively large among the 28 samples.[8]

9. EDCP Permit Requirement Compliance

Various conditions guiding the EDCP involve water physical and/or chemical characteristics (e.g., DO, pH, salinity) that

[7] The standard deviation of DO for the 28 samples was 2.17. The standard deviation of pH for the 28 samples was 0.50.

[8] The standard deviation of turbidity for the 28 samples was 112.25.

limit either when treatments are allowed or limit changes in water characteristics as a result of the treatment. In general, EDCP activities did not appear to be out of compliance with these. However, there were occasions when the program did not meet a specific requirement.

Concentrations of EDCP herbicides cannot exceed specified limits. Diquat concentrations cannot exceed 370 ppb (max. label rate). Fluridone concentration cannot exceed 150 ppb (max. label rate). On one occasion, diquat concentration exceeded the limit. On October 1, 2001, water collected downstream from the treatment area at Disappointment Slough was measured at 922.43 ppb. There were no samples of fluridone concentration that exceeded the specified limit.

A requirement of the EDCP is that the dissolved oxygen measured after treatment cannot be below 5.0 mg/L when the DO measured before treatment is greater than 5.0 mg/L. During the five-year period 2001 through 2005, the DBW measured the DO of water areas associated with a treatment area prior to treatment on 115 occasions. Of these pre-treatment samples, 109 had a DO greater than 5.0 mg/L. The DBW also measured the DO after treatment. On 14 occasions, the post-treatment DO dropped below 5 mg/L from a pre-treatment level that was greater than 5 mg/L. These 14 occurrences are listed in **Table 4.19**, on the following page.

10. Downstream Residue Concentrations

The receiving waters downstream from any treatment area cannot exceed specified limits. Diquat concentrations cannot exceed 20 ppb (MCL). Fluridone concentrations cannot exceed 560 ppb (Municipal Drinking Water Standard). On one occasion, diquat concentration exceeded the limit. On July 1, 2004, the first water sample collected downstream after treatment area at Franks Tract was measured at 170.00 ppb. There were no samples of fluridone concentrations that exceeded the specified limit.

11. Change in pH After Treatment

The Basin Plan[9] requires that changes in ambient pH levels shall not exceed 0.5 in fresh waters with designated cold or warm beneficial uses. Based on results of multiple statistical tests, there was no statistical evidence that the pH changed by more than 0.5 from what the pH was before treatment.

Determining statistically whether the pH changed by more than 0.5 required examining the 46 sampling events for which the pH was measured before and after treatment within the same location (e.g., inside the treatment area). For each sampling event, the DBW constructed the following pairs of pH measures <u>inside</u> the treatment area:

[9] California Regional Water Quality Control Board, Central Valley Region, adopted the Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins, July 19, 2002, page III-6.00.

Table 4.19
***Egeria densa* Control Program**
Post-Treatment Samples with a DO < 5 mg/L that had Pre-Treatment DO > 5 mg/L

Site #	Site Name	Date Measured	Location [(a)]	DO (mg/L)
100	Old River Connection	09/20/02	3A	4.99
112	Dutch Slough	08/09/02	6A	1.38
118	Big Break Wetlands	09/11/02	4A	4.74
173	Franks Tract	08/05/02	2A	2.55
173	Franks Tract	08/09/02	3A	0.89
173	Franks Tract	08/09/02	3C	1.50
175	Franks Tract	08/22/02	2A	4.40
031	Pixley Slough	09/03/03	2A	4.77
031	Pixley Slough	09/03/03	2B	4.50
056	Bacon Island	09/22/03	5A	4.63
056	Bacon Island	10/07/03	6A	4.29
031	Pixley Slough	08/19/04	3A	4.82
031	Pixley Slough	08/31/04	4A	4.18
173	Franks Tract	09/13/05	3A	3.08

(a) The first of the two-character location code indicates when the water sample was taken. A "1" indicates before the treatment. All remaining numbers are sequentially assigned for each post treatment collection (2 is the first post treatment collection, 3 is second collection, etc.). The second character indicates where the collection was made at the site. "A" indicates inside the treatment area, "B" indicates downstream from the treatment area, and "C" indicates a control area (e.g., upstream).

- The pH inside the treatment area before treatment was paired with the pH measured from the first post-treatment collection inside the treatment area. This resulted in 43 pairs of pH measured before and after treatment.
- The pH inside the treatment area before treatment was paired with the pH measured from the second post-treatment collection inside the treatment area. This resulted in 38 pairs of pH measured before and after treatment.
- The pH inside the treatment area before treatment was paired with the pH measured from the third post-treatment collection inside the treatment area. This resulted in 32 pairs of pH measured before and after treatment.
- The pH inside the treatment area before treatment was paired with the pH measured from the fourth post-treatment collection inside the treatment area. This resulted in 25 pairs of pH measured before and after treatment.
- The pH inside the treatment area before treatment was paired with the pH measured from the fifth post-treatment collection inside the treatment area. This resulted in 17 pairs of pH measured before and after treatment.

Table 4.20
***Egeria densa* Control Program**
Post-Treatment Samples with pH Outside Allowable Range

Herbicide	Number of Samples	Number Below Limit	Number within Range	Number Exceeding Limit	Percent Exceeding Limit
Diquat	50	0	35	15	30.0%
Fluridone liquid	6	0	6	0	0.0
Fluridone pellet	23	0	8	5	21.7
Fluridone aqueous/pellet combined	8	0	6	2	25.0
Total	**87**	**0**	**65**	**22**	**25.3%**

Five additional sets of paired measures similar to those above also were constructed for the pre-treatment pH measure and the pH measure taken downstream from the treatment area after treatment. The resulting number of pairs for each of these five sets was similar to those shown above for inside the treatment area.

The statistical test used to determine whether there was a change of more than 0.5 in pH was the paired difference t test. Because there are ten sets of pairs, ten of these paired difference t tests were conducted. For each of these, the null hypothesis was that the difference in pH was 0.5. Formally stated:

H_0: $\mu_d = 0.5$

where μ_d is the average of all differences of pH measurements before and after treatment at the same location (e.g., inside the treatment area or downstream from the treatment).

In all ten cases, there was no statistical evidence that the change in pH exceeded 0.5. In fact, in all ten cases, the null hypothesis was rejected because the change in pH was statistically less than 0.5 pH.

12. Range of Water Sample pH after Treatment

The Basin Plan[10] requires that the pH shall not be depressed below 6.5 nor raised above 8.5. Approximately one-quarter of the samples collected by the DBW indicated that the pH of water after treatment exceeded 8.5 pH. There were no post treatment samples that fell below 6.5 pH.

The DBW collected 87 water quality samples immediately after treatment (or generally within one week of treatment), from within the treatment area and downstream from the treatment area. **Table 4.20**, above, provides a profile of the pH conditions of these 87 samples.

[10] Ibid.

The 22 samples that exceeded a pH of 8.5 occurred in all five years. The 15 occurrences from diquat treated sites were as follows:

- 2001 2 occurrences Franks Tract
- 2002 5 occurrences Franks Tract, Rhode Island, Dutch Slough
- 2003 1 occurrence Dutch Slough
- 2004 3 occurrences Franks Tract, Rhode Island
- 2005 4 occurrences Franks Tract, Rhode Island.

The five occurrences from fluridone pellet treated sites were as follows:

- 2001 1 occurrence Big Break Wetlands
- 2002 2 occurrences Franks Tract
- 2003 2 occurrences Franks Tract.

The two fluridone aqueous pellet samples that exceeded the allowable pH limit occurred during 2005. Both of these were at Franks Tract.

The pH of the 87 water quality samples ranged from 7.14 up to 9.40, and was distributed a bit unevenly across this range. As shown in **Figure 4.1**, on the following page, the distribution of pH values was asymmetrical. The water quality samples demonstrate the range of the waters' alkalinity (values above 7) in areas treated during the EDCP. Sea water, which generally has a pH of 8.4, may have a strong influence on the ambient pH of Delta waters.

13. Turbidity Changes Resulting from EDCP Treatments

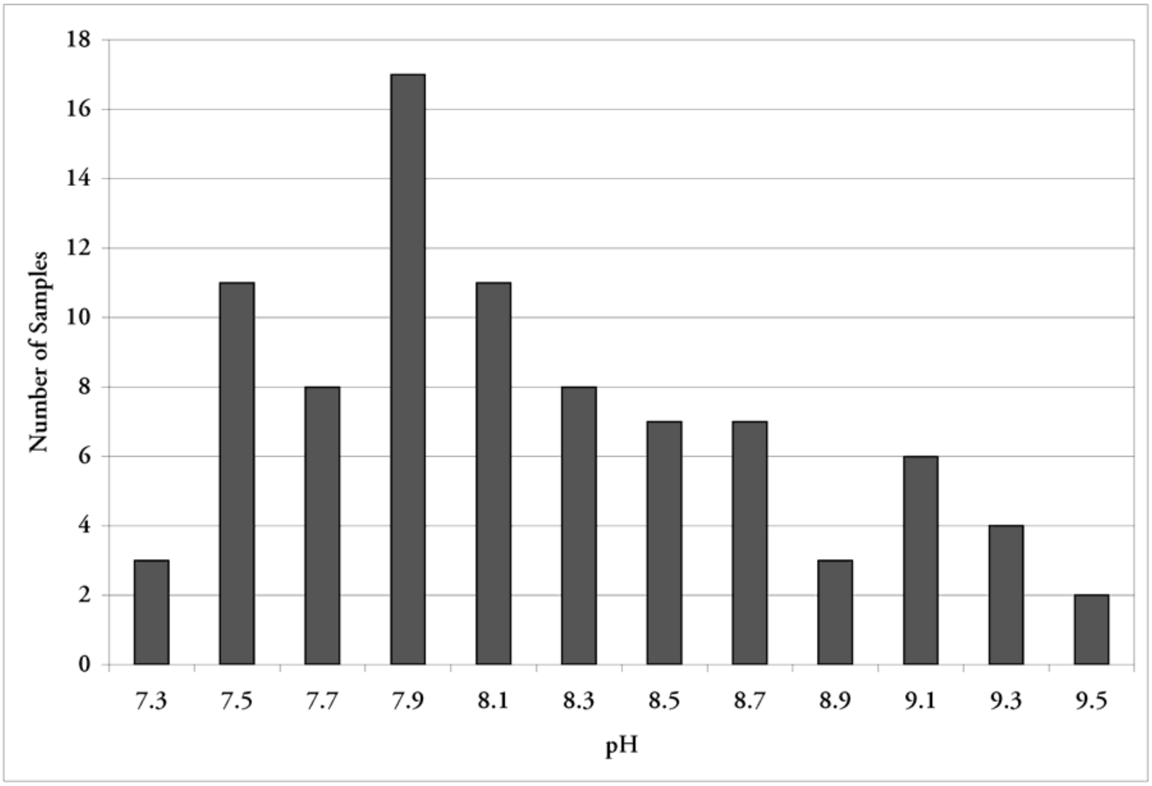
The Basin Plan establishes specified limits on increases in turbidity from "natural turbidity" that are attributable to controllable water quality factors. Basin Plan requirements differ, depending on the natural turbidity of the water. The EDCP complied with this requirement throughout the five-year period. There was one exception where the EDCP was not in compliance. Where the natural turbidity was between 0 and 5 NTUs, the turbidity of the first post-treatment samples collected downstream from the treatment area exceeded the limit established in the Basin Plan. Subsequent follow-up post-treatment visits to the same locations found that turbidity had declined back to within the Basin Plan limit.

The Basin Plan[11] requires that increases in turbidity attributable to controllable water quality factors shall not exceed the following limits:

- Where natural turbidity is between 0 and 5 Nephelometric Turbidity Units (NTUs), increases shall not exceed 1 NTU
- Where natural turbidity is between 5 and 50 NTUs, increases shall not exceed 20 percent
- Where natural turbidity is between 50 and 100 NTUs, increases shall not exceed 10 NTUs

[11] California Regional Water Quality Control Board, Central Valley Region, adopted the Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins, July 19, 2002, page III-9.00.

Figure 4.1
***Egeria densa* Control Program**
Distribution of 87 Post Treatment Water Samples pH



- Where natural turbidity is greater than 100 NTUs, increases shall not exceed 10 percent.

Because the Basin Plan does not define "natural turbidity," it is assumed the natural turbidity for any sampling event is the turbidity measured before treatment. In addition, evaluating compliance with the Basin Plan required a comparison of the change in turbidity inside the treatment area and the change in turbidity downstream from the treatment area. Therefore, the baseline "natural turbidity" for waters inside the treatment area was the measure taken inside the treatment area prior to treatment. The baseline "natural turbidity" for waters downstream from the treatment area was the turbidity measured downstream from the treatment area prior to treatment. Determining Basin Plan compliance required identifying which of the four turbidity requirements was applicable to every water quality sample collected by the DBW.

The DBW conducted up to seven follow-up visits to collect water quality data. Each follow-up visit generally was one to two weeks after the prior visit. Determining Basin Plan compliance required analysis of the change in natural turbidity at each follow up visit.

To determine whether turbidity increased and whether the increase was statistically significant, the DBW used the paired difference t test, with a 95 percent confidence level ($\alpha = 0.05$). The analysis first determined which of the four Basin Plan requirements was applicable to a sampling event. Then, the turbidity of the first water quality sample following treatment was paired with the pre-treatment turbidity for that sampling event. For example, one group of paired turbidity measures analyzed were those collected during the first follow-up visit that had an associated pre-treatment turbidity between 0 and 5 NTUs.

In all, there were 20 different groups of paired turbidity values, with as few as four pairs to as many as 28 pairs. These paired groups included 276 post-treatment water samples collected during the five-year period. Of these, 132 were collected inside the treatment area and the remaining 144 were collected downstream from the treatment area.

Of the 20 groups analyzed, 19 complied with Basin Plan turbidity requirements. In other words, none of these 19 exceeded allowable increases in turbidity.

The only exception that prevented full compliance with the Basin Plan was in waters with the lowest "natural" turbidity, 0 to 5 NTUs, in only the case of the downstream water samples collected immediately after treatment. Ten water samples (from 10 sampling events) comprised this group. The average increase in natural turbidity for these 10 samples was 4.7 NTUs. The Basin Plan requires the increase not exceed 1 NTU. The remaining 134 water quality samples collected downstream after the first post-treatment collection (144 samples collected downstream – 10 samples not in compliance) were in compliance with Basin Plan turbidity requirements.

D. A Third Party Environmental Assessment of the EDCP and Ongoing Delta Pelagic Organism Decline (POD) Investigations

Pelagic Organism Decline (POD) Workgroup

In addition to the above extensive five-year DBW analysis of environmental monitoring data showing that the EDCP has not done any environmental harm in the Delta, another third party analysis has reached the same conclusion. The Interagency Ecological Program (IEP), Pelagic Organism Decline (POD), Workgroup completed (on April 25, 2006) its Tier 1 Risk Assessment of EDCP aquatic herbicide use.[12] The IEP workgroup found that Sonar (fluridone) applications, the primary herbicide used for the EDCP, are unlikely to have the potential to cause Delta ecosystem water quality impacts, and are unlikely to cause toxicity to non-target aquatic organisms.

While the IEP work group found a number of "level of concern exceedances" for the herbicide Reward (Diquat), the EDCP, and other regulatory agencies involved, have been aware of this potential prior to treatment applications. The appropriate regulatory agencies (NMFS, USFWS, and CVRWQCB) have issued

[12] Geoffrey Siemering, San Francisco Estuary Institute, Oakland, California, "Technical Report for the Interagency Ecological Program (IEP) Pelagic Organism Decline (POD) Workgroup: Tier 1 Risk Assessment of California Department of Boating and Waterways Aquatic Herbicide Use in the Sacramento-San Joaquin River Delta, Prepared for the Interagency Ecology Program, April 25, 2006.

mitigating guidelines for Reward applications, and have determined the risks to be minimal.

Independent Review Panel of POD

An independent external scientific review panel of the IEPs ongoing POD investigations had some interesting comments that the DBW believes may be relevant to the EDCP.[13] This independent scientific panel found that the data analysis and dynamic models used for the POD program lack the sophistication to match complexity in the hydrological and population/ community dynamics of the Bay-Delta system. They also found that the POD program relies too heavily on local perspectives and resources for problem analysis, research, and assumptions, giving rise to a culture that impedes exploration of alternative possibilities.

One of several questions the independent scientific panel had was whether or not submerged aquatic vegetation (SAV) was providing positive or negative habitat functions for the early life stages of pelagic fishes. The panel asked a question of if it was worth considering the potential effects of herbicide use on spawning habitat of delta smelt or other species of interest.

Spawning habitat and spawning sub strata used by delta smelt in the Sacramento-San Joaquin Delta-Region is unknown and there is a significant gap in the life history of this species. The independent scientific panel went on to opine that if either shallow sub tidal or inter tidal vegetation play a role as spawning habitat for these species, it could provide a link between essential fish habitat and the application of aquatic herbicides, even if there are no lethal direct effects of the herbicides or the carrier compounds (e.g. surfactants) on the fishes.

A corollary of this interesting independent panel question from the standpoint of the EDCP, is what role has *Egeria* infestation itself, played on the decline in abundance of delta smelt and other pelagic species in the Delta-Region starting around 2001 or 2002? At what point of *Egeria* infestation does *Egeria* impact the entire health of the Delta ecosystem?

During the same time that declines in pelagic organisms become a Delta concern (i.e., 2001), the EDCP was just in its infancy and realizing only modest site efficacy and little program efficacy. It would not be reasonable to link declines in either native or non-native SAV (and hence pelagic organisms) to the EDCP at that time. It may be more logical to ask the direct question of how does non-native *Egeria densa* infestation associate with the pelagic organism decline?

Contra Costa Water District POD Studies

A recent analysis by engineers at the Contra Costa Water District has hypothesized that salinity may be a

[13] Mark D. Bertness (Brown University), Stephen M. Bollens (Washington State University), James H. Cowan, Jr. (Louisiana State University), et. al., Review Panel Report, San Francisco Estuary Sacramento-San Joaquin Delta Interagency Ecological Program on Pelagic Organism Decline, December 19, 2005.

threat to dwindling Delta smelt.[14] The engineers have hypothesized that shifting the timing of State water project deliveries may have led to saltier water in the fall, and for some reason, that may be leading to fewer Delta smelt.

Balancing the flow of water into the Delta with the amount of water pumped out is a complex business, and its consequences are not always well understood. The Delta is an extremely complex ecosystem influenced by the tides rolling in from the ocean and the flow of snowmelt from the Sierra Nevada.

How salinity determines the fate of Delta smelt remains a mystery. Nothing has been proven by the POD workgroup, as of this writing.

Department of Water Resources POD Studies

Another recent science paper presentation, relevant to the EDCP, was made by California Department of Water Resource (DWR) environmental scientists at the 4th Biennial CALFED Science Conference on October 24, 2006.[15] This oral presentation was part of a special session on the pelagic organism decline.

The scientists evaluated a long-term, time-series data record to evaluate habitat trends for delta smelt, striped bass, and threadfin shad in the San Francisco Estuary. The scientists found declines in indices for habitat quality associated with salinity and turbidity variables. The scientists opined that turbidity indicators can be closely associated with submerged aquatic vegetation (SAV), including *Egeria densa.* At the time of this writing, the paper was in draft form and not available for distribution.

Finally, DWR scientists are now studying the effects of toxic algae in the Delta to determine whether it poses a serious threat to human health, and to determine if it plays a role in the Delta's ongoing ecosystem concerns.[16] The algae, called *Microcystis aeruginosa* (Microcystis toxins) was first discovered in the Delta circa 1999.

Water quality officials in California do not yet have a full grasp of the threat this toxic algae poses. Not unlike *Egeria,* this algae grows in still water and near the surface. *Egeria* growth is highly correlated with algae growth, but it is not clear the extent that this unique toxic algae is correlated with *Egeria*.

* * * * *

There is likely never just one answer to the above ecosystem questions. This is complex and ever-changing Delta ecosystem biology, with no simple "yes" or "no" answers. All these on-going higher level Delta ecosystem investigations re-emphasize to the EDCP how dynamic an ecosystem environment it is working in, and the need to constantly coordinate and share information with other relevant Agencies working in the Delta.

[14] Mike Taugher, Contra Costa Times, "Salinity May be Greatest Threat to Dwindling Delta Smelt, Engineers Find", April 23, 2006.

[15] Frederick Feyrer, Matt Nobriga, and Ted Sommer, California Department of Water Resources, "Multi-Decadal Habitat Trends: Patterns and Mechanisms for Three Fishes in San Francisco Estuary".

[16] Mike Traugher, Contra Costa Times, " Effects of Toxic Algae in Delta Unknown", October 18, 2005.

Chapter 5
Future Program Operations (2006 to 2010)

Chapter 5 – Future Program Operations (2006 to 2010)

This chapter provides an overview of EDCP operations for the next five-year operating period (2006 to 2010). During this time, the EDCP will execute a number of program changes with the intent of maximizing treatment flexibility, realizing greater treatment efficacy, and keeping potential environmental impacts at a level below that originally presented in the 2001 EDCP EIR.

The EDCP plans to expand the list of sites treated from 35 priority sites to 73 sites, while removing acreage limits and application method specifications for a given site. During three years (2007 to 2009) of the next five-year operating period, the EDCP will focus its efforts on the Franks Tract Management Area (a major *Egeria densa* nursery) in an effort to demonstrate regional program efficacy and to address the single largest *Egeria densa* problem area in the Delta.

The EDCP will add a new version of Sonar (Sonar Q), to its "tools in the toolbox." The EDCP will remove Sonar SRP, and the previous limited two-year Komeen (herbicide) research trials from its program menu. Also, the EDCP will conditionally remove mechanical harvesting from the program until viable technologies are available.

The EDCP will incorporate new program strategies for controlling *Egeria densa.* These strategies will include treating at the optimal times in the plant growth cycle; using water quality data and other environmental variables (e.g., tide, currents, etc.) to optimize treatment timings; comparing data on fluridone concentrations with efficacy; and carefully adjusting where, when, and how treatments are conducted in a given planning year.

The future EDCP also will have improved environmental monitoring protocols, efficacy monitoring approaches, and program reporting. This chapter addresses these changing procedures and protocols. Finally, the EDCP will require new resources and a revised budget allocation to realize optimum program results.

The remainder of this chapter is organized into the following seven (7) sections:

A. Areas of Treatment
B. Control Methods and Strategies
C. Efficacy Monitoring
D. Environmental Monitoring
E. Program Reporting
F. Coordination with Aquatic Species Control Plans and Efforts
G. Portfolio of Focused Improvements.

A. Areas of Treatment

The EDCP had been restricted to treatment at 35 priority sites.[1] Over the past five years, the EDCP was constrained by the combination of 35 priority sites and regulatory treatment timing restrictions. The EDCP expects that in light of the growth and spread of *Egeria densa* infection, the future EDCP will require more latitude to treat at more sites and with associated earlier start dates within the Delta, and its tributaries.

[1] *Egeria densa* Control Program Environmental Impact Report, 2001 (with 2003 addendum).

The EDCP had been limited to treating a specific acreage within each site.[2] Sometimes the allowed acreage was considerably less than the amount of *Egeria densa* present within the site. For example, the maximum treatment acreage at Franks Tract was just 142 acres of the estimated 1,700 acres of *Egeria densa* infestation at that site. These former site specific acreages will no longer be applicable for the EDCP as a result of this Second Addendum.

The 2001 EDCP EIR specified a control method for each site in each year. This specification did not allow the EDCP to select the most appropriate treatment methods for the site conditions at a given time.

1. Delta-wide Treatment Areas

For the EDCP to have the best opportunity to advance program efficacy over the next five years, the EDCP will need to expand the list of sites that it can treat, and remove limitations on the quantity of acres that it can treat within a site. Subject to formal regulatory consultations and approvals in 2007, the EDCP plans to have flexibility to treat any one of 73 sites going forward. The 73 sites will include the 70 high and low priority sites previously identified in the 2001 EDCP EIR, with the following adjustments:

- ***Delete 2 Sites***
  - Old Site 31 – Bacon Island (already counted within another site, Middle River Jones)
  - Old Site 32 – Paradise Cut (non-navigable)
- ***Add 5 Sites***
  - Site 69 – Decker Island/Horseshoe
  - Site 70 – Stone Lakes
  - Site 71 – Mokelumne Consumnes
  - Site 72 – Georgiana Slough Ox Bow
  - Site 73 – Santa Clara Shoal
- ***Rename 1 Site***
  - Old Site 41 – rename “Indian Slough” as “Indian Slough (Discovery Bay areas).”

A map showing these 73 EDCP named sites is provided in **Exhibit 5.1**, and a map showing the corresponding DBW site identification numbers for the 73 sites is provided in **Exhibit 5.2**, both following this page.

At each site, the EDCP will not be restricted to treat a portion of the total acreage at the site, but rather will have latitude to treat all of the infested acres at a site, as needed. The EDCP also will not be restricted to use a specific control method at a site, but will select the most appropriate treatment method for the real-time field conditions.

Increasing geographic and timing program flexibility will allow the EDCP to appropriately respond to changes in where *Egeria densa* is present. This change will remove unnecessary restrictions placed on the EDCP and allow the EDCP to have greater ability to control this ever-spreading, non-native nuisance aquatic weed.

---

[2] Ibid.

