

## Third Draft

### Other Stressors Conservation Measures

*Note to Steering Committee:* This handout presents third draft other stressors conservation measures (i.e., measures that address stressors to covered fish species that are not related to operations and physical habitat restoration). All new text added to this draft from the second draft provided to Steering Committee on October 17, 2008 is displayed in underlined red text; text in black is the same as delivered in the second draft.

This third draft incorporates comments received from Steering Committee members to second draft conservation measures presented to the Steering Committee at its October 17, 2008 meeting.

These third draft conservation measures will be discussed at the October 31, 2008 Steering Committee meeting.

#### Introduction

Other stressors on covered fish species include non-native species, toxic contaminants, other water quality issues (e.g., dissolved oxygen, organic content), hatcheries, harvest, non-project diversions, and commercial and recreational activities. The conservation measures are categorized in this document according to the stressor they address. For tracking purposes, the numbering of conservation measures is the same as the previous draft despite revisions, deletions, and combining of conservation measures.

After the conservation measure description, the following information is provided with each conservation measure.

**Rationale.** This section describes the justification for proposing the conservation measure. Rationale statements are primarily directed at identifying the covered species and ecosystem benefits that would be expected with implementing the conservation measure.

**Implementation timeframe.** This section describes the BDCP implementation period (i.e., near-term or long-term) that is likely the most appropriate period for implementing the measure. The BDCP near-term implementation period refers to the period from issuance of BDCP permits to completion of the around-Delta conveyance facilities and the BDCP long-term implementation period includes the period from when dual-conveyance operations are initiated over the remainder of the term of the BDCP.

**Implementation considerations.** This section describes relevant items that may need to be addressed by the BDCP Implementing Entity when planning implementation of the conservation measure.

1           **Resiliency to future change.** This section provides a qualitative assessment of  
2 the likely ability of the conservation measure to continue to provide the desired  
3 level of covered species and ecosystem benefits into the future with anticipated  
4 changes in environmental conditions with climate change and sea level rise.  
5

6           **Uncertainties/risks.** This section describes important uncertainties associated  
7 with the ability of the conservation measure to achieve the desired covered  
8 species and ecosystem benefits and the ecological risks that may be associated  
9 with implementing the proposed conservation measure.  
10

11           **Monitoring and adaptive management considerations.** This section describes  
12 monitoring and adaptive management-related elements of the conservation  
13 measure, including elements of implementation that may be subject to adaptive  
14 management and the types of monitoring that may be appropriate for assessing the  
15 effectiveness of the conservation measure in achieving desired ecological benefits  
16 and for informing the adaptive management process. [*Note to reviewers: The*  
17 *content of this section will be expanded for each conservation measure to provide*  
18 *more specificity regarding monitoring actions and metrics and adaptive*  
19 *management triggers and actions, as appropriate, through future iterations of*  
20 *these materials.*]  
21

22           **Reversibility.** This section qualitatively assesses the likely ability to reverse the  
23 environmental outcomes of the conservation measure, if necessary.  
24

25 The information described above for each of the draft conservation measures will be  
26 expanded upon and incorporated into appropriate sections of the BDCP Conservation  
27 Strategy chapter.  
28

## 29 ***Non-Native Invasive Species***

### 30 **Introduction**

31  
32 This section contains a wide range of conservation measures focused on preventing non-  
33 native species from reaching the Delta and controlling non-native species already  
34 established in the Delta. Stopping non-native invasive species before they reach the Delta  
35 is the most effective way to protect covered species and other native species from  
36 additional stressors. Past invasions have documented the substantial effects non-natives  
37 can have on covered species and the Delta ecosystem. Conservation measures provided  
38 here include measures to increase the detection of invasive species and prevent their entry  
39 into California and the Delta, to rapidly respond to stop invasions at early stages, to  
40 remove invasive plant species from areas important to covered fish species, and to reduce  
41 the effects of non-native predators on covered species.  
42  
43  
44

1 **Conservation Measure NNIS2: Reduce the Risk for Future Introductions of Non-**  
2 **Native Aquatic Organisms from Commercial Vessels.** *[Note to reviewers: This*  
3 *conservation measure addresses the hull fouling program of the California State Lands*  
4 *Commission. As requested by the Steering Committee, SAIC is investigating adding*  
5 *support of the ballast water program to this conservation measure, SAIC is currently in*  
6 *discussions with the U.S. Coast Guard and State Lands Commission to identify any*  
7 *deficiencies in their respective ballast water control programs that could be addressed by*  
8 *the BDCP. In future drafts, this conservation measure would be revised and expanded to*  
9 *include these findings, as appropriate].* To implement this conservation measure, the  
10 BDCP Implementing Entity would support the development of the California State Lands  
11 Commission's Commercial Vessel Fouling Program at a funding level of \$ [REDACTED] over the  
12 term of the BDCP. Initially, this conservation measure would provide funding for the  
13 program to conduct targeted research to characterize the introduction risk posed by  
14 commercial vessel fouling and, if necessary, develop and adopt regulations that prevent  
15 or minimize introductions via vessel fouling and support the development of hull  
16 husbandry technology.

17  
18 The BDCP Implementing Entity would enter into a Memorandum of Agreement (MOA)  
19 or similar binding instrument with the State Lands Commission that would describe  
20 respective roles and obligations for expenditure of BDCP funding. Elements of the MOA  
21 would include a description of specific research and other activities that would be funded  
22 by BDCP, requirements for preparation of work plans for BDCP funded activities,  
23 provisions for documenting work performed, monitoring responsibilities, and provisions  
24 for modifying or terminating the MOA. The BDCP Implementing Entity, in coordination  
25 with the Fishery Agencies, would review proposed targeted research plans to ensure  
26 results would be useful in assessing the likely efficacy of supporting actions to minimize  
27 vessel fouling for substantially reducing the risk of introductions of non-native aquatic  
28 species.

29  
30 The BDCP Implementing Entity would also provide funding to CSLC to develop  
31 effective hull husbandry technologies and enforce commercial fouling regulations  
32 adopted in response to research results indicating that commercial vessel fouling poses a  
33 substantial risk for the introduction of non-native aquatic species into the Delta  
34 ecosystem. If results of the initial targeted research do not indicate that there is a  
35 substantial risk of species introductions from vessel fouling or that technologies to reduce  
36 introduction risk are not cost-effective or feasible, the BDCP Implementing Entity, in  
37 coordination with Fishery Agencies, may terminate this conservation measure. The  
38 BDCP Implementing Entity, in coordination with the Fishery Agencies, would also  
39 terminate this conservation measure if State Lands Commission chooses not to enter into  
40 a MOA with the BDCP Implementing Entity. If terminated, remaining funding would be  
41 deobligated from this conservation measure and reallocated to augment funding for other  
42 more effective conservation measures identified in coordination with the Fishery  
43 Agencies through the BDCP adaptive management process.

44  
45 **Rationale:** Prevention of non-native species introductions is the most cost effective  
46 and environmentally sensitive method to respond to non-native invasive species

1 (CDFG 2008). New introductions of aquatic organisms are often caused by release of  
2 organisms in ballast water discharges and by dispersal of organisms growing on the  
3 outside surfaces of hulls (Takata et al. 2006). The California State Lands Commission  
4 (CSLC) has an existing Ballast Water Program to prevent new non-native species  
5 introductions that includes ballast water management tracking, compliance,  
6 enforcement, research, education, and outreach (Falkner et al. 2007). According to  
7 State Lands Commission staff, the Ballast Water Program is fully funded by a fee  
8 system and is >90% successful in gaining compliance of vessel operators (N.  
9 Dobroski, pers. comm.). However, hull husbandry to prevent fouling by non-native  
10 species introductions into California is not currently regulated by State Lands  
11 Commission (Takata et al. 2006). This topic has gained interest among regulators  
12 recently but does not have the level of infrastructure, knowledge base, or technology  
13 needed to be effective. The State Lands Commission has recommended that the  
14 Legislature allow the State Lands Commission to adopt regulations to broaden the  
15 State programs to control non-native invasive species to include a Vessel Fouling  
16 Program (Takata et al. 2006). Although vessel fouling primarily transports marine  
17 species over long distances, the same vessels frequently make multiple stops along  
18 the west coast of North America and can move organisms that are adapted to brackish  
19 water environments (such as Suisun Bay and Marsh and the West Delta) from port to  
20 port. Additionally, many brackish and freshwater species are tolerant of high salinity  
21 and other adverse environmental conditions for extended periods, such as those  
22 required to travel between North America and Asia (Panov 1996, Mann and Harding  
23 2003, Bailey et al. 2004) and could pose a threat to the Delta.  
24

25 The Marine Invasive Species Act of 2003 directed the State Lands Commission to  
26 analyze the risk of introductions via vessel fouling in consultation with a technical  
27 advisory group that produced a list of recommendations (Takata et al. 2006). The  
28 highest priorities identified in the analysis include: 1) authorizing the State Lands  
29 Commission to develop and adopt regulations that prevent or minimize introductions  
30 via vessel fouling; 2) expanding and coordinating targeted biological research  
31 directed towards characterizing the introduction risk posed by commercial vessel  
32 fouling with other state and federal agencies, and; 3) supporting research promoting  
33 technology development (Takata et al. 2006).  
34

35 Although it is difficult to predict the potential effects of future introductions of non-  
36 native species, there are several well-documented examples of deleterious effects  
37 caused by non-natives introductions into the Delta. Two non-native invasive aquatic  
38 plants, water hyacinth (*Eichhornia crassipes*) and Brazilian waterweed (*Egeria*  
39 *densa*), have reduced habitat quantity and quality for many native fishes in the  
40 Planning Area (NMFS 2004), and possibly are providing habitat for non-native  
41 predatory centrarchids. The introductions of two clams from Asia, the overbite clam  
42 (*Corbula amurensis*) and the Asian clam (*Corbicula fluminea*) have resulted in  
43 substantial effects in the Delta in just 20 years. These clams are considered ecosystem  
44 modifiers because of their wide ranging effects on the aquatic ecosystem and specific  
45 native species. Both are highly efficient filter feeders that reduce phytoplankton and  
46 zooplankton in the water column, which can be food for native fishes, such as delta smelt

1 and young Chinook salmon (Kimmerer and Orsi 1996, NMFS 2004, Center for  
2 Biological Diversity 2007). Several introduced invertebrate species that are food for  
3 several covered fish species have replaced native species in the low salinity zone, and  
4 may have led to lower foraging efficiency, starvation, and reduced growth rates of these  
5 fishes (Moyle 2002). If the effects of past introductions are an indication of the effects  
6 of future introductions, there will likely be large ecosystem scale effects of non-natives  
7 introduced in the Delta in the future. Further, although not yet in the Delta, zebra  
8 (*Dreissena polymorpha*) and quagga mussels (*Dreissena rostriformis bugensis*) may  
9 soon establish. These mussels have caused >90% mortality of native bivalves in other  
10 parts of North America (Ricciardi et al. 1996).

11  
12 **Implementation timeframe:** It is anticipated that this conservation measure could be  
13 implemented in the BDCP near-term implementation period.

14  
15 **Implementation considerations:** Implementation would be accomplished through a  
16 funding agreement with State Lands Commission and by the transfer of funds, both of  
17 which would address the three high priorities described above.

18  
19 **Resiliency to future changes:** This action would not be influenced by future climate  
20 change.

21  
22 **Uncertainties/risks:** There are currently no data describing the frequency of  
23 introductions of fouling organisms due to short range port-to-port movement of ships  
24 (Foss et al. 2007). Therefore, the benefits of this conservation measure cannot be  
25 easily predicted. The benefits could be very large depending on the non-native  
26 invasive introductions that are prevented by the measures. Existing non-native  
27 invasive species in the Delta have a wide range of substantial impacts on covered  
28 species and future introductions would be expected to have a similar range of  
29 substantial impacts on covered species, if preventative measures are not taken.

30  
31 **Monitoring and adaptive management considerations:** *[Note to reviewers: this*  
32 *section is a general summary; more detail will be provided in future iterations]* The  
33 State Lands Commission would be responsible for monitoring the effectiveness of the  
34 Commercial Vessel Fouling Program for reducing the risk of the introduction and  
35 establishment of non-native species in the Delta. The BDCP Implementing Entity  
36 would review progress reports and other relevant reports prepared by State Lands  
37 Commission for the Commercial Vessel Fouling Program to assess the effectiveness  
38 of the programs in assessing the importance of hull fouling, formulating regulations,  
39 and improving hull husbandry technology. The BDCP Implementing Entity would  
40 coordinate with State Lands Commission to adjust strategies and funding levels  
41 through the BDCP adaptive management process as appropriate based on review of  
42 agency reports.

43  
44 If results of the initial targeted research do not indicate that there is a substantial risk  
45 of species introductions from vessel fouling or that technologies to reduce

1 introduction risk are not cost-effective or feasible, the BDCP Implementing Entity, in  
2 coordination with Fishery Agencies, may terminate this conservation measure.

3  
4 **Reversibility:** This conservation measure is considered to be moderately reversible.  
5 Possible expenditures in equipment purchases would not be recovered if the program  
6 were to not be continued.