Exhibit 5.1
***Egeria densa* Control Program**
Future Northern and Central Delta Control Sites

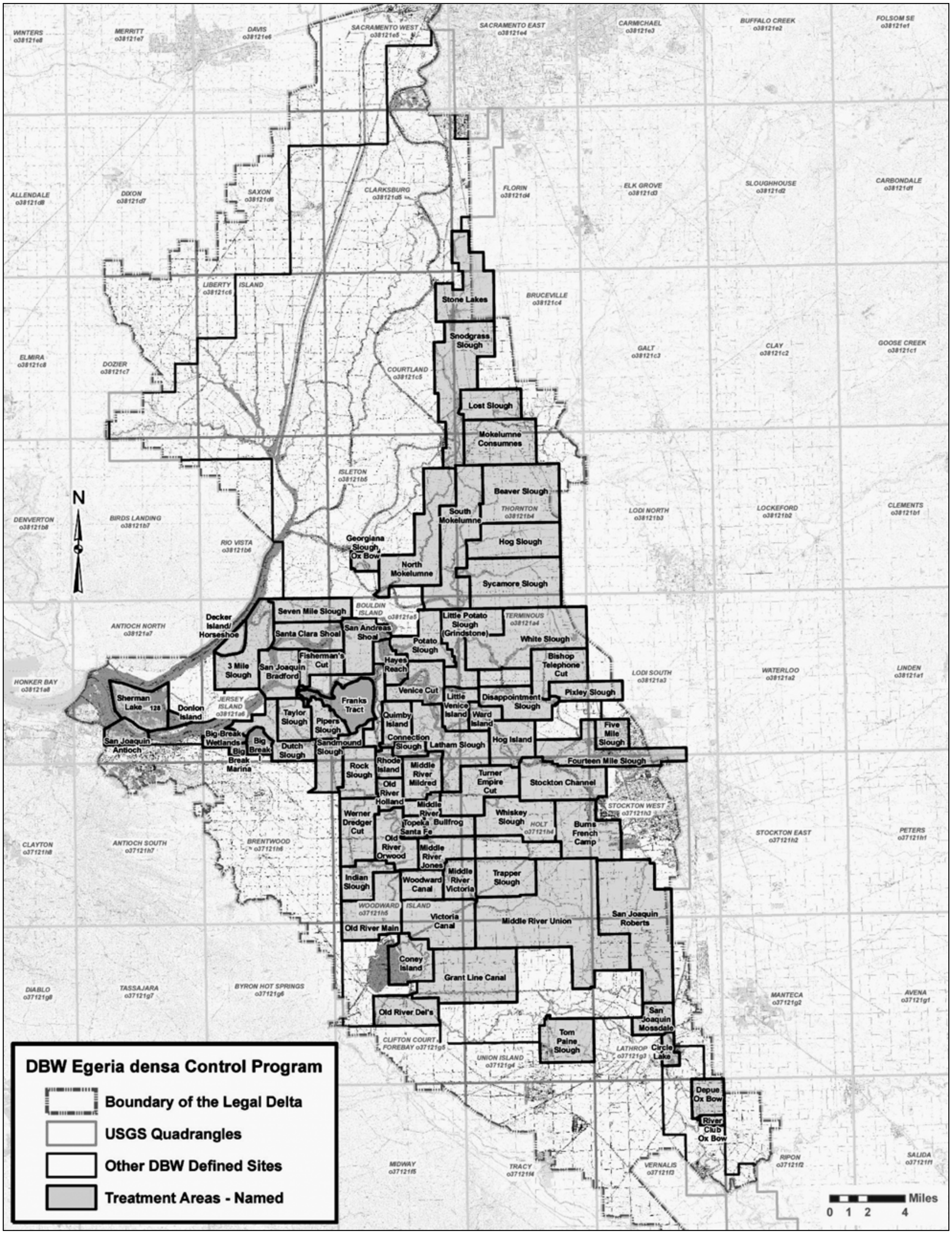
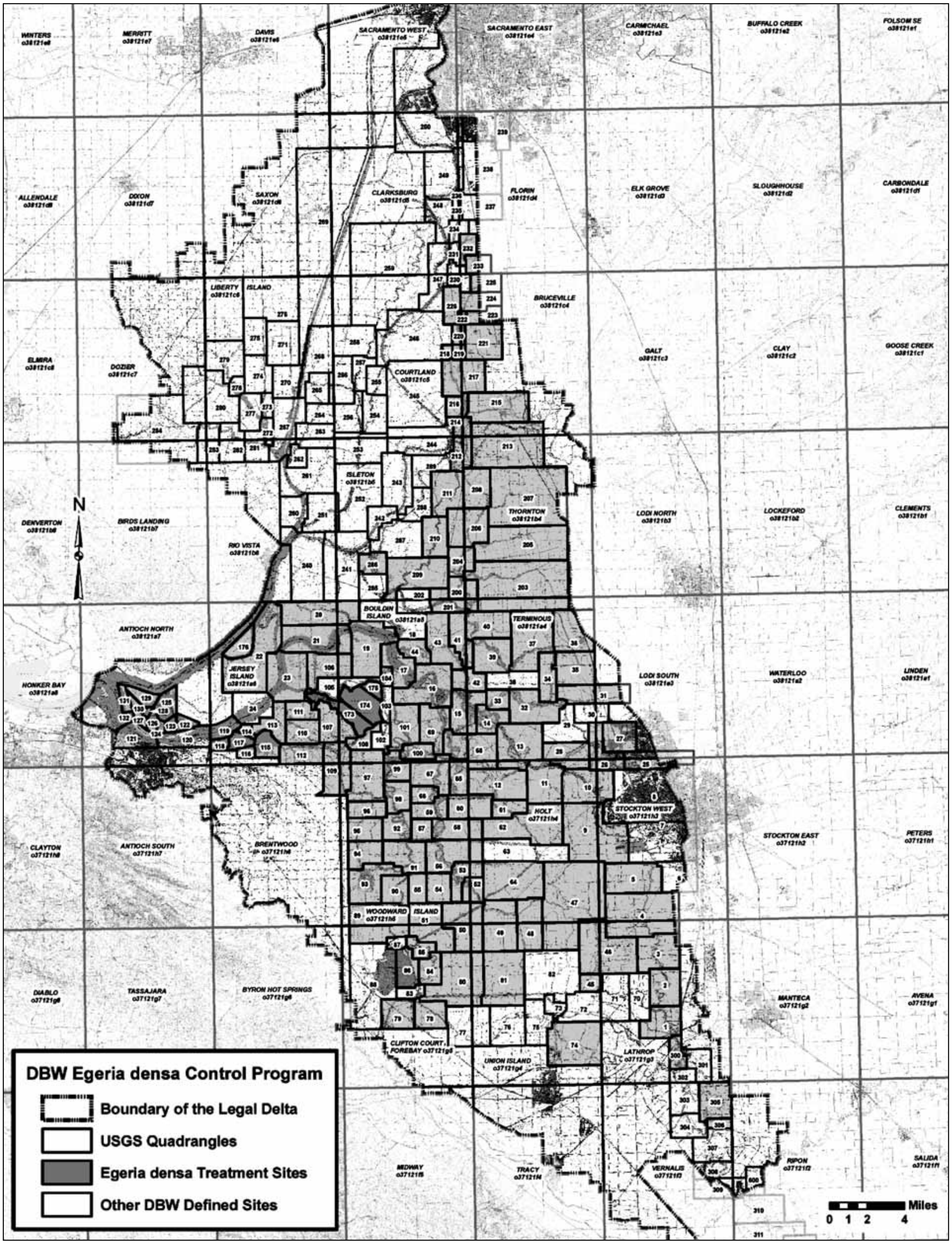


Exhibit 5.2
***Egeria densa* Control Program**
Future Northern and Central Delta Control Sites
(Listed by DBW Site Number)



2. Franks Tract Management Area

A lesson learned for the EDCP is that past treatment efforts were too diffused with not enough emphasis on demonstrated program efficacy. While the EDCP plans to increase the universe of sites for maximum program flexibility over the next five years, it also intends to prioritize and focus its treatment resources in the first three years of the five-year period.

The EDCP will narrow its treatment efforts on more focused objectives over the next three years. Specifically, the EDCP will attempt to demonstrate successful management of *Egeria densa* in Franks Tract over the next three years. The Franks Tract Management Area will include Franks Tract and smaller adjacent areas such as Sandmound Slough and Piper Slough.

The EDCP will use a "regional" management focus for the first three years of the five-year period. Along with a regional management approach, will be more focused monitoring of residues and water quality within this defined area. The EDCP believes that by apportioning their limited resources on this major nursery area, they will have a greater opportunity for program efficacy.

Support for this three-year regional EDCP management strategy includes the following arguments:

- Prior EDCP treatment efforts have been spread too thin; efficacy has been too patchy to create significant treatment impacts, or to even come close to moving toward "restoration" conditions
- Current EDCP pre- and post-treatment efficacy measurement assessments will be more accurate in a concentrated geographic area with limited field personnel resources
- Regulatory agency goals of moving toward "restoration" will be more aligned with a prioritized focus on Franks Tract
- Franks Tract is already a priority site of the USGS, and several other major State agencies, and therefore more collaborative field work will be developed with these other governmental entities to benefit Delta-wide research and management (e.g., fisheries, invertebrates, waterfowl habitat, etc.). For example, the California Department of Water Resources, Bay-Delta Office, is studying the feasibility of modifying Franks Tract to improve water quality, reduce salinity, enhance the ecosystem, and improve recreational opportunities
- Franks Tract is a likely potential recipient of new (not yet present) invasive species due to its high traffic potential, and its ideal *Egeria densa* suitable habitat. High intensity management and monitoring at Franks Tract will increase the chances of discovering new, non-native invasive species in time to react quickly
- The EDCP will separate Franks Tract into two to three "experimental" blocks to best understand efficacy of various treatment combinations and formulations
- Franks Tract is already well-mapped for hydrologic conditions and flow models, and this valuable

information will be used to improve EDCP program efficacy

- Success in Franks Tract within three years will increase the chances of applying program "lessons learned" to other EDCP sites. Lack of success at Franks Tract, with a best prioritized effort, may suggest that current program approaches must be radically adjusted for continued program operations
- Franks Tract research data collected over the next three years will aid future potential applications of host-specific biological control agents
- Prioritizing EDCP treatments to Franks Tract will allow for early treatments in the entire area and greater site efficacy success.

In summary, the EDCP will have the following management strategy over the next five years:

- The EDCP will intensively treat the Franks Tract Management Area (including surrounding sloughs) over a three-year period. During this three-year treatment effort, while the focus will be on Franks Tract, the EDCP will leave open the option to treat other "hot spot" Delta areas as needed (e.g., Indian Slough/Discovery Bay, Bethel Island, Taylor Slough, and others).

  During this three-year period, the EDCP, subject to Federal regulatory approval in 2007, plans to be able to treat a range of between <u>3,000 and 5,000 water acres in total per year</u>, up from a maximum of less than 700 acres treated program-to-date, and up from the maximum of 1,733 water acres originally specified in the 2001 EDCP EIR. Of this total acreage, the EDCP expects that the Franks Tract and other neighboring sloughs management area alone will represent approximately 3,000 water acres of this 3,000 to 5,000 water acre range.

  The EDCP expects to set up new monitoring strategies for the Franks Tract Management Area which may include permanent continuous monitoring stations (possibly in conjunction with the USGS). The EDCP also will implement varying treatment approaches based on unique flow rates, bathymetry, and sediment conditions present in the Franks Tract Management Area. The EDCP will continue to follow all environmental monitoring requirements specified in permits with regulatory agencies.

- During the last two years where the EDCP is not focusing on the Franks Tract Management Area, the EDCP plans to treat any of the 73 named sites in the legal Delta. This will open up the number of sites from the former "35 priority sites" to the 73 named sites (specified in Exhibit 5.1 and showed listed by DBW site numbers in Exhibit 5.2).

  For a specific site, the DBW will not be constrained as to how much of the site it will treat, but rather will treat as needed, up to the total water acreage for that site. The <u>total treatment acreage during the last two years also is expected to</u>

range from between 3,000 and 5,000 water acres.

- For the Franks Tract Management Area the EDCP's measurable goal will be to realize an average fifty (50) percent net reduction in *Egeria densa,* from the 2006 estimate, over the next three years (2007 to 2009), for the treated areas within Franks Tract. "Net reduction" will reflect the net impact of EDCP treatments and off-season *Egeria densa* grow-back. This efficacy measurement goal could be impacted by program resource and/or regulatory constraints. This targeted goal is just for the *Egeria densa* invasive weed and not for other non-native invasive weeds.
- None of these EDCP treatment area planning goals will preclude the EDCP from treating any of the 73 named sites at any time, over the five-year planning period, to meet: (1) navigation and safety needs, (2) emergency control requirements, (3) marina access issues, (4) fish passage and ecosystem restoration goals, and (5) responses to ongoing public concerns.
- In any of the five years, the EDCP will be able to treat all 73 named sites with Sonar aquatic herbicides beginning April 1st of each year. Currently, regulatory agencies limit early start dates to only a selected number of sites on the eastern side of the Delta.

B. Control Methods and Strategies

The EDCP will make several changes to the program control methods and operating strategies for the next five-year period. The EDCP will remove Sonar Slow Release Pellet (SRP) and replace it with Sonar Q, another pellet version of Sonar. The EDCP also will conditionally remove mechanical harvesting from the program.

As the limited two-year Komeen research trials have been completed, the EDCP will remove any reference to Komeen use from the EDCP. The 2001 EDCP EIR evaluated the potential impacts of Komeen for trials. Results of the two-year research trials are presented in Research Report 13, in **Appendix B.** A number of the environmental impacts identified in the 2001 EDCP EIR (Chapter 4) associated with the two-year Komeen research trials are no longer applicable.

After five years of operations, the EDCP has identified a number of alternative strategies for control of *Egeria densa* in the Delta. These strategies are summarized below.

1. Control Methods

The EDCP will add Sonar Q, a pellet form aquatic herbicide, as an additional control method. Sonar Q has very similar label conditions to that of Sonar Precision Release (Sonar PR), a pellet form aquatic herbicide already used for the EDCP. Sonar Q has faster release properties than Sonar PR as a result of a different type of inert clay ingredient.

The EDCP will test Sonar Q in a range of its control sites. Where possible, Sonar Q will be used, in lieu of Sonar PR (pellet) or Sonar AS (aqueous), for Delta areas with higher organics in the sediment (e.g., Big Break). As Sonar Q pellets release faster, they theoretically have less potential than Sonar PR pellets to become bound to organics in the sediment, and therefore greater efficacy potential for these types of sites. A copy of the Sonar Q label and Material Safety Data Sheet is provided in **Appendix C.**

Additionally, the EDCP proposed to use mechanical harvesting in the 2001 EDCP EIR for emergency purposes over 52 acres. Due to (1) large harvesting costs, (2) operating limitations caused by Delta field conditions (high winds and tidal exchanges), and (3) the potential for *Egeria densa* stem fragmentations, the EDCP has conditionally removed mechanical harvesting from its treatment options until viable technologies are available.

The EDCP has elected to remove Sonar Slow Release Pellet (SRP) as an aquatic herbicide used for the program. This decision is based on the availability of Sonar Q and Sonar PR as EDCP options, both of which have release properties more suited for Delta applications. Also, SRP has more potential to remain bound in Delta sediments.

The United States Department of Agriculture, Agriculture Research Service (Dr. Lars Anderson) is currently conducting ongoing research in Argentina on potential bio-control agents for *Egeria densa* control. An abstract for this research is expected to be prepared in 2007. Should this research indicate that bio-control agents are applicable for the EDCP, the EDCP would consider incorporating these methods as part of the EDCP's adaptive management.

2. Treatment Strategies and Approaches

Based on ongoing adaptive management of the program, where possible, the EDCP will continue to refine its operational approaches for future control efforts including the following approaches:

- *Focus treatments at sites where regulatory agencies allow earlier start dates.* The EDCP has determined that during the early part of the year between April and June, efficacy is highest with its aquatic herbicides because *Egeria densa* is at the optimal point of the growing cycle. The EDCP has found that these earlier site treatment dates are absolutely critical for the EDCP to have meaningful site efficacy and a chance for overall program efficacy.

  The EDCP will seek approval from regulatory agencies to treat all of its sites (at a minimum with Sonar herbicides) on April 1st, so that the EDCP can have a realistic opportunity to stop the ever-expanding infestation of *Egeria densa* in the Delta. Absent these earlier start dates for most of its key sites, the EDCP will be severely constrained to realize some degree of measurable long-term program efficacy. The levels of *Egeria densa* will continue to ever increase, and create environmental risk for the health of the Delta ecosystem and environment.

  To the degree that regulatory agencies approve the use of aquatic herbicides (particularly Sonar) early in the treatment season, the EDCP will work to augment its program resources so that it has sufficient field staff, and environmental scientists, to treat and monitor sites with these earlier start dates.

- *Plan treatment methods to coincide with optimal water quality or hydrologic conditions present.* The EDCP will continue to take a more scientific approach to treatments whereby the EDCP can maximize efficacy, while minimizing environmental impacts, if treatments can be performed under specific water quality conditions (e.g., turbidity and salinity) or tidal conditions (i.e., application of aquatic herbicides during an optimal point in the tidal cycle).

  The EDCP will advance its use of information regarding tidal exchange, water flow, and particle movements at specific sites to optimize treatment efforts. Other agencies have modeled Delta water dynamics (e.g., California Department of Water Resources). Where this information can be used, or where the EDCP can research particle movement, the EDCP will use these kinds of information to identify specific locations and times within a site that provide the greatest opportunity for applications to remain present throughout the treatment. For example, the EDCP has determined that Sonar AS applications are best performed during incoming tides, and will attempt to make these applications at incoming tides where possible.

- *Base annual treatments at a site on prior efficacy results.* The EDCP may elect to skip treating a site following a year with significant measurable site efficacy. This approach is consistent with an ongoing maintenance program strategy.

- *Plan regional treatment efforts to maximize efficacy in a given Delta area.* The EDCP will consider treating in a selected region of the Delta (e.g., north, south, east, or west), in a given year, to see if program efficacy can be enhanced. This approach is in contrast to a more wide selection of treatment sites throughout the entire Delta.

- *Emphasize treating sites that are determined critical to navigation or boating activity.* The EDCP will elect to stop treating highly infested sites that are very rarely navigated in cases that these sites are not nursery sites, and are not materially contributing to the spread of *Egeria densa* in the Delta.

- *Utilize sequential treatments where efficacy is improved without changes to potential environmental impacts.* In an effort to increase efficacy, while following permit and label restrictions, the EDCP will continue to experiment with "sequential" applications, or one type of herbicide application immediately followed by a different type of aquatic herbicide application. As an example, the EDCP has experimented with sequential treatments of Reward (Diquat) and Sonar PR (Fluridone).

- *For Sonar treatments, compare FasTEST results with efficacy to determine optimal Sonar concentrations throughout treatment.* The EDCP measures concentrations of Sonar in the water during the six- to eight-week treatment cycle at a given site. The FasTEST is used to measure Sonar concentrations and becomes the basis for adjusting the concentration of weekly Sonar applications throughout the treatment period. The EDCP will compare time-series concentrations of Sonar with site efficacy to optimize specific treatment approaches at a site.

- *Use combinations of Sonar AS, and Sonar PR or Sonar Q, to maximize application concentrations through treatment periods.* The EDCP has had greater success in keeping fluridone concentrations higher throughout the treatment period by utilizing Sonar PR applications applied monthly in combination with biweekly or weekly Sonar AS applications. The result is that FasTEST results generally show higher ongoing fluridone concentrations.
- *Consider restricting use of Sonar PR should Sonar Q provide greater efficacy.* The EDCP is in continual adaptive management of the program. The EDCP has not used Sonar Q yet. Should Sonar Q prove more efficacious, the EDCP will expect to use a greater amount of Sonar Q than Sonar PR.

EDCP efforts may not result in successful complete vegetation restoration of Delta waterways due to the presence of other non-native invasive aquatic weeds. Other non-native species that could fill in and grow to replace *Egeria densa* as it is controlled by the EDCP include, among others, *Myriophyllum spicatum* (Eurasian Watermilfoil) and *P. crispus* (Curlyleaf Pondweed). These non-*Egeria* non-native species have different growth properties that require other control approaches and techniques than those used by the EDCP. Successful long-term Delta restoration efforts ultimately will need to address these other non-native invasive aquatic weeds. Currently, these other non-native weeds do not fall under the scope of the EDCP. Long-term successful Delta restoration will be dependent on an as yet to be defined Integrated Vegetation Management Strategy (IVMS).

C. Efficacy Monitoring

The EDCP plans to continue to invest in the ever important area of efficacy monitoring. With out this monitoring program component, there is no accurate measurement of *Egeria densa* infestation in the Delta.

The EDCP will move towards greater ground truthing of *Egeria densa* infestation in order to measure a larger program area and to better be able to monitor program efficacy. More EDCP resources will be allocated to conduct systematic, on-site field surveys to assess *Egeria densa* infestation.

The EDCP plans to develop and pilot test a new methodology for measuring *Egeria densa* in the Delta using a field-based approach. This approach could include ground-truthing with DBW generated digitized maps, and using Geographical Information System (GIS) capabilities. (See Chapter 3, Section H., Future EDCP Efforts for Efficacy Measurement and Improved Control).

The EDCP also will improve upon its hydroacoustic analyses going forward.

More control sites will be studied, and statistical inference testing will be incorporated into the hydroacoustic analyses using control versus treatment site paired analyses. The hydoracoustic analyses will also expand its specialized *Egeria densa* matrices to include more mainstream program acreage estimates of *Egeria densa* infestation.

D. Environmental Monitoring

There are several areas of the EDCP environmental monitoring program that the EDCP will evaluate for improvement opportunities. These areas include: (1) sampling and data collection, (2) types of data collected, and (3) data management and analysis.

Sampling and Data Collection

The EDCP will review the quantity, and timing of, water samples and follow-up water quality monitoring data taken, to determine whether it can provide more meaningful results for the same level of effort. Specifically, the EDCP will assess whether more extensive water sampling and water quality data collected immediately following a treatment (e.g., within 24 hours) can be substituted for data taken over a longer time interval.[3]

The EDCP will assess whether to expand the number of sampling stations at a site, while limiting the number of follow-up visits required. This change will allow the EDCP to make better inferences about aquatic herbicide dissipation and movement following a treatment. The EDCP will consider revising the sample numbering methodology it uses to identify water samples by station and date.

Types of Data Collected

The EDCP will evaluate whether to continue to take different types of water quality data if they serve no meaningful regulatory purpose (e.g., specific conductivity). The EDCP also will perform more extensive analysis on those data that are of concern by regulatory agencies (e.g., dissolved oxygen, pH, turbidity).

Data Management and Analysis

The EDCP will review how it manages and analyzes water quality data. The EDCP will set up a new database format and build in a repeatable process for future time-series data analyses.

The EDCP needs to assess whether to consolidate data collected by environmental scientists and field crews into a single database. This could include combining pesticide use data with environmental monitoring data so that relationships between these data sets can more easily be gleaned. Both field groups of personnel collect dissolved oxygen data, but field crew dissolved oxygen data (pre- and post-treatment) is not currently utilized. Among the other field crew data which is collected, but not currently used for data analysis purposes includes wind speed, application rates, and water temperature (pre- and post); however, these data are still useful for field treatment planning.

[3] These improvements are subject to regulatory approvals by the Central Valley Regional Water Quality Control Board (under current NPDES permit).

E. Program Reporting

The EDCP will revise the format and content of its annual reports so that (1) the most salient results are presented in a consistent and comprehensive fashion, (2) well supported conclusions and recommendations are made, and (3) where applicable, results are compared over time. Over the past five years, annual reports have varied in terms of the quantity and types of information presented as the program "came up to speed" and different approaches were used by different program staff.

The EDCP needs clear and consistently applied pesticide usage reporting metrics, including:

- Acreage treated
- Sites treated
- Treatments
- Applications
- Gallons of herbicide used
- Pounds of herbicide used
- Pounds of active ingredient used.

These metrics should have common definitions so that stakeholders can understand what the data means and users can apply them. For example, a single treatment often includes multiple applications. The EDCP is not currently set up to manage and analyze its data in this applied way. The EDCP will ultimately use consistent data definitions in all facets of the program, from *Egeria densa* acreage monitoring to environmental monitoring to pesticide use reporting.

The EDCP will create a better linkage between pesticide use data, efficacy data, and environmental monitoring results. To date, these results are often reported separately and their relationships need to be assessed and integrated more clearly in EDCP reporting.

The EDCP will revise how it (1) reports environmental monitoring results, (2) makes statistical inferences about the data, and (3) provides consistent and comprehensive comparisons of results with standards (e.g., Basin Plan). The EDCP will use a standard data collection and analysis approach, building upon prior year data, so that meaningful long-term results can be inferred.

F. Coordination with Aquatic Species Control Plans and Efforts

The EDCP will coordinate its future program operations with other Federal and State of California aquatic species control plans and efforts as follows.

1. Federal Aquatic Invasive Species Control

On the federal level, there is heightened concern over the spread of nuisance aquatic invasive species (AIS) and their control. The EDCP is essentially meeting objectives of a larger recent national imperative to gain control and manage aquatic invasive species. There is a National Aquatic Nuisance Species Task Force and a National Invasive Species Council established to address AIS.

Primary federal authorities for managing and regulating AIS include:

- Nonindigenous Aquatic Nuisance Prevention and Control Act (NANPCA, 1990)
- National Invasive Species Act (NISA, 1996)
- Executive Order 13112 (1999)
- Lacey Act (1998)
- Noxious Weed Act (1974)
- Plant Protection Act (2000).

NANPCA is the first major federal program to prevent the introduction and spread of aquatic nuisance species. NISA funds research on aquatic nuisance species prevention and control. Executive Order 13112 prevents introduction of invasive species, provides for their control, and minimizes their impacts through improved coordination of federal agencies. The Lacey Act and Plant Protection Act restrict movement and spread of non-indigenous species.

EDCP goals for preventing the spread of *Egeria densa* within the Delta, and its tributaries, and to other federal bodies of water are highly consistent with national AIS goals. Support for continued effective EDCP control efforts therefore not only is from State of California legislation, and program stakeholders, but also from these numerous federal authorities.

2. California Aquatic Invasive Species Control

California Aquatic Invasive Species Management Plan

The California Department of Fish and Game (DFG) is currently preparing the California State Aquatic Invasive Species (AIS) Management Plan, intended for signature by the Governor in 2007. The plan is being prepared in response to the NANPCA.

The AIS plan identifies the DBW's Aquatic Weed Control Program as the largest and oldest aquatic weed control program in California. DBW staff participated in the plan's development. The EDCP is mentioned as one of four case studies in the plan. This direct involvement demonstrates that the EDCP is an important part of the larger initiative to control AIS in California.

Current funding for the AIS plan comes from multiple agencies, including the Ocean Protection Council, the State Coastal Conservancy, and the U.S. Fish and Wildlife Service. Prior drafts of this plan were supported by funding from the DFG and the University of California at Davis. Other contributors to the plan include the California State Lands Commission, the California Department of Food and Agriculture, the California Coastal Commission, the State and Regional Water Quality Control Board, the National Marine Fisheries Service, the United States Department of Agriculture – Agriculture Research Service, and others.

EDCP goals are similar to the AIS plan's goals. The plan provides a framework for responding to AIS, and for protecting the biological integrity of California waters and native plant and animal communities. The plan acknowledges the extensive direct ecological impacts of AIS on habitats, species, and food webs, and the impact of AIS on efforts to restore and protect these resources.