7  
8  
9 **Conservation Measure NNIS3: Reduce the Risk for Future Introductions of Non-**  
10 **Native Aquatic Organisms from Recreational Watercraft.** To implement this  
11 conservation measure, the BDCP Implementing Entity would support a watercraft  
12 inspection program of the California Department of Fish and Game (CDFG) to prevent  
13 future invasions of non-natives into the Delta at a funding level of up to \$\_\_\_\_\_ over the  
14 term of the BDCP. Such a program could establish a certificate program whereby boats  
15 and trailers entering Delta waterways would be required to be inspected and, if free of  
16 standing water and organisms, would be given a seven-day certificate. Multiple  
17 inspection stations would be set up along major driving routes throughout the Delta. The  
18 program could be operated under the auspices of CDFG game wardens, potentially as  
19 part of DBEEP. Funding would be provided to implement the certificate program and  
20 increase the number of watercraft inspections over the level provided under current  
21 funding and staffing resources. Initial stages of the program would determine the level of  
22 effort and geographical extent needed for the program. Public outreach and education are  
23 implicitly necessary for the program to be implemented effectively.

24  
25 The BDCP Implementing Entity would enter into a Memorandum of Agreement (MOA)  
26 or similar binding instrument with CDFG that would describe respective roles and  
27 obligations for expenditure of BDCP funding. Elements of the MOA would include a  
28 description of specific activities that would be funded by BDCP, requirements for  
29 preparation of work plans for BDCP funded activities, provisions for documenting work  
30 performed, monitoring responsibilities, and provisions for modifying or terminating the  
31 MOA. CDFG would also be responsible for monitoring the effectiveness of the  
32 inspection program and inspection methods to improve their effectiveness over time.

33  
34 The BDCP Implementing Entity would review progress or other relevant reports prepared  
35 by CDFG to assess the effectiveness of the program in reducing risk of the introduction  
36 and establishment of non-native species. The BDCP Implementing Entity would  
37 coordinate with the CDFG to adjust inspection strategies and funding levels through the  
38 BDCP adaptive management process as appropriate based on review of agency reports.

39  
40 If results of effectiveness monitoring indicate that the inspection program does not  
41 substantially and cost-effectively reduce the risk of introductions of non-native aquatic  
42 species into the Delta aquatic ecosystem, the BDCP Implementing Entity, in coordination  
43 with Fishery Agencies, may terminate this conservation measure. This conservation  
44 measure would also be terminated if CDFG chooses not to enter into MOAs with the  
45 BDCP Implementing Entity. If terminated, remaining funding would be deobligated  
46 from this conservation measure and reallocated to augment funding for other more

1 effective conservation measures identified in coordination with the Fishery Agencies  
2 through the BDCP adaptive management process.

3  
4  
5 **Rationale:** A primary vector of local introductions of aquatic non-native species is  
6 recreational watercraft and trailers used to transport them (CDFG 2008). Non-natives  
7 can become attached to the hulls and engines of watercraft or various parts of trailers  
8 or be transported in standing bilge water or live bait tanks. Increasing inspection  
9 efforts of watercraft by trained experts could increase the identification and  
10 subsequent removal of non-natives from watercraft, thereby reducing the risk of  
11 introduction into the Delta. Since the invasion of quagga mussels into Southern  
12 California waterways in January 2007, the California Department of Food and  
13 Agriculture and CDFG boat inspection efforts at California borders have increased  
14 and many reservoirs have begun inspection programs. However, there is currently no  
15 comprehensive effort to inspect boats entering Delta waterways.

16  
17 Inspections have been implemented at reservoirs throughout the state. Although it is  
18 difficult to predict the potential effects of future introductions of non-native species,  
19 there are well-documented examples of deleterious effects caused by non-natives  
20 introduced into the Delta. If the impacts of past introductions are an indication of the  
21 impacts of future introductions, there will likely be new large-scale ecosystem effects  
22 of non-natives in the Delta. Recent introductions of quagga and zebra mussels into  
23 southern California, likely via recreational watercraft, have indicated a need to  
24 develop a Delta-specific watercraft inspection program to slow and contain the spread  
25 of the mussels across the state, particularly with respect to the Delta. To prevent new  
26 aquatic species invasions, a comprehensive inspection program would need to be  
27 developed in which all boats are inspected in all locations that could influence the  
28 Delta.

29  
30 Funding would be sufficient to support up to    additional wardens over existing  
31 staffing levels and an annual training program (or refresher) on aquatic invasive  
32 species identification, disposal, and reporting methods.

33  
34 **Implementation timeframe:** It is anticipated that this conservation measure could be  
35 implemented in the BDCP near-term implementation period.

36  
37 **Implementation considerations:** Significant coordination and funding would be  
38 needed for this program to be developed. There would likely be contention among the  
39 boating community regarding this conservation measure. Implementation would be  
40 accomplished through a funding agreement with CDFG or by the transfer of funds.

41  
42 **Resiliency to future changes:** This action would not be influenced by future climate  
43 change.

44  
45 **Uncertainties/risks:** The benefits of this conservation measure cannot be easily  
46 predicted but the benefits could be very large depending on the non-native invasive



1 introductions that are prevented and the control or eradication methods that are  
2 implemented. Existing non-native invasive species in the Delta have a wide range of  
3 substantial impacts on covered species and future introductions would be expected to  
4 have a similar range of substantial impacts on covered species. There will always  
5 remain the risk that invasive species propagules on recreational vessels will avoid  
6 detection to reach and invade the Delta.

7  
8 **Monitoring and adaptive management considerations:** *[Note to reviewers: this*  
9 *section is a general summary; more detail will be provided in future iterations]* The  
10 Department of Fish and Game would be responsible for monitoring the effectiveness  
11 of BDCP-funded elements of a watercraft inspection program. The BDCP  
12 Implementing Entity would review progress or other relevant reports prepared by the  
13 Department of Fish and Game to assess the effectiveness of the program in reducing  
14 risk for the introduction and establishment of non-native species. The BDCP  
15 Implementing Entity would coordinate with the Department of Fish and Game to  
16 adjust inspection strategies and funding levels through the BDCP adaptive  
17 management process as appropriate based on review of agency reports.

18  
19 **Reversibility:** This conservation measure is expected to be easily reversible.  
20

21  
22 **Conservation Measure NNIS7: Provide for Rapid Detection of and Response to New**  
23 **Introductions of Non-Native Species into Delta Waterways.** The BDCP

24 Implementing Entity would support the formation of a CDFG Delta-specific rapid  
25 response team for new non-native introductions into the Delta at a funding level of up to  
26 \$\$ over the term of the BDCP. In addition to funding, the BDCP Implementing  
27 Entity would assist and work with DFG to meet other elements of a successful rapid  
28 response program:

- 29 1. Obtaining legal authority to take action;  
30 2. Developing a mechanism or process by which to agree upon species targeted for  
31 eradication; and  
32 3. Developing a mechanism or process by which to agree upon control strategies, and  
33 clear them of regulatory hurdles.

34 This conservation measure would contribute funding to form a rapid response team  
35 specific to the Delta by specifying that these monies fund actions in the Delta or at  
36 locations outside the Delta for species with a high likelihood of invading the Delta.

37  
38 The BDCP Implementing Entity would enter into a Memorandum of Agreement (MOA)  
39 or similar binding instrument with CDFG that would describe respective roles and  
40 obligations for expenditure of BDCP funding. Elements of the MOA would include a  
41 description of specific activities and equipment that would be funded by BDCP,  
42 preparation of annual work plans for BDCP funded activities, provisions for documenting  
43 work performed, monitoring responsibilities, and provisions for modifying or terminating  
44 the MOA.

45  
46 CDFG would be responsible for:



- 1       ▪ developing annual work plans that specify the extent and types of activities to be  
2       implemented by CDFG at funded levels for submittal to the BDCP Implementing  
3       Entity;
- 4       ▪ implementing the scope of work and submitting reports as specified in the MOAs  
5       that demonstrate that work plans have been successfully implemented; and
- 6       ▪ monitoring the effectiveness of detection and response procedures and improving  
7       them as warranted over time.

8  
9       The BDCP Implementing Entity, in coordination with the Fishery Agencies, would  
10      periodically review the cost effectiveness of this conservation measure in achieving  
11      benefits for covered fish species. If it is determined that this conservation measure does  
12      not provide a substantial cost-effective benefit for covered fish species, the BDCP  
13      Implementing Entity in coordination with Fishery Agencies may terminate this  
14      conservation measure. The BDCP Implementing Entity would also terminate this  
15      conservation measure if CDFG chooses not to enter into a MOA with the BDCP  
16      Implementing Entity. If terminated, remaining funding would be deobligated from this  
17      conservation measure and reallocated to augment funding for other more effective  
18      conservation measures identified in coordination with the Fishery Agencies through the  
19      BDCP adaptive management process.

20  
21      **Rationale:** The CAISMP contains an action recommending the development of  
22      “species- and/or location-specific rapid response plans” (CDFG 2008). Immediate  
23      response to initial invasions by non-native species can eradicate those species before  
24      they become widespread and established in the Delta. Any delay in response could  
25      allow for establishment of a non-native species over an area too large for eradication  
26      efforts. By stopping invading species before they become well established, this  
27      measure could prevent substantial adverse effects on covered species as evinced by  
28      past non-native invasions. The CAISMP also contains a Draft Rapid Response Plan  
29      for aquatic invasive species in California. The Draft Rapid Response Plan states that  
30      “the Plan cannot be implemented without adequate, stable and dedicated funding”  
31      (CDFG 2008).

32  
33      **Implementation timeframe:** It is anticipated that this conservation measure could be  
34      implemented in the BDCP near-term implementation period.

35  
36      **Implementation considerations:** Implementation would be accomplished through a  
37      funding agreement with CDFG and by the transfer of funds.

38  
39      **Resiliency to future changes:** This action would be resilient to future climate change  
40      because adaptive management is built into the CAISMP.

41  
42      **Uncertainties/risks:** The benefits of this conservation measure cannot be easily  
43      predicted but the benefits could be very large depending on the success of the control  
44      or eradication methods that are implemented. Existing non-native invasive species in  
45      the Bay/Delta have a wide range of impacts on covered species and future

1 introductions would be expected to have a similar range of impacts on covered  
2 species.

3  
4 **Monitoring and adaptive management considerations:** *[Note to reviewers: this*  
5 *section is a general summary; more detail will be provided in future iterations]* The  
6 BDCP Implementing Entity would review progress reports or other relevant reports  
7 prepared by CDFG to assess the effectiveness of the Delta-specific rapid response  
8 team in preventing the establishment of new invasive non-native species in the Delta.  
9 The BDCP Implementing Entity would coordinate with CDFG to adjust invasive  
10 species control strategies and funding levels through the BDCP adaptive management  
11 process as appropriate, based on review of agency reports.

12  
13 **Reversibility:** This conservation measure is expected to be highly reversible.

14  
15  
16 **Conservation Measure NNIS8: Reduce the Risk for Establishment of Zebra Mussel**  
17 **and Quagga Mussel in Delta Waterways.** The BDCP Implementing Entity would  
18 support implementation of the following actions to a funding level of \$\$ over the  
19 term of the BDCP:

20  
21 1. Complete annual updates of the Zebra Mussel Rapid Response Plan for California  
22 (ZMRRPC) to include quagga mussel (*Dreissena rostriformis bugensis*) and  
23 incorporate eradication scenarios that reflect the operations and covered species data  
24 that are generated by the development and implementation of the BDCP. The  
25 scenarios should include a full range of possible invasion patterns, invasion extents,  
26 covered species distributions and life history sensitivities, and water status and  
27 operation patterns that represent drought and normal rainfall water years.

28  
29 2. Apply to the EPA for the appropriate permits to use potassium salt solution and/or  
30 the common soil bacterium, *Pseudomonas fluorescens*, as control measures and  
31 develop a draft template Environmental Assessment for USFWS and NOAA that is  
32 reviewed annually to incorporate the latest Delta specific data. Similar templates  
33 would be developed for the appropriate State agencies' compliance with CEQA.

34  
35 3. Conduct mussel control experiments to evaluate a range of potassium chloride salt  
36 and *P. fluorescens* solution delivery options in waterways of different sizes and  
37 hydrological dynamics.

38  
39 4. Conduct research on the effects of potassium chloride salt and *P. fluorescens* on  
40 covered fish species.

41  
42 5. Endow a control program with permanent funding to cover eradication efforts.

43  
44 The BDCP Implementing Entity would enter into Memoranda of Agreement (MOAs),  
45 contracts, or other binding instruments with appropriate entities as needed to implement  
46 this conservation measure. Agreements with these entities would describe respective

1 roles and obligations for expenditure of BDCP funding. Elements of agreements would  
2 include a description of specific activities and equipment purchases funded by BDCP,  
3 preparation of annual work plans for BDCP funded activities, provisions for documenting  
4 work performed, monitoring responsibilities, and provisions for modifying or terminating  
5 agreements.

6  
7 Funded entities would be responsible for implementing the scopes of work and  
8 submitting reports as specified in the agreements that demonstrate that work plans are  
9 successfully implemented. The BDCP Implementing Entity in coordination with the  
10 Fishery Agencies will periodically review the cost effectiveness of this conservation  
11 measure in achieving benefits for covered fish species. If it is determined that this  
12 conservation measure does not provide a substantial cost-effective benefit for covered  
13 fish species, the BDCP Implementing Entity in coordination with Fishery Agencies may  
14 terminate this conservation measure. If terminated, remaining funding would be  
15 deobligated from this conservation measure and reallocated to augment funding for other  
16 more effective conservation measures identified in coordination with the Fishery  
17 Agencies through the BDCP adaptive management process.