The future EDCP will be closely aligned with AIS plan objectives. The plan has eight objectives, three of which are most relevant to the future EDCP:

- Objective #1, Coordination and Collaboration - improve coordination and collaboration among the people, agencies, and activities involved with AIS
- Objective #2, Prevention - minimize the introduction and spread of AIS into, and throughout, waters of California
- Objective #5, Long Term Control and Management - control the spread of invasive species and minimize their impact on native habitats, listed species, and restoration projects.

The AIS plan identifies numerous specific action items supporting plan objectives. The EDCP will review this plan and attempt to align with relevant action items. For example, the future EDCP may need to enhance efforts to educate the boating community regarding ways in which *Egeria densa* can spread (referred to as recreation vectors).

While the AIS plan is in draft stage, the State of California definitely has AIS on its policy agenda. Multiple State of California departments/agencies are involved in various control efforts and they view AIS as a significant ongoing problem that requires extensive coordination and adequate resource commitments. The future EDCP should be viewed as an important model program with direct linkages to this AIS plan and the global Statewide effort.

Other Similar California Weed Control Efforts

The EDCP is not alone in invasive weed control efforts in California. Other similar control programs include:

- The California Department of Water Resources (DWR) has programs aimed at controlling invasive weeds along eroding Sacramento River banks, within flood control and water conveyance structures, and along urban streams. DWR coordinates its activities with other state and federal agencies as a member of the CALFED Non-native Invasive Species Advisory Council (NISAC). The DWR controls *Egeria densa* in Clifton Court Forebay using Komeen and Sonar.
- The California Department of Food and Agriculture operates a Hydrilla eradication program in several California lakes and various other places (e.g., Clear Lake) using Sonar.
- Other local agencies (e.g., Contra Costa Water District) control *Egeria densa* in channels using Reward and Sonar.

The future EDCP will closely coordinate with these other departments/agencies so that best practices, lessons learned, research efforts, and operating and monitoring results are openly shared.

The EDCP will coordinate future control efforts with another State of California initiative responsible for Delta ecosystem planning. This new initiative is the Water Education Foundation two-year Delta Vision process, underway in 2006 to help educate stakeholders about Delta issues, and sponsored by the California Resources Agency and U.S. Bureau of Reclamation. The program is responsible for developing short and long-term strategies for sustainable management of the Delta.

The future EDCP also will coordinate its control and research efforts with other State of California organizations such as:

- California Interagency Noxious Weed Coordinating Committee – facilitates, promotes, and coordinates integrated pest management partnerships between public and private land mangers toward eradication and control of noxious weeds
- California Invasive Species Council – protects wildlands from invasive plants through research, restoration, and education
- California Invasive Weed Awareness Coalition – promotes increased funding for management of invasive weeds and influences state and national policy on invasive weeds.

Other non-*Egeria* invasive vegetation could limit success of EDCP vegetation restoration efforts because the EDCP is only Legislatively mandated to control *Egeria densa*. The EDCP believes that its control efforts will not worsen the vegetation ecological situation in the Delta, but the EDCP could potentially be substituting one invasive weed problem for another. The EDCP hopes to be part of, and provide leadership to, a Delta-wide research panel on Integrated Vegetation Management Strategy.

G. Portfolio of Focused Improvements

Over the next five program years (2006 to 2010), the EDCP plans several focused improvement initiatives to improve program administration, environmental monitoring, field operations, and efficacy measurement. **Exhibit 5.3**, on the following page, presents seventeen (17) potential EDCP focused improvement initiatives. Subject to staffing constraints and program resources, the EDCP will attempt to execute as many of these initiatives as possible, in order of the general priorities listed.

Exhibit 5.3
***Egeria densa* Control Program**
Potential Focused Improvement Initiatives, Listed by Priority

Initiative	Improvement
Program Administration	1. Review and revise the current EDCP budget to determine the optimal use of available program funding
Environmental Monitoring	2. Prepare a Franks Tract Management Area detailed treatment and monitoring plan, including where, when, and how future treatments and monitoring would occur in this area (subject to NOAA Fisheries approval in current biological opinion consultation) 3. Coordinate with other scientists currently seeking funding for research on problems created by *Egeria densa* in the Delta, possibly providing ongoing DBW funding support (e.g. "Effects of the Invasive Aquatic Plant, *Egeria densa*, on Native Fish Habitat in the Sacramento-San Joaquin Delta" – Larry R. Brown, USGS) 4. Consider funding a separate DBW scientific research project on ecological damages created by *Egeria densa*
Field Operations	5. Provide detailed year 2007 EDCP treatment planning so as to maximize opportunities for program efficacy in light of current resource constraints and regulatory limitations 6. Work with aquatic herbicide vendors to develop more focused and detailed treatment approaches that are specific to unique Delta site conditions (e.g., water flow, water movement, tide, water quality parameters, and sediment conditions) (i.e., SePro)
Environmental Monitoring	7. Review and revise environmental monitoring sampling procedures and protocols 8. Review and revise approaches for analyzing and presenting annual environmental monitoring data 9. Develop a new format and content for EDCP annual reports submitted to regulatory agencies
Efficacy Measurement	10. Develop and pilot test a new methodology for measuring *Egeria densa* in the Delta using a field-based approach (e.g., ground-truthing with DBW digitized maps and using GIS capabilities), and recommend procedures for conducting annual field surveys for measurement of program efficacy (will likely require some new field equipment purchases) 11. Develop improved approaches for collection, analysis, presentation, and use of data collected by *Egeria densa* surveillance contractors (i.e., ReMetrix) that are more integrated with on-going program reporting needs
Program Administration	12. Review and revise the DBW site identification system
Field Operations	13. Assess for improvement opportunities (1) field operations maintenance facilities; (2) tools and parts inventories; and (3) field practices 14. Create formal aquatic herbicide storage and inventory procedures 15. Examine alternative EDCP boat and herbicide storage locations for improved program efficiency 16. Identify alternative spray boat layouts and configurations that could create a more safe, efficient, and effective field operating environment 17. Review existing field operations and monitoring boat fleets to determine if alternative treatment work boats and research vessels could be beneficial (e.g., larger treatment work boats for bigger water treatment areas like Sherman Lakes)

Chapter 6
Analysis of Changes to EDCP (2006 to 2010)

Chapter 6 – Analysis of Changes to EDCP (2006 to 2010)

This Second Addendum to the 2001 EDCP EIR incorporates changes to EDCP treatment areas, treatment timings, and control methods. Potential impacts expected from these program changes will not create new significant environmental effects. These program changes also will not increase the significance of impacts documented in the 2001 EDCP EIR, and 2003 First Addendum to the EIR.

This chapter assesses, in Section A, changes to EDCP treatment areas and treatment timings, including: (1) an expanded site list, (2) an increase in allowable site-specific acreage, (3) use of system-wide earlier start dates, (4) an increase in overall treatment acreages, and (5) a new Franks Tract Management Area. This chapter also addresses, in Section B, changes to planned EDCP control methods, including: (1) addition of Sonar Q, (2) removal of Sonar SRP, (3) reduction in Reward (Diquat) use, (4) conditional removal of mechanical harvesting, and (5) removal of Two-Year Komeen Research Trials. Section C discusses changes in the planned intensity of EDCP treatments.

The chapter concludes in Section D with a revised Environmental Checklist that identifies areas that have changed from the 2001 EDCP EIR. Program changes for 2006 to 2010 will not increase existing environmental impacts or create new impacts, but instead will likely reduce formally stated potential environmental impacts.

A. Changes to EDCP Treatment Areas and Timing

The EDCP plans to increase both the number of treatment sites, and the treatment acreage within a site. The EDCP plans to treat any site during the active stage of *Egeria densa* growth, or after April 1st of each year, a necessity for the EDCP to have an opportunity for program efficacy. The EDCP will focus on the Franks Tract Management Area for the first three years of the five-year planning period.

1. Expanded Site List

Subject to regulatory approvals, the EDCP plans to increase its treatment site list from 35 to 73, an increase of 38 sites. The EDCP will add these 38 sites to provide future program flexibility.

A total of 33 of these 38 additional sites were previously “low priority” sites in the 2001 EDCP EIR. For these 33 sites, the EDCP will simply remove the high and low priority distinction.[1] The other five of 38 additional sites will be new sites (not identified in the 2001 EDCP EIR). None of the five new sites have conditions that will create different, or unique, potential program impacts, if treated.

The expanded 73 site list will be more consistent with the EDCP’s legislative authority to control *Egeria densa* within the entire Delta region, and its tributaries. The 73 site list alone will not necessarily

[1] Referred to as “high priority” and “low priority” based on degree of navigational impairment and level of infestation of the time.

increase the EDCP acreage treated, nor the quantity of aquatic herbicides applied, both of which are largely a function of ongoing EDCP resources and priorities.

Delta sites generally have similar characteristics (e.g., highly tidal) so the impacts from treating any one of the 73 sites compared with another will not usually vary significantly. For example, future program impacts will not differ if a treatment is conducted at Disappointment Slough (previously high priority) or Snodgrass Slough (previously low priority).[2]

Environmental monitoring results (presented in Chapter 4), and the extensive research performed over the past five years (documented in Appendix B), both indicate that future Sonar and Reward environmental impacts will be minimal to the Delta, and likely less extensive than originally described in the 2001 EDCP EIR. Continued use of these aquatic herbicides, over a broadened number of treatment sites, will not pose any additional concerns.

Conclusion: The expanded site list will not create new significant environmental effects, or increase the significance level of impacts already addressed in the 2001 EDCP EIR and 2003 addendum.

2. Increase in Allowed Site-Specific Treatment Acreage

For 2006 through 2010, for any of the 73 sites, the EDCP will treat up to the maximum estimated acreage of *Egeria densa* at that site.[3] This change will allow the EDCP to focus on the entire infestation at a site, rather than just part of the infestation.

Over time, as site infestation changes, the EDCP will change the treatment acreage at that site. With increases in *Egeria densa* infestation at a site, the treatment acreage will increase at that site. With decreases in site infestation, the site treatment acreage will decrease.

Environmental monitoring results (described in Chapter 4) do not show that impacts were different for a site with a large treatment acreage. The extensive research performed over the past five years (documented in Appendix B) indicates EDCP Sonar and Reward impacts are minimal to the Delta. Use of these aquatic herbicides over larger acreages within a site will not pose an additional concern.

Conclusion: Expanded allowable site-specific treatment acreages will not create new significant environmental effects, or increase the significance level of impacts already addressed in the 2001 EDCP EIR and 2003 addendum.

[2] EDCP impacts were not presented on a site-specific basis in the 2001 EDCP EIR, but rather on an overall program basis. Regulatory agency concerns focus on when a treatment occurs at a site, rather than which site is treated.

[3] The 2001 EDCP EIR set limits on the number of treatment acres at a site. For 7 of 35 priority sites, the treatment acreage was less than the *Egeria densa* estimate at that site, and in most cases, much less than the *Egeria densa* estimate. Additionally, *Egeria densa* at each site have increased and the EDCP needs to increase site-specific treatment acreages to accommodate this growth.

3. Earlier System Wide Start Dates

Subject to Federal regulatory consultations and approvals in 2007, the EDCP will have latitude to treat all sites after April 1st.[4] Early start dates will be necessary for future program efficacy success. The EDCP will have the best opportunity for site efficacy between the April and June "early start date" period. The EDCP will use Sonar for nearly all of these early start date treatments.

A primary reason for the limited number of allowed early start date sites, to-date, was that fish runs through the Delta coincide with the early start date period. The EDCP has undergone extensive research on EDCP aquatic herbicide impacts to Delta fish species. A description of the EDCP's current analysis of potential impacts to fish species is provided in **Appendix D.** From this research, the EDCP concludes that early start date treatments, mostly conducted with Sonar (see Section B.3. of this chapter for a discussion of reduction in Reward use), will not adversely impact fish.

Recent DBW-sponsored studies of Sonar toxicity reveal that:

- Migrating salmon are not adversely affected by EDCP Fluridone use. There are no long-term effects to Salmon. There are no adverse impacts to smolts following adaptation to saline environment as part of seawater challenge tests (Report # 5, Appendix B)
- Fluridone does not accumulate in the tissue of Chinook salmon smolts, on their outward migration through the Delta, based on data collected from various locations (Report #3, Appendix B)
- Fluridone concentrations in sediment do not reach a concentration that is of a major concern (Report #2, Appendix B)
- Sonar LC50 values are several orders of magnitude higher than detected concentrations in the Delta. It is unlikely acute toxicity will occur (Report #9, Appendix B).

EDCP early start date treatments also will not likely cause any fish takes. There is no evidence of detrimental impacts to fish from prior EDCP efforts.[5]

Based on this analysis, even with earlier start dates, Sonar and Reward use will continue to have no direct impacts to fish and no indirect impacts to fish migration corridors. In fact, treating *Egeria densa* at its most vulnerable state might improve program efficacy, and in turn enhance fish migration corridors and spawning habitat.

Following efficacious treatments, *Egeria densa* will be replaced by native plant species. These native species may provide more beneficial spawning habitat for migratory fish.

[4] The EDCP was not permitted to treat most sites during the critical April through June period when the plant was actively growing. The EDCP was allowed to treat just eight sites on or before April 15th of 2003 through 2005 (mostly western Delta sites). In 2006, the EDCP was allowed to treat 12 sites on or before April 15th (including some eastern Delta sites like Franks Tract, Rhode Island, and Sandmound Slough).

[5] EDCP field and environmental monitoring personnel have not observed any fish takes at all during the five-years of the program. More importantly, for sites treated during the early start date period, EDCP field and monitoring crew did not observe any fish takes at these sites.

The 2001 EDCP EIR stated that Reward use would have an indirect impact to special status fish due to reductions in abundance of aquatic invertebrate prey base following treatments. This impact will not change with earlier start dates.

Earlier start date applications will have the potential to, over time, lead to greater long-term site and program efficacy. With improved efficacy and a smaller *Egeria densa* problem, the EDCP consequently will use less aquatic herbicides and reduce the potential for program impacts.

Conclusion: Earlier start dates will not create new significant environmental effects, or increase the significance level of impacts already addressed in the 2001 EDCP EIR and 2003 addendum.

4. Increase in Total Treatment Acreages

The EDCP plans to treat from between 3,000 and 5,000 acres per year from 2006 to 2010. The increase in treatment acreage is needed to keep up with the growth and spread of *Egeria densa* in the Delta.[6]

In the 2001 EDCP EIR, the EDCP originally set an expectation that close to 4,000 acres of *Egeria densa* infestation were present within the 70 high and low priority sites. This 4,000 acre number is the midpoint of the 3,000 to 5,000 acre projection.[7]

The EDCP will immediately attempt to reallocate existing resources to increase and prioritize EDCP treatment capabilities. Over the next five-year planning period, the EDCP will attempt to increase its program resources.

Based on five years of operations, the EDCP determined that total treatment acreage did not have an influence on program impacts. In years with more acres treated, the EDCP continued to observe minimal impacts from program operations.

The EDCP will proportionately increase its environmental monitoring so that it is representative of this larger treatments acreage. Even with the increase in treatment acreage, applications will continue to rapidly dissipate due to the highly tidal nature of the Delta.

Conclusion: Increases in total treatment acreage, to an annual amount of 3,000 to 5,000 acres, will not create new significant environmental effects, or increase the significance level of impacts already addressed in the 2001 EDCP EIR and 2003 addendum.

5. New Franks Tract Management Area

In the next three years, the EDCP will treat the Franks Tract Management area, including Franks Tract and sloughs and channels surrounding Franks Tract. The EDCP will continue to treat between

[6] The EDCP has been limited to an annual treatment acreage, for the 35 priority sites, of 1,733 acres per year. Annually, the EDCP treated up to 622 acres in the last five years. Based on current aquatic herbicide budgets, the EDCP theoretically could treat up to 1,500 acres per year.

[7] This does not reflect significant growth of *Egeria densa* since 2000.

3,000 and 5,000 acres during this time, with about 3,000 acres focused on the Franks Tract Management Area.

The EDCP will setup monitoring stations throughout the perimeter of the Franks Tract Management Area. The EDCP will consider using monitoring stations that take continuous water quality data so that time series results are available.

The EDCP will proportionately increase its environmental monitoring so that it is representative of this large concentrated treatment acreage. Even with the increase in treatment acreage, treatment applications will continue to rapidly dissipate due to the highly tidal nature of the Franks Tract area.

Conclusion: Addition of the Franks Tract Management Area will not create new significant environmental effects, or increase the significance level of impacts already addressed in the 2001 EDCP EIR and 2003 addendum.

B. Changes to EDCP Control Methods

The EDCP will change the control methods, or "tools in its toolbox" over the next five years. The EDCP will incorporate use of Sonar Q, a registered pellet version of Sonar, as a new control method. The EDCP will initially test Sonar Q use in certain areas of the Delta with higher organics in the sediments. The EDCP will monitor the efficacy potential, and post-treatment Fluridone concentrations, of Sonar Q to determine how extensively Sonar Q will be used.

The EDCP will deemphasize Reward (Diquat) in lieu of Sonar use. Reward (Diquat) will be used in relatively limited cases where immediate results are required.

The EDCP also will remove Sonar Slow Release Pellet, conditionally remove mechanical harvesting, and remove the Two-Year Komeen Research Trials from the 2001 EDCP EIR. Removal of these control methods will significantly lessen overall EDCP impacts.

1. Addition of Sonar Quick Release (Sonar Q)

The EDCP will add Sonar Quick Release (Sonar Q), a pellet version of Sonar (Fluridone) with faster release properties than Sonar Precision Release (Sonar PR) and Sonar Slow Release Pellet (Sonar SRP). Compared to other Sonar pellet types, Sonar Q releases more active ingredient, more quickly, into the target plant. Sonar Q pellets begin to degrade immediately.

Sonar Q will potentially lessen program impacts because the herbicide will be used for more specific Delta conditions. Sonar Q will be intended for sites with high organic content in their sediments.[8] For Delta areas with high organics in sediments, more herbicide will be released for plant control.

Sonar Q also theoretically will hold higher concentrations longer than Sonar AS (aqueous) which immediately

[8] With Sonar Q, Fluridone will be less likely to bind to soft bottom sediments than other Sonar pellet types.

dissipates with tide and water flow.[9] Sonar Q will allow more accurate placement than Sonar AS, but will retains the efficient concentration level of a liquid.

Sonar PR was added to the EDCP via an addendum to the 2001 EDCP EIR in 2003. The rationale to add Sonar Q to the EDCP at this time is similar to that provided in the 2003 addendum.

No new significant environmental effects will be expected from use of Sonar Q. Sonar Q has a virtually identical label and Material Safety Data Sheet (MSDS) as Sonar PR, and Sonar PR already was approved in the 2003 addendum to the 2001 EDCP EIR. The following comparisons between Sonar Q and Sonar PR support this determination:

- Sonar Q has the same percent active ingredient as with Sonar PR. Each contains five percent Fluridone.
- Sonar Q has the same percent inert ingredient as with Sonar PR. Each contains 95 percent inerts.
- Labeled rates are the same for Sonar Q and Sonar PR, not to exceed a maximum of 150 ppb and recommended at rates to maintain a 10 ppb to 40 ppb concentration for a minimum of 45 days.
- Like Sonar PR, Sonar Q is registered for aquatic use and is labeled for *Egeria densa* control.

<u>Conclusion</u>: The addition of Sonar Q will not create new significant environmental effects, or increase the significance level of impacts already addressed in the 2001 EDCP EIR and 2003 addendum.

2. Removal of Sonar Slow Release Pellet (SRP)

With two other available Sonar pellet products, Sonar Q and Sonar PR, each of which has release timing properties better suited to the Delta environment, the EDCP will remove Sonar SRP from the EDCP.

The EDCP found that Sonar PR was superior for Delta conditions in maintaining higher concentrations of Fluridone throughout the treatment period. The EDCP essentially replaced Sonar SRP use with Sonar PR following treatment year 2002. The EDCP effectively has discontinued Sonar SRP use since that time.

Sonar pellets, or Fluridone residual, remaining in sediments, as stated in the 2001 EDCP EIR and in a subsequent study by the California Department of Fish and Game (see report #2 in Appendix B) pose minimal risk. However, replacement of Sonar SRP with Sonar Q and Sonar PR will lessen the potential for Fluridone to linger in Delta sediments.

<u>Conclusion</u>: Removal of Sonar SRP will not create new significant environmental effects, or increase the significance level of impacts already addressed in the 2001 EDCP EIR and 2003 addendum.

[9] Sonar Q pellets have less chance for UV light degradation than Sonar AS because Sonar Q is immediately carried to the bottom of the waterbody.

3. Reduction in Reward (Diquat) Use

Due to potential environmental impacts to aquatic invertebrates the EDCP will largely deemphasize use of Reward over the next five years. The EDCP will use the various Sonar products more extensively. Reward will continue to be an option for emergency control efforts and in situations where a combination Reward/Sonar treatment would enhance site efficacy.

EDCP environmental monitoring over the past five years showed that Diquat concentrations, when measured in excess of Basin Plan standards (20 ppb), are toxic to water fleas. This is consistent with the 2001 EDCP EIR "unavoidable significant impact" that Reward use could be toxic to invertebrates.

Reward use at maximum application rates also approaches LC50 values for fathead minnow, Sacramento splittail, and other larval fish. However, due to limited contact time in the Delta due to tidal activity, there is relatively limited potential for impacts to larval fish from Reward.

The EDCP has elected to minimize this potential impact through a large reduction in expected Reward use (a couple of hundred acres per year) from that originally stated in the 2001 EDCP EIR (over one thousand acres per year). Sonar use also has been shown to have as good, or better, efficacy potential as Reward.

<u>Conclusion</u>: Reducing Reward use will not create new significant environmental effects, and will decrease the significance level of impacts already addressed in the 2001 EDCP EIR and 2003 addendum.

4. Conditional Removal of Mechanical Harvesting

The EDCP did not use mechanical harvesting during the 2001 through 2005 period. Until such time as a mechanical harvester is available that is practical operationally, has more limited potential environmental impacts, does not propagate *Egeria densa,* and is cost effective, the EDCP will conditionally remove mechanical harvesting from its options until viable technologies are available, leaving only chemical control methods. The EDCP reserves the option to incorporate a viable mechanical harvesting control method into the EDCP at such later date that this technology becomes feasible via an additional Addendum to the EDCP EIR.

Current harvesting technology has the potential for too many environmental impacts and fragmentation. The only way that *Egeria densa* spreads is through fragmentation. Harvesting has a range of second and third order impacts/limitations, including how to collect/transport the harvested material, where to dispose of the harvested material, and associated waste discharge issues.

In general re-growth from mechanical harvesting is said to be rapid, so as a method it has less applicability for overall program efficacy. Harvesters are shown to cut the top five feet of plant material, leaving one to three feet of vegetation left.

By conditionally removing mechanical harvesting from the EDCP, the following previously identified potential significant impacts from the 2001 EDCP will no longer be applicable:

- Harvester maneuvering causes localized increases in turbidity, affecting hydrology and water quality
- Fragmentation from harvester causes nuisance by creating floating material (3,000 fragments per hour)
- Harvester maneuvering causes localized increases in turbidity, affecting drinking water quality
- Adverse impact to intertidal wetland plants due to harvester
- Temporary decrease in abundance of aquatic invertebrates
- Removal or physical destruction of fish present in *Egeria* beds
- Temporary decreases in abundance of aquatic invertebrates results in indirect impact to fish prey base
- Harvesting operations/staging of equipment could kill or maim reptiles/amphibians in channels or on channel banks
- Mechanical harvesting staging operations could adversely impact birds that nest or forage along channel banks

Numerous other lower-level impacts also will not be applicable with removal of mechanical harvesting use.

<u>Conclusion</u>: Removal of mechanical harvesting will not create new significant environmental effects, and will decrease the significance level of impacts already addressed in the 2001 EDCP EIR and 2003 addendum.

5. Removal of Two-Year Komeen Research Trials

The EDCP conducted limited Komeen (a chelated copper herbicide) Research Trials in Franks Tract (9/5/02 and 7/7/03) and Sandmound Slough (7/8/02 and 7/8/03). The four days of trials were primarily intended to resolve whether or not copper from Komeen applications would persist in Delta sediments.

Results of these Komeen trials indicated that copper levels in sediments were highly variable and that no consistent trends were observed between pre- and post-treatment levels. This finding was largely because of the high ambient copper levels in Delta sediments.

While Komeen efficacy potential appears acceptable, the EDCP at this time will discontinue further research on its use for the EDCP, primarily due to impacts presented in the 2001 EDCP EIR. The EDCP may, at a future point, revisit whether a chelated copper-based herbicide is an appropriate method for control of *Egeria densa* in the Delta.

By removing the Two-Year Komeen Research Trials from the EDCP, the following previously identified unavoidable significant impacts from the 2001 EDCP (Chapter 4) will no longer be applicable:

- Komeen use would result in a violation of Basin Plan standard for copper
- Komeen use conflicts with Basin Plan standards regarding toxicity

- Chelated copper, the active ingredient in Komeen, does not biodegrade and thus could accumulate in the sediments
- Intertidal wetland plants could be adversely impacted or killed due to inundation by Komeen treated water
- Komeen use could cause a temporary decrease in the abundance of aquatic invertebrates
- Komeen exposure could result in direct adverse impacts to fish (due to moderate toxicity)
- Komeen use could adversely impact reptiles/amphibians utilizing channels and channel banks
- Komeen use could adversely impact birds nesting on channel banks.

With removal of the Komeen trials, numerous other impacts also will not be applicable. The entire Chapter 4 will be removed from the EDCP EIR.

Conclusion: Removal of Two-Year Komeen Research Trials will not create new significant environmental effects, and will decrease the significance level of impacts already addressed in the 2001 EDCP EIR and 2003 addendum.

C. Increases in Treatment Intensity

The EDCP will seek opportunities to limit the number of treatments conducted at below labeled rates. In particular, for Sonar treatments, the EDCP will attempt to maximize concentrations so that they equal the maximum label rate over the treatment period.

The EDCP will closely monitor its Sonar applications using FasTEST results. FasTEST results have been modest over the past five years suggesting that the EDCP may not have applied Sonar at concentrations sufficient to realize maximum Fluridone concentrations. This will not be the case for the next five years of the program. The EDCP will make every effort, to increase concentrations of Fluridone throughout the treatment, while never exceeding labeled rates.

Program impacts for the EDCP were assessed assuming that maximum labeled rates would be used so impacts from the program are not expected to change. However, the EDCP believes that it is important to clarify that this new more diligent maximum concentration approach will be used.

Under this maximum label rate approach, both Sonar and Reward application concentrations continue to fall below those that would pose a problem for sensitive fish and wildlife species. The EDCP will continue to conduct representative monitoring (in keeping with regulatory requirements) with the intent of closely monitoring time series post-treatment concentrations to ensure they do not exceed labeled rates.

Conclusion: Increases in treatment intensity will not create new significant environmental effects, and will decrease the significance level of impacts already addressed in the 2001 EDCP EIR and 2003 addendum.

D. Summary of Potential Program Impacts

Exhibit 6-1, beginning on the next page, is an updated checklist of environmental factors potentially affected by the EDCP. This checklist is an evaluation of the EDCP that reflects five years of program operations, extensive environmental monitoring results, newly available program research, and the program changes presented in sections A., B., and C. of this chapter.

Consistent with the format and content of the Environmental Checklist included in the 2001 EDCP EIR (page EC-1), impacts are shown as either: (1) unavoidable or potentially unavoidable significant impact, (2) avoidable significant impact, (3) less than significant impact, (4) no impact. This checklist adds a new "beneficial impact" category and shows how the category changed from the Environmental Checklist presented in the 2001 EDCP EIR.

In comparison to the 2001 EDCP EIR Environmental Checklist, this new Environmental Checklist has the following changes:

- The response to five questions is lowered one impact level
- The response to one questions is lowered two impact levels
- For a total of 13 questions, a beneficial impact has been added
- One question is added (XVI h.). The level of significance of this question was reported as it was stated in the text of the 2001 EDCP EIR (so not a new impact).

In summary, the potential for environmental impacts from the EDCP on an overall basis, are <u>expected to be lower</u> as a result of the reduction in impact level in six responses and the added beneficial impact in 13 responses (for a total of 19 responses changed).

The rationale for the change to each of 19 responses is shown in **Exhibit 6-2**, starting on page 6-20. Findings supporting each of the five remaining responses with unavoidable, or potentially unavoidable impacts, are shown in **Exhibit 6-3**, on page 6-22.

The DBW continues to find that with the program changes proposed for 2006 to 2010, that the EDCP has the potential for unavoidable program impacts. The Mandatory Findings of Significance (Section XVII of the Environmental Checklist), show that environmental impacts from the EDCP are unavoidable/potentially unavoidable (XVII a)), cumulative impacts are unavoidable/potentially unavoidable (XVII b)), and impacts to human beings are avoidable (XVII c)).

Exhibit 6.1 **Page 1 of 9**
***Egeria densa* Control Program**
Comparison of 2006 Environmental Checklist with 2001 Environmental Checklist

ENVIRONMENTAL FACTORS POTENTIALLY AFFECTED

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

[ ] Aesthetics	[**X**] Agriculture Resources	[ ] Air Quality
[**X**] Biological Resources	[ ] Cultural Resources	[ ] Geology/Soils
[**X**] Hazards & Hazardous Materials	[**X**] Hydrology/Water Quality	[ ] Land Use/Planning
[ ] Mineral Resources	[ ] Noise	[ ] Population/Housing
[ ] Public Services	[ ] Recreation	[ ] Transportation/Traffic
[ ] Utilities/Service Systems	[**X**] Mandatory Findings of Significance	

	Unavoidable or Potentially Unavoidable Significant Impact	Avoidable Significant Impact	Less than Significant Impact	No Impact	Beneficial Impact	Change Since 2001 EDCP EIR
I. AESTHETICS — Would the project:						
a) Have a substantial adverse effect on a scenic vista?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
c) Substantially degrade the existing visual character or quality of the site and its surroundings?	[ ]	[ ]	[ ]	[**X**]	[**X**]	*Beneficial impact added*
d) Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
II. AGRICULTURE RESOURCES — In determining whether impacts to agricultural resources are significant environmental effects, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model (1997) prepared by the California Dept. of Conservation as an optional model to use in assessing impacts on agriculture and farmland. Would the project:						
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
c) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
d) Adversely impact agricultural crops or agricultural operations, such as irrigation?	[ ]	[**X**]	[ ]	[ ]	[**X**]	*Beneficial impact added*

Exhibit 6.1 **Page 2 of 9**
***Egeria densa* Control Program**
Comparison of 2006 Environmental Checklist with 2001 Environmental Checklist

	Unavoidable or Potentially Unavoidable Significant Impact	Avoidable Significant Impact	Less than Significant Impact	No Impact	Beneficial Impact	Change Since 2001 EDCP EIR
III. AIR QUALITY — Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:						
a) Conflict with or obstruct implementation of the applicable air quality plan?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors)?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
d) Expose sensitive receptors to substantial pollutant concentrations?	[ ]	[ ]	[**X**]	[ ]	[ ]	No change
e) Create objectionable odors affecting a substantial number of people?	[ ]	[ ]	[**X**]	[ ]	[ ]	No change
IV. BIOLOGICAL RESOURCES — Would the project:						
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	[**X**]	[ ]	[ ]	[ ]	[**X**]	*Beneficial impact added*
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or US Fish and Wildlife Service?	[ ]	[**X**]	[ ]	[ ]	[ ]	*Reduced impact (one level)*
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	[**X**]	[ ]	[ ]	[ ]	[**X**]	*Beneficial impact added*
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?	[**X**]	[ ]	[ ]	[ ]	[**X**]	*Beneficial impact added*
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?	[ ]	[ ]	[**X**]	[ ]	[ ]	*Reduced impact (two levels)*

Exhibit 6.1 **Page 3 of 9**
***Egeria densa* Control Program**
Comparison of 2006 Environmental Checklist with 2001 Environmental Checklist

	Unavoidable or Potentially Unavoidable Significant Impact	Avoidable Significant Impact	Less than Significant Impact	No Impact	Beneficial Impact	Change Since 2001 EDCP EIR
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?	[ ]	[ ]	[ ]	[**X**]	[**X**]	*Beneficial impact added*
V. CULTURAL RESOURCES — Would the project:						
a) Cause a substantial adverse change in the significance of a historical resource as defined in §15064.5?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to §15064.5?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
d) Disturb any human remains, including those interred outside of formal cemeteries?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
VI. GEOLOGY AND SOILS — Would the project:						
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:						
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
ii) Strong seismic ground shaking?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
iii) Seismic-related ground failure, including liquefaction?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
iv) Landslides?	[ ]	[ ]	[ ]	[**X**]	[ ]	*Reduced impact (one level)*
b) Result in substantial soil erosion or the loss of topsoil?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change

Exhibit 6.1 **Page 4 of 9**
Egeria densa **Control Program**
Comparison of 2006 Environmental Checklist with 2001 Environmental Checklist

	Unavoidable or Potentially Unavoidable Significant Impact	Avoidable Significant Impact	Less than Significant Impact	No Impact	Beneficial Impact	Change Since 2001 EDCP EIR
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
VII. HAZARDS AND HAZARDOUS MATERIALS — Would the project:						
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	[ ]	[**X**]	[ ]	[ ]	[ ]	No change
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?	[ ]	[**X**]	[ ]	[ ]	[ ]	No change
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?	[ ]	[ ]	[ ]	[**X**]	[**X**]	*Reduced impact (one level) and beneficial impact added*
h) Expose people or structures to a significant risk of loss, injury or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
VIII. HYDROLOGY AND WATER QUALITY — Would the project:						
a) Violate any water quality standards or waste discharge requirements?	[**X**]	[ ]	[ ]	[ ]	[**X**]	*Beneficial impact added*

Exhibit 6.1
***Egeria densa* Control Program**
Comparison of 2006 Environmental Checklist with 2001 Environmental Checklist

	Unavoidable or Potentially Unavoidable Significant Impact	Avoidable Significant Impact	Less than Significant Impact	No Impact	Beneficial Impact	Change Since 2001 EDCP EIR
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?	[ ]	[ ]	[ ]	[**X**]	[ ]	*Reduced impact (one level)*
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?	[ ]	[ ]	[ ]	[**X**]	[**X**]	*Beneficial impact added*
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?	[ ]	[ ]	[ ]	[**X**]	[ ]	*No change*
f) Otherwise substantially degrade water quality?	[**X**]	[ ]	[ ]	[ ]	[**X**]	*Beneficial impact added*
g) Otherwise substantially degrade drinking water quality?	[ ]	[**X**]	[ ]	[ ]	[ ]	No change
h) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
i) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
j) Expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
k) Inundation by seiche, tsunami, or mudflow?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
IX. LAND USE AND PLANNING — Would the project:						
a) Physically divide an established community?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change

Exhibit 6.1 **Page 6 of 9**
***Egeria densa* Control Program**
Comparison of 2006 Environmental Checklist with 2001 Environmental Checklist

	Unavoidable or Potentially Unavoidable Significant Impact	Avoidable Significant Impact	Less than Significant Impact	No Impact	Beneficial Impact	Change Since 2001 EDCP EIR
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
X. MINERAL RESOURCES — Would the project:						
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	[ ]	[ ]	[ ]	[**X**]	[**X**]	*Beneficial impact added*
b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
XI. NOISE — Would the project result in:						
a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project?	[ ]	[ ]	[**X**]	[ ]	[ ]	No change
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change

Exhibit 6.1
Egeria densa **Control Program**
Comparison of 2006 Environmental Checklist with 2001 Environmental Checklist

	Unavoidable or Potentially Unavoidable Significant Impact	Avoidable Significant Impact	Less than Significant Impact	No Impact	Beneficial Impact	Change Since 2001 EDCP EIR
XII. POPULATION AND HOUSING — Would the project:						
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
XIII. PUBLIC SERVICES — Would the project:						
a) Result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services:						
Fire protection?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
Police protection?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
Schools?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
Parks?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
Other public facilities?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
XIV. RECREATION — Would the project:						
a) Increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	[ ]	[ ]	[ ]	[**X**]	[**X**]	*Beneficial impact added*
b) Include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
c) Would the project adversely impact existing recreational opportunities?	[ ]	[ ]	[**X**]	[ ]	[**X**]	*Beneficial impact added*

Exhibit 6.1
***Egeria densa* Control Program**
Comparison of 2006 Environmental Checklist with 2001 Environmental Checklist

	Unavoidable or Potentially Unavoidable Significant Impact	Avoidable Significant Impact	Less than Significant Impact	No Impact	Beneficial Impact	Change Since 2001 EDCP EIR
XV. TRANSPORTATION/TRAFFIC — Would the project:						
a) Cause an increase in traffic which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections)?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
e) Result in inadequate emergency access?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
f) Result in inadequate parking capacity?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
g) Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
XVI. UTILITIES AND SERVICE SYSTEMS — Would the project:						
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
e) Result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change

Exhibit 6.1 **Page 9 of 9**
***Egeria densa* Control Program**
Comparison of 2006 Environmental Checklist with 2001 Environmental Checklist

	Unavoidable or Potentially Unavoidable Significant Impact	Avoidable Significant Impact	Less than Significant Impact	No Impact	Beneficial Impact	Change Since 2001 EDCP EIR
f) Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?	[ ]	[ ]	[ ]	[**X**]	[ ]	No change
g) Comply with federal, state, and local statutes and regulations related to solid waste?	[ ]	[ ]	[ ]	[**X**]	[ ]	*Reduced impact (one level)*
h) Result in problems for local or regional water utility intake pumps?	[ ]	[**X**]	[ ]	[ ]	[ ]	*Added category, but described in 2001 EDCP EIR (no change to level)*
XVII. MANDATORY FINDINGS OF SIGNIFICANCE — Does the project:						
a) Have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	[**X**]	[ ]	[ ]	[ ]	[ ]	No change
b) Have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?	[**X**]	[ ]	[ ]	[ ]	[ ]	No change
c) Have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?	[ ]	[**X**]	[ ]	[ ]	[ ]	No change

Exhibit 6.2 **Page 1 of 2**
***Egeria densa* Control Program**
Explanation of Changes to *Egeria densa* Control Program EIR Environmental Checklist

No.	Environmental Checklist Reference	Change since 2001 EDCP EIR	Rationale
1	Aesthetics I c) - Substantially degrade the existing visual character or quality of the site and its surroundings?	Beneficial impact added	Removal of *Egeria densa* through EDCP efforts could improve the appearance of Delta waterways.
2	Agricultural Resources II d) – Adversely impact agricultural crops or agricultural operations, such as irrigation?	Beneficial impact added	Removal of *Egeria densa* through EDCP efforts could limit agricultural pumps from clogging.
3	Biological Resources IV a) – Have a substantial adverse effect, either directly or through habitat modifications on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Fish and Game or U.S. Fish and Wildlife Service?	Beneficial impact added	Removal of *Egeria densa* through EDCP efforts could improve the habitat used by sensitive fish species (through regrowth of native plant species, improving navigation channels, and freeing up shallow water habitat for spawning opportunities).
4	Biological Resources IV b) - Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or US Fish and Wildlife Service?	Reduced impact (one level to "Avoidable Impact")	Removal of mechanical harvesting operations (including staging and maneuvering on channel banks) reduces the level of significance of this impact. During 2001-05, the EDCP did not identify sensitive riparian species in the treatment area (e.g., Northern California black walnut).
5	Biological Resources IV c) - Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	Beneficial impact added	Removal of *Egeria densa* in the Delta through EDCP efforts could indirectly limit its spread to federally protected wetland areas.
6	Biological Resources IV d) - Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?	Beneficial impact added	Removal of *Egeria densa* through EDCP efforts could improve the habitat used by sensitive fish species (through re-growth of native aquatic plant species, improving navigation channels, and freeing up shallow water habitat for spawning opportunities).
7	Biological Resources IV e) - Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?	Reduced impact (two levels to "Less than Significant Impact")	Based on five years of operations, the EDCP has determined that aquatic herbicides did not have a significant effect on local policies or ordinances protecting biological resources.
8	Biological Resources IV f) - Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?	Beneficial impact added	Removal of *Egeria densa* through EDCP efforts could positively influence several State of California conservation efforts including the Franks Tract Project, CALFED/DWR efforts to enhance Delta shallow water habitat, and State efforts to stop pelagic fish species declines.
9	Geology and Soils VI a) iv) - Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving: Landslides?	Reduced impact (one level to "No Impact")	The landslide potential was originally associated with mechanical harvesting which has been removed from the EDCP.

Exhibit 6.2 **Page 2 of 2**
***Egeria densa* Control Program**
Explanation of Changes to *Egeria densa* Control Program EIR Environmental Checklist

No.	Environmental Checklist Reference	Change since 2001 EDCP EIR	Rationale
10	Hazards and Hazardous Materials VII g) - Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?	Reduced impact (one level to "No Impact") and beneficial impact added	The EDCP will not impact an adopted emergency response plan or emergency evacuation plan. Removal of *Egeria densa* could improve access to waterways used by emergency boats.
11	Hydrology and Water Quality VIII a) - Violate any water quality standards or waste discharge requirements?	Beneficial impact added	Removal of *Egeria densa* through EDCP efforts could improve Delta water quality so that measurements are more closely aligned with standards (e.g., dissolved oxygen).
12	Hydrology and Water Quality VIII c) - Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?	Reduced impact (one level to "No Impact")	Based on five years of operations, the EDCP has determined that it did not have a negative affect on existing drainage patterns.
13	Hydrology and Water Quality VIII d) - Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?	Beneficial impact added	Removal of *Egeria densa* through EDCP efforts could free up currently clogged waterways. Removal of *Egeria densa,* which acts like a sponge for sediment/silt collection and build up, could improve Delta channel flows and overall hydrology.
14	Hydrology and Water Quality VIII f) - Otherwise substantially degrade water quality?	Beneficial impact added	Removal of *Egeria densa* through EDCP efforts could improve Delta water quality.
15	Mineral Resources X a) - Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	Beneficial impact added	Removal of *Egeria densa* through control efforts could improve boat gasoline consumption efficiencies and agricultural and State Water Project pumping efficiencies.
16	Recreation XIV a) - Increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	Beneficial impact added	Removal of *Egeria densa* through control efforts could limit deterioration of boat launching, boat storage, and marina facilities.
17	Recreation XIV c) - Would the project adversely impact existing recreational opportunities?	Beneficial impact added	Removal of *Egeria densa* through control efforts could improve recreational opportunities, and the safety of these activities, by opening up clogged waterways (e.g., for swimming, boating, and fishing).
18	Utilities and Service Systems XVI g) - Comply with federal, state, and local statutes and regulations related to solid waste?	Reduced impact (one level to "No Impact")	Solid waste issues were associated with disposing of mechanically harvested *Egeria densa*. Mechanical harvesting was removed from the EDCP.
19	Utilities and Service Systems XVI h) - Result in problems for local or regional water utility intake pumps?	Added category ("Avoidable Significant Impact"), but described in 2001 EDCP EIR (no change to level)	There is the potential that increases in floating debris, following an aquatic herbicide application, could negatively affect some water utilities by temporarily clogging pumps, though the impact is expected to be avoidable through communication with utilities as to when treatments occur.

Exhibit 6.3
***Egeria densa* Control Program**
Reason for Questions Answered As “Unavoidable or Potentially Unavoidable Significant Impact”
***Egeria densa* Control Program EIR Environmental Checklist**

No.	Environmental Checklist Question	Findings Supporting Conclusions
1	Biological Resources IV a) – Have a substantial adverse effect, either directly or through habitat modifications on any species identified as a candidate, sensitive, or special status species in local or regional plants, policies, or regulations, or by the California Fish and Game or U.S. Fish and Wildlife Service?	■ Indirect impact to special status fish due to reductions in abundance of aquatic invertebrate prey base following Reward (Diquat) treatment. ■ Loss of emergent and submergent intertidal wetland plants, including special status plants, due to Reward (Diquat) or Sonar (Fluridone) contact.
2	Biological Resources IV c) - Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	■ Direct impact due to decrease in abundance of aquatic invertebrates due to Reward (Diquat) contact.
3	Biological Resources IV d) - Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?	■ Indirect impact to special status fish due to reductions in abundance of aquatic invertebrate prey base following Reward (Diquat) treatment. ■ Loss of emergent and submergent intertidal wetland plants, including special status plants, due to Reward (Diquat) or Sonar (Fluridone) contact.
4	Hydrology and Water Quality VIII a) - Violate any water quality standards or waste discharge requirements?	■ Reward (Diquat) and Sonar (Fluridone) use involve input of a toxic substance into the water column and conflict with Basin Plan standards. The Basin Plan states that Delta waters shall “remain free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life.”
5	Hydrology and Water Quality VIII f) - Otherwise substantially degrade water quality?	■ Reward (Diquat) and Sonar (Fluridone) use involve input of a toxic substance into the water column.

Appendices

Appendix A
EDCP CEQA Addendum Assessment

The California Department of Boating and Waterways (DBW) has operated the *Egeria densa* Control Program (EDCP) in the Sacramento-San Joaquin Delta, and its tributaries, since 2001. The DBW prepared an Environmental Impact Report (EIR) in 2001 using only available information at the time. Based on five years of program operations, and changes to the program that have occurred since inception, the DBW has prepared this Second Addendum to update its environmental documentation.

This appendix details factors the DBW used in deciding to prepare a Second Addendum to the 2001 EDCP. This appendix supports the DBW's decision to prepare a Second Addendum to the 2001 EDCP EIR, and a five-year program update report in support of the Second Addendum.

The remainder of this appendix is organized into the following three (3) sections:

A. Environmental Impact Report Background
B. Context for Second Addendum to 2001 EDCP EIR
C. CEQA Guidelines for Second Addendum.

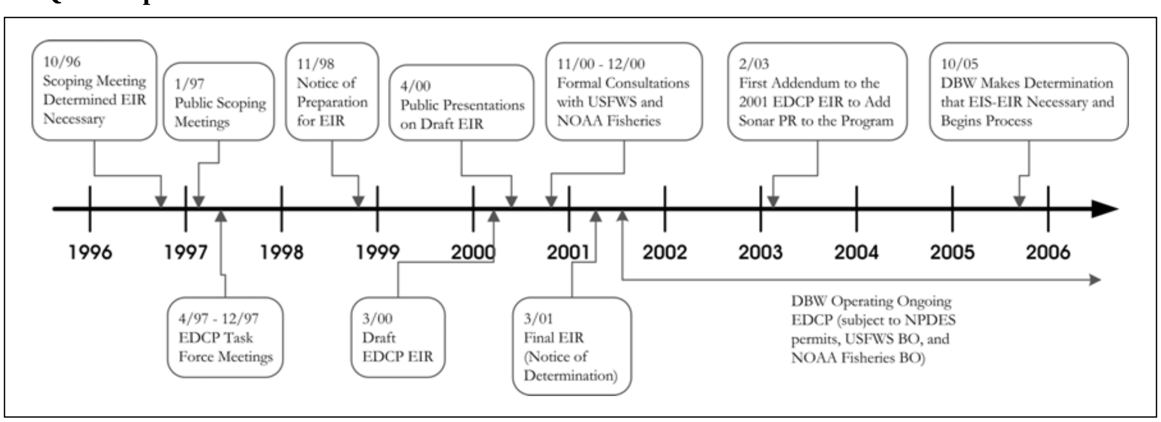
A. Environmental Impact Report Background

Figure 1.1, below, shows an overview of the history of CEQA compliance activities for the EDCP. The DBW determined that an EIR was necessary for the EDCP in October 1996.

EDCP stakeholders include environmental organizations; and Delta residents, business owners, and recreational users. In February 1997, the DBW held several public meetings to inform these stakeholders of the proposed EDCP and to obtain initial input from Delta residents and property owners regarding the level of *Egeria densa* infestation in their localities. Three additional public outreach meetings were held in April 1998, where the DBW provided background information on the CEQA process, and an overview of the EDCP.

The DBW began a process to prepare an EDCP Environmental Impact Report an 1998. The DBW issued a Notice of Preparation to prepare an EDCP EIR on

Figure 1.1
History of the *Egeria densa* Control Program CEQA Compliance Activities



November 11, 1998. This Notice of Preparation was sent to the State Clearinghouse at the State of California Office of Planning and Research.

The DBW submitted a draft of the EDCP EIR to the State Clearinghouse in March 2000. The draft EDCP EIR was released at that time for a 45-day public review and comment period between April 10, 2000 and May 24, 2000. The draft was circulated to fourteen regulatory agencies and departments. Other organizations also received copies of the draft EDCP EIR.

The EDCP made five public presentations in April 2000 to various stakeholders to review the draft EDCP EIR and to obtain public comment. Presentations were made in April 2000 at the following five locations:

- Sacramento on 4/20/2000
- Antioch on 4/24/2000
- Walnut Grove on 4/26/2000
- Stockton on 4/27/2000
- Discovery Bay on 4/27/2000.

The EDCP received nineteen comment letters following the public review and input period. Responses to these comments were included in Volume III, of the 2001 EDCP EIR.

In November and December 2000, the EDCP conducted formal consultations with the United States Fish and Wildlife Service and National Marine Fisheries Service. Topics addressed during these EDCP consultations included: (1) dissolved oxygen, (2) toxicity to fish, (3) water quality, (4) potential for copper to remain in Delta sediments (Komeen Trials), (5) aquatic invertebrate prey, and (6) cumulative project impacts.

The DBW, as the lead agency for the EDCP, considered all information contained in the 2001 EDCP EIR. The DBW certified the 2001 EDCP on March 2, 2001. The DBW filed a Notice of Determination with the State of California Office of Planning and Research on March 2, 2001. The 2001 EDCP EIR included the following four volumes:

- Volume I – Environmental Impact Report (Chapters 1-8 and Appendices)
- Volume II – Research Trial Reports
- Volume III – Response to Comments
- Volume IV – Findings of Fact and Statement of Overriding Considerations.

The DBW posted copies of the EIR on its website at www.dbw.ca.gov for public access since 2001. The DBW retained a complete administrative record of the EIR process and this is available at DBW offices located on 2000 Evergreen Street, Suite 100, Sacramento, California 95815.

At the time the 2001 EDCP EIR was prepared, the EDCP was an entirely new program. Treatment sites and control methods were selected based on available site acreage estimates, *Egeria densa* infestation estimates, limited research trials on control methods used in the Delta, and other estimates and projections.

B. Context for Second Addendum to 2001 EDCP EIR

Many aspects of the EDCP have changed since 2001 based on five years of actual operations. The DBW desired that the 2001 EDCP EIR be updated to more accurately describe current operational realities and practices.

In 2001, there were limited available best practices for operating a control program for *Egeria densa* in a complex tidally influenced Delta ecosystem. The EDCP represents a unique program requiring continuous adaptive management and a degree of trial and error research. As expected, there have been differences between initial program plans and actual operating practices and results. Some provisions stated in the 2001 EDCP EIR were too narrow or limiting, while other provisions have been replaced by the extensive permit conditions required by regulatory agencies.

The March 2001 EDCP EIR indicated:

> **"should the DBW determine after five years that the EDCP is meeting its intended objectives, the DBW would prepare supplemental environmental documentation, in accordance with CEQA requirements, to continue EDCP activities." [Section 1.4.1, page 1-9]**

The DBW has responded to this five-year requirement through this Second Addendum.

Since 2001, the EDCP has had five years of actual operational experience as a basis to plan future treatment procedures and practices. There are five years of water quality, chemical residue, and toxicity monitoring data on which to assess EDCP environmental impacts.

Changes in the EDCP since 2001 include:

- New biological opinions and limitations imposed by the USFWS and NOAA Fisheries
- New NPDES permit requirements, limitations, and monitoring program requirements
- Changes in quantities and locations of *Egeria densa* in the Delta
- Changes in treatment site priorities
- Differences in how treatment sites are identified and characterized
- Newly registered variation of the aquatic herbicide Sonar (Fluridone) called Sonar Q
- Measured environmental impacts of aquatic herbicides Reward (Diquat) and Sonar (Fluridone)
- Adaptive management experience based on results of special scientific studies, both sponsored by the DBW, and available from external sources
- Information on the efficacy of EDCP treatment methods
- Removal of the two-year Komeen trials
- Removal of mechanical harvesting
- Removal of Sonar Slow Release Pellet (SRP).

C. CEQA Guidelines for Second Addendum

The DBW has fully complied with CEQA requirements by completing the 2001 EDCP EIR. The DBW also prepared a First Addendum to the 2001 EDCP EIR in February 2003 to incorporate the use of Sonar Precision Release as a treatment method and to identify new approaches for combination treatments.