18  
19 **Rationale:** The ZMRRPC and its appendices contain a series of rapid response  
20 actions and control alternatives that were written specifically for the Delta and  
21 intended to be used as a template for other bodies of water (Messer and Veldhuizen  
22 2005). In its current form, the ZMRRPC anticipates that control options and permits  
23 would be applied after either zebra or quagga mussels are detected and it provides a  
24 number of scenarios and potential control responses that are specific to the Delta.  
25 Quagga mussel has been detected in Lake Mead in 2007 and subsequently at a  
26 number of other locations along the Colorado River and in canals and reservoirs that  
27 receive Colorado River water in southern California. A 2003 survey of boaters at the  
28 same boat launches on Lake Mead where quagga mussel was detected found that  
29 1.2% of all vessels came from zebra mussel infested states and that no boaters had  
30 launched in infested waterways within 30 days (Gerstenberger et al. 2003). The  
31 response to the Lake Mead infestation has been studied and a number of  
32 recommendations for a rapid response program have been proposed (California  
33 Science Advisory Panel 2007). The included recommendations provide for a  
34 management structure that will permit an efficient response (M. Volkoff, pers.  
35 comm.) but does not address control or management methods. The report also notes  
36 that the lack of a dedicated rapid response funding source caused many of the Lake  
37 Mead managers to spend a significant amount of their time trying to obtain funding  
38 and staff instead of responding to the emergency. In 2008, zebra mussels were  
39 detected in San Justo Reservoir that receives Delta water; the reservoir has since been  
40 quarantined.

41  
42 **Implementation timeframe:** It is anticipated that this conservation measure could be  
43 implemented in the BDCP near-term implementation period.

44  
45 **Implementation considerations:** Implementation would be accomplished through a  
46 funding agreement with CDFG and CDWR and by the transfer of funds.

1  
2 **Resiliency to future changes:** This action would be resilient to future climate change  
3 because adaptive management is built into both rapid response plans.  
4

5 **Uncertainties/risks:** Adverse effects of zebra and quagga mussels on freshwater  
6 aquatic ecosystems have been documented across the U.S.  
7

8 **Monitoring and adaptive management considerations:** *[Note to reviewers: this*  
9 *section is a general summary; more detail will be provided in future iterations].* The  
10 agencies charged with implementing the ZMRRPC would be responsible for  
11 monitoring the effectiveness of BDCP-funded elements of the program. The BDCP  
12 Implementing Entity would review progress reports or other relevant reports prepared  
13 by the agencies to assess the effectiveness of the program in reducing risk for the  
14 introduction and establishment of zebra and quagga mussels. The BDCP  
15 Implementing Entity would coordinate with the agencies to adjust mussel control  
16 strategies and funding levels through the BDCP adaptive management process as  
17 appropriate, based on review of agency reports.  
18

19 **Reversibility:** This conservation measure is expected to be highly reversible.  
20  
21

22 **Conservation Measure NNIS9: Remove Non-Native Submerged and Floating**  
23 **Aquatic Vegetation from [REDACTED] Acres of Delta Waterways.** The BDCP Implementing  
24 Entity would ensure the removal of Brazilian waterweed (*Egeria densa*), water hyacinth  
25 (*Eichhornia crassipes*), and other non-native submerged and floating aquatic vegetation  
26 (SAV and FAV) from at least [REDACTED] acres of Delta waterways to increase turbidity  
27 conditions and reduce effects of predation on covered fish species (see *Rationale*  
28 discussion below). The BDCP Implementing Entity would ensure the maintenance of  
29 areas cleared of SAV and FAV over the term of the BDCP. The implementation of the  
30 control program would target control efforts on the highest priority fish migration  
31 corridors and habitat for the covered fish species and would be coordinated with and  
32 integrated into BDCP habitat restoration and flow operations programs. Following initial  
33 removal of SAV and FAV, the reestablishment of SAV and FAV in treated waterways  
34 would be monitored to determine the need for subsequent treatments to remove SAV and  
35 FAV.  
36

37 To implement this conservation measure, the BDCP would support the California  
38 Department of Boating and Waterways Brazilian waterweed and Water Hyacinth Control  
39 Program and applicable future non-native aquatic vegetation control programs to reduce  
40 the impacts of SAV and FAV on covered fish species at a funding level of \$ [REDACTED] over  
41 the term of the BDCP.  
42

43 The BDCP Implementing Entity would enter into a Memorandum of Agreement (MOA)  
44 or similar binding instrument with the California Department of Boating and Waterways  
45 that would describe respective roles and obligations for expenditure of BDCP funding.  
46 Elements of the MOA would include a description of specific activities that would be

1 funded by BDCP, preparation of annual work plans for BDCP funded activities,  
2 provisions for documenting work performed, monitoring responsibilities, and provisions  
3 for modifying or terminating the MOA. The BDCP Implementing Entity would  
4 implement this conservation measure if the California Department of Boating and  
5 Waterways does not choose to participate in its implementation.  
6

7 The BDCP Implementing Entity would be responsible for developing annual work plans  
8 in coordination with U.S. Fish and Wildlife Service, National Marine Fisheries Service,  
9 and Department of Fish and Game (Fishery Agencies) that specify the extent and  
10 locations of SAV and FAV control activities to be implemented by the Department of  
11 Boating and Waterways at funded levels. Treatment areas would be focused on removing  
12 SAV and FAV from channels that support important juvenile salmonid, delta smelt, and  
13 longfin smelt habitat use areas. The Department of Boating and Waterways would be  
14 responsible for implementing the scope of work and submitting reports as specified in the  
15 MOA that demonstrate that the work plan has been successfully implemented. The  
16 Department of Boating and Waterways would also be responsible for monitoring the  
17 effectiveness of SAV and FAV control measures and adjusting control methods to  
18 improve their effectiveness over time.  
19

20 The BDCP Implementing Entity would be responsible for monitoring the effectiveness of  
21 the control activities in achieving covered species benefits. This monitoring would be  
22 required because of the uncertainties of the effectiveness of SAV and FAV removal in  
23 providing covered fish species benefits such as reduction in predators and increase in  
24 turbidity (see *Uncertainties/Risks* below). Monitoring would be conducted to assess the  
25 effect of removing SAV and FAV on turbidity levels, predator abundance, and abundance  
26 of juvenile salmonids, delta smelt, and longfin smelt in treated channels. The BDCP  
27 Implementing Entity in coordination with the Fishery Agencies may discontinue  
28 monitoring in future years if monitoring results indicate a strong correlation between  
29 SAV and FAV control efforts and responses of covered fish species.  
30

31 The BDCP Implementing Entity would use results of effectiveness monitoring to  
32 determine if controlling SAV and FAV results in measurable benefits to covered fish  
33 species and to identify adjustments to funding levels, intensity of control efforts, control  
34 methods, or other related aspects of the program that would improve the biological  
35 effectiveness of the program. Such changes would be enacted through the BDCP  
36 adaptive management process and would be included in the subsequent annual work  
37 plans.  
38

39 If results of monitoring indicate that control of SAV and FAV does not substantially and  
40 cost-effectively benefit covered fish species, the BDCP Implementing Entity in  
41 coordination with Fishery Agencies may terminate this conservation measure. If  
42 terminated, remaining funding would be deobligated from this conservation measure and  
43 reallocated to augment funding for other more effective conservation measures identified  
44 in coordination with the Fishery Agencies through the BDCP adaptive management  
45 process.  
46

1       **Rationale:** This rationale is primarily focused on SAV because of its much greater  
2       distribution and coverage in the Bay and Delta and because control programs have  
3       been very effective against non-native FAV, such as water hyacinth. Recent simple  
4       conceptual models of the Delta ecosystem have hypothesized that SAV may alter  
5       ecosystem food web properties in two different ways to the detriment of the covered  
6       species. The models propose that the SAV may exert a “top down” reduction of  
7       covered fish populations indirectly through increased levels of predation on covered  
8       species by non-native fish species in the sunfish family (Centrarchidae) that includes  
9       largemouth bass (Brown 2003, IEP 2008a). A “bottom up” reduction of habitat  
10      quality is also proposed. In the “bottom up” models, dense stands of SAV are  
11      hypothesized to reduce food availability by physically obstructing access (IEP  
12      2008a). SAV is also hypothesized to impact the amount of invertebrate and  
13      planktonic prey available to native fishes, a “bottom up” effect, through its effects on  
14      the physical and chemical characteristics of the water column (Scheffer 2004, Brown  
15      and Michniuk 2007).

16  
17      Top down predation impacts are hypothesized to arise in two ways. First, SAV  
18      provides relatively high quality habitat for non-native piscivores that is spread across  
19      large portions of the Delta in or adjacent to significant migration corridors and  
20      pelagic and subtidal open water habitat for covered species (Figure 1). The interior of  
21      SAV stands is hypothesized to be good habitat for largemouth bass larvae and  
22      juveniles (Brown 2003, Grimaldo et al. 2004) while adult largemouth bass hunt  
23      immediately outside of the SAV bed and feed on juvenile Chinook salmon (Brown  
24      2003, IEP 2008a) and, potentially, on pelagic native species (potentially including  
25      delta smelt and longfin smelt). Second, it is hypothesized that a SAV driven decrease  
26      in turbidity will increase the hunting efficiency of non-native piscivores (Nobriga et  
27      al. 2005).

28  
29      While it has been clearly demonstrated that SAV is unique and valuable habitat for  
30      centrarchids, the hypothesized impacts of *Egeria densa* supported populations of non-  
31      native piscivores on the covered species have not been subjected to rigorous testing.  
32      The paper frequently cited to support the *Egeria* /non-native piscivore hypothesis  
33      concluded that “our data and analysis do not support any particular explanation for  
34      the decline in native fish [catch per unit effort]” (Brown and Michniuk 2007).  
35      Additionally, the statistical analyses used in this paper may be questionable.

36  
37      Bottom up effects of SAV are hypothesized to be due to both physical obstruction and  
38      reduced turbidity caused by dense populations of SAV. The dense population can  
39      significantly reduce wave energy and current speed, which results in the suspended  
40      particles of inorganic and organic matter being trapped on or near the bottom or  
41      provides a refuge for zooplankton. These zooplankton can reduce phytoplankton to  
42      very low concentrations, resulting in a clear water state (Stacey 2003, Scheffer 2004,  
43      Jones et al. 2008). None of these potential effects have been demonstrated as  
44      significant overall for the Delta (Jassby 2008).

45

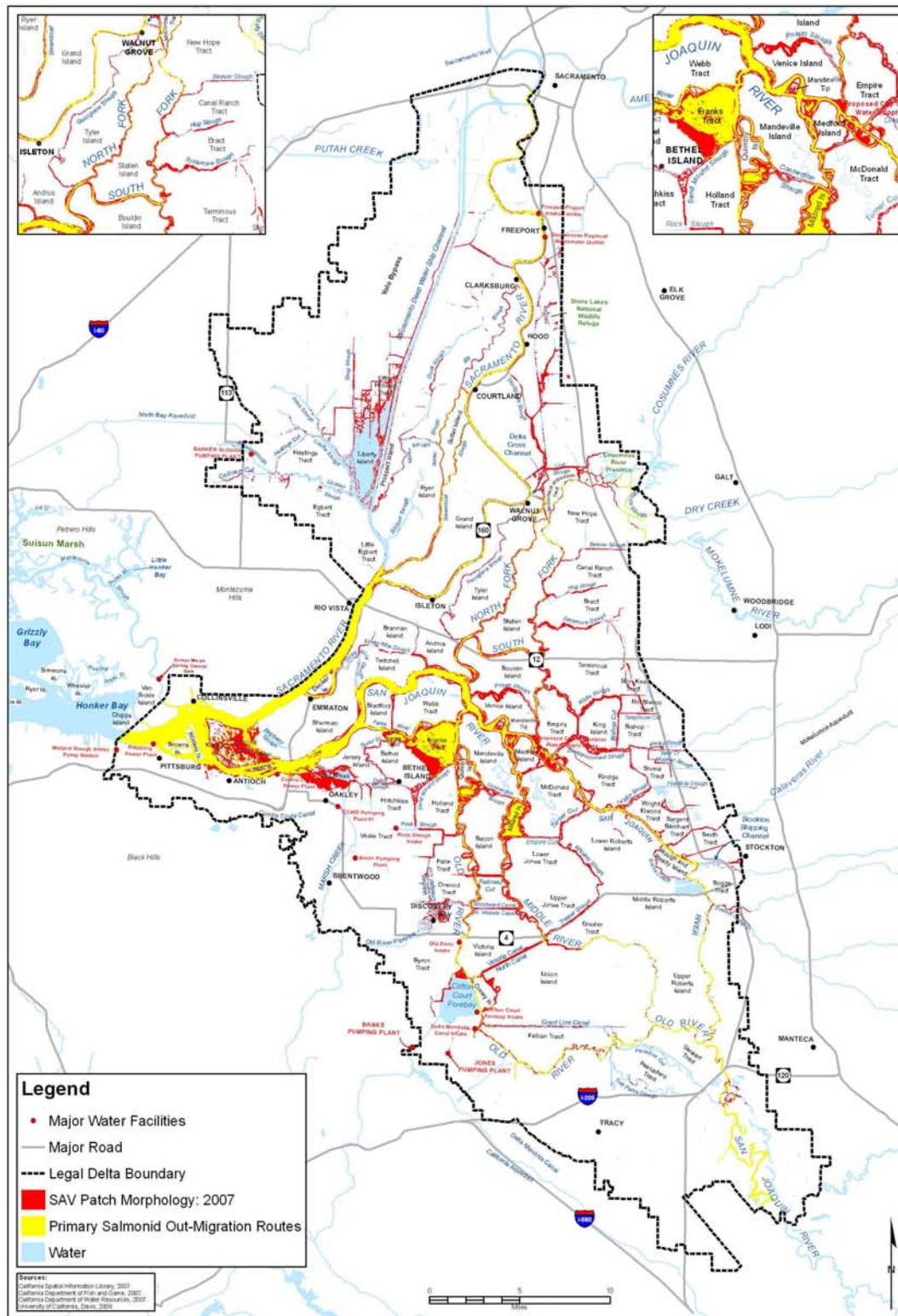


1       Currently, there appear to be few data from Delta studies that directly link the non-  
2       native SAV invasion to negative impacts on the covered species but there are strong  
3       data showing that the invasion is completely eliminating native SAV and sub-tidal  
4       communities. This situation exists because the direct effect of SAV colonizing a new  
5       area is relatively easy to (Scheffer 2004) quantify while the potential impacts of the  
6       invasion on the food web have only recently been recognized and are very difficult to  
7       test. Despite the fact that the impacts of the rapid expansion of *Egeria* and other non-  
8       native SAV on the Bay/Delta ecosystem have not yet been rigorously tested, basic  
9       principles of ecology suggest that significant impacts have occurred simultaneously  
10      with SAV establishment in similar ecosystems (Scheffer 2004) and, by analogy, have  
11      also occurred in the Delta. Those basic ecological principles also caution that it will  
12      be difficult to detect trends in the SAV impacts due to the possibility of the ecosystem  
13      switching between different states in an almost chaotic fashion (Scheffer 2004).  
14      Additionally, a management choice to not address the *Egeria* invasion is an