Below is an assessment of whether a subsequent, supplemental, or an addendum to the EIR is the appropriate document at this time to use to update the 2001 EDCP EIR.

1. Assessment of Subsequent EIR

Guidelines for CEQA indicate that no subsequent EIR shall be prepared for a project unless:

- Substantial changes are made that will require major revisions of the previous EIR due to the *involvement of new significant environmental effects* or a *substantial increase in the severity of previously identified effects*

  (not true at this time)

- Substantial changes occur with respect to the circumstances under which a project is undertaken which will require major revisions of a previous EIR due to the *involvement of new significant environmental effects* or a *substantial increase in the severity of previously identified effects*

  (not true at this time)

- New information of substantial importance which was not known or could not have been known with the exercise of reasonable diligence at the time the previous EIR was certified as completed shows:
  - ❑ The project will have one or more significant effects not discussed in the previous EIR
  - ❑ Significant effects previously examined will be substantially more severe that shown in the previous EIR
  - ❑ Mitigation measures or alternatives previously found not feasible would be feasible
  - ❑ Mitigation measures or alternatives which are considerably different from those analyzed in the previous EIR would substantially reduce one or more significant effects on the environment, but the project proponents decline to adopt the mitigation measure or alternative

  (none of these are true at this time).

Based on a current review of the potential environmental impacts, changes proposed by the DBW for the EDCP are not expected to increase the significance of the environmental impacts previously presented in 2001 and are not expected to result in new significant environmental impacts. The changes expected are likely to reduce the level of significance of environmental impacts, on an overall basis, from that previously presented in the 2001 EDCP EIR. Based on these factors, <u>a subsequent EIR is not required at this time.</u>

2. Assessment of Supplement to an EIR

Guidelines for CEQA indicate that the Lead Agency may prepare a Supplement to an EIR versus a Subsequent EIR if:

- Substantial changes are made that will require major revisions of the previous EIR due to the involvement of new significant environmental effects or a substantial increase in the severity of previously identified effects

  (not true at this time)

- Substantial changes occur with respect to the circumstances under which a project is undertaken which will require major revisions of a previous EIR due to the involvement of new significant environmental effects or a substantial increase in the severity of previously identified effects

(not true at this time)

- New information of substantial importance which was not known or could not have been known with the exercise of reasonable diligence at the time the previous EIR was certified as completed shows:
  - ❑ The project will have one or more significant effects not discussed in the previous EIR
  - ❑ Significant effects previously examined will be substantially more severe than shown in the previous EIR
  - ❑ Mitigation measures or alternatives previously found not feasible would be feasible
  - ❑ Mitigation measures or alternatives which are considerably different from those analyzed in the previous EIR would substantially reduce one or more significant effects on the environment, but the project proponents decline to adopt the mitigation measure or alternative.

  (none of these are true at this time)

  - And only minor additions or changes would be necessary to make the previous EIR adequately apply to the project in the changed situation

    (not true at this time).

Based on a review of the potential environmental impacts, changes proposed by the DBW for the EDCP are not expected to increase the significance of the environmental impacts previously presented in 2001 and are not expected to result in new significant environmental impacts. The changes expected are likely to reduce the level of significance of environmental impacts, on an overall basis, from that previously presented in the 2001 EDCP EIR. Based on these factors, <u>a supplemental EIR is not required at this time</u>.

3. Assessment of Amendment to EIR

An Addendum is appropriate to use in cases where changes or additions are necessary, but none of the conditions stated for a Subsequent or Supplemental EIR exist. Based on responses to 1. and 2. above, none of the conditions for a Subsequent or Supplemental EIR exist and <u>an Addendum is appropriate at this time to reflect the changes proposed by the DBW for the EDCP</u>.

An Addendum requires an explanation as to why a Subsequent or Supplemental EIR was not prepared. This explanation must be supported by "substantial evidence." Consequently, in support of this Addendum, the DBW has included a Five-Year Program Review and Future Operations Plan in this Addendum documentation. The Five-Year Program Review and Future Operations Plan provides evidence that environmental impacts will not increase as a result of changes proposed to the program.

Appendix B
EDCP DBW Sponsored Research Reports

This appendix presents an annotated bibliography of sixteen (16) different scientific research reports either directly or indirectly commissioned/sponsored by the DBW for the EDCP over the eight years from 1997 to 2005.

A. 2005

Report 1 – "Fluridone (4AS) Dissipation During Typical Applications of Sonar (4AS)"

Lars W.J. Anderson, Ph.D., USDA-ARS, Exotic and Invasive Weed Research

Key Findings/Recommendations

- Maximum concentrations of Sonar (fluridone) ranged from 20 to 76 ppb in the upper water column (0.5 to 1 ft. deep) within 30 to 60 minutes post application.
- Most maxima were 20 to 50 ppb in the upper one foot of water.
- Maximum concentrations in upper one foot of water lasted between one and 1.5 hours.
- Maximum concentrations within bottom 0.5 foot of water column ranged from one to 10 ppb.
- Mixing of fluridone injected into the upper surface with the rest of the water began to occur between 60 and 120 minutes and was complete in most cases 24 hours post application.

Report 2 – "Residue of Fluridone and Diquat Dibromide in Sediment from the Sacramento-San Joaquin Delta, California, 2002-2005"

Robert C. Hosea, California Department of Fish and Game

Key Findings/Recommendations

- Results of sediment analyses indicate treatment site mean concentrations of fluridone range from below the detection limit to 1,951 parts per billion (ppb) dry weight.
- Results of sediment analyses indicate treatment site mean concentrations of diquat range from below the detection limit to 596.6 ppb dry weight.
- Residues of fluridone and diquat dibromide are persisting in Delta sediments between treatment seasons.
- Organic material and different types of clay particles can influence the rate that fluridone is released from individual pellets and thus, the half life in the sediment.
- The higher the organic content of the sediment, the slower fluridone is released from pellets, resulting in higher than concentrations of fluridone in sediment than expected.
- Neither herbicide appears to be approaching a concentration that is a major concern.

Report 3 – "Residue of Fluridone in Chinook Salmon Smolts from the Sacramento-San Joaquin Delta, California, 2005"

Robert C. Hosea, California Department of Fish and Game

Key Findings/Recommendations

- Based on Chinook salmon smolts collected from (1) Chipps Island, (2) Sherwood Harbor, and (3) Antioch, it was concluded that neither fluridone (>10 ppb) nor 4- hydroxy fluridone (> 10 ppb) accumulated in tissues of salmon smolts during their outward migration through the Delta.

B. 2004

Report 4 – "Dissipation of Copper in Water and Copper Uptake in *Egeria densa* Following Applications of Komeen Herbicide"

Lars W.J. Anderson, Ph.D., USDA-ARS, Exotic and Invasive Weed Research

Key Findings/Recommendations

- The impact of Komeen applications on Delta water quality, sediment, and *Egeria densa* were measured during applications at Frank's Tract and Sandmound Slough in 2002 and 2003.
- Maximum copper levels in the water occur approximately 2 hours post-application and by 24 hours post application, copper levels in the water return to pre-application concentrations.
- Copper levels in *Egeria densa* increase over the 24 hour post-application period, but appear to level or plateau by 48 hours.
- Copper levels in sediments were highly variable at all sites and no consistent trends were observed between pre and post-treatment samples, nor between in-plot and adjacent samples.
- There is continual seasonal loading of copper in sediments with naturally occurring copper transported down and within Delta waters. This results in highly heterogeneous copper levels.
- Pre-treatment copper levels were at or near levels of many of the post-treatment results.
- Copper levels in water and plants, and partitioning of copper, show that treatments are spatially and temporally limited to boundaries of treated sites.
- There were no signs of adverse impacts to fish and wildlife during two year trials (2002 and 2003).
- Point-sampling and hydroacoustical scanning showed Komeen reduced plant height and density of *Egeria densa* but that recovery occurred within 60 days after treatment in some sites.

Report 5 – "An Evaluation of Potential Effects of Fluridone on Pacific Salmon in the California Delta"

Clifford Habig, Ph.D.

Key Findings/Recommendations

- Evidence from this study suggests that migrating salmon will not be adversely impacted based on EDCP fluridone use.
- No long term effects are expected due to an estimated 50-fold margin of safety between concentrations measured in EDCP monitoring and no-observed effect or lowest-observed effect concentrations.
- No adverse effects on smolts are expected during physiological adaptation to a higher saline environment when exposed to fluridone (based on seawater challenge tests).
- All available data indicated that Fluridone, as used in the EDCP, would not be expected to adversely impact migrating populations of salmon, particularly with a short-term exposure.

Report 6 – "Acute Oral and Dermal Toxicity of Aquatic Herbicides and a Surfactant to Garter Snakes"

Robert C. Hosea, California Department of Fish and Game

Key Findings/Recommendations

- Based on the results of the oral and dermal toxicity tests on the common garter snake *(Thamnophis sirtalis)*, the herbicides used by the EDCP are not acutely toxic to the Giant Garter Snake *(Thamnophis gigas).*

Report 7 – "Diquat Dissipation During Typical Applications for Control of *Egeria densa"*

Lars W.J. Anderson, USDA-ARS, Exotic and Invasive Weed Research

Key Findings/Recommendations

- Mixing of Reward (diquat) injected into the upper surface with the rest of the water column began to occur between 7.5 minutes and 30 minutes after application, and was complete in most cases between 60 and 120 minutes post application.
- Most maximum concentrations in the upper one foot of water ranged from 20 to 50 ppb, and the durations of maximum diquat concentrations in the upper one foot lasted from 15 to 30 minutes post application.
- Maximum concentrations of Reward (diquat) held between 0.5 and 2 feet of water.
- The data from this study suggests that maximum diquat exposures are transient (less than 60 minutes). The levels rapidly decline throughout the water column as a result of lateral mixing and turbulence created by tidal flows.

Report 8 – "Chronic Toxicities of Herbicides Used to Control Water Hyacinth and Brazilian Elodea on Noenate Cladoceran and Larval Fathead Minnow"

Frank Riley and Sandra Finlayson, California Department of Fish and Game

Key Findings/Recommendations

- The Reward (diquat) LC50 values were found to be:

- Reward 96-h LC50 for C. dubia, cladocerans – 0.14 mg/L, or 140 ppb
- Reward 7-d LC50 for C. dubia, cladocerans – 0.078 mg/L, or 78 ppb
- Reward 7-d MATC for C. dubia, cladocerans – 0.015 mg/L, or 15 ppb
- Reward 96-h LC50 for larval fathead minnow – 0.43 mg/L, or 430 ppb
- Reward 7-d LC50 for larval fathead minnow – 0.40 mg/L, or 400 ppb
- Reward 7-d MATC for larval fathead minnow – 0.37 mg/L, or 370 ppb

- Biological effect levels for cladocerans are lower than concentrations in the environment following Reward (diquat) applications, suggesting impacts to sensitive invertebrates.
- The Sonar (fluridone) LC50 values were found to be:
  - Sonar 96-h LC50 for C. dubia, cladocerans – 7.2 mg/L, or 7,200 ppb
  - Sonar 7-d LC50 for C. dubia, cladocerans – 6.9 mg/L, or 6,900 ppb
  - Sonar 7-d MATC for C. dubia, cladocerans – 3.35 mg/L, or 3,350 ppb
  - Sonar 96-h LC50 for larval fathead minnow – 5.7 mg/L, or 5,700 ppb
  - Sonar 7-d LC50 for larval fathead minnow – 3.6 mg/L, or 3,600 ppb
  - Sonar 7-d MATC for larval fathead – 1.06 mg/L, or 10,600 ppb
- Biological effect levels for both species are several orders of magnitude higher than concentrations in the environment following Sonar (fluridone) applications, suggesting minimal impacts to fish and wildlife.

Report 9 – "Acute Toxicities of Herbicides Used to Control Water Hyacinth and Brazilian Elodea on Larval Delta Smelt and Sacramento Splittail"

Frank Riley and Sandra Finlayson, California Department of Fish and Game

Key Findings/Recommendations

- For Reward (diquat) applications, the target application rates (0.47 mg/L) are higher than the LC50 value for the fathead minnow and approach the LC50 for Delta Smelt.
- The Reward (diquat) LC50 values for each species were found to be:
  - Reward LC50 for larval Delta smelt – 1.1 mg/L, or 1,100 ppb
  - Reward 96-h LC50 for larval fathead minnow – 0.43 mg/L, or 430 ppb
  - Reward 7-d LC50 for larval fathead minnow – 0.40 mg/L, or 400 ppb
  - Reward LC50 for larval Sacramento splittail – 3.7 mg/L, or 3,700 ppb

A suggested Reward mitigation is not to use Reward (diquat) when larval fish are present during spring time.

- Sonar LC50 values for the three fish species are several orders of magnitude higher than detected concentrations in the Delta. It is unlikely acute toxicity will occur.
- The Sonar (fluridone) LC50 values for each species were found to be:
  - Sonar LC50 for larval Delta smelt – 6.1 mg/L, or 6,100 ppb
  - Sonar 96-h LC50 for larval fathead minnow – 5.7 mg/L, or 5,700 ppb
  - Sonar 7-d LC50 for larval fathead minnow – 3.6 mg/L, or 3,600 ppb
  - Sonar LC50 for larval Sacramento splittail – 4.8 mg/L, or 4,800 ppb

- Sonar should be further examined for sub-lethal effects due to its slow break down and because repeated treatments in the same location occur from use of this herbicide.

C. 2003

Report 10 – "Experimental Studies of the Effects of Temperature, Salinity and Light Intensity of Growth of *Egeria densa"*

Steven Obrebski and Robin Rooth, Romberg Tiburon Center, San Francisco State University

Key Findings/Recommendations

- Both *Egeria* root formation and growth decline were observed with increases in salinity levels (0, 3, and 6 parts per thousand were tested). Abrupt changes in *Egeria* density in the western Delta at the periphery of the distribution of the plant are likely attributable to salinity excursions.

- Temperature variations may affect *Egeria* growth more than light intensity.
- Interactions between temperature, light intensity, and salinity are not statistically significant for *Egeria* growth.
- Sensitivity of *Egeria* growth as a result of temperature and light intensity interactions was not determined due to problems with experimental methods.

Report 11 – *Ceriodaphnia dubia* (water flea) Static Definitive Chronic Toxicity Text Data (7-day) for exposure to various aquatic herbicides

California Department of Fish and Game, Aquatic Toxicology Laboratory

Key Findings/Recommendations

- Reward (diquat) 96-hour LC50 value for *C. dubia* (water flea) was determined to be 0.14 mg/L (ppm), or 140 ppb
- Reward (diquat) 7-day LC50 value for *C. dubia* (water flea) was determined to be 0.078 mg/L (ppm), or 78 ppb
- Reward (diquat) 7-day No Observable Effect Concentration (NOEC) value for *C. dubia* (water flea) was determined to be 0.012 mg/L (ppm), or 12 ppb
- Reward (diquat) 7-day Lowest Observable Effect Concentration (LOEC) value for *C. dubia* (water flea) was determined to be 0.019 mg/L (ppm), or 19 ppb
- Sonar (fluridone) 96-hour LC50 value for *C. dubia* (water flea) was determined to be 7.2 mg/L (ppm), or 7,200 ppb
- Sonar (fluridone) 7-day LC50 value for *C. dubia* (water flea) was determined to be 6.9 mg/L (ppm), or 6,900 ppb
- Sonar (fluridone) 7-day NOEC value for *C. dubia* (water flea) was determined to be 2.43 mg/L (ppm), or 2,430 ppb
- Sonar (fluridone) 7-day LOEC value for *C. dubia* (water flea) was determined to be 4.6 mg/L (ppm), or 4,600 ppb

Report 12 – *Pogonichthys macrolepidotus* (Sacramento splittail) Static Definitive Acute Toxicity Text Data (96-hour) for exposure to various aquatic herbicides

California Department of Fish and Game, Aquatic Toxicology Laboratory

Key Findings/Recommendations

- Reward (Diquat) 96-hour LC50 value for *Pogonichthys macrolepidotus* (Sacramento splittail) was determined to be 3.7 mg/L (ppm), or 3,700 ppb
- Reward (Diquat) 96-hour NOEC value for *Pogonichthys macrolepidotus* (Sacramento splittail) was determined to be 2.3 mg/L (ppm), or 2,300 ppb
- Reward (Diquat) 96-hour LOEC value for *Pogonichthys macrolepidotus* (Sacramento splittail) was determined to be 4.6 mg/L (ppm), or 4,600 ppb
- Sonar (Fluridone) 96-hour LC50 value for *Pogonichthys macrolepidotus* (Sacramento splittail) was determined to be 4.8 mg/L (ppm), or 4,800 ppb
- Sonar (Fluridone) 96-hour NOEC value for *Pogonichthys macrolepidotus* (Sacramento splittail) was determined to be 1.3 mg/L (ppm), or 1,300 ppb
- Sonar (Fluridone) 96-hour LOEC value for *Pogonichthys macrolepidotus* (Sacramento splittail) was determined to be 2.8 mg/L (ppm), or 2,800 ppb

D. 1997/1998

Report 13 – "Dissipation and Movement of Sonar, and Komeen Following Typical Applications for Control of *Egeria densa* in the Sacramento/San Joaquin Delta and Production Viability of *E. densa* Fragments Following Mechanical Harvesting"

Lars W.J. Anderson USDA-Agricultural Research Service, Aquatic Weed Control Research Laboratory, Invasive Weed Research Unit-U.C. Davis, with Technical Assistance from Mr. Chris Pirosko, Ms. Debe Holmberg, Dr. Doreen Gee, and Rob Duvall

Key Findings/Recommendations

- Dissipation and movement of Rhodamine WT dye provides a good approximation of specific tidal-flow directions and approximate dilution rates.
- Nearly 100 percent of collected *Egeria* fragments were capable of producing numerous lateral shoots and roots.
- High dilution rates at most sites necessitate frequent, split applications of Sonar, whether liquid or pellet formulation is used.
- Early spring applications of Sonar provide better uptake and efficacy.
- Sonar may be more effective when used in conjunction with mechanical harvesting or other herbicides.
- Komeen remained in 3 to 5-acre test plots at efficacious concentrations for approximately 6 to 9 hours post-application.

Report 14 – "Effects of Control Methods on the *Egeria densa* Community"

Steve Obrebski, Terry Irwin, and Jennifer Pearson; Romberg Tiburon Center, San Francisco State University

Key Findings/Recommendations

- Maximum *Egeria* densities occur in late April and June, declining thereafter
- Data on treatment efficacy, collected at three trial locations, suggest that the chemical Sonar was the least effective in reducing *Egeria* biomass.
- At two sites, Owl Harbor and Sandmound Slough, the copper based herbicide, Komeen was the most effective control method.
- At one site within White Slough, mechanical harvesting produced the best results while at another site within White Slough, Reward was most effective.
- No species found were on the list of rate/endangered species in California.

Report 15 – "Fishes Associated with Submersed Aquatic Vegetation, *Egeria densa*, in the Sacramento -San Joaquin Delta in 1998 as Sampled by Pop Nets"

Michael F. McGowan, Ph.D., Romberg Tiburon Center, San Francisco State University

Key Findings/Recommendations

- There was no statistically significant difference in fish abundance between control and treatment locations.
- No threatened, endangered, or special status fish or aquatic invertebrate species were collected in samples.
- There were 13 species of fish collected from multiple locations from within the *Egeria*. Only one of the species, the Prickly Sculpin, is native while the others are considered resident but non-native members of the Delta fish community.
- Some differences in mean abundance of fish were noted among treatment types and sampling dates. Fish abundance was often slightly higher at control locations than at treatment locations; however, the differences were generally not statistically significant. No evidence of a large negative impact on species abundance was noted.

Report 16 – "Persistence of Diquat in Three Field Environments"

Sylvia J. Richman and S. Mark Lee

Key Findings/Recommendations

- Substantial mixing of diquat occurred within one hour of application
- Under favorable conditions, concentrations remained at 30 to 75 percent of initial levels after three hours and remained significant after six hours
- In some cases, diquat sank and provided higher concentrations in the bottom of the water column after six hours
- The lifetime of diquat in a tidal environment is shorter than that

observed for closed ponds. Differences in diquat levels could partially be explained by different tidal cycles during application.

- The optimal time to apply diquat is 2 to 3 hours before slack tide, which corresponds with low tide.
- Spraying at the optimal time may help control the variability between individual spray events at the same location, but other factors such as, density of vegetation, amount of silt, and wind velocity affect diquat applications.

Appendix C

Sonar Q Label and Material Safety Data Sheet

Sonar Q Label
Page 1 of 7

Specimen Label

Sonar* Q
Aquatic Herbicide

SePRO

An herbicide for management of aquatic vegetation in fresh water ponds, lakes, reservoirs, potable water sources, drainage canals, irrigation canals and rivers.

Active Ingredient
Fluridone:
1-methyl-3-phenyl-5-[3-(trifluoromethyl)phenyl]
-4(1*H*)-pyridinone 5.0%
Other Ingredients 95.5%
TOTAL.. 100.0%
Contains 0.05 pounds active ingredient per pound.

Keep Out of Reach of Children
CAUTION / PRECAUCIÓN

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

Precautionary Statements

Hazards to Humans and Domestic Animals

Harmful if Swallowed, Absorbed Through Skin, or if Inhaled

Avoid breathing of dust or contact with skin, eyes or clothing. Wash thoroughly with soap and water after handling. Remove contaminated clothing and wash before reuse.

ENVIRONMENTAL HAZARDS

Follow use directions carefully so as to minimize adverse effects on non-target organisms. In order to avoid impact on threatened or endangered aquatic plant or animal species, users must consult their State Fish and Game Agency or the U.S. Fish and Wildlife Service before making applications.

Trees and shrubs growing in water treated with Sonar Q may occasionally develop chlorosis. Do not apply in tidewater/brackish water.

Lowest rates should be used in shallow areas where the water depth is considerably less than the average depth of the entire treatment site, for example, shallow shoreline areas.

First Aid	
If in eyes	• Hold eye open and rinse slowly and gently with water for 15 - 20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. • Call poison control center or doctor for treatment advice.
If on skin or clothing	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15 – 20 minutes. • Call a poison control center or doctor for treatment advice.
If swallowed	• Call a poison control center or doctor immediately for treatment advice. • Have person sip a glass of water if able to swallow. • Do not induce vomiting unless told to do so by a poison control center or doctor. • Do not give anything by mouth to an unconscious person.
If inhaled	• Move person to fresh air. • If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. • Call a poison control center or doctor for further treatment advice.

EMERGENCY NUMBER
Have the product container or label with you when calling a poison control center or doctor, or going for treatment. In case of emergency endangering health or the environment involving this product, call **INFOTRAC** at **1-800-535-5053**.

Refer to inside of label booklet for additional precautionary information and Directions for Use.

Notice: Read the entire label before using. Use only according to label directions. **Before buying or using this product, read "Warranty Disclaimer", "Inherent Risks of Use"** and **"Limitation of Remedies"** inside label booklet.

For product information, visit our web site at **www.sepro.com**.

EPA Reg. No. 67690-3
FPL 060206

*Trademark of SePRO Corporation.
SePRO Corporation Carmel, IN 46032 U.S.A.

Sonar Q Label
Page 2 of 7

Directions for Use

It is a violation of Federal Law to use this product in a manner inconsistent with its labeling.

Read all Directions Carefully Before Applying Sonar Q.

GENERAL INSTRUCTIONS

Sonar Q herbicide is a selective systemic aquatic herbicide for management of aquatic vegetation in fresh water ponds, lakes, reservoirs, drainage canals, irrigation canals, and rivers. Sonar Q is a pelleted formulation containing 5% fluridone. Sonar is absorbed from water by plant shoots and from hydrosoil by the roots of aquatic vascular plants. It is important to maintain Sonar in contact with the target plants for as long as possible. Rapid water movement or any condition which results in rapid dilution of Sonar in treated water will reduce its effectiveness. In susceptible plants, Sonar inhibits the formation of carotene. In the absence of carotene, chlorophyll is rapidly degraded by sunlight. Herbicidal symptoms of Sonar appear in seven to ten days and appear as white (chlorotic) or pink growing points. Under optimum conditions 30 to 90 days are required before the desired level of aquatic weed management is achieved with Sonar. Species susceptibility to Sonar Q may vary depending on time of year, stage of growth and water movement. For best results, apply Sonar Q prior to initiation of weed growth or when weeds begin active growth. Application to mature target plants may require higher application rates and may take longer to control.

Sonar Q is not corrosive to application equipment.

The label provides recommendations on the use of a chemical analysis for the active ingredient. SePRO Corporation recommends the use of an Enzyme-Linked Immunoassay (ELISA Test) for the determination of the active ingredient concentration in the water. Contact SePRO Corporation to incorporate this test, known as a FasTEST*, into your treatment program. Other proven chemical analyses for the active ingredient may also be used. The chemical analysis, FasTEST, is referenced in this label as the preferred method for the rapid determination of the concentration of the active ingredient in the water.

Application rates are provided in pounds of Sonar Q to achieve a desired concentration of the active ingredient in part per billion (ppb). The maximum application rate or sum of all application rates is 90 ppb in ponds and 150 ppb in lakes and reservoirs per annual growth cycle. This maximum concentration is the amount of product calculated as the target application rate, NOT determined by testing the residues of the active ingredient in the treated water.

GENERAL USE PRECAUTIONS

- **Obtain required permits:** Consult with appropriate state or local water authorities before applying this product. Permits may be required by state or local public agencies.
- **NEW YORK STATE:** Application of Sonar Q is not permitted in waters less than two (2) feet deep.
- **Hydroponic Farming:** Do not use Sonar Q treated water for hydroponic farming.
- **Greenhouse and Nursery Plants:** Do not use Sonar Q treated water for irrigating greenhouse or nursery plants. Use of an approved assay should confirm that residues are <1 ppb.
- **Water Use Restrictions Following Applications with Sonar Q (Days)**

Application Rate	Drinking†	Fishing	Swimming	Livestock/Pet Consumption	Irrigation††
Maximum Rate (150 ppb) or less	0	0	0	0	See irrigation instructions below

† Note below, under Potable Water Intakes, the information for application of Sonar Q within 1/4 miles, (1320 feet) of a functioning potable water intake.
††Note below, under Irrigation, specific time frames or fluridone residues that provide the widest safety margin for irrigating with fluridone treated water.