DRAFT

1

2 Figure 1. Overlap of SAV in 2007 and primary salmonid outmigration routes.



3

1 affirmative management action that will have irreversible effects. In this case,  
2 management actions should (CDBW 2006) be based on the precautionary principle of  
3 affirmatively acting to conserve the resources in the face of substantial uncertainty.  
4

5 The historical extent of native SAV in the Delta ecosystem is unknown but non-  
6 native invasive SAV species have recently invaded large areas of the Delta (Brown  
7 2003, CDFG 2008, Ustin et al. 2008) and the invasion is continuing to expand into a  
8 greater proportion of channels and to colonize new areas (IEP 2008b). The majority  
9 of the surface cover of SAV detected through the recent use of airborne hyperspectral  
10 imagery has been shown to be the non-native *Egeria densa*, although the SAV  
11 vegetation frequently contains a mixture of three invasive non-native species: *Egeria*  
12 *densa*, *Potamogeton crispus* (curlyleaf pond weed), and *Myriophyllum spicatum*  
13 (Eurasian watermilfoil) (Ustin et al. 2008). Of the 55,000 acres of the Delta surveyed  
14 in 2007, SAV cover has been estimated to be between 5,500 acres (raster data) and  
15 10,000 acres (vector data after post processing) (Ustin et al. 2008).  
16

17 California Department of Boating and Waterways (CDBW) developed and has  
18 operated the *Egeria densa* Control Program (EDCP) since 2001 in response to AB  
19 2193 which amended the Harbors and Navigation Code to designate CDBW as the  
20 lead agency for the control of *Egeria densa* in the Delta (CDBW 2006, 2008).  
21 Initially, the program focused control efforts in a number of locations where *Egeria*  
22 impeded navigation, on a range of mechanical and chemical control techniques, and  
23 on an extensive suite of toxicology and water quality tests and sampling that were  
24 required by the terms of its National Pollution Discharge Elimination System  
25 (NPDES) permit and under biological opinions issued by USFWS and NOAA  
26 Fisheries (CDBW 2008). After 5 years of field trials, toxicology tests on a variety of  
27 species, and water quality sampling CDBW determined that herbicide formulations  
28 based on Fluridone had no detectible toxicological or water chemistry impact  
29 (CDBW 2006). This conclusion was supported by an independent review (Siemerling  
30 and Hayworth 2005, Siemerling et al. 2008). CDBW has periodically reviewed the  
31 effectiveness of the EDCP as required by the 2001 EIR adaptive management plan. In  
32 2006, CDBW concluded that its current approach was not effective and proposed  
33 expanding the treatment area to sites across most of the legal Delta between 2006-  
34 2010 and concentrating on Franks Tract between 2006-2008 (CDBW 2006). CDBW  
35 has also explicitly stated that the EDCP will be integrated into the proposed Delta-  
36 wide Integrated Vegetation Management Strategy; will be coordinated with  
37 restoration efforts by other entities, such as California Department of Water  
38 Resources; and that CDBW will seek alternative and supplemental resources and  
39 funding (CDBW 2006). Finally, CDBW has identified curly leaf pondweed, and  
40 Eurasian watermilfoil as non-native SAV that could invade areas where *Egeria* is  
41 controlled and modifications to existing control measures may be required for those  
42 species (CDBW 2006). Given that curly leaf pondweed and Eurasian watermilfoil are  
43 wide spread in the Delta (Ustin et al. 2008) and given that curly leaf pondweed is  
44 adapted to higher flow conditions (Champion and Tanner 2000) and produces floating  
45 seed dispersed by water and waterfowl (DiTomaso and Healy 2003), these species  
46 may become a significant problem.

1  
2 The budget for the combined *Egeria densa* and Water Hyacinth Control Program in  
3 fiscal years 2005/2006 and 2007/2008 was \$7,000,000 with regulatory costs up to  
4 64% of the control costs (CDFG 2007). It is difficult to estimate a per-acre cost for  
5 active channels in the Delta as the current control techniques were developed for  
6 relatively enclosed and isolated areas such as Franks Tract where the applied  
7 herbicide is not rapidly dispersed by currents.

8  
9 **Implementation timeframe:** It is anticipated that this conservation measure could be  
10 implemented in the BDCP near-term implementation period.

11  
12 **Implementation considerations:** The optimal time for SAV control efforts that rely  
13 on Fluridone-based products is early April which is at the end of the wet season. If  
14 the applied herbicide is found to be doing harm to other ecosystem aspects, its use  
15 should be halted.

16  
17 **Resiliency to future changes:** One potential changed condition could be a successful  
18 invasion of the Delta by either zebra mussel or quagga mussel. Filtering by these  
19 mussels could result in rapid reductions in turbidity and potentially allow non-native  
20 SAV to grow in much deeper water (due to increased light penetration) leading to  
21 much greater extent of SAV and greater impacts on the covered species. If such a  
22 changed condition were to occur, the efficacy of this conservation measure would  
23 need to be reevaluated.

24  
25 **Uncertainties/risks:** There are no well established SAV control methods for channels  
26 with substantial currents and new techniques would have to be developed. The  
27 continuous use of the same herbicide control method may select for an herbicide-  
28 resistance genotype which might render the present control method ineffective. There  
29 is a risk that another non-native SAV will invade areas where *Egeria* is controlled and  
30 be resistant to control.

31  
32 **Monitoring and adaptive management considerations:** *[Note to reviewers: this*  
33 *section is a general summary; more detail will be provided in future iterations.]* The  
34 California Department of Boating and Waterways would be responsible for  
35 monitoring the effectiveness of BDCP-funded elements of the non-native aquatic  
36 vegetation control programs. The BDCP Implementing Entity would review progress  
37 reports or other relevant reports prepared by the Department of Boating and  
38 Waterways to assess the effectiveness of the program for controlling non-native  
39 aquatic vegetation in the Delta. The BDCP Implementing Entity would coordinate  
40 with the Department of Boating and Waterways to adjust inspection strategies and  
41 funding levels through the BDCP adaptive management process as appropriate based  
42 on review of program reports.

43  
44 **Reversibility:** The implementation of the program could be terminated immediately  
45 without impacts on covered species. Areas where SAV is controlled may be subject to  
46 reinvasion by the same species of SAV or potentially by species with greater

1 ecological impacts that invade the Delta in the future or which are currently present in  
2 low numbers.

3  
4  
5 **Conservation Measure NNIS10: Increase the Harvest of Non-Native Predatory Fish  
6 to Decrease their Abundance.**

7 The BDCP Implementing Entity would develop, in  
8 coordination with the Fishery Agencies, a proposal describing recommended fishing  
9 regulations that relax the size and daily bag limits for non-native invasive predatory fish  
10 species in the Delta (e.g., centrarchids and striped bass) for submittal to the California  
11 Fish and Game Commission for their consideration and adoption. The purpose of  
12 relaxing harvest recommendations would be to reduce the abundance and average size of  
13 predatory fish sufficiently to improve survivorship of covered fish species. The proposal  
14 would include a description of monitoring that would be conducted to assess the  
15 effectiveness of the regulations in reducing the abundance and size of non-native  
16 predatory fish and reducing predation on covered fish species. Based on monitoring  
17 results, if predator abundance and predation levels on covered fish species are not  
18 measurably reduced, the BDCP Implementing Entity in coordination with the Fishery  
19 Agencies may prepare subsequent proposals requesting that the regulations on size and  
20 bag limits be further relaxed or requesting that the original regulations be reinstated. In  
21 addition, the proposal would describe the processes, monitoring requirements, and  
22 findings that would be required from the regulation. The BDCP Implementing Entity  
23 would conduct ongoing consultation and coordination with the Fish and Game  
24 Commission to facilitate consideration of the proposal.

25 **Rationale:** Humans have been extremely effective historically at harvesting fish  
26 species to very low numbers in many parts of the world. Relaxation of bag limits of  
27 non-native invasive fish species could result in a much greater amount of take,  
28 contributing to the reduction of their abundance. Relaxing size limits would allow  
29 smaller fish to be taken, reducing the reproductive capacity of the population because  
30 fewer fish would be at a reproductive size before being taken.

31  
32 Predation by non-native centrarchids in the Delta is thought to affect juvenile  
33 salmonids and splittail. These species regularly use shallow channel margins. The  
34 effect of centrarchids on smelt and sturgeon in the Delta may be minor due to their  
35 use of different locations in the water column (M. Nobriga pers. comm.). Striped  
36 bass in the Delta are thought to consume juvenile salmonids primarily and may  
37 possibly consume delta and longfin smelt and splittail (M. Nobriga pers. comm.). The  
38 impact of non-native basses on juvenile sturgeon is likely small in the Delta.

39  
40 It is anticipated that this conservation measure **would** result in fewer non-native  
41 predatory fish and remaining fish averaging a smaller size. As a result, populations of  
42 these non-native predators would likely be better controlled and have lower predation  
43 effects on covered species.

44  
45 **Implementation timeframe:** It is anticipated that this conservation measure could be  
46 implemented in the BDCP near-term implementation period.



1  
2 **Implementation considerations:** The conservation measure contributes to the  
3 reduction of the recreational fishery for these species. As a result, there will likely be  
4 opposition to this conservation measure by the angling community. The effectiveness  
5 of this conservation measure may be limited by anglers continuing catch and release  
6 practices and trying to preserve the fishery in the Delta.

7  
8 By allowing anglers to take as many individuals from these species, anglers may eat  
9 more than the recommended number of fish per week to minimize the human health  
10 risk of exposure to mercury that has accumulated in the fish tissue.

11  
12 **Resiliency to future changes:** This conservation measure is not expected to be  
13 affected by future change.

14  
15 **Uncertainties/risks:** If fishing pressures on non-native fishes does not substantially  
16 increase, this measure may not have a population effect on those non-natives and  
17 hence may not result in benefits to covered species through reduced predation. There  
18 is low certainty in the magnitude of overall effects of this conservation measure on  
19 covered fish species because the relationship between non-native predator species and  
20 covered fish species is not well understood.

21  
22 **Monitoring and adaptive management considerations:** *[Note to reviewers: this*  
23 *section is a general summary; more detail will be provided in future iterations.]*  
24 Monitoring would consist of assessing the abundance, distribution, and size of  
25 centrarchid species before and after implementation of new regulations to determine  
26 the effectiveness of regulations. Studies would be conducted to determine size-based  
27 predation rates of centrarchids on covered fish species to determine whether  
28 relaxation of the regulations has an impact on these species.

29  
30 If results of fish monitoring indicate that relaxation of regulations have not been  
31 sufficient to significantly reduce adverse affects of non-natives on native fish, actions  
32 would be modified to be more effective through the adaptive management process.

33  
34 **Reversibility:** This conservation measure is expected to be highly reversible.

35  
36  
37 **Conservation Measure NNIS11: Reduce Mortality of Released Salvaged Fish by**  
38 **Non-Native Predators.** The BDCP Implementing Entity would support the strategies  
39 under development by DWR to reduce predation mortality of salvaged covered fish  
40 species at release sites of CVP/SWP facilities at a funding level of \$\$\_\_\_\_\_ over the  
41 term of the BDCP.

42  
43 The BDCP Implementing Entity would enter into a Memorandum of Agreement (MOA)  
44 or similar binding instruments with DWR that would describe respective roles and  
45 obligations for expenditure of BDCP funding. Elements of the MOA would include a  
46 description of specific activities and equipment purchases that would be funded by



1 BDCP, preparation of annual work plans for BDCP funded activities, provisions for  
2 documenting work performed, monitoring responsibilities, and provisions for modifying  
3 or terminating the MOA.

4  
5 DWR would be responsible for:

- 6     ▪ developing and submitting to the BDCP Implementing Entity annual work plans  
7         that specify the extent and types of activities to be implemented by DWR at funded  
8         levels;
- 9     ▪ implementing scopes of work and submitting reports as specified in the MOA that  
10        demonstrate that work plans have been successfully implemented;
- 11    ▪ monitoring the effectiveness of salvage procedures and improving them if  
12        warranted over time; and
- 13    ▪ monitoring the effectiveness of salvage and release methods for reducing post-  
14        release predation mortality on covered fish species.

15 The BDCP Implementing Entity would use results of effectiveness monitoring to  
16 determine if implementation of the salvage program results in measurable benefits to  
17 covered fish species and to identify adjustments to funding levels, management practices,  
18 or other related aspects of the program that would improve the biological effectiveness of  
19 the program. Such changes would be effected through the BDCP adaptive management  
20 process and would be included in the subsequent annual work plans.

21  
22 If results of monitoring indicate that the salvage program does not substantially and cost-  
23 effectively benefit covered fish species, the BDCP Implementing Entity, in coordination  
24 with Fishery Agencies, may terminate this conservation measure. This conservation  
25 measure would also be terminated if DWR chooses not to enter into a MOA with the  
26 BDCP Implementing Entity. If terminated, remaining funding would be deobligated  
27 from this conservation measure and reallocated to augment funding for other  
28 conservation measures identified in coordination with the Fishery Agencies through the  
29 BDCP adaptive management process that more effectively provide covered fish species  
30 benefits.

31  
32     **Rationale:** Anecdotal information indicates that predatory fish, including non-native  
33 species, congregate near the four regular release locations of CVP/SWP salvage  
34 facilities (DWR 2005). It is thought that these predators have learned to gather near  
35 the pipe exits when flushing pumps are activated, resulting in increased risk of  
36 predation to salvaged fish. Salvaged fish are released in high concentrations in a  
37 relatively small area and, upon release, tend to be disoriented and stressed and are  
38 sometimes injured, resulting in higher predation rates.

39  
40 The Department of Water Resources' Bay-Delta Office is currently working  
41 collaboratively with other state and federal agencies to assess the extent of predation  
42 mortality at four SWP salvage release sites (DWR 2005). In the study, DWR is  
43 assessing the abundance and composition of predatory fish near release sites and  
44 predation movement and behavior before, during, and after releases using standard

1 fish sampling methods (e.g., beach seines), bioacoustics, underwater cameras, and  
2 acoustic tagging. It is anticipated that this work will provide the necessary  
3 information to assess the importance of predation of salvaged fish. If predation  
4 mortality is deemed a significant stressor to salvaged fish, this study will provide  
5 information used to identify and evaluate new technologies to reduce or avoid  
6 predation of released fish. A report on their findings is expected in December 2008.  
7 This conservation measure could fund technologies that are proposed by the  
8 December 2008 report.

9  
10 This conservation measure is expected to reduce predation of salvaged fish that are  
11 typically at higher risk to predation. However, it is unlikely that this measure will  
12 have population level effects on the covered species.

13  
14 **Implementation timeframe:** This conservation measure will be primarily  
15 implemented in the near term until the peripheral canal is operational. Once the  
16 South Delta facilities are operated secondarily to the Hood diversion, the effect of  
17 non-native predation on the covered species at release sites is expected to be reduced.

18  
19 **Implementation considerations:** The conservation measure is dependent on the  
20 results of an ongoing study by DWR that is expected to be completed by the end of  
21 2008.

22  
23 **Resiliency to future changes:** This conservation measure is not expected to be  
24 affected by future change.

25  
26 **Uncertainties/risks:** Because salvaged fish release locations occur at such a limited  
27 spatial scale, it is unlikely that this measure will have population level effects on the  
28 covered species.

29  
30 **Monitoring and adaptive management considerations:** *[Note to reviewers: this*  
31 *section is a general summary; more detail will be provided in future iterations.]* The  
32 Department of Water Resources would be responsible for monitoring the  
33 effectiveness of BDCP-funded elements of the program. The BDCP Implementing  
34 Entity would review progress reports or other relevant reports prepared by the  
35 Department of Water Resources to assess the effectiveness of the program for  
36 increasing the survival of released salvaged fish. The BDCP Implementing Entity  
37 would coordinate with the Department of Water Resources to adjust salvage  
38 strategies and funding levels through the BDCP adaptive management process as  
39 appropriate based on review of agency reports.

40  
41 **Reversibility:** This conservation measure is expected to be highly reversible.

## 42 43 44 *Toxic Contaminants*

## 45 46 **Introduction**

1  
2 The following conservation measures address the control of substances known to be or  
3 potentially toxic to covered species or other aquatic organisms on which covered species  
4 depend. These measures address a wide range of chemicals including ammonia,  
5 pesticides, herbicides, mercury, endocrine disruptors, and others. The measures include  
6 creation of new programs, support and funding of existing programs, and providing input  
7 on actions by other agencies, all for the purpose of reducing the adverse effects of toxic  
8 contaminants on covered fish species and other aquatic species.  
9

10 **Conservation Measure TOCO1: Reduce the Load of Ammonia in Effluent**  
11 **Discharged from the Sacramento Regional County Sanitation District into the**  
12 **Sacramento River to Less than [redacted] if Warranted Based on Research.** In coordination  
13 with the Sacramento Regional County Sanitation District (SRCSD), evaluate the need  
14 and, if demonstrated to be necessary to protect covered fish species, reduce the levels of  
15 effluent-derived ammonia entering the Delta. The BDCP Implementing Entity would  
16 work closely with SRCSD in evaluating ongoing research and funding additional  
17 research to determine the effects of effluent-derived ammonia and ammonium ion on  
18 covered species. Based on scientific findings, the BDCP and SRCSD would work  
19 together to determine the appropriate conservation measures (if necessary) and source of  
20 funding to address substantial adverse effects on covered species. The Central Valley  
21 Regional Water Quality Control Board (CVRWQCB) would be included in the design  
22 and evaluation these studies and in the determination of any measures that are proposed  
23 to be implemented to address ammonia discharges from the treatment plant.  
24

25 The BDCP Implementing Entity, Fishery Agencies, and SRCSD would be responsible for  
26 reviewing research currently being conducted by SRCSD and others to ensure that results  
27 of the research would provide conclusive evidence of whether or not the discharge of  
28 ammonia effluent from the SRCSD Wastewater Treatment Plant has substantial adverse  
29 direct or indirect effects on covered fish species. If additional research is required, the  
30 BDCP Implementing Entity, in coordination with Fishery Agencies and SRCSD, would  
31 develop additional research studies that would be necessary to determine the types and  
32 levels of effects, if any, of discharged ammonia effluent on covered fish species. The  
33 BDCP Implementing Entity would enter into a Memorandum of Agreement (MOA) or  
34 similar binding instrument with SRCSD that would describe respective roles and  
35 obligations for funding and conducting any additional research identified through the  
36 process described above. Elements of the MOA would include:

- 37     ▪ a description of specific activities that would be funded by BDCP;
- 38     ▪ preparation of annual research work plans for BDCP funded activities;
- 39     ▪ provisions for documenting work performed;
- 40     ▪ a description of the BDCP Implementing Entity's role in assisting SRCSD to  
41         acquire funding necessary to implement measures to eliminate or minimize the  
42         discharge of ammonia effluent if the need for such measures is indicated through  
43         research results; and
- 44     ▪ provisions for modifying or terminating the MOA.

1 If research results establish a conclusive linkage between SRCSD discharged ammonia  
2 effluent and substantial adverse effects on covered fish species, the BDCP Implementing  
3 Entity would work jointly with SRCSD and appropriate state and federal entities to  
4 secure sources of funding to identify and implement measures that would eliminate or  
5 minimize adverse effects of the effluent on covered fish species. If measures to address  
6 the discharge of ammonia effluent are implemented, the BDCP Implementing Entity  
7 would also work jointly with SRCSD in conducting any subsequent covered fish species-  
8 response monitoring necessary to assess the effectiveness of the those measures in  
9 eliminating or minimizing effects of ammonia on covered fish species.

10  
11 **Rationale:** Wastewater treatment plants can be a large source of ammonia (Jassby  
12 2008). The Sacramento Regional County Sanitation District Wastewater Treatment  
13 Plant is the largest wastewater treatment plant in the Delta which contributed an  
14 average of 158 million gallons of treated effluent into the Delta per day during 2001-  
15 2005 (Jassby 2008), although multiple other wastewater treatment plants within the  
16 Delta may contribute locally high loads of ammonia. The Sacramento Regional  
17 Wastewater Treatment Plant employs primary and secondary treatment processes to  
18 meet current waste discharge specifications in its existing NPDES permit, which is  
19 protective of beneficial uses and currently meets the USEPA aquatic criteria for  
20 ammonia. However, secondary treatment processes may not remove levels of  
21 ammonia and/or other toxic compounds to levels below which they affect fish. The  
22 technology for such advanced treatment processes exists and has been implemented at  
23 other wastewater treatment plants in the Delta where necessary, such as the Stockton  
24 Wastewater Treatment Plant. Such advanced treatment processes can be up to 90%  
25 efficient at reducing ammonia loads in effluent (Wallace et al. 2006, Chan et al.  
26 2008).

27  
28 Ammonia is readily converted into its ionized form, ammonium ion, in the water  
29 column depending on temperature and pH. The role of ammonium ion in disrupting  
30 the uptake of nitrate ( $\text{NO}_3^-$ ) by phytoplankton during spring in San Francisco, San  
31 Pablo, and Suisun Bays has been previously demonstrated by Wilkerson et al. (2006)  
32 and Dugdale et al. (2007). New preliminary evidence from a CVRWQCB-funded  
33 study suggests that ammonium reduces the uptake of nitrate by phytoplankton in the  
34 Delta, as well (Dugdale 2008). Phytoplankton form the base of the food web from  
35 which much of the food energy for the Delta ecosystem is derived (Jassby and Cloern  
36 2000). Ammonia can be directly toxic to fish at elevated levels, although  
37 concentrations in the Delta are well below levels at which the U.S. Environmental  
38 Protection Agency considers to be toxic (SWRCB 2008). Recent research suggests  
39 that, in combination with other chemicals (i.e., pesticides), ammonia at elevated  
40 levels can reduce the survival of prey species for delta smelt and longfin smelt (Teh et  
41 al. 2008). High concentrations of ammonium ion, although of secondary importance  
42 to other factors, may promote blooms of harmful cyanobacteria, *Microcystis*  
43 *aeruginosa*, which produce microcystins that are toxic to other aquatic organisms  
44 (Lehman 2008).  
45

1       **Implementation timeframe:** It is anticipated that this conservation measure could  
2       be implemented in the BDCP near-term implementation period.

3  
4       **Implementation Considerations:** There could be significant costs associated with  
5       this conservation measure for improved treatment facilities.

6  
7       **Resiliency to future changes:** This action would not be influenced by future climate  
8       change.

9  
10       **Uncertainties/risks:** A major uncertainty associated with this conservation measure  
11       is the extent to which ammonia has population level effects on covered fish species at  
12       ambient concentrations in the Sacramento River. The Sacramento Regional County  
13       Sanitation District has conducted multiple modeling and experimental efforts and  
14       concluded that the residual impacts of ammonia in their effluent on aquatic organisms  
15       are “less than significant” (SRCSD 2003). The treatment facility operates in  
16       accordance within its NPDES permit and within EPA criteria. Recent evidence  
17       suggests that diatoms may be sensitive to ambient concentrations of ammonia in the  
18       Sacramento River (Wilkerson et al. 2006, Dugdale et al. 2007). Multiple research  
19       projects focused on the effects of ammonia on aquatic organisms will be conducted  
20       over the next few years (SWRCB 2008). Information gathered from these studies  
21       will be used to inform and guide the BDCP in refining this conservation measure.

22  
23       **Monitoring and adaptive management considerations:** *[Note to reviewers: this*  
24       *section is a general summary; more detail will be provided in future iterations.]* If  
25       effluent-derived ammonia and ammonia ion are found to have adverse effects on  
26       covered fish species, the BDCP Implementing Entity will coordinate with the  
27       Sacramento Regional County Sanitation District to develop an adaptive management  
28       and monitoring plan for assessing effectiveness of the proposed conservation  
29       measures. The adaptive management plan will identify the range of adaptive  
30       management responses appropriate to proposed ammonia-reduction conservation  
31       measures and the process for adaptively adjusting implementation based on  
32       monitoring results. The types of monitoring that may be appropriate include:

- 33  
34       ▪ monitoring of ammonia in influent and effluent at the treatment facility;  
35       ▪ In-laboratory exposure of delta smelt and, as appropriate, other covered fish  
36       species to effluent samples to assess lethality;  
37       ▪ diatom nitrate uptake inhibition; and  
38       ▪ Microcystis abundance patterns relative to ammonia effluent loads.

39  
40       If results of monitoring of ammonia effects on the covered fish species and their food  
41       base indicate that ammonia reduction efforts have not been sufficient to significantly  
42       reduce adverse affects, treatment actions would be modified to be more effective  
43       through the adaptive management process.

44  
45       **Reversibility:** Should studies indicate the need for ammonia removal to protect and  
46       enhance covered species populations, due to the high costs and additional

1 infrastructure associated with implementation of ammonia treatment of such a large  
2 volume of effluent, this conservation measure would have a low value of reversibility.

3  
4  
5 **Conservation Measure TOCO2: Reduce the Load of Endocrine Disrupting**  
6 **Compounds in Effluent Discharged from Wastewater Treatment Plants into Delta**  
7 **Waterways to Less than [redacted] if Warranted Based on Research.** In coordination with  
8 agencies that discharge wastewater in the Delta, evaluate the need and, if demonstrated to  
9 be necessary to protect covered fish species, improve treatment processes at wastewater  
10 treatment facilities to reduce loads of endocrine disrupting compounds (EDCs) into the  
11 Delta. The BDCP Implementing Entity would work closely with wastewater treatment  
12 districts in the Delta in evaluating ongoing research and funding additional research to  
13 determine the effects of effluent-derived EDCs on covered species. Based on scientific  
14 findings, the BDCP and wastewater agencies will work together to determine the  
15 appropriate conservation measures (if necessary) and source of funding to address  
16 substantial adverse effects on covered species. In addition, the CVRWQCB would be  
17 included in the design and evaluation these studies and in the determination of any  
18 measures that are proposed to be implemented to address ammonia discharges from  
19 treatment plants.