- **Potable Water Intakes:** Concentrations of the active ingredient fluridone up to 150 ppb are allowed in potable water sources; however, in lakes and reservoirs or other sources of potable water, **DO NOT APPLY** Sonar Q at application rates greater than 20 ppb within one-fourth mile (1320 feet) of any functioning potable water intake. At application rates of 8 - 20 ppb, Sonar Q **MAY BE APPLIED** where functioning potable water intakes are present.
  Note: Existing potable water intakes which are no longer in use, such as those replaced by connections to potable water wells or a municipal water system, are not considered to be functioning potable water intakes.
- **Irrigation:** Irrigation with Sonar Q treated water may result in injury to the irrigated vegetation. SePRO Corporation recommends following these precautions and informing those who irrigate from areas treated with Sonar Q of the irrigation time frames or water assay requirements presented in the table below. These time frames and assay recommendations are suggestions which should be followed to reduce the potential for injury to vegetation irrigated with water treated with Sonar Q. Greater potential for crop injury occurs where Sonar Q treated water is applied to crops grown on low organic and sandy soils.

2

Sonar Q Label
Page 3 of 7

Days After Application			
Application Site	Established Tree Crops	Established Row Crops/ Turf/Plants	Newly Seeded Crops/Seedbeds or Areas to be Planted Including Overseeded Golf Course Greens
†Ponds and Static Canals	7	30	Assay required
Canals	7	7	Assay required
Rivers	7	7	Assay required
††Lakes and Reservoirs	7	7	Assay required

† For purposes of Sonar Q labeling, a pond is defined as a body of water 10 acres or less in size. A lake or reservoir is greater than 10 acres.
†† In lakes and reservoirs where one-half or greater of the body of water is treated, use the pond and static canal irrigation precautions.

Where the use of Sonar Q treated water is desired for irrigating crops prior to the time frames established above, the use of FasTEST assay is recommended to measure the concentration in the treated water. Where FasTEST has determined that concentrations are less than 10 parts per billion, there are no irrigation precautions for irrigating established tree crops, established row crops or turf. **For tobacco, tomatoes, peppers or other plants within the Solanaceae Family and newly seeded crops or newly seeded grasses such as overseeded golf course greens, do not use Sonar Q treated water if concentration are greater than 5 ppb; furthermore, when rotating crops, do not plant members of the Solanaceae family in land that has been previously irrigated with fluridone concentrations in excess of 5 ppb. It is recommended that an aquatic specialist be consulted prior to commencing irrigation of these sites.**

PLANT CONTROL INFORMATION

Sonar Q selectivity is dependent upon dosage, time of year, stage of growth, method of application, and water movement. The following categories, controlled, partially controlled, and not controlled are provided to describe expected efficacy under ideal treatment conditions using higher to maximum label rates. Use of lower rates will increase selectivity of some species listed as controlled or partially controlled. Additional aquatic plants may be controlled, partially controlled, or tolerant to Sonar Q. Consult an aquatic specialist prior to application of Sonar Q to determine a plant's susceptibility to Sonar Q.

VASCULAR AQUATIC PLANTS CONTROLLED BY SONAR Q†

Submersed Plants:

Bladderwort (*Utricularia* spp.)
Common coontail (*Ceratophyllum demersum*)
Common Elodea (*Elodea canadensis*)
Egeria, Brazilian Elodea (*Egeria densa*)
Fanwort, Cabomba (*Cabomba caroliniana*)
Hydrilla (*Hydrilla verticillata*)
Naiad (*Najas* spp.)
Pondweed (*Potamogeton* spp., except Illinois pondweed)
Watermilfoil (*Myriophyllum* spp. except variable-leaf milfoil)

Shoreline Grasses:

Paragrass (*Urochloa mutica*)

†Species denoted by an asterisk are native plants that are often tolerant to Sonar at lower use rates. Please consult an aquatic specialist for recommended Sonar Q use rates when selective control of exotic species is desired.

VASCULAR AQUATIC PLANTS PARTIALLY CONTROLLED BY SONAR Q

Floating Plants:

Salvinia (*Salvinia* spp.)

Emersed Plants:

Alligatorweed (*Alternanthera philoxeroides*)
American lotus (*Nelumbo lutea*)
Cattail (*Typha* spp.)
Creeping waterprimrose (*Ludwigia peploides*)
Parrotfeather (*Myriophyllum aquaticum*)
Smartweed (*Polygonum* spp.)
Spatterdock (*Nuphar luteum*)
Spikerush (*Eleocharis* spp.)
Waterlily (*Nymphaea* spp.)
Waterpurslane (*Ludwigia palustris*)
Watershield (*Brasenia schreberi*)

Submersed Plants:

Illinois pondweed (*Potamogeton illinoensis*)
Limnophila (*Limnophila sessiliflora*)
Tapegrass, American eelgrass (*Vallisneria americana*)
Watermilfoil–variable-leaf (*Myriophyllum heterophyllum*)

Shoreline Grasses:

Barnyardgrass (*Echinochloa crusgalli*)
Giant cutgrass (*Zizaniopsis miliacea*)
Reed canarygrass (*Philaris arundinaceae*)
Southern watergrass (*Hydrochloa caroliniensis*)
Torpedograss (*Panicum repens*)

Sonar Q Label
Page 4 of 7

VASCULAR AQUATIC PLANTS NOT CONTROLLED BY SONAR Q

Floating Plants:
Floating waterhyacinth (*Eichhornia crassipes*)
Waterlettuce (*Pistia stratiotes*)

Emersed Plants:
American frogbit (*Limnobium spongia*)
Arrowhead (*Sagittaria* spp.)
Bacopa (*Bacopa* spp.)
Big floatingheart, banana lily (*Nymphoides aquatica*)
Bulrush (*Scirpus* spp.)
Pickerelweed, lanceleaf (*Pontederia* spp.)
Rush (*Juncus* spp.)
Water pennywort (*Hydrocotyle* spp.)

Shoreline Grasses:
Maidencane (*Panicum hemitomon*)

NOTE: Algae (chara, nitella, and filamentous species are not controlled by Sonar Q).

APPLICATION DIRECTIONS

The aquatic plants present in the treatment site should be identified prior to application to determine their susceptibility to Sonar Q. It is important to determine the area (acres) to be treated and the average depth in order to select the proper application rate. Do not exceed the maximum labeled rate for a given treatment site per annual growth cycle.

Application to Ponds

Sonar Q may be applied to the entire surface area of a pond. For single applications, rates may be selected to provide 45 to 90 ppb to the treated water, although actual concentrations in treated water may be substantially lower at any point in time due to the slow-release formulation of this product. When treating for optimum selective control, lower rates may be applied for sensitive target species. Use the higher rate within the rate range where there is a dense weed mass, when treating more difficult to control species, and for ponds less than 5 acres in size with an average depth less than 4 feet. Application rates necessary to obtain these concentrations in treated water are shown in the following table. For additional application rate calculations, refer to *Application Rate Calculations – Ponds, Lakes and Reservoirs.* Split or multiple applications are recommended where dilution of treated water is anticipated; however, the sum of all applications should total 45 to 90 ppb and must not exceed a total of 90 ppb per annual growth cycle.

Application Rates for Ponds

Average Water Depth of Treatment Site (feet)	Pounds of Sonar Q per treated surface acre 45 ppb	to 90 ppb
1	2.5	5
2	5	10
3	7.5	15
4	10	20
5	12.5	25
6	15	30
7	17	34
8	19.5	39
9	22	44
10	24.5	49

Application to Lakes and Reservoirs

The following treatments are recommended for treating both whole lakes or reservoirs and partial areas of lakes or reservoirs (bays, etc.). For best results in treating partial lakes and reservoirs, Sonar Q treatment areas should be a minimum of 5 acres in size. Treatment of areas smaller than 5 acres or treatment of narrow strips such as boat lanes or shorelines may not produce satisfactory results due to dilution by untreated water. Rate ranges are provided as a guide to include a wide range of environmental factors, such as target species, plant susceptibility, selectivity and other aquatic plant management objectives. Application rates and methods should be selected to meet the specific lake/reservoir aquatic plant management goals.

A. Whole Lake or Reservoir Treatments (Limited or No Water Discharge)

1. Single Application to Whole Lakes or Reservoirs

Where single applications to whole lakes or reservoirs are desired, apply Sonar Q at an application rate of 16 to 90 ppb. Application rates necessary to obtain these concentrations in treated water are shown in the following table. For additional rate calculations, refer to *Application Rate Calculation – Ponds, Lakes and Reservoirs.* Choose an application rate to meet the aquatic plant management objective. **Where greater plant selectivity is desired such as when controlling Eurasian watermilfoil and curlyleaf pondweed, choose an application rate lower in the rate range.** For other plant species, SePRO recommends contacting an aquatic specialist in determining when to choose application rates lower in the rate range to meet specific plant management goals. Use the higher rate within the rate range where there is a dense weed mass or when treating more difficult to control plant species or in the event of a heavy rainfall event where dilution has occurred. In these cases, a second application or more may be required; however, the sum of all applications cannot exceed 150 ppb per annual growth cycle. Refer to the following Section (No. 2) *Split or Multiple Applications* for guidelines and maximum rate allowed.

Sonar Q Label
Page 5 of 7

Single Application Rates

Average Water Depth of Treatment Site (feet)	Pounds of Sonar Q per treated surface acre 45 ppb	to 90 ppb
1	0.9	5
2	1.7	10
3	2.6	15
4	3.5	20
5	4.3	25
6	5.2	30
7	6.0	34
8	6.9	39
9	7.8	44
10	8.6	49
11	9.5	54
12	10.4	59
13	11.2	64
14	12.1	68
15	13.0	73
16	13.8	78
17	14.7	83
18	15.6	88
19	16.4	93
20	17.3	98

2. Split or Multiple Applications to Whole Lakes or Reservoirs
To meet certain plant management objectives, split or multiple applications may be desired in making whole lake treatments. Split or multiple application programs are desirable when the objective is to use the minimum effective dose and to maintain this lower dose for the sufficient time to ensure efficacy and enhance selectivity. Under these situations, use the lower rates (16 to 75 ppb) within the rate range. **In controlling Eurasian watermilfoil and curlyleaf pondweed and where greater plant selectivity is desired, choose an application rate lower in the rate range.** For other plant species, SePRO recommends contacting an aquatic specialist in determining when to choose application rates lower in the rate range to meet specific plant management goals. For split or repeated applications, the sum of all applications must not exceed 150 ppb per annual growth cycle.

NOTE: In treating lakes or reservoirs that contain potable water intakes and the application requires treating within 1/4 mile of a potable water intake, no single application can exceed 20 ppb. Additionally, the sum of all applications cannot exceed 150 ppb per annual growth cycle.

B. Partial Lake or Reservoir Treatments

Where dilution of Sonar Q with untreated water is anticipated, such as in partial lake or reservoir treatments, split or multiple applications may be used to extend the contact time to the target plants. The application rate and use frequency of Sonar Q in a partial lake is highly dependent upon the treatment area. Higher application rates may be required and frequency of applications will vary depending upon the potential of untreated water diluting the Sonar Q concentration in the treatment area. Use higher rates where greater dilution with untreated water is anticipated.

1. Application Sites Greater Than 1/4 Mile from a Functioning Potable Water Intake
For single applications, apply Sonar Q at application rates from 45 to 150 ppb. Split or multiple applications may be made; however, the sum of all applications cannot exceed 150 ppb per annual growth cycle. Split applications should be conducted to maintain a sufficient concentration in the target area for a period of 45 days or longer. The use of FasTEST is recommended to maintain the desired concentration in the target area over time.

2. Application Sites Within 1/4 Mile of a Functioning Potable Water Intake
In treatment areas that are within 1/4 mile of a potable water intake, no single application can exceed 20 ppb. When utilizing split or repeated applications of Sonar Q for sites which contain a potable water intake, FasTEST is required to determine the actual concentration in the water. Additionally, the sum of all applications cannot exceed 150 ppb per annual growth cycle.

APPLICATION RATE CALCULATION – PONDS, LAKES AND RESERVOIRS

The amount of Sonar Q to be applied to provide the desired ppb concentration of active ingredient equivalents in treated water may be calculated as follows:

- Pounds of Sonar Q required per treated acre **=** Average water depth of treatment site **x** Desired ppb concentration of active ingredient equivalents **x** 0.054

For example, the pounds per acre of Sonar Q required to provide a concentration of 25 ppb of active ingredient equivalents in water with an average depth of 5 feet is calculated as follows:

5 **x** 25 **x** 0.054 **=** 6.75 pounds per treated surface acre.

NOTE: Calculated rates should not exceed the maximum allowable rate in pounds per treated surface acre for the water depth listed in the application rate table for the site to be treated.

Sonar Q Label
Page 6 of 7

APPLICATION TO DRAINAGE CANALS, IRRIGATION CANALS AND RIVERS

Static Canals: In static drainage and irrigation canals, Sonar Q should be applied at the rate of 20 to 40 pounds per surface acre.

Moving Water Canals and Rivers: The performance of Sonar Q will be enhanced by restricting or reducing water flow. In slow moving bodies of water use an application technique that maintains a concentration of 10 to 40 ppb in the applied area for a minimum of 45 days. Sonar Q can be applied by split or multiple broadcast applications or by metering in the product to provide a uniform concentration of the herbicide based upon the flow pattern. The use of FasTEST is recommended to maintain the desired concentration in the target area over time.

Static or Moving Water Canals or Rivers Containing a Functioning Potable Water Intake: In treating a static or moving water canal or river which contains a functioning potable water intake, applications of Sonar Q greater than 20 ppb must be made more than 1/4 mile from a functioning potable water intake. Applications less than 20 ppb may be applied within 1/4 mile from a functioning potable water intake; however, if applications of Sonar Q are made within 1/4 mile from a functioning water intake, the FasTEST must be utilized to demonstrate that concentrations do not exceed 150 ppb at the potable water intake.

APPLICATION RATE CALCULATION – DRAINAGE CANALS, IRRIGATION CANALS AND RIVERS

The amount of Sonar Q to be applied through a metering system to provide the desired ppb concentration of active ingredient in treated water may be calculated as follows:

1. Average flow rate (feet per second) **x** average width (ft.) **x** average depth (ft.) x 0.9 **=** CFS (cubic feet per second)

2. CFS **x** 1.98 **=** acre feet per day (water movement)

3. Acre feet per day **x** desired ppb **x** 0.054 **=** pounds Sonar Q required per day

Storage and Disposal

Do not contaminate water, food or feed by storage or disposal.

Pesticide Storage: Store in original container only. Do not store near feed or foodstuffs. In case of leak or spill, contain material and dispose as waste.
Pesticide Disposal: Wastes resulting from use of this product may be used according to label directions or disposed of at an approved waste disposal facility.
Container Disposal: Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or by incineration, or if allowed by State and Local authorities, by burning. If burned, stay out of smoke.
General: Consult federal, state, or local disposal authorities for approved alternative procedures.

Sonar Q Label
Page 7 of 7

Warranty Disclaimer

SePRO Corporation warrants that the product conforms to the chemical description on the label and is reasonably fit for the purposes stated on the label when used in strict accordance with the directions, subject to the inherent risks set forth below. SEPRO CORPORATION MAKES NO OTHER EXPRESS OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER EXPRESS OR IMPLIED WARRANTY.

Inherent Risks Of Use

It is impossible to eliminate all risks associated with use of this product. Plant injury, lack of performance, or other unintended consequences may result because of such factors as use of the product contrary to label instructions (including conditions noted on the label such as unfavorable temperatures, soil conditions, etc.), abnormal conditions (such as excessive rainfall, drought, tornadoes, hurricanes), presence of other materials, the manner or application, or other factors, all of which are beyond the control of SePRO Corporation as the seller. All such risks shall be assumed by buyer.

Limitation of Remedies

The exclusive remedy for losses or damages resulting from this product (including claims based on contract, negligence, strict liability, or other legal theories) shall be limited to, at SePRO Corporation's election, one of the following:

1. Refund of purchase price paid by buyer or user for product bought, or
2. Replacement of amount of product used.

SePRO Corporation shall not be liable for losses or damages resulting from handling or use of this product unless SePRO Corporation is promptly notified of such losses or damages in writing. In no case shall SePRO Corporation be liable for consequential or incidental damages or losses.

The terms of the Warranty Disclaimer above and this Limitation of Remedies can not be varied by any written or verbal statements or agreements. No employee or sales agent of SePRO Corporation or the seller is authorized to vary or exceed the terms of the Warranty Disclaimer or Limitations of Remedies in any manner.

Sonar Q Material Safety Data Sheet
Page 1 of 4

Material Safety Data Sheet

SePRO

Transportation and Medical Emergency Phone: 1-800-535-5053 (INFOTRAC)
General Phone: 317-580-8282

EPA Reg. Number: 67690-3
Effective Date: 9/11/02

Sonar* Q Herbicide

SePRO Corporation Carmel, IN 46032

1. PRODUCT AND COMPANY IDENTIFICATION

PRODUCT: Sonar* Q Herbicide

COMPANY IDENTIFICATION:
SePRO Corporation
11550 North Meridian Street, Suite 600
Carmel, IN 46032
www.sepro.com

2. COMPOSITION / INFORMATION ON INGREDIENTS

Fluridone: 1-Methyl-3-phenyl-5-(3-(Trifluoro-methyl)phenyl)-4(1H)-Pyridinone	CAS # 059756-60-4	5%
Inert Ingredients, Total, Including		95%
Clay (Crystalline Silica)	CAS # 001332-58-7	

This document is prepared pursuant to the OSHA Hazard Communication Standard (29 CFR 1910.1200). In addition, other substances not 'Hazardous' per this OSHA Standard may be listed. Where proprietary ingredient shows, the identity may be made available as provided in this standard.

3. HAZARDOUS IDENTIFICATIONS

EMERGENCY OVERVIEW
Dark gray to dark brown pellet with a faint musty odor. May cause eye irritation. LD_{50} for skin absorption in rabbits is >2000 mg/kg. Oral LD_{50} for rats is >5000 mg/kg.
EMERGENCY PHONE NUMBER: 800-535-5053

POTENTIAL HEALTH EFFECTS: This section includes possible adverse effects, which could occur if this material is not handled in the recommended manner.

EYE: May cause slight eye irritation and/or slight transient (temporary) corneal injury.

SKIN: Essentially non-irritating to skin. A single prolonged exposure is not likely to result in the material being absorbed through the skin in harmful amounts. The LD_{50} for skin absorption in rabbits is >2000 mg/kg. Fluridone did not cause allergic skin reactions when tested in guinea pigs.

INGESTION: Single dose oral toxicity is extremely low. The oral LD_{50} for rats is >5000 mg/kg. No hazards anticipated from swallowing small amounts incidental to normal handling operations.

INHALATION: Single exposure to dust is not likely to be hazardous. Dust may cause irritation to upper respiratory tract (nose and throat).

SYSTEMIC (OTHER TARGET ORGAN) EFFECTS: Fluridone, in animals, has been shown to cause liver and kidney effects. Repeated excessive exposure to crystalline silica may cause silicosis, a progressive and disabling disease of the lungs. Some evidence suggests that kidney effects may result from excessive exposures also.

CANCER INFORMATION: Fluridone did not cause cancer in laboratory animals. This product contains clay that has naturally occurring crystalline silica as quartz. Crystalline silica is listed by IARC and NTP as a carcinogen for hazard communication purposes under OSHA Standard 29 CFR Part 1910.1200.7. Inhalation of excessive concentrations of any dust, including this material, may lead to lung injury.

TERATOLOGY (BIRTH DEFECTS): Fluridone did not cause birth defects; other fetal effects occurred only at doses toxic to the mother.

REPRODUCTIVE EFFECTS: Fluridone did not interfere with reproduction in animal studies.

4. FIRST AID

EYE: Hold eyes open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eyes. Call a poison control center or doctor for treatment advice.

SKIN: Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.

INGESTION: Call a poison control center or doctor immediately for treatment advice. Have person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so by the poison control center or doctor. Never give anything by mouth to an unconscious person.

*Trademark of the SePRO Corporation

Sonar Q Material Safety Data Sheet
Page 2 of 4

Material Safety Data Sheet

SePRO

Transportation and Medical Emergency Phone: 1-800-535-5053 (INFOTRAC)
General Phone: 317-580-8282

EPA Reg. Number: 67690-3
Effective Date: 9/11/02

Sonar* Q Herbicide

SePRO Corporation Carmel, IN 46032

INHALATION: Move person to fresh air. If person is not breathing, call 911 or ambulance, then give artificial respiration, preferably by mouth to mouth. Call a poison control center or doctor for further treatment advice.

NOTE TO PHYSICIAN: No specific antidote. Treatment of exposure should be directed at the control of symptoms and the clinical condition of the patient.

5. FIRE FIGHTING MEASURES

FLASH POINT: Not applicable
METHOD USED: Not applicable

FLAMMABLE LIMITS:
LFL: Not applicable
UFL: Not applicable

AUTO-IGNITION TEMPERATURE: No ignition up to 1382°F (750°C)

EXTINGUISHING MEDIA: Use water, CO_2, or dry chemicals.

FIRE AND EXPLOSION HAZARDS: Will emit toxic vapors as it burns.

FIREFIGHTING EQUIPMENT: Wear positive-pressure, self-contained breathing apparatus and full protective clothing.

6. ACCIDENTAL RELEASE MEASURES

ACTION TO TAKE FOR SPILLS AND LEAKS: Contain and sweep up small spills and dispose as waste. Report large spills to INFOTRAC and consult SePRO Corporation for assistance. Prevent runoff.

7. HANDLING AND STORAGE

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE: Keep out of reach of children. Harmful if swallowed, absorbed through the skin, or inhaled. Avoid breathing dust or contact with skin, eyes, or clothing. Wash thoroughly with soap and water after handling. Wash exposed clothing before reuse.

8. EXPOSURE CONTROL/PERSONAL PROTECTION

These precautions are suggested for conditions where the potential for exposure exists. Emergency conditions may require additional precautions.

EXPOSURE GUIDELINES: Crystalline silica: ACGIH TLV is 0.05 mg/M^3 for quartz, tripoli, and fused silica; 0.05 mg/M^3 (respirable) for cristobalite and tridymite. OSHA PEL is 10/%SiO2 + 2 mg/M^3 (respirable) for quartz, tripoli, and fused silica; 1/2 the value calculated from the respirable dust formula for quartz for cristobalite and tridymite.

PELs are in accord with those recommended by OSHA, as in the 1989 revision of PELs.

ENGINEERING CONTROLS: Provide general and/or local exhaust ventilation to control airborne levels below the exposure guidelines.

RECOMMENDATIONS FOR MANUFACTURING, COMMERCIAL BLENDING, AND PACKAGING WORKERS:

RESPIRATORY PROTECTION: Atmospheric levels should be maintained below the exposure guidelines. In dusty atmospheres, use a NIOSH approved dust respirator.

SKIN PROTECTION: Use gloves impervious to this material.

EYE/FACE PROTECTION: Use safety glasses.

APPLICATORS AND ALL OTHER HANDLERS: Refer to the product label for personal protective clothing and equipment.

9. PHYSICAL AND CHEMICAL PROPERTIES

SOLUBILITY IN WATER: Insoluble (disintegrates in water)

APPEARANCE: Dark gray or dark brown pellet

ODOR: Faint musty

pH: (aqueous 50/50) 3.5

*Trademark of the SePRO Corporation.

Sonar Q Material Safety Data Sheet
Page 3 of 4

Material Safety Data Sheet

SePRO

Transportation and Medical Emergency Phone: 1-800-535-5053 (INFOTRAC)
General Phone: 317-580-8282

EPA Reg. Number: 67690-3
Effective Date: 9/11/02

Sonar* Q Herbicide

SePRO Corporation Carmel, IN 46032

10. STABILITY AND REACTIVITY

STABILITY: Stable under normal storage conditions.

INCOMPATIBILITY: (Specific materials to avoid) Not determined.

HAZARDOUS DECOMPOSITION PRODUCTS: None known.

HAZARDOUS POLYMERIZATION: Not known to occur.

11. TOXICOLOGICAL INFORMATION

MUTAGENICITY: For fluridone, in-vitro mutagenicity studies were predominantly negative and animal mutagenicity studies were negative.

12. ECOLOGICAL INFORMATION

Follow label use directions carefully so as to avoid adverse effects on non-target organisms. In order to avoid impact on threatened or endangered aquatic plant or animal species, users must consult their state fish and game agency or the U.S. Fire and wildlife Service before making applications. Do not contaminate water when disposing of equipment wash waters. Trees and shrubs growing in water treated with Sonar Q may be injured. Do not apply in tidewater or brackish waters.

13. DISPOSAL CONSIDERATIONS

DISPOSAL: Do not contaminate water, food, or feed by storage or disposal. Wastes resulting from the use of this product may be disposed of on site per label use directions or at an approved waste disposal facility. Follow all local, state, and federal requirements for disposal.

14. TRANSPORT INFORMATION

For DOT regulatory information, if required, consult transportation regulations, product shipping papers, or your SePRO Corporation representative.

15. REGULATORY INFORMATION

NOTICE: The information herein is presented in good faith and believed to be accurate as of the effective date shown above. However, no warranty, express or implied, is given. Regulatory requirements are subject to change and may differ from one location to another; it is the buyer's responsibility to ensure that its activities comply with federal, state or provincial, and local laws. The following specific information is made for the purpose of complying with numerous federal, state or provincial, and local laws and regulations.

U.S. REGULATIONS

SARA TITLE III, SECTION 313: To the best of our knowledge, this product contains no chemical subject to SARA Title III, Section 313 supplier notification requirements.

SARA HAZARD CATEGORY: This product has been reviewed according to the EPA "Hazard Categories" promulgated under Sections 311 and 312 of the Superfund Amendments and Reauthorization Act of 1986 (SARA Title III) and is considered, under applicable definitions, to meet the following categories:

An Immediate Health Hazard
A Delayed Health Hazard

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA 701): (4 = Extreme; 3 = High; 2 = Moderate; 0 = Insignificant)

Health	1
Flammability	0
Reactivity:	0

STATE RIGHT-TO-KNOW: The following product components are cited on certain state lists as mentioned. Non-listed components may be shown in Section 1 of the MSDS.