20  
21 The BDCP Implementing Entity, Fishery Agencies, and wastewater treatment districts  
22 would be responsible for reviewing ongoing EDC-related research to determine whether  
23 results provide conclusive evidence that discharge of EDCs from wastewater treatment  
24 plants in the Delta has substantial adverse direct or indirect effects on covered fish  
25 species. If additional research is required, the BDCP Implementing Entity in  
26 coordination with Fishery Agencies and the wastewater agencies would identify  
27 additional research studies that would be necessary to determine the types and levels of  
28 effects, of discharged EDCs on covered fish species. The BDCP Implementing Entity  
29 would enter into a Memoranda of Agreement (MOAs) or similar binding instruments  
30 with each of the Delta wastewater treatment agencies that would describe respective roles  
31 and obligations for funding and conducting any additional research identified through the  
32 process described above. Elements of the MOAs would include:

- 33     ▪ a description of specific activities that would be funded by BDCP;
- 34     ▪ preparation of annual research work plans for BDCP funded activities;
- 35     ▪ provisions for documenting work performed;
- 36     ▪ a description of the BDCP Implementing Entity's role in assisting wastewater  
37         treatment plants to acquire funding necessary to implement measures to eliminate  
38         or minimize the discharge of EDCs in effluent if the need for such measures is  
39         indicated through research results; and
- 40     ▪ provisions for modifying or terminating the MOAs.

41 If research results establish a conclusive linkage between EDCs discharged at wastewater  
42 treatment plants and substantial adverse effects on covered fish species, the BDCP  
43 Implementing Entity would work jointly with each wastewater agency and appropriate



1 state and federal entities to secure sources of funding to identify and implement measures  
2 that would eliminate or minimize adverse effects of EDCs on covered fish species. If  
3 measures to address the discharge of EDCs are implemented, the BDCP Implementing  
4 Entity would also work jointly with the wastewater treatment plants in conducting any  
5 subsequent covered fish species-response monitoring that may be required to assess the  
6 effectiveness of the those measures in eliminating or minimizing effects of EDCs on  
7 covered fish species.

8  
9 If wastewater agencies do not choose to participate in implementing this conservation  
10 measure, the BDCP Implementing Entity, in coordination with Fishery Agencies, may  
11 terminate this conservation measure. If terminated, remaining funding would be  
12 deobligated from this conservation measure and reallocated to augment funding for other  
13 more effective conservation measures identified in coordination with Fishery Agencies  
14 through the BDCP adaptive management process.

15  
16 **Rationale:** Wastewater treatment plants can be large sources of EDCs (Sumpter and  
17 Jobling 1995, Jobling et al. 1998, Chambers and Leiker 2006, Barber et al. 2007).  
18 Treatment processes presently employed by wastewater treatment facilities in the  
19 Delta may not remove EDCs to levels below which they affect fish (Huang and  
20 Sedlak 2001, Campbell et al 2006)). Advanced treatment facilities have been shown  
21 to reduce EDCs by 30-85%, but reduction levels are highly variable depending on the  
22 EDC (Hemming et al. 2004, Drewes et al. 2005, Gray and Sedlak 2005).

23  
24 There are currently no criteria defined by the EPA for EDCs. EDCs can interact with  
25 hormone receptors in fish and, as a result, can interfere with reproduction,  
26 development, and other hormonally mediated processes (Pait and Nelson 2002,  
27 Falconer et al. 2006). Because natural endogenous endocrines (hormones) occur in  
28 extremely low concentrations in fish, it is thought that extremely low concentrations  
29 of exogenous endocrine disruptors could affect fish. However, the potency of  
30 exogenous EDCs is typically orders of magnitude lower than endogenous endocrines  
31 (Pait and Nelson 2002). Endocrine disruption has been observed in fish exposed to  
32 wastewater effluents (Sumpter and Jobling 1995, Jobling et al. 1998, Chambers and  
33 Leiker 2006, Kidd et al. 2007). In Central Valley stream sampling, up to 38% of  
34 male fall-run Chinook salmon showed signs of endocrine disruption in the form of  
35 sex reversal (Williamson and May 2002). In 2005, a low level (6%) of adult delta  
36 smelt males showed evidence of endocrine disruption (S. Teh, unpubl. data, as cited  
37 in IEP 2008). The identity and source of the EDCs causing these effects, however,  
38 are not known.

39  
40 **Implementation timeframe:** It is anticipated that this conservation measure could  
41 be implemented in the BDCP near-term implementation period.

42  
43 **Implementation Considerations:** There would be significant costs associated with  
44 this conservation measure for improved treatment facilities. Actions could prove  
45 inadequate if reductions in fish risk levels are not achievable by wastewater treatment  
46 alone.

1  
2 **Resiliency to future changes:** This action would not be influenced by future climate  
3 change.

4  
5 **Uncertainties/risks:** A major uncertainty associated with this conservation measure  
6 is the extent to which EDCs have population level effects on covered fish species at  
7 ambient concentrations in the Delta. This uncertainty is not unique to covered fish  
8 species in the Delta; the effects on species in other systems is also largely uncertain  
9 (Pait and Nelson 2002)

10  
11 **Monitoring and adaptive management considerations:** *[Note to reviewers: this*  
12 *section is a general summary; more detail will be provided in future iterations.]* If  
13 EDCs are found to have adverse effects on covered fish species, the BDCP  
14 Implementing Entity will coordinate with wastewater treatment districts to develop  
15 district-specific adaptive management and monitoring plans for assessing  
16 effectiveness of the proposed conservation measures. Adaptive management plans  
17 will identify the range of adaptive management responses appropriate to proposed  
18 EDC-reduction conservation measures and the process for adaptively adjusting  
19 implementation based on monitoring results. The types of monitoring that may be  
20 appropriate include monitoring of influent and effluent for EDCs and field sampling  
21 and evaluations of endocrine and reproductive systems of covered fish species to  
22 assess the effectiveness of conservation measures in reducing EDC effects. If  
23 monitoring results indicate that EDC reduction efforts have not been sufficient to  
24 significantly reduce adverse affects, treatment actions would be modified to be more  
25 effective through the adaptive management process. This effort would not substitute  
26 for any of the requirements prescribed by the CVQWQCB through permits or other  
27 regulatory authorities.

28  
29 **Reversibility:** Should studies indicate the need for EDC removal to protect covered  
30 species populations, the substantial investment in infrastructure associated with  
31 implementing EDC treatment for such a large volume of effluent would give this  
32 conservation measure a low reversibility.

33  
34  
35 **Conservation Measure TOCO3: Reduce the Load of Methylmercury Entering**  
36 **Delta Waterways by [redacted] Percent from 200 [redacted] Levels.** Support the Central Valley  
37 Regional Water Quality Control Board's (CVRWQCB) Draft TMDL to reduce the load  
38 of methylmercury entering the Delta and in-Delta sources by 50%<sup>1</sup> at a funding level of  
39 \$[redacted] over the term of the BDCP. Four primary actions could be supported: (1) Modify  
40 the Cache Creek settling basin to improve mercury and sediment trapping efficiency, (2)  
41 remediate inorganic mercury sources upstream of the Delta, including mercury  
42 contaminated sediment "hot spots" in stream channels and mercury and gold mines, (3)  
43 avoid or minimize transport of loads of methylmercury entering the Delta from floodplain  
44 and intertidal marsh restoration actions by the BDCP, and (4) work with the Central

---

<sup>1</sup> This value was reported in the Draft TMDL; it will be updated with the Final TMDL value when released.

1 Valley Regional Water Quality Control Board to identify best management practices for  
2 other sources of methylmercury.

3  
4 The BDCP Implementing Entity would enter into a Memorandum of Agreement (MOA)  
5 or similar binding instrument with CVRWQCB that would describe respective roles and  
6 obligations for expenditure of BDCP funding. Elements of the MOA would include a  
7 description of specific activities that would be funded by BDCP, preparation of annual  
8 work plans for BDCP funded activities, provisions for documenting work performed,  
9 monitoring responsibilities, and provisions for modifying or terminating the MOA.

10  
11 The BDCP Implementing Entity, in coordination with Fishery Agencies, would be  
12 responsible for developing annual work plans that specify the extent of mercury reduction  
13 activities to be implemented by CVRWQCB at funded levels. CVRWQCB would be  
14 responsible for implementing the scope of work and submitting reports as specified in the  
15 MOA that demonstrate that the work plan has been successfully implemented.  
16 CVRWQCB would also be responsible for monitoring the effectiveness of mercury  
17 reduction measures and adjusting control methods to improve their effectiveness over  
18 time.

19  
20 The BDCP Implementing Entity would be responsible for monitoring the effectiveness of  
21 mercury reduction activities in achieving covered fish species benefits. This monitoring  
22 would be required because of the uncertainties surrounding the population level benefits  
23 of reducing mercury loads on covered fish species (see *Uncertainties/Risks* discussion  
24 below).

25  
26 The BDCP Implementing Entity would use results of effectiveness monitoring to  
27 determine if reducing mercury loads results in measurable benefits to covered fish species  
28 and to identify adjustments to funding levels, control methods, or other related aspects of  
29 the program that would improve the biological effectiveness of the program. Such  
30 changes would be effected through the BDCP adaptive management process and would  
31 be included in the subsequent annual work plans.

32  
33 If results of monitoring indicate that reducing mercury loads does not substantially and  
34 cost-effectively benefit covered fish species, the BDCP Implementing Entity, in  
35 coordination with Fishery Agencies, may terminate this conservation measure. The  
36 BDCP Implementing Entity, in coordination with the Fishery Agencies, would also  
37 terminate this conservation measure if the CVRWQCB chooses not to enter into a MOA  
38 with the BDCP Implementing Entity. If terminated, remaining funding would be  
39 deobligated from this conservation measure and reallocated to augment funding for other  
40 more effective conservation measures identified in coordination with the Fishery  
41 Agencies through the BDCP adaptive management process.

42  
43 **Rationale:** The Central Valley Regional Water Quality Control Board recently  
44 released a Draft Sacramento-San Joaquin Delta TMDL for Methylmercury  
45 (CVRWQCB 2008). The Draft TMDL calls for a 50% reduction of methylmercury  
46 entering the Delta, sources of which include tributaries from upstream watersheds and

1 within-Delta sources, municipal and industrial wastewater, agricultural drainage, and  
2 urban runoff. The largest sources of methylmercury to the Delta are flux from  
3 wetland and open water sediments within the Delta and Yolo Bypass (~35% of total  
4 load) and upstream tributaries (~58% of total load). The Draft TMDL recommends  
5 total mercury load reductions from the Cache Creek, Feather River, American River,  
6 and Putah Creek watersheds.

7  
8 This conservation measure would support funding of existing efforts by the  
9 CVRWQCB to reduce sources of methylmercury. The conservation measure could  
10 support staff salaries and/or fund specific actions to reduce these sources (e.g., Cache  
11 Creek Settling Basin efficiency improvements).

12  
13 **Implementation timeframe:** It is anticipated that this conservation measure could  
14 begin to be implemented in the BDCP near-term implementation period. Timing of  
15 some actions would be dependent on the timing of other actions (e.g., floodplain and  
16 tidal marsh restoration).

17  
18 **Implementation Considerations:** Many of the upstream “hot spot” sites are  
19 Superfund sites and tied up in legal, funding, and logistical issues. There could be  
20 significant costs associated with this conservation measure for improved treatment  
21 facilities. Operation of settling basins (i.e., periodic removal of mercury-laden  
22 sediment) must occur in perpetuity. Much of this conservation measure is dependent  
23 on the Final TMDL.

24  
25 **Resiliency to future changes:** This conservation measure is moderately resilient to  
26 future climate change, although the location of floodplain and tidal marsh and timing  
27 of floodplain inundation are expected to change with climate change.

28  
29 **Uncertainties/risks:** Mercury has known adverse effects to humans and wildlife, can  
30 bioaccumulate in fish tissue (including sturgeon), and can have sublethal  
31 physiological effects to some species (particularly sturgeon) (see Alpers et al. 2008).  
32 However, there is limited evidence that mercury causes direct mortality or has  
33 significant population level effects on BDCP covered fish species. Therefore, the  
34 magnitude of a population-level effect on covered species of this conservation  
35 measure has low certainty and is dependent on research to determine whether there  
36 are population-level effects.

37  
38 **Monitoring and adaptive management considerations:** *[Note to reviewers: this*  
39 *section is a general summary; more detail will be provided in future iterations.]* The  
40 Central Valley Regional Water Quality Control Board would be responsible for  
41 conducting monitoring necessary to assess the effectiveness of BDCP supported  
42 mercury reduction projects. The Implementing Entity will provide ongoing review of  
43 Central Valley Regional Water Quality Control Board monitoring, progress, and other  
44 relevant reports to assess the effectiveness of supported projects for reducing mercury  
45 loads entering the Delta and providing beneficial to covered fish species. The  
46 Implementing Entity will coordinate with the Central Valley Regional Water Quality

1 Control Board to adjust mercury reduction strategies and funding levels through the  
2 BDCP adaptive management process as appropriate based on review of Central  
3 Valley Regional Water Quality Control Board monitoring and other reports.

4  
5 **Reversibility:** Due to the high costs and additional infrastructure associated with  
6 implementation, this conservation measure is expected have a low reversibility.