Sonar Q Material Safety Data Sheet
Page 4 of 4

Material Safety Data Sheet

SePRO

Transportation and Medical Emergency Phone: 1-800-535-5053 (INFOTRAC)
General Phone: 317-580-8282

EPA Reg. Number: 67690-3
Effective Date: 9/11/02

Sonar* Q Herbicide

SePRO Corporation Carmel, IN 46032

Chemical Name	CAS Number	List
Crystalline Silica	001332-58-7	NJ3, PA1

NJ3=New Jersey Workplace Hazardous Substance (present at >/= to 1.0%).
PA1=Pennsylvania Hazardous Substance (present at >/= to 1.0%).

TOXIC SUBSTANCES CONTROL ACT (TSCA): All ingredients are on the TSCA inventory or are not required to be listed on the TSCA inventory.

OSHA HAZARD COMMUNICATION STANDARD: This product is a "hazardous Chemical" as defined by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

16. OTHER INFORMATION

MSDS STATUS: New

The information herein is given in good faith, but no warranty, express or implied, is made. Consult SePRO Corporation for further Information.

Appendix D

Potential Impacts to Listed Fish Species or Critical Habitat

The following appendix is an updated assessment of impacts to fish species from the EDCP. The original version of this assessment was completed in 2001. Updates have been made to reflect new available research data and information.

A. Use of *Egeria densa* Beds by Fish

Shallow vegetated areas function as nurseries for small fish, providing relatively abundant food and shelter from predators. Some native fish of the Delta, including the threatened splittail and Delta smelt, are known to use aquatic vegetation for spawning and rearing.[1] Likewise, juvenile salmon may use shallow water during their migrations through the Delta.

Recent studies found that Delta smelt were more abundant in offshore habitats,[2] and four native species, Chinook salmon, Delta smelt, hitch, and starry flounder were not detected at Mildred Island, a sample site with the greatest extent of submerged aquatic vegetation (primarily *Egeria densa*).[3] An evaluation of the importance of tidal wetland restoration to native fish species found that fish communities of freshwater tidal wetlands and associated near-shore habitats are dominated by alien species, and that the most common plant species in these habitats in the Delta are *Egeria densa* and tules.[4]

Use of dense aquatic vegetation, such as *Egeria densa*, by fish is not well documented. Although some studies report that dense beds of *Egeria densa* provide habitat for certain fish, other studies suggest that depressed oxygen levels and reduced temperature characteristic of beds are limiting to certain species.[5] A study evaluating behavior of juvenile bluegill and largemouth bass in a Wisconsin lake found that fish species have variable preferences for plant densities, with juvenile bluegill preferring moderately dense vegetation and largemouth bass preferring lower plant densities or the periphery of plant beds.[6] Plant habitats in this study typically consisted of two or more plants, while *Egeria densa* forms in extremely dense monospecific mats.

According to Brown and others, "for ecosystems, *Egeria densa* is a major agent of change, altering basic abiotic properties of ecosystems, which results in increased predation on and competition for native fishes. In fact, <u>previous research indicates that *E. densa* has all the makings of an ecosystem engineer</u> (Champion and Tanner 2000; Brown 2003), <u>which is defined as 'a species that directly or indirectly modulates the availability of resources (other than themselves) by causing physical state changes in biotic or abiotic materials'</u> (Jones et. al, 1994, 1997).[7]

Researchers at San Francisco State University, under contract with the DBW, studied the use of *Egeria densa* beds by Delta smelt, splittail, migratory salmonids, and other fish of the Sacramento-San Joaquin Estuary.[8] Pop nets and light traps were used to collect fish in *Egeria densa* beds. Additionally, piles of *Egeria densa* mechanically harvested during other DBW experiments were sampled and sorted in their entirety for fish and invertebrates. (See McGowan 1998 for an explanation of sampling methods.) Samples were collected from May through late October at six sites in the Delta: Sandmound Slough, Seven Mile Slough, White Slough, Big Break Marina, Franks Tract, and Little Venice

Island. A total of 257 pop-net samples and 193 light trap samples were collected over the sampling period. In the pop-net samples, 2,181 individual fish were collected; 840 fish were collected in the light traps, and 671 fish, crabs, and tadpoles were sorted from the harvested *Egeria densa*.

A total of fourteen (14) species of fish were collected from the sampling effort as shown in **Exhibit D.1**, below. Of the fourteen species of fish collected, only one is a native species (prickly sculpin). According to McGowan (1998), species collected were typical non-native residents of the Delta. Small individuals of bluegill, sunfish, largemouth bass, threadfin shad, and inland silversides dominated the catches. No sensitive species such as Delta smelt, splittail, juvenile Chinook, or steelhead were collected.

These data should provide a fairly accurate indication of which fish species may be found in *Egeria densa* beds during EDCP operations, since the sampling was conducted during many of the same months that project operations would occur. Five of the fourteen species identified by McGowan were also among the dominant Delta species captured in beach seine and trawl studies in 2005: inland silverside, golden shiner, mosquito fish, threadfin shad, and red shiner.[9]

McGowan's findings are similar to those of the Grimaldo and Hymanson, who report that introduced fish species and Chinese mitten crabs were most abundant in *Egeria densa* stands in the Delta, as opposed to other submerged macrophyte habitat types.[10] Further, these researchers found that native fish were far less frequent inhabitants of the *Egeria densa* beds. The findings of McGowan and Grimaldo and Hymanson suggest that *Egeria densa* is not typically

Exhibit D.1
***Egeria densa* Control Program**
Fish Collected in *Egeria densa* Beds within the Delta

Species	Big Break	Franks Tract	Little Venice	Seven Mile Slough	Sandmound Slough	White Slough
Blue gill	X	X	X	X	X	X
Redear			X	X	X	X
Largemouth bass	X	X	X	X	X	X
Black crappie				X	X	X
Warmouth				X	X	X
Golden shiner					X	
Red shiner	X			X		
Cyprinidae					X	
Inland silverside	X	X	X	X	X	X
Killifish	X	X		X	X	
Mosquito fish	X		X		X	X
Threadfin shad	X		X	X	X	X
Brown bullhead					X	
Prickly sculpin	X			X		

used by native fish species or specifically any threatened, endangered, or special status species as habitat or as a migration corridor.

B. Potential for Exposure of Special Status and Other Fish to EDCP Treatments

The potential exists for impacts to occur to native and listed fish species under the EDCP, since these fish do occur in the general project area, whether or not they occur in *Egeria densa* beds specifically. This section briefly discusses the potential for exposure of special status and other fish to EDCP treatments.

Although not specific to *Egeria densa* beds, the Stockton Fish and Wildlife Office of the USFWS conducts an annual monitoring program for juvenile Delta fisheries. The focus is on Chinook salmon, however the program identifies, tracks, and monitors all fish species sampled at several beach seine and trawl locations. These studies provide time-series data on fish abundance and assemblages in six Delta regions, and support previous findings that the most abundant fish species captured in the Delta are non-indigenous.[11]

Study results in 2005, for the monitoring period May 1 through August 31 (coinciding with significant EDCP activity) captured a total of 56,793 fish and 51 different species.[12] Although over fifty different species were captured in total, a small number of species made up the majority of fish. Between one and six species made up at least 75 percent of the sample in each region.[13]

The most abundant fish captured were introduced inland silversides and red shiners, each 27 percent of the total. The most commonly captured native fish were Sacramento suckers (8 percent), and Sacramento splittail (2 percent). Fish assemblage stability measured between May and August from 1995 to 2005 was moderately stable in most regions, and most stable in the Lower Sacramento River region.[14] Fish diversity during the same time period showed a declining trend, except in the South Delta, although data is highly variable and it is difficult to make definitive inferences.[15]

The DBW will conduct EDCP treatments between April and mid-October. Sonar (fluridone) treatments, which are non-toxic to fish at treatment levels, will be the primary control method used during the critical spawning and rearing period for many fish species, or approximately December through June. These timing requirements help protect larval fish, which are present in the Delta during these months, and tend to be much more sensitive to toxins and water quality conditions than are juvenile and adult fish. Not only are larval fish physiologically more sensitive, but they also do not have the same capacity to escape from disturbances as do juvenile and adult fish. **Exhibit D.2,** on the following page, identifies when various fish, including special status species, spawn in the Delta.

The EDCP treatment period also coincides temporarily with the migration and emigration of certain runs of Chinook salmon through the Delta. **Exhibit D.3,** following Exhibit D.2, lists the timing of salmon migration and emigration through the Delta.

Exhibit D.2
***Egeria densa* Control Program**
Spawning Periods for Various Fish in the Delta

Fish Species	Spawning in Delta	Reference
Delta smelt	December-July	Wetland Goals 1997
Splittail	January-July	Wetland Goals 1997
Longfin smelt	December-June	Wang 1986
Striped bass	Peak: May-June	Wetland Goals 1997
Prickly sculpin	January-May	Wang 1986

Exhibit D.3
***Egeria densa* Control Program**
Timing of Adult Migration and Juvenile Emigration of Chinook Salmon Through the Delta (Entrix 1996)

Fish Species/Run	Adult Migration	Emigration
Winter-run Chinook	December to June	July to October of following year
Spring-run	March to September	October through April
Late fall-run	October to April	November to January
Fall-run	July to December	April to June

Exhibit D.4
***Egeria densa* Control Program**
Special Status Fish Monitoring Results

EDCP Program Year	Outcome of Special Status Fish Monitoring
2001	No known take or harassment of federal endangered and threatened species. One Sonar (fluridone) treatment occurred in an area considered critical habitat for splittail (Site 118).
2002	No known take or harassment of federal endangered and threatened species. EDCP was not present in critical habitats at critical times.
2003	No known take or harassment of federal endangered and threatened species. One Sonar (fluridone) treatment occurred in potential rearing habitat (Site 118), one Reward (diquat) application occurred in potential rearing habitat (Site 116). Four sites were treated near potential rearing habitat during July and August (Sites 112, 173, 20, 175).
2004	No known take or harassment of federal endangered and threatened species.
2005	No known take or harassment of federal endangered and threatened species.

Over the last five years of the program, the EDCP has monitored the impact on special status fish species. **Exhibit D.4**, on the previous page, summarizes the results of special status fish monitoring from 2001 to 2005. During these five years, there have been no known cases of take or harassment of special status fish species due to operations of the EDCP.

Fish could potentially be directly and indirectly impacted by EDCP activities. Direct impacts could occur through herbicide toxicity, and bioaccumulation of herbicides. Indirect impacts include impacts to habitat and to the invertebrate prey base. These potential impacts are discussed below.

C. Direct Impacts to Fish: Toxicity

Herbicide use under the EDCP could result in loss of fish, including special status species, due to herbicide toxicity. The following discusses the toxicity of Reward and Sonar to various fish species.

1. Reward

Reward use is unlikely to have direct adverse impacts to adult and juvenile fish during or following treatments. Under the EDCP, Reward would be applied to achieve a water column concentration of 0.375 ppm diquat for three to six hours. This concentration is less than the levels identified as lethal to adult and juvenile fish. However, toxicity tests conducted during the last five years of the EDCP, and summarized below, indicate that diquat could have lethal impacts on larval fish. As a result of these studies, <u>Reward use has been deemphasized by the EDCP</u>. In addition, the large majority of EDCP treatments utilize Sonar (fluridone), rather than Reward.

Department of Fish and Game (DFG) tested larval Delta smelt, Sacramento splittail, and fathead minnows to compare and determine acute toxicity utilizing 96-hour LC50 tests for all three species, plus a 7-day LC50 test for fathead minnows.[16] LC50 values for the 96-hour tests ranged from 0.43 ppm for the fathead minnow to 3.7 ppm for the Sacramento splittail. The fathead minnow level is very close to the 0.375 ppm treatment level, resulting in the concern that larval fish present in an application area could be killed.

DFG testing of EDCP sample waters with and without detectable diquat levels showed similar survival rates for adult fathead minnows between 2002 and 2005, indicating that actual treatment waters do not impact adult fish.

Results of toxicity tests using diquat are summarized below and presented in **Exhibit D.5,** on page 8:

- NYSDEC (1981) considers diquat, to have moderate toxicity to fish at certain concentrations, while EXTOXNET (1996) describes it as moderately to practically non-toxic to fish. Pesticide Action Network classifications range from slightly toxic to not acutely toxic.[17]
- The 96-hour LC50 concentrations for American eel, adult fathead minnows, Emerald shiner, and striped bass range from 26 to 43 ppm.[18]

- The 96-hour LC50 concentration for goldfish is higher, at 92 ppm, and for sheepshead minnow is significantly higher, at 228 ppm.[19]
- The 8-hour LC50 for diquat is **28.5 ppm for Chinook salmon** and 12.3 for rainbow trout (Pimentel 1971).
- The 96-hour LC50 is 16 ppm for northern pike, 20.4 ppm for fingerling trout, 245 ppm for bluegill, 60ppm for yellow perch, and 170 ppm for black bullhead (Johnson and Finley 1980, Simonin and Skea 1977).
- Toxicity tests conducted on walleye, largemouth bass and smallmouth bass during early life stages resulted in 96-hour LC50 values of 0.74 to 4.9 ppm (Paul and others 1994). These researchers found that diquat is more toxic to fish tested than was fluridone. The tests indicated that the very early life stages of walleye are the most sensitive, and that walleye are in general more sensitive than largemouth bass or smallmouth bass.
- Surber and Pickering (1962) found a 96-hour LC50 of diquat to largemouth bass of 7.8 ppm.
- 96-hour LC50 values for bluegill have been reported at 35 ppm (Gilderhus 1967), while similar test indicated that 96-hour LC50 value for mosquitofish is 289 ppm.
- Although Paul and others (1994) assert that diquat may be lethal to early life stages of certain game fish, the lowest LC50 value (0.74 ppm) they identify is still higher than the concentration of diquat 0.37 ppm that would be used under the proposed EDCP.

Reward concentrations are rapidly diluted in the flowing water system of the Delta, limiting the time that fish are exposed to the herbicide. Additionally, the high turbidity in the Delta further reduces the time diquat is available in the water column, since diquat binds irreversibly with sediment particles. Thus the opportunity for exposure of Reward to non-target organisms such as fish is small.

The DFG data indicate that at maximum application rates for diquat, the EDCP has the potential to result in some loss of larval fish to the degree that they are present during Reward applications. However, at this time, the EDCP has elected to use Sonar (fluridone) as the primary control method going forward, so Reward (diquat) use is expected to decline from previous levels.

2. Sonar

Sonar use is unlikely to have direct adverse impacts to fish exposed during or following treatments. Under the EDCP, Sonar would be applied to achieve a water column concentration of 10 to 40 ppb (0.01 ppm to 0.04 ppm). This concentration is well below that known to result in lethal effects to fish species. Results of DFG fathead minnow toxicity tests using fluridone treated sample water found no difference in toxicity for samples with detectable, and non-detectable, levels of fluridone between 2002 and 2005.

Pest control recommendations, prepared by a licensed pest control advisor, are used for EDCP Sonar applications. Generally, recommendations for Sonar AS have targeted concentrations of between 10 and 30 ppb, with the most common concentration 15 ppb. Recommendations for Sonar PR have targeted concentrations of between 25 and 75 ppb, with the most common concentration 50 ppb.

For Sonar treatments, the EDCP measures the concentration of fluridone during the treatment period. EDCP staff collects water samples, generally at biweekly intervals, throughout the treatment period. The SePro laboratory, an EDCP contractor, tests fluridone concentrations in these water samples using the FasTest, an immunoassay test. FasTest results are intended to be used to adjust application rates to optimize ambient Sonar concentrations throughout the treatment period.

Average fluridone concentrations based on FasTests are shown in **Exhibit D.6,** on the following page. In all cases, average Sonar concentrations over the four years are below targeted concentrations. Combined Sonar PR and Sonar AS applications resulted in the highest average concentrations, approximately six percent greater than average Sonar AS applications.

Fluridone concentrations have increased since the early years of the program as different application approaches were utilized. In 2002, average FasTest results, for all tests, showed 2.63 ppb fluridone while in 2005 the average concentration for all tests was 6.16 ppb fluridone.

For the 325 tests performed, the average FasTest concentration was 4.88 ppb, roughly half of the lower bound target of 10 ppb. In 2004 and 2005, through use of Sonar PR/AS in combination, average FasTest results approached the lower bound 10 ppb target at 9.8 ppb and 8.1 ppb respectively. All of these results suggest that ongoing Sonar concentrations throughout the treatment period are significantly below the LC50 values reported in this section.

Exhibit D.5
***Egeria densa* Control Program**
Acute Response of Various Fish Species to Diquat Concentration

Species	LC50 [a] Value (ppm)	Comments	Reference
Chinook salmon	**28.5**	**8-hour test**	**Pimentel, 1971**
Rainbow trout	12.3	8-hour test	Pimentel ,1971
Northern pike	16	96-hour test	Johnson and Finley, 1980
Fingerling trout	20.4	96-hour test	Johnson and Finley, 1980
Bluegill	245	96-hour test	Johnson and Finley, 1980
Bluegill	35	96-hour test	Gilderhus, 1967
Yellow perch	60	96-hour test	Johnson and Finley, 1980
Black bullhead	170	96-hour test	Johnson and Finley, 1980
Larval walleye, largemouth bass, smallmouth bass	0.74 to 4.9	96-hour test	Paul and others, 1994
Largemouth bass	7.8	96-hour test	Surber and Pickering, 1962
Mosquito fish	298	96-hour test	Gilderhus, 1967
Fathead minnow, larval	1.4	96-hourtest	CDFG ATL, 2002
Fathead minnow, larval	1.1	NOEC	CDFG ATL, 2002
Delta smelt, larval	1.1	96-hour test	CDFG ATL, 2002
Delta smelt, larval	0.82	NOEC	CDFG ATL, 2002
Sacramento splittail, larval	3.7	96-hour test	Riley and Finlayson, 2004
Sacramento splittail, larval	2.3	96-hour NOEC	DFG-ATL, 2003
Sacramento splittail, larval	4.6	96-hour LOEC	DFG-ATL, 2003
Fathead minnow, larval	0.43	96-hour test	Riley and Finlayson, 2004
Fathead minnow, larval	0.40	7-day LC50	Riley and Finlayson, 2004
American eel	43	96-hour test	Pesticide Action Network, 2006
Goldfish	92	96-hour test	Pesticide Action Network, 2006
Sheepshead minnow	228	96-hour test	Pesticide Action Network, 2006
Striped bass	33	96-hour test	Pesticide Action Network, 2006
Emerald shiner	26	96-hour test	Pesticide Action Network, 2006
Fathead minnow, adult	35	96-hour test	Pesticide Action Network, 2006
Summary Range (ppm)	0.40 – 298		
Target Application Rate (ppm)	0.375		
Maximum Label Rate (ppm)	0.375		
Average Post-Treatment Concentration (ppm)	0.016		

[a] Unless otherwise specified in comments

Exhibit D.6
***Egeria densa* Control Program,**
Fluridone Concentrations (in parts per billion)
Based on FasTest Results for Sonar Applications (2002 to 2005)

	Sonar AS		Sonar PR		Sonar PR/AS		Total	
Year	(ppb)	tests	(ppb)	tests	(ppb)	tests	(ppb)	tests
2002	-	-	2.70	52	2.55	46	2.63	98
2003	5.49	33	1.80	39	-	-	3.49	72
2004	7.16	12	7.48	28	9.80	20	8.19	60
2005	5.02	23	4.72	34	8.13	38	6.16	95
Total	5.62	68	3.80	153	5.98	104	4.88	325

Research on fluridone impacts to various fish species is summarized below and presented in **Exhibit D.7,** on the following page.

- Habig (2004) reported NOEC levels from three fluridone studies. The bluegill NOEC level was 2 ppm, sheepshead minnow NOEC was 3.1 ppm, and **Chinook smolt NOEC was 0.725 ppm.** All three of these levels are well below EDCP fluridone treatment concentrations.
- Habig (2004) also reported 96-hour LC50 results for five fish species, including rainbow trout (4.2 ppm), fathead minnow (22 ppm), channel catfish (8.2 ppm), sheepshead minnow (10.7 ppm), and **Chinook smolts (>5.76 ppm).**
- The USEPA (1986) reports that the LC50 for rainbow trout (*Salmo gairdneri*) and bluegill (*Lepomis macrochirus*) exposed to fluridone for a 96-hour period was 11.7 ppm and 12.0 ppm respectively, between 600 and 1,000 times greater than the target water column concentration for the EDCP.
- Results of numerous acute and chronic toxicity tests conducted by Hamelink and others (1986) revealed similar findings. These researchers found 96-hour LC50 concentrations of 10.4 +/- 3.9ppm for the representative fish used in their study: rainbow trout (*Salmo gairdneri*), fathead minnows (*Pimephales promelas*), channel catfish (*Ictalurus punctatus*), bluegills (*Lepomis macrochirus*), and sheepshead minnows (*Cyprinodon variegatus*). Channel catfish fry exposed to fluridone concentrations of 0.5 ppm were not significantly affected. Catfish fry growth was reported as reduced at fluridone concentrations of 1.0 ppm. Chronic exposure of fathead minnows to mean concentrations of 0.48 ppm did not produce adverse effects.
- Fluridone concentrations of 0.95 and 1.9 ppm resulted in reduced survival of fathead minnows within 30 days of hatching (Hamelink and others 1986).
- USEPA (1986) also lists a Maximum Acceptable Toxicant Concentration (MATC) of greater than 0.48 ppm, but less than 0.96 ppm, for exposure of fathead minnow fry (*Pimephales promelas*) to fluridone. This indicates that no treatment related effects to fathead minnows were observed at or below 0.48 ppm.
- Habig (2004), and Hamelink and others (1986) reported results of a variety of chronic and subchronic toxicity tests on fish and invertebrates (see **Exhibit D.8**, following Exhibit D.7). The lowest impact level reported, a 0.2 ppm NOEC level for daphnids, is well above the EDCP treatment concentrations for fluridone.

Exhibit D.8, on the following page, identifies results of subchronic and chronic aquatic toxicity testing with fluridone on several invertebrates and fish. These tests illustrate that even maintaining fluridone concentrations at a treatment site for 6 to 8 weeks is not likely to have any adverse impacts on fish or aquatic invertebrates.

Exhibit D.7
***Egeria densa* Control Program**
Acute Response of Various Fish to Varying Concentrations of Fluridone

Species	LC50 [a] Value (ppm)	Comments	Reference
Rainbow trout	11.7	96-hour test	USEPA, 1986
Rainbow trout	10.4 +/-3.9	96-hour test	Hamelink and others, 1986
Bluegill	12.0	96-hour test	USEPA, 1986
Bluegill	10.4 +/-3.9	96-hour test	Hamelink and others, 1986
Fathead minnow	10.4 +/-3.9	96-hour test	Hamelink and others, 1986
Sheepshead minnow	10.4 +/-3.9	96-hour test	Hamelink and others, 1986
Channel catfish	10.4 +/-3.9	96-hour test	Hamelink and others, 1986
Bluegill	2	NOEC	In Habig, 2004
Rainbow trout	4.2	96-hour test	In Habig, 2004
Fathead minnow	22	96-hour test	In Habig, 2004
Channel catfish	8.2	96-hour test	In Habig, 2004
Sheepshead minnow	10.7	96-hour test	In Habig, 2004
Sheepshead minnow	3.1	NOEC	In Habig, 2004
Chinook smolts	**>5.76**	**96-hour test**	**In Habig, 2004**
Chinook smolts	**0.725**	**NOEC**	**In Habig, 2004**
Delta smelt, larval	6.1	96-hour test	DBW, 2003
Delta smelt, larval	1.28	NOEC	DBW, 2003
Sacramento splittail, larval	4.8	96-hour test	DFG-ATL, 2003
Sacramento splittail, larval	1.3	96-hour NOEC	DFG-ATL, 2003
Sacramento splittail, larval	2.8	96-hour LOEC	DFG-ATL, 2003
Sacramento splittail, juvenile	23.8	96-hour test	DBW, 2003
Sacramento splittail, juvenile	19.3	NOEC	DBW, 2003
Fathead minnow, larval	6.2	96-hour test	DBW, 2003
Fathead minnow, larval	1.88	NOEC	DBW, 2003
Summary Range (ppm)	0.725 – 23.8		
Target Application Rate (ppm) Maximum Label Rate (ppm) Average Post-Treatment Concentration (ppm) Average Fastest Result (ppm)	0.010 – 0.040 0.150 0.001 – 0.005 0.005		

[a] Unless otherwise specified in comments

Exhibit D.8
***Egeria densa* Control Program**
Subchronic and Chronic Aquatic Toxicity Testing Results

Species	Type of Test	Result (mg/L or ppm)	Reference
Daphnid	21-day lifecycle	NOEC = 0.2	In Habig, 2004
Amphipod	60-day growth	Growth NOEC = 0.6	In Habig, 2004
Midge	30-day adult emergence	Emergence NOEC = 0.6	In Habig, 2004
Fathead minnow	Full lifecycle plus F_1 growth/survival	NOEC = 0.48	In Habig, 2004
Fathead minnow	Full lifecycle plus F_1 growth/survival	Reduced survival of minnows exposed to 0.95 and 1.9	Hamelink and others, 1986
Channel catfish	Early life stage	NOEC = 0.5	In Habig, 2004
Channel catfish fry	Early life stage	Growth NOEC =1	Hamelink and others, 1986
Chinook salmon	**Early life stage**	**Growth NOEC = 0.848** **Gill histopath NOEC = 0.222**	**Habig, 2004**

These findings indicate that the concentrations at which Sonar applications are applied throughout the treatment period, the subsequent Sonar concentrations measured between applications, and the post-treatment Sonar concentrations, are significantly below all published LC50 values for fish and associated invertebrates. In conclusion, there is not expected to be any toxic affects to fish and invertebrate species (including all sensitive species) from EDCP Sonar applications.

D. Direct Impacts to Fish: Bioaccumulation

Herbicide use under the EDCP is unlikely to result in bioaccumulation of toxic substances in fish.

Bioaccumulation Defined

Bioaccumulation is an increase in the concentration of a chemical in a biological organism over time, compared to the chemical's concentration in the environment. Compounds accumulate in organisms whenever they are taken up and stored faster than they are broken down (metabolized) or excreted (EXTOXNET 1993).