7  
8  
9 **Conservation Measure TOCO4/5: Reduce the Load of Pesticides and Herbicides**  
10 **Entering Delta Waterways from In-Delta Sources that are Believed to be Toxic to**  
11 **Covered Fish Species by [REDACTED] Percent from 200[REDACTED] Levels.** To implement this  
12 conservation measure, the BDCP Implementing Entity would develop two tasks:

- 13 1. Support efforts by the Central Valley Regional Water Quality Control Board  
14 (CVRWQCB) under its Irrigated Lands Regulatory Program to reduce inputs of  
15 toxics from agricultural return flows into the Delta and tributaries to levels at  
16 which they are not toxic to covered fish species at a funding level of \$[REDACTED] over  
17 the term of the BDCP; and
- 18 2. Work with groups of farmers or large individual farmers and with reclamation  
19 districts and irrigation/drainage districts to develop voluntary agricultural  
20 chemical management plans to reduce the amounts of pesticides and herbicides  
21 reaching Delta waterways. Plans could include funding conservation easements,  
22 cost-sharing programs, and working with farmers and irrigation districts to:
  - 23 ■ Change pesticides and herbicides used to less toxic compounds to aquatic  
24 species and provide education on proper use;
  - 25 ■ Reduce amounts of pesticides and herbicides used through more direct  
26 application methods or implementation of integrated pest management  
27 techniques;
  - 28 ■ Reduce concentrations of pesticides and herbicides in return flows to Delta  
29 waterways through specific management practices;
  - 30 ■ Reduce return flows from agricultural fields to the Delta by using water-  
31 efficient technologies (e.g., drip irrigation); and
  - 32 ■ Reduce wind drift of pesticides and herbicides into Delta waterways.

33  
34 To accomplish Task 1, the BDCP Implementing Entity would enter into a Memorandum  
35 of Agreement (MOA) or similar binding instrument with CVRWQCB that would  
36 describe respective roles and obligations for expenditure of BDCP funding. Elements of  
37 the MOA would include a description of specific activities that would be funded by  
38 BDCP, preparation of annual work plans for BDCP funded activities, provisions for  
39 documenting work performed, monitoring responsibilities, and provisions for modifying  
40 or terminating the MOA.

41

1 The BDCP Implementing Entity would be responsible for developing annual work plans  
2 in coordination with Fishery Agencies that specify the extent of agricultural contaminant  
3 reduction activities to be implemented by CVRWQCB at funded levels. CVRWQCB  
4 would be responsible for implementing the scope of work and submitting reports as  
5 specified in the MOA that demonstrate that the work plan has been successfully  
6 implemented. CVRWQCB would also be responsible for monitoring the effectiveness of  
7 agricultural contaminant reduction measures and adjusting reduction methods to improve  
8 their effectiveness over time.

9  
10 The BDCP Implementing Entity would be responsible for monitoring the effectiveness of  
11 agricultural contaminant reduction activities in achieving covered fish species benefits.  
12 This monitoring would be required because of the uncertainties surrounding the  
13 population level benefits of reducing loads of agricultural pesticides and herbicides on  
14 covered fish species (see *Uncertainties/Risks* discussion below). The BDCP  
15 Implementing Entity in coordination with the Fishery Agencies may discontinue  
16 monitoring in future years if monitoring results indicate a strong correlation between  
17 reduction in agricultural pesticides and herbicides entering the Delta and responses of  
18 covered fish species.

19  
20 The BDCP Implementing Entity would use results of effectiveness monitoring to  
21 determine if reducing pesticide and herbicide loads results in measurable benefits to  
22 covered fish species and to identify adjustments to funding levels, control methods, or  
23 other related aspects of the program that would improve the biological effectiveness of  
24 the program. Such changes would be effected through the BDCP adaptive management  
25 process and would be included in the subsequent annual work plans.

26  
27 If results of monitoring indicate that reducing pesticide and herbicide loads does not  
28 substantially and cost-effectively benefit covered fish species, the BDCP Implementing  
29 Entity, in coordination with Fishery Agencies, may terminate this conservation measure.  
30 The BDCP Implementing Entity, in coordination with the Fishery Agencies, would also  
31 terminate this conservation measure if the CVRWQCB chooses not to enter into a MOA  
32 with the BDCP Implementing Entity. If terminated, remaining funding would be  
33 deobligated from this conservation measure and reallocated to augment funding for other  
34 more effective conservation measures identified in coordination with the Fishery  
35 Agencies through the BDCP adaptive management process.

36  
37 To accomplish Task 2, the BDCP Implementing Entity would enter into binding  
38 agreements (e.g., conservation easements, contracts) with participating farmers and  
39 irrigation districts that would specify specific actions that would need to be implemented  
40 by participants to receive BDCP funding. The BDCP Implementing Entity will  
41 coordinate with the Fishery Agencies, the CVRWQCB, and the Department of Pesticide  
42 Regulation to identify specific pesticides and herbicides targeted for reduction and a  
43 menu of the types of measures that could be implemented that would cost-effectively  
44 reduce loads of targeted compounds. Elements of participant agreements would include:

- 45     ▪ a description of specific BDCP funded activities to be implemented by participants;



- 1       ▪ provisions for documenting compliance with the agreements;
- 2       ▪ access to conduct BDCP effectiveness monitoring; and
- 3       ▪ provisions for modifying or terminating participant agreements.

4 The BDCP Implementing Entity would develop a pesticide and herbicide reduction  
5 monitoring program to assess the effectiveness of funded activities for reducing pesticide  
6 and herbicide loads in Delta waterways and providing benefits for covered fish species.

7 The BDCP Implementing Entity, in coordination with the Fishery Agencies, may  
8 discontinue monitoring in future years if monitoring results indicate a strong correlation  
9 between reduction in pesticide and herbicide loads entering the Delta and responses of  
10 covered fish species.

11  
12 To address uncertainties related to the effectiveness of reducing pesticide and herbicide  
13 loads in achieving population-level benefits for covered fish species (see  
14 *Uncertainties/Risks* discussion below), the BDCP Implementing Entity, in coordination  
15 with the Fishery Agencies, will periodically review relevant research to determine if  
16 reducing pesticides and herbicides has been shown to provide direct or indirect benefits  
17 to covered fish species. If research indicates that specific pesticides and herbicides do  
18 not measurably adversely affect covered fish species, funding for programs to reduce  
19 loads of those pesticides and herbicides would be discontinued and redirected through the  
20 BDCP adaptive management process to increase funding for reduction of pesticides and  
21 herbicides that are shown to be harmful to covered fish species.

22  
23       **Rationale:** Agricultural runoff has been identified as a source of pesticides and other  
24 chemical stressors of covered fish species that adversely effect aquatic biota (Werner  
25 et al. 2008, Werner and Oram 2008). Pesticides have known sublethal effects on fish  
26 species and direct impacts on invertebrates (Van Wijngaarden et al. 2005), which  
27 could serve as prey species for covered fish species. Fertilizers in high  
28 concentrations, [although rare \(CVRWQCB 2007a\)](#), can be directly toxic to fish,  
29 although concentrations in the Delta are well below levels the U.S. Environmental  
30 Protection Agency considers to be toxic (SWRCB 2008). High levels of sediment  
31 can be released by agricultural return flows (Ebbert et al. 2003). Suspended sediment  
32 is the primary attenuator of sunlight in the water column and thus can reduce  
33 photosynthesis in phytoplankton and submerged aquatic vegetation and affect fish  
34 behavior and health (Schoelhammer et al. 2007). In contrast, if suspended sediment  
35 were to increase turbidity in the water column, there may benefits to some covered  
36 species, such as delta smelt, whose populations are positively correlated with  
37 turbidity levels (Feyrer et al 2007).

38  
39 The Irrigated Lands Regulatory Program of the Central Valley Regional Water  
40 Quality Control Board [provides](#) dischargers of irrigation water and storm water from  
41 irrigated lands [with the ability to obtain a waiver](#) to discharge, [but the waiver must be](#)  
42 [conditional, must be enforceable, and must contain monitoring to ensure compliance](#)  
43 [with these conditions](#). Dischargers must either join an established coalition group or  
44 proceed as an individual discharger. Coalitions collect fees to monitor and report  
45 water quality in discharges.

1  
2 This conservation measure would support and coordinate existing efforts of the  
3 Irrigated Lands Regulatory Program in the form of technical assistance, monetary  
4 support, and encouragement of voluntary actions.  
5

6 There is increasing evidence that some pesticides (e.g., pyrethroids), although very  
7 effective at reducing pests on agricultural crops, are highly toxic in the aquatic  
8 environment (Werner 2007). Therefore, reduced use of these pesticides and increased  
9 use of other less toxic pesticides would reduce risk to the aquatic ecosystem. A more  
10 effective way to reduce inputs of toxics to the aquatic ecosystem is to reduce the  
11 concentrations of pesticides and herbicides through more direct application. Further,  
12 integrated pest management could be used to minimize environmental and human  
13 health risks. The use of water-efficient technologies, such as drip irrigation, reduces  
14 pesticide and herbicide return flows into the river and reduces water demand (K.  
15 Fisher pers. comm.).  
16

17 The BDCP Implementing Entity would work with reclamation districts and groups of  
18 or individual large farmers to develop pesticide and return water management  
19 programs aimed at reducing pesticides entering the Delta channels. At the June 17,  
20 2008 State Water Resources Control Board Meeting, the Board approved \$8 million  
21 of Proposition 84 money to fund cost-sharing efforts for Central Valley farmers who  
22 implement improved management practices to reduce runoff of pesticides, fertilizers,  
23 and sediment. This BDCP conservation measure could emulate this cost-sharing  
24 effort by providing additional incentive funding to farmers whose improved  
25 management of discharge could improve water quality in the Delta.  
26

27 **Implementation timeframe:** It is anticipated that this conservation measure could  
28 be implemented in the BDCP near-term implementation period.  
29

30 **Implementation Considerations:** Working in coordination with willing farmers will  
31 be key to the success conservation measure. The Irrigated Lands Regulatory Program  
32 is expected to be updated in 2011. Therefore, the efficacy of Task 1 in the  
33 conservation measure may need re-evaluation at that time. For Task 2, it will be  
34 difficult to determine the extent of benefits until the level of participation has been  
35 identified. Substitution of one product could lead to its own set of problems, such as  
36 the switch from organophosphates to pyrethroids.  
37

38 **Resiliency to future changes:** If sea level rise or other market factors make farming  
39 in the Delta impractical in the future, this action may be deemed unnecessary.  
40

41 **Uncertainties/risks:** The effect of pesticides on covered fish species at a population  
42 level is not well known (Werner and Oram 2008). There is much evidence that  
43 pyrethroids have sublethal effects on fish species (e.g., Weston et al. 2004) and even  
44 more evidence that pyrethroids have direct acute impacts on invertebrates, which  
45 could serve as prey species for covered fish species (Van Wijngaarden et al. 2005).

1 There is also evidence that pesticides work synergistically with other stressors to  
2 adversely affect fish in the Delta (Clifford et al. 2005).

3  
4 It is unknown how many farmers in the Delta that would be willing to participate in  
5 this conservation measure.

6  
7 **Monitoring and adaptive management considerations:** *[Note to reviewers: this*  
8 *section is a general summary; more detail will be provided in future iterations.]* For  
9 Task 1, the Central Valley Regional Water Quality Control Board would be  
10 responsible for conducting monitoring necessary to assess the effectiveness of BDCP  
11 supported elements of its Irrigated Lands Regulatory Program. The Implementing  
12 Entity will provide ongoing review of Central Valley Regional Water Quality Control  
13 Board monitoring, progress, and other relevant reports related to the effectiveness the  
14 Program for reducing contaminant loads in agricultural return flows entering the  
15 Delta and providing benefits to covered fish species. The Implementing Entity will  
16 coordinate with the Central Valley Regional Water Quality Control Board to adjust  
17 Program contaminant reduction strategies and funding levels through the BDCP  
18 adaptive management process as appropriate based on review of Central Valley  
19 Regional Water Quality Control Board monitoring and other reports.

20  
21 For Task 2, the Implementing Entity will monitor the effectiveness of participating  
22 farmers/farmer groups in reducing loads of targeted pesticides and herbicides. The  
23 types of monitoring that may be appropriate include:

- 24       ▪ monitoring changes in targeted pesticide and herbicide loads in agricultural  
25       drain water from participant's farmed lands;
- 26       ▪ monitoring responses of primary and secondary production to reductions in  
27       pesticide and herbicide loads;
- 28       ▪ monitoring ambient pesticide levels in effluent and in water samples  
29       throughout the Delta; and
- 30       ▪ monitoring for incidences of mortality and sublethal effects of pesticides and  
31       herbicides on covered fish species throughout the Delta.

32 The Implementing Entity will also conduct ongoing reviews of relevant research  
33 related to the effects of pesticides and herbicides on covered fish species and food  
34 production and abundance. The Implementing Entity may adjust activities for which  
35 cost sharing is provided to participating farmers based on monitoring and research  
36 results through the BDCP adaptive management process.

37  
38 **Reversibility:** This conservation measure is expected to be highly reversible.