A number of terms are used in conjunction with bioaccumulation. Bioconcentration is the specific bioaccumulation process by which the concentration of a chemical in an organism becomes higher than its concentration in the air or water around the organism. Although the process is the same for both natural and man-made chemicals, the term bioconcentration usually refers to chemicals foreign to the organism. For fish and other aquatic animals, bioconcentration after uptake through the gills (or sometimes the skin) is usually the most important bioaccumulation process. Biomagnification describes a process that results in the accumulation of a chemical in an organism at higher levels than are found in its food. It occurs when a chemical becomes increasingly concentrated as it moves through a food chain.[20]

Bioaccumulation Pathways

Bioaccumulation of chemicals in herbicides can occur in fish tissues due to direct uptake through the gills or skin[21] or by consumption and ingestion of invertebrates or other fish that have bioaccumulated these chemicals. Wildlife can potentially bioaccumulate herbicides either by direct uptake through the skin (in the case of frogs and aquatic snakes), drinking of water treated by an herbicide, or consumption of fish and other organisms that had bioaccumulated the herbicide. The potential for bioaccumulation to occur, as well as the potential impacts due to bioaccumulation, depend on the ingredients of the herbicide, environmental conditions, and the physiology of the organism exposed to the herbicide.

1. Reward

The U.S. National Library of Medicine (1995) asserts that there is little or no bioconcentration of diquat in fish or other aquatic organisms because of the herbicides very high solubility in water. Likewise, Syngenta[22] asserts that Reward does not have any potential for bioaccumulation, because diquat has high solubility in water and is rapidly excreted by fish and other animals. Consequently, there is no potential for biomagnification through food chains.[23] In conclusion, exposure of fish to Reward would not result in bioaccumulation in the tissues of fish (or other aquatic organisms).

2. Sonar

Studies indicate that fluridone has a low potential for accumulation in fish and other aquatic organisms.[24] The California Department of Fish and Game (DFG) analyzed Chinook salmon smolts for residues of fluridone and the primary fluridone metabolite, 4-hydroxy fluridone in 2005.[25] The smolts were collected at three sites in the Delta during regular trawls monitoring salmon movement in the Delta. All smolts were from either the Feather River or Merced hatcheries. No residues of >10ppb of either fluridone or 4-hydroxy fluridone were detected in any of the smolt samples. The study determined that salmon are not concentrating fluridone in their tissues, and presented several possible reasons: (1) dilution of fluridone after treatment, (2) short residence time of smolts in treatment areas, and (3) rapid adsorption of fluridone to sediments and suspended solids, reducing bioavailability.

Several researchers have observed instances of bioaccumulation of fluridone, however, these studies generally involved exposure to much higher concentrations of the chemical than would be used under the EDCP. West and others identified total average bioconcentration factors for total fluridone residues of 1.33 for edible tissue, 7.38 for inedible tissue, and 6.08 for whole body.[26] These data were obtained from 175 fish samples collected from across the country. Muir and others reported bioconcentration factors of up to 85 in duckweed following exposure to 5.0ppm of fluridone in water.[27] West and others reported bioconcentration factors ranging from 0 to 15.5 in vascular plants following exposure to 0.10 ppm of fluridone in water.[28] These peak values of fluridone residues were followed by a decline in concentrations as fluridone dissipated from the water column.

No circumstance was identified in the scientific literature where fluridone irreversibly accumulated in biological tissues and remained after the dissipation of the chemical from the water column. SePro Corporation reports that studies have shown that fluridone does not accumulate in fish tissue to any significant degree, and that the relatively minor amounts of fluridone that are absorbed by fish are eliminated as the concentrations of fluridone in the water decline.[29] In conclusion, is unlikely that Sonar use at the concentrations proposed under the EDCP would result in bioaccumulation to any significant degree or in any way that would result in adverse impacts to fish (or other aquatic organisms).

E. Indirect Impacts to Fish: Impacts to Habitat

Loss of Acreage of Egeria in Shallow Water Habitat

An indirect impact to fish, including special status species, could occur through alteration of spawning, rearing, and foraging habitat. The definition of harm under the Endangered Species Act (ESA) prevents major acts of habitat destruction and degradation that prevent a species from breeding, feeding, and sheltering (Mueller 1994). Special status fish species could be impacted by removal of large beds of aquatic plants that they use as habitat. As explained, available data does not indicate that any threatened, endangered, or special status fish species use *Egeria densa* beds for spawning, rearing, or forage. Nor have any migratory fish, such as steelhead or Chinook salmon, been observed in *Egeria densa* beds. However, while there is not evidence that *Egeria densa* beds function as habitat for these fish, it is possible that in some instances they do serve habitat functions. Thus, their removal could negatively impact sensitive fish species to some extent due to loss of cover, rearing, and forage areas.

However, this potentially adverse impact would likely be more than offset by the benefits derived from opening up substrate for native aquatic plants. Removal of *Egeria densa* would likely result in improvements to fish habitat, by enabling native aquatic vegetation (e.g., pond weed) to colonize areas previously dominated by *Egeria densa*. While *Egeria densa* is generally too dense for spawning, rearing, and foraging by native fish, native aquatic vegetation, which is generally less dense, is ideal for these functions.

Loss of Native Aquatic Plants

Treatment of *Egeria densa* is not likely to remove native aquatic plants growing near treatment sites as found by ReMetrix. Native plants may be utilized frequently by special status fish for rearing, cover and forage. While loss of habitat is an important impact to consider, it is unlikely that the EDCP would result in significant loss of native aquatic vegetation and based on ReMetrix results it appears native vegetation replaces *Egeria* following treatments.

Impacts to Habitat due to Decreases in Dissolved Oxygen

Another potential impact to habitat could occur due to the rapid decay of *Egeria densa*, other aquatic macrophytes, and algae, following application of certain herbicides. Decomposition of this vegetative material may create an organic carbon slug, which could in turn reduce dissolved oxygen concentrations. Low dissolved oxygen can result in fish kills and impede migration of salmonids.

1. Reward

Reward use could potentially result in decreases in dissolved oxygen. As a contact herbicide, Reward is taken up quickly and produces results rapidly.[30] The sudden addition of decaying plant biomass in the water column could potentially result in a rapid decrease in dissolved oxygen, if no minimization measures were incorporated into project operations. Resulting impacts include fish kills and blockage of salmonid migration. In conclusion, use of Reward could result in less than significant impacts to habitat from decreases in dissolved oxygen.

The EDCP mitigates for potential reductions in dissolved oxygen levels. EDCP field crews take dissolved oxygen readings prior to treatments and will not initiate a treatment if measured dissolved oxygen levels are between 3.0 and 5.0 mg/L (current Basin Plan standards). EDCP environmental scientists continue to measure post-treatment dissolved oxygen levels to ensure that they do not fall to levels which would create problems for fish or violate Basin Plan standards. From the statistical analysis conducted by the EDCP, over the past five years, dissolved oxygen levels are not shown to decrease, but rather can be shown to increase following EDCP treatments. This suggests the potential for improved oxygen levels in areas where *Egeria densa* has been controlled.

Further, at no time during Reward (diquat) applications, has any DBW field crew member or environmental scientist observed fish kills from these applications. EDCP applications could result in beneficial impacts to salmonid migration areas by displacing the restrictive, matted *Egeria densa* in favor of native pondweed and increasing ambient oxygen levels in the waterway.

2. Sonar

Decreases in dissolved oxygen due to rapid decomposition of plant material are not expected to occur following the use of Sonar. Sonar is a slow-acting systemic herbicide that can take 30 to 60 days to produce its herbicidal effect on the target population.[31] Thus, addition of organic material into the water column would be slow. McLaren/Hart Environmental Corp. cite various researchers (Parka and others 1978, Struve and others 1991) who reported that Sonar applications of up to 0.125 ppm have not resulted in significant decreases in dissolved oxygen content. In field tests conducted by Arnold (1979), fluridone in an aqueous solution at application rates of up to 1.0 ppm did not change water quality parameters as measured by dissolved oxygen, pH, biochemical oxygen demand (BOD), color, dissolved solids, hardness, nitrate, specific conductance, total phosphates, and turbidity.

In conclusion, there are no expected impacts to fish habitat due to decreases in dissolved oxygen levels following Sonar applications. The EDCP mitigates for potential reductions in dissolved oxygen levels. EDCP field crews take dissolved oxygen readings prior to treatments and will not initiate a treatment if measured dissolved oxygen levels are between 3.0 and 5.0 mg/L (current Basin Plan standards). EDCP environmental scientists continue to measure post-treatment dissolved oxygen levels.

F. Indirect Impacts to Fish: Decrease in Abundance of Invertebrate Prey Base

Special status fish species could be impacted indirectly if the EDCP decreased the abundance of invertebrates upon which these fish feed. If applications of herbicides resulted in a high mortality to certain invertebrates, fish that feed on those invertebrates could be adversely affected.

Prey Base of Special Status Fish Species

Juvenile Chinook salmon feed on various aquatic and terrestrial insects, crustaceans, chironomid larvae and pupae, caddisflies (in fresh water), and *Neomysis spp.*, *Gammarus spp*. and *Crangon spp*. in more saline water.[32] Juvenile Delta smelt primarily eat planktonic crustaceans, small insect larvae, and mysid shrimp while older fish feed almost exclusively on copepods (Moyle 1976). Splittail are opportunistic benthic foragers that consume copepods, dipterans, detritus, algae, clams, and amphipods. Herbold (1987) found that splittail select Neomysis as their main prey item in the estuary.

Aquatic Invertebrates That Occur in Stands of Egeria

Exhibit D.9, on the following page, identifies aquatic invertebrates found in *Egeria densa*. Several of these invertebrates, in particular various crustaceans including copepods and dipterans, are consumed by special status species such as splittail, juvenile Chinook salmon, and Delta smelt (Moyle 1976, Wang 1986, and Herbold 1987).

Loss of certain aquatic invertebrates, such as copepods and dipterans, could be potentially significant to Delta smelt, given that Delta smelt abundance is believed correlated with invertebrate abundance. However, this impact would likely be temporary, since planktonic (floating) invertebrates, such as zooplankton and shrimp, would be reintroduced to treatment areas inadvertently through water flow. Further, benthic (bottom dwelling) organisms and plant-dwelling organisms likely would recolonize a treatment area relatively rapidly once regrowth of plant material began.

Exhibit D.9
***Egeria densa* Control Program**
Aquatic Invertebrates Found in *Egeria densa*

Phylum	Class	Order	Family	Genus
Coelenterata				*Hydra*
Platyhelminthes				*Dugesia*
Nemertea				*Prostoma*
Bryozoa				*Plumatella*
Mollusca			Physidae	*Physa*
			Planorbidae	*Gyraulus*
			Ancylidae	*Ferrisia*
Annelida	Oligochaeta		Naididae	*Stylaria*
				Chaetogaster
			Tubificidae	*Tubifex*
			Hirundinea	*Helobdella stagnalis*
				Helobdella fusca
Arthropoda	Crustacea	Amphipoda		*Hyalella azteca*
				Corophium
		Ostracoda		
		Copepoda		
		Cladocera		
			Moinidae	
				Moinodaphnia
			Sididae	
				Sida
			Chydoridae	
				Eurycercus
				Psuedochydorus
Insecta		Odonata	Zygoptera	
		Tricoptera		
		Diptera		
			Culicoidea	
Arachnida		Hydracarina		

1. Reward

Reward use could result in a decrease in the abundance of aquatic invertebrates in and around treatment sites. Under the EDCP, Reward would be applied to achieve a water column concentration of 0.375 ppm diquat for three to six hours. This concentration could be lethal to certain aquatic invertebrates.

Research indicates that diquat is moderately toxic to aquatic invertebrates.[33] USEPA reports a 96-hour LC50 of 0.42 ppm for mysid shrimp.[34] Wilson and Bond found the amphipod *Hyalella azteca* one of the most sensitive aquatic organisms tested, with a 96-hour LC50 of 0.048 ppm.[35] These LC50 values are close to (in the case of the mysid shrimp) or lower than (in the case of the amphipod) the concentrations at which Reward would be applied. This suggests that at least some aquatic invertebrates could be adversely impacted by Reward use.

The California Department of Fish and Game, Aquatic Toxicology Laboratory (DFG-ATC) conducted chronic (7-day) toxicity testing on daphnid (*Ceriodaphnia dubia*) and found an LC50 of 0.078 ppm diquat.[36] The 96-hour LC50 was higher, at 0.14 ppm, but still below the EDCP treatment level. The 7-day NOEC and LOEC levels for diquat were 0.012 ppm and 0.019 ppm, respectively. The DFG-ATL also found a significant difference between individual total average reproduction in the control and concentrations above 0.019ppm.[37]

DFG-ATL testing using EDCP sample waters found that three of seven samples with detectable diquat (4.2, 60, and 110 ppm) resulted in a zero to ten percent survival rate of the water flea (daphnid), *Ceriodaphnia dubia* (7-day test), while the remaining four samples, with generally lower diquat levels of 4.9 to 14 ppm, did not result in significant water flea mortality.[38] In 2002, there was 100 percent mortality of *Ceriodaphnia dubia* in the 96-hour toxicity tests at one site with a high chemical residue level (72 ppb).[39] The EDCP modified their management approach after this high reading to improve mixing of diquat in the treatment zone. At other sites with diquat levels below 20 ppb, survival rates of waterflea in samples with and without detectable diquat both ranged between 80 percent and 100 percent.[40]

Some level of original *Egeria densa* vegetation at any given Reward treatment site is expected to remain following treatment. This remaining vegetation likely would facilitate recolonization of plant-dwelling invertebrates since it would be available as habitat. Invertebrates would be reintroduced to treatment areas inadvertently by water flow.

2. Sonar

Sonar use would not result in a decrease in invertebrate abundance in or around EDCP treatment sites. Under the EDCP, Sonar would be applied to achieve a water column concentration of 10 to 40 ppb (0.01 to 0.04 ppm). This concentration is well below that which is lethal to aquatic invertebrates. DFG testing in 2002 found no difference in *Ceriodaphnia dubia* survival rates in water samples with, and without, detectable fluridone in both 2002 and 2003.[41]

Research indicates that Sonar is toxic to aquatic invertebrates only at high concentrations. The following summarizes relevant research findings. **Exhibit D.10,** on the following page, summarizes the response of various aquatic invertebrates to fluridone.

- Habig (2004) reported results of a number of toxicity tests of fluridone on invertebrates. He reported no observable effect levels (NOEC) of 2 ppm in daphnid, 0.6 ppm in pink shrimp, 5.1 ppm in embryo-larval Eastern oyster, and 13.4 ppm in blue crab. These NOEC levels are several times higher than EDCP concentrations.
- The DFG-ATL found a 7-day LC50 value of 6.9 ppm fluridone, and statistically significant differences between individual total average reproduction at fluridone concentrations above 4.6 ppm,[42] both levels two orders of magnitude greater than EDCP treatment concentrations.
- Habig (2004) also reported results of a number of LC50 tests, also finding levels several times above EDCP treatment concentrations. LC50 and EC50 concentrations in daphnid, amphipod, midge, pink shrimp, eastern oyster, and blue crab ranged from 2.1 ppm to 34 ppm.
- Trumbo (1998) conducted toxicity tests with Sonar and determined the 96-hour LC50 value for crayfish (*Procambarus clarkii*) and snails (*Physa sp.*) to be 105.9 mg/l and 130.8 mg/l (as fluridone) respectively.
- USEPA (1986) asserts that the 48-hour LC50 value for exposure to fluridone is 6.3 ppm.
- Parka and others (1978) noted that 0.3 ppm of fluridone in water did not significantly reduce total numbers of benthic organisms. However, at the exaggerated rate of 1.0 ppm of fluridone in the water, the total number of benthic organisms were significantly reduced when compared to a control population.
- Naqvi and Hawkins (1989) reported Sonar LC50 values of 12.0 ppm, 8.0 ppm, 13.0 ppm and 13.0 ppm for the microcrustaceans *Diaptomus sp.*, *Eucyclops sp.*, *Alonella sp.*, and *Cypria sp.*, respectively.
- Hamelink and others (1986) found that for invertebrates, an average 48-hour or 96-hour LC50 or EC50 (depending on the organism) was 4.3 +/- 3.7 ppm. The representative invertebrates used in the study included amphipods, midges, daphids, crayfish, blue crabs, eastern oysters, and pink shrimp.

Exhibit D.10
***Egeria densa* Control Program**
Response of Various Invertebrates to Fluridone

Organism	LC50 Value [b] (ppm)	Comments	Reference
Procambarus clarkii (crayfish)	105.9	96-hour test	Trumbo 1998
Physa sp. (snail)	130.8	96-hour test	Trumbo 1998
Diaptomus sp. (microcrustacean)	12.0	Not indicated	Naqvi and Hawkins 1989
Eucyclops sp. (")	8.0	Not indicated	Naqvi and Hawkins 1989
Alonella sp. (")	13.0	Not indicated	Naqvi and Hawkins 1989
Cypria sp. (")	13.0	Not indicated	Naqvi and Hawkins 1989
"Representative invertebrates"[a]	4.3+/-3.7	96-hour test	Hamelink and others 1986
Daphnid (water flea)	3.6	48-hour EC50	In Habig 2004
Daphnid	2.0	NOEC	In Habig 2004
Daphnid	6.9	7-day test	DFG-ATL, 2003
Daphnid	7.2	96-hour test	DFG-ATL, 2003
Daphnid	2.43	7-day NOEC	DFG-ATL, 2003
Daphnid	4.6	7-day LOEC	DFG-ATL, 2003
Amphipod	2.1	96-hour test	In Habig 2004
Midge	1.3	48-hour EC50	In Habig 2004
Pink shrimp	2.4	96-hour test	In Habig 2004
Pink shrimp	0.6	NOEC	In Habig 2004
Eastern oyster	>0.62	96-hour shell deposition EC50 and NOEC	In Habig 2004
Eastern oyster	6.8	48-hour embryo-larval EC50	In Habig 2004
Eastern oyster	5.1	48-hour embryo-larval NOEC	In Habig 2004
Blue crab	34	96-hour test	In Habig 2004
Blue crab	13.4	NOEC	In Habig 2004

[a] "Representative invertebrates" used in the study included amphipods, midges, daphnids, crayfish, blue crabs, eastern oysters, and pink shrimp.

[b] Unless otherwise noted in comments

- In chronic toxicity tests conducted by Hamelink and others (1986), no effects were observed in daphnids, amphipods, and midge larvae at fluridone concentrations of 0.2, 0.6, and 0.6 ppm, respectively.

These findings indicate that EDCP Sonar treatments would not result in lethal or sublethal effects to invertebrates present at treatment sites.

G. Indirect Impacts to Fish: Impacts to Essential Fish Habitat (EFH)

EFH for Chinook salmon and two groundfish species (English sole and starry flounder), as defined by the Magnuson-Stevens Fishery Conservation and Management Act (MSA), and regionally implemented by the Pacific Fishery Management Council (PFMC), could potentially be impacted by the EDCP. An adverse effect to EFH is "any impact which reduces the quality and/or quantity of EFH, including direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to benthic organisms, prey species, and their habitat, and other ecosystem components."[43]

1. Impacts to Chinook Salmon EFH

Three Chinook salmon life stages utilize, or move through, the Delta: adult migration pathways, smolt migration pathways, and estuarine habitat. There are a number of habitat concerns for each of these life stages, as identified by the PFMC, ranging from water flow and passage blockage, to water quality.

There are three habitat concerns that may be adversely impacted by the EDCP: water quality, increased predation resulting from habitat simplification or modification/loss of cover, and diminished prey/competition for prey. All three of these concerns have been evaluated previously by the EDCP in the 2001 EDCP EIR.

2. Impacts to Groundfish EFH

The Groundfish Fish Management Plan, Appendix D (GFMP App. D), identifies non-fishing activities with the potential to adversely impact groundfish EFH in riverine, estuarine, and marine systems. GFMP App. D also identifies known and potential impacts of each activity, and provides proactive conservation measures to minimize adverse impacts.[44] The EDCP encompasses one of the described activities, "Pesticide Application." GFMP App. D identifies three ways in which pesticide applications can adversely affect EFH:

1. "A direct toxicological impact on the health or performance of exposed fish,
2. An indirect impairment of the productivity of aquatic ecosystems,
3. A loss of aquatic vegetation that provides physical shelter for fish."[45]

While the FMP notes that fish kills are relatively rare, the plan discusses concerns with sublethal exposure to pesticides, adverse impacts to fish habitat through reduced productivity of aquatic ecosystems, and toxicity to aquatic plants that provide shelter for various fish species. All three of these potential adverse impacts are discussed in this Appendix, in relation to impacts on special status fish species. These potential adverse impacts could adversely impact starry flounder, however, it is unlikely that English sole would be impacted by EDCP activities, as this species is not known to occur within habitats characteristic of EDCP treatment sites.[46] While there is the potential for adverse impacts to starry flounder EFH, these impacts would likely be more than offset by the benefits of removing large, monospecific beds of *Egeria densa*, which are generally too dense for rearing, or foraging by native fish.

GFMP App. D recommends four conservation measures to mitigate potential adverse impacts from pesticide applications in or near EFH.[47] **Exhibit D.11,** below, identifies these four measures, and the associated EDCP approach.

Exhibit D.11
***Egeria densa* Control Program**
EFH Recommended Conservation Measures and EDCP Actions

EFH Recommended Conservation Measure	EDCP Action
Incorporate integrated pest management (IPM) and BMPs as part of the authorization or permitting process to ensure that reduction of pesticide contamination in EFH	EDCP implements an adaptive management approach, IPM, and BMPs as part of the permit conditions and general program protocols and operations (e.g., EDCP Monitoring Plan and Aquatic Pesticide Application Plan)
Carefully review labels and ensures that application is consistent. Follow local, supplemental instructions such as county use bulletins where they are available	EDCP follows label requirements for the two approved aquatic-use pesticides in the program; follows pest control recommendations; submits NOIs; and consults with county Agricultural commissioners prior to treatment
Avoid use of pesticides in and near EFH designated waters	EDCP attempts to minimize use of pesticides, and utilizes two pesticides approved for aquatic use. However, the program includes the application of pesticides into EFH designated waters
Refrain from aerial spraying of pesticide on windy days	EDCP applications take place under water. Treatments on windy/wavy days are avoided to reduce wave-wash of treated water. In general, EDCP applications are avoided when wind exceeds 15 mph

[1] McGowan, 1998.

[2] Matthew L. Nobriga and others, "Evaluating Entrainment Vulnerability to Agricultural Irrigation Diversions: A Comparison among Open-Water Fishes," *American Fisheries Society Symposium* 39 (2004): 281-295.

[3] Matthew L. Norbriga and others, "Fish Community Ecology in an Altered River Delta: Spatial Patterns in Species Composition, Life History Strategies, and Biomass." *Estuaries* 28, no.5 (October 2005), 776-785.

[4] Larry R. Brown, "Will Tidal Wetland Restoration Enhance Populations of Native Fishes?" San Francisco Estuary and Watershed Science 1, no.1 (October 2003), 1-42.

[5] Cook and Urmi-Konig, 1984.

[6] Sherry L. Harrel, Eric D. Dibble, and K. Jack Killgore, "Foraging Behavior of Fishes in Aquatic Plants" (Vicksburg, Mississippi: U.S. Army Corps of Engineers Engineer Research and Development Center, February 2001).

[7] Judith Drexler, et. al., "Effects of the invasive aquatic plant, *Egeria densa*, on native fish habitat in the Sacramento-San Joaquin Delta (Proposal), U.S. Geological Survey, 2006.

[8] McGowan, 1998; McGowan and March, 1998.

[9] Jason Hanni, "USFWS Seasonal Fishery Catch and a Follow Up Investigation of Fish Fauna Assemblages in the Sacramento-San Joaquin River Delta and Bays," IEP Newsletter 18, no. 3 (Fall 2005): 3-8.

[10] Grimaldo and Hymanson, 1999.

[11] Jason Hanni, "USFWS Seasonal Fishery Catch and a Follow Up Investigation of Fish Fauna Assemblages in the Sacramento-San Joaquin River Delta and Bays," *IEP Newsletter* 18, no. 3 (Fall 2005): 3-8.

[12] Ibid., 5.

[13] Ibid., 6.

[14] Ibid., 5.

[15] Ibid., 7.

[16] Frank Riley and Sandra Finlayson, Acute Toxicities of Herbicides Used to Control Water Hyacinth and Brazilian Elodea on Larval Delta Smelt and Sacramento Splittail (Elk Grove, California: DFG, June 8, 2004), also DFG-ATL. "Aquatic Toxicology Laboratory Report" (Rancho Cordova, California: DFG-ATL, June 23, 2003).

[17] Pesticide Action Network (PAN), "Pesticide Database," PAN, www.pesticidinfo.org.

[18] Ibid.

[19] Ibid.

[20] EXTOXNET, 1993.

[21] Ibid.

[22] Syngenta, "Reward Landscape and Aquatic Herbicide", Syngenta, www.syngentaprofessionalproducts.com.

[23] Ibid.

[24] USEPA, 1986.

[25] Hosea, Robert C. "Residues of Fluridone and Primary Fluridone Metabolite in Chinook Salmon Smolts from the Sacramento-San Joaquin Delta, California, 2005" (Rancho Cordova, CA: DFG, Pesticide Investigations Unit, 2006.

[26] West and others, 1983.

[27] Muir and others, 1980.

[28] West and others, 1979.

[29] SePro Corporation, "Sonar* An Effective Herbicide that Poses Negligible Risk to Human Health and The Environment," SePro Corporation, www.sepro.com.

[30] McLaren/Hart Environmental Engineering Corp., 1995.

[31] Ibid.

[32] Wang, 1986.

[33] NYSDEC, 1981.

[34] USEPA, 1995.

[35] Wilson and Bond, 1969.

[36] California Department of Fish and Game, Aquatic Toxicology Laboratory (DFG-ATC). "Aquatic Toxicology Laboratory Report" (Rancho Cordova, California: DFG-ATL, July 28, 2003).

[37] Ibid.

[38] DBW, January 27, 2004.

[39] DBW, January 2003, 22.

[40] Ibid., 31.

[41] DBW, January 2003; DBW, January 27, 2004.

[42] DFG-ATL, July 28, 2003.

[43] 50 CFR 600.910(a) in, PFMC, "Pacific Coast Groundfish Fishery Management Plan for the California, Oregon, and Washington Groundfish Fishery, Appendix D (Portland, Oregon: PFMC, November 2005), 1.

[44] PFMC, November 2005.

[45] Ibid., 10.

[46] However, if English sole did occur in EDCP treatment sites, the potential impacts and mitigation approach would be the same as those described for starry flounder.

[47] Ibid., 10.