39  
40  
41 **Conservation Measure TOCO7: Reduce the Loads of Toxic Contaminants in**  
42 **Stormwater Pollution and Urban Runoff by Working with Existing Efforts in the**  
43 **Delta.** *[Note to Reviewers: Conservation Measure TOCO7 was previously reviewed and*  
44 *removed by the Other Stressors Working Group. However, at the request of DFG and*

1 CDFA, the focus of the measure has been revised and detail added. DFG and CDFA are  
2 concerned about the large toxic load from urban runoff and its effects on covered  
3 species. The measure is presented here for SC review.] The BDCP Implementing Entity  
4 would coordinate with the Sacramento Stormwater Quality Partnership, the City of  
5 Stockton, the City of Tracy, and other smaller municipalities (“cities”) under National  
6 Pollutant Discharge Elimination System (NPDES) MS4 stormwater permits to implement  
7 actions from and in addition to their respective stormwater management plans.  
8

9 The BDCP Implementing Entity would enter into Memoranda of Agreement (MOAs) or  
10 similar binding instruments with the Sacramento Stormwater Quality Partnership, the  
11 City of Stockton, the City of Tracy, and other smaller municipalities that would describe  
12 respective roles and obligations for expenditure of BDCP funding. Elements of the MOA  
13 would include a description of specific activities that would be funded by the BDCP,  
14 preparation of annual work plans for BDCP funded activities, provisions for documenting  
15 work performed, monitoring responsibilities, and provisions for modifying or terminating  
16 the MOA.  
17

18 The BDCP Implementing Entity would be responsible for developing annual work plans  
19 in coordination with Fishery Agencies that specify the extent of stormwater pollution  
20 load reduction activities to be implemented by the cities at funded levels. The cities  
21 would be responsible for implementing the scope of work and submitting reports as  
22 specified in the MOA that demonstrate that the work plan has been successfully  
23 implemented. The cities would also be responsible for monitoring the effectiveness of  
24 agricultural contaminant reduction measures and adjusting reduction methods to improve  
25 their effectiveness over time.  
26

27 The BDCP Implementing Entity would be responsible for monitoring the effectiveness of  
28 stormwater pollution load reduction activities in achieving covered fish species benefits.  
29 This monitoring would be required because of the uncertainties surrounding the  
30 population level benefits of reducing stormwater pollution loads on covered fish species  
31 (see *Uncertainties/Risks* discussion below). The BDCP Implementing Entity, in  
32 coordination with the Fishery Agencies, may discontinue monitoring in future years if  
33 monitoring results indicate a strong correlation between reduction in stormwater pollution  
34 loads entering the Delta and responses of covered fish species.  
35

36 The BDCP Implementing Entity would use results of effectiveness monitoring to  
37 determine if reducing stormwater pollution loads results in measurable benefits to  
38 covered fish species and to identify adjustments to funding levels, control methods, or  
39 other related aspects of the program that would improve the biological effectiveness of  
40 the program. Such changes would be effected through the BDCP adaptive management  
41 process and would be included in the subsequent annual work plans.  
42

43 If results of monitoring indicate that reducing stormwater pollution loads does not  
44 substantially and cost-effectively benefit covered fish species, the BDCP Implementing  
45 Entity, in coordination with Fishery Agencies, may terminate this conservation measure.  
46 The BDCP Implementing Entity, in coordination with the Fishery Agencies, would also

1 terminate this conservation measure if the cities choose not to enter into a MOA with the  
2 BDCP Implementing Entity. If terminated, remaining funding would be deobligated  
3 from this conservation measure and reallocated to augment funding for other more  
4 effective conservation measures identified in coordination with the Fishery Agencies  
5 through the BDCP adaptive management process.

6  
7 **Rationale:** Stormwater runoff has been identified as the leading source of water  
8 pollution in the United States (Lee et al. 2007) and is thought to be a large contributor  
9 to toxics in the Delta (Weston et al. 2005, Amweg et al. 2006, Werner et al. 2008).  
10 As stormwater runoff returns to the Delta, it accumulates sediment, oil and grease,  
11 pesticides, and many other toxic chemicals. Weston et al. (2008) found that  
12 residential runoff is a larger source of pyrethroid pesticides than agricultural runoff.  
13 Pyrethroids are known to affect aquatic organisms in the Delta, including covered fish  
14 species and their food (Weston et al. 2005, Werner et al. 2008). Further, suspended  
15 sediment is the primary attenuator of sunlight in the water column and thus can  
16 reduce photosynthesis in phytoplankton and submerged aquatic vegetation and affect  
17 fish behavior and health in the Delta (Schoelhammer et al. 2007). Unlike sewage,  
18 stormwater is not treated in any way before entering the Delta.

19  
20 Regulation of and reductions in runoff are ongoing (EPA 1993). All major urban  
21 centers in the Delta, including Sacramento, Stockton, and Tracy, and multiple smaller  
22 cities are under National Pollutant Discharge Elimination System (NPDES) MS4  
23 permits to develop and implement a Storm Water Management Plan/Program with the  
24 goal of reducing the discharge of pollutants to the maximum extent practicable under  
25 Section 402(p) of the Clean Water Act. These permits require development and  
26 implementation of a Storm Water Management Plan/Program to meet this goal.

27  
28 This conservation measure would help cities develop and implement stormwater  
29 management plans and programs and implement actions in addition to these  
30 plans/programs with the goal of reducing stormwater pollution loads that can be  
31 harmful to covered aquatic species from entering Delta waterways. Actions in  
32 addition to those in plans/programs would be implemented if benefits are expected to  
33 BDCP covered species.

34  
35 **Implementation timeframe:** It is anticipated that this conservation measure could  
36 be implemented in the BDCP near-term implementation period.

37  
38 **Implementation Considerations:** The BDCP Implementing Entity would  
39 coordinate with each city separately because each is under a separate NPDES MS4  
40 permit.

41  
42 **Resiliency to future changes:** This conservation measure is not expected to be  
43 affected by future changes.

44  
45 **Uncertainties/risks:** The effect of some contaminants in stormwater on covered fish  
46 species at a population level is not well known.



1  
2 **Monitoring and adaptive management considerations:** *[Note to reviewers: this*  
3 *section is a general summary; more detail will be provided in future iterations.]*

4 Individual cities would be responsible for conducting monitoring necessary to assess  
5 the effectiveness of BDCP supported elements of their stormwater management  
6 plans. The Implementing Entity will provide ongoing review of monitoring, progress,  
7 and other relevant reports from the cities related to the effectiveness the Program for  
8 reducing contaminant loads in stormwater runoff. The Implementing Entity will  
9 coordinate with the cities to adjust stormwater pollution reduction strategies and  
10 funding levels through the BDCP adaptive management process as appropriate based  
11 on review of the cities' monitoring and other reports.

12  
13 **Reversibility:** Reversibility of this conservation measure is expected to be moderate  
14 due to the possibility of needed infrastructure.

15  
16  
17 **Conservation Measure TOCO12: Provide for Rapid Detection of and Response to**  
18 **Toxic Contaminant Events that could Affect Covered Fish Species.** To implement  
19 this conservation measure, the BDCP Implementing Entity would contribute to the  
20 development and implementation of a comprehensive real time monitoring, assessment,  
21 and response program (CRTMARP) for contaminants in the Delta at a funding level of  
22 \$\$ over the term of the BDCP.

23  
24 The BDCP Implementing Entity would enter into a Memorandum of Agreement (MOA)  
25 or similar binding instrument with the CRTMARP implementing entity that would  
26 describe respective roles and obligations for expenditure of BDCP funding. Elements of  
27 the MOA would include a description of specific activities (e.g., monitoring for and  
28 responding to toxic events of contaminants shown to be harmful to covered fish species)  
29 that would be funded by BDCP, preparation of annual work plans for BDCP funded  
30 activities, provisions for documenting work performed, monitoring responsibilities, and  
31 provisions for modifying or terminating the MOA.

32  
33 The BDCP Implementing Entity, in coordination with the Fishery Agencies, would be  
34 responsible for developing annual work plans that specify the activities to be  
35 implemented by the CRTMARP implementing entity at funded levels. The CRTMARP  
36 implementing entity would be responsible for implementing the scope of work and  
37 submitting reports as specified in the MOA that demonstrate that the work plan has been  
38 successfully implemented. The CRTMARP implementing entity would also be  
39 responsible for monitoring the effectiveness of toxic contaminant event response  
40 measures and adjusting response methods to improve their effectiveness over time.

41  
42 The BDCP Implementing Entity, in coordination with the Fishery Agencies, will  
43 periodically review the cost effectiveness of this conservation measure in achieving  
44 benefits for covered fish species. If it is determined that this conservation measure does  
45 not provide a substantial cost-effective benefit for covered fish species, the BDCP  
46 Implementing Entity, in coordination with Fishery Agencies, may terminate this



1 conservation measure. The BDCP Implementing Entity, in coordination with the Fishery  
2 Agencies, would also terminate this conservation measure if the CRTMARP  
3 implementing entity chooses not to enter into a MOA with the BDCP Implementing  
4 Entity. If terminated, remaining funding would be deobligated from this conservation  
5 measure and reallocated to augment funding for other more effective conservation  
6 measures identified in coordination with the Fishery Agencies through the BDCP  
7 adaptive management process.

8  
9 **Rationale:** There is currently no comprehensive framework for gathering, compiling,  
10 assessing, reporting, and responding to data on a real time basis for contaminants in  
11 the Delta. Implementing a comprehensive, well coordinated program would be an  
12 efficient way to identify and respond to toxic events in a timely manner to minimize  
13 effects on covered species in the Delta as well as to establish temporal and spatial  
14 baseline patterns of toxic events. Real-time monitoring and reporting would be  
15 conducted for evidence of toxicity in water quality, phytoplankton, invertebrates, and  
16 fish. Monitoring would be conducted year-round at multiple locations throughout the  
17 Delta, potentially by DFG's Office for Oil Spill Prevention. If a toxic event occurs,  
18 the program would allow rapid response to minimize effects of the event on covered  
19 fish species and the rest of the ecosystem (BJ Miller, pers. comm.).

20  
21 The Central Valley Regional Water Quality Control Board is currently developing a  
22 work plan to establish both a long and short term framework for a regional  
23 monitoring program (SWRCB et al. 2008). This framework will be developed  
24 through a process that includes extensive coordination among multiple Water Board  
25 programs, with outside agencies and stakeholders.

26  
27 This conservation measure will provide funding for development and implementation  
28 of this program to allow for early detection of and rapid response to toxic events  
29 adversely affecting on covered species. The contaminant(s) could be removed (e.g.,  
30 filtered out) from the system or the point source could be stopped more quickly.

31  
32 **Implementation timeframe:** It is anticipated that this conservation measure could  
33 be implemented in the BDCP near-term implementation period.

34  
35 **Implementation Considerations:** This conservation measure is expected to be  
36 implemented with moderate ease. High levels of coordination with agencies will be  
37 required.

38  
39 **Resiliency to future changes:** This conservation measure is not expected to be  
40 affected by future changes.

41  
42 **Uncertainties/risks:** None

43  
44 **Monitoring and adaptive management considerations:** *[Note to reviewers: this*  
45 *section is a general summary; more detail will be provided in future iterations.]* The  
46 Implementing Entity will review progress or other relevant reports prepared by the

1 entity(ies) charged with implementing a comprehensive real time monitoring,  
2 assessment, and response program to assess the effectiveness of the Program for  
3 detecting and responding to toxic events. The Implementing Entity will coordinate  
4 with the program entity(ies) to adjust program strategies and funding levels through  
5 the BDCP adaptive management process as appropriate based on review of agency  
6 reports.

7  
8 **Reversibility:** Reversibility of this conservation measure is expected to be high.  
9

## 10 *Other Water Quality Issues*

### 11 **Introduction**

12  
13  
14  
15 This section provides conservation measures that address water quality issues other than  
16 toxic contaminants. Two conservation measures are provided, one to address low oxygen  
17 levels in the Stockton Deep Water Ship Channel and another to address high organic  
18 content, low oxygen levels, and methylmercury in water released from managed seasonal  
19 wetlands.  
20

21 **Conservation Measure OTWQ1: Maintain Dissolved Oxygen Levels of at Least [REDACTED]**  
22 **[REDACTED] ppm in the Stockton Deep Water Ship Channel during Periods Covered Fish**  
23 **Species are Present.** The BDCP Implementing Entity would coordinate with the Port of  
24 Stockton, the US Army Corps of Engineers, and the Central Valley Regional Water  
25 Quality Control Board to solve dissolved oxygen problems in the Stockton Deep Water  
26 Ship Channel at a funding level of \$\$ [REDACTED] over the term of the BDCP.  
27

28 The BDCP Implementing Entity would enter into Memoranda of Agreement (MOAs) or  
29 similar binding instruments with the Port of Stockton, the US Army Corps of Engineers,  
30 and the Central Valley Regional Water Quality Control Board that would describe  
31 respective roles and obligations for expenditure of BDCP funding. Elements of the MOA  
32 would include a description of specific activities that would be funded by BDCP,  
33 preparation of annual work plans for BDCP funded activities, provisions for documenting  
34 work performed, monitoring responsibilities, and provisions for modifying or terminating  
35 the MOA.  
36

37 The BDCP Implementing Entity would be responsible for developing annual work plans,  
38 in coordination with Fishery Agencies, that specify the extent of dissolved oxygen  
39 improvements to be implemented by the Port of Stockton the US Army Corps of  
40 Engineers, and the Central Valley Regional Water Quality Control Board at funded  
41 levels. The Port of Stockton, the US Army Corps of Engineers, and the Central Valley  
42 Regional Water Quality Control Board would be responsible for implementing the scope  
43 of work and submitting reports as specified in the MOA that demonstrate that the work  
44 plan has been successfully implemented. The Port of Stockton, the US Army Corps of  
45 Engineers, and the Central Valley Regional Water Quality Control Board would also be

1 responsible for monitoring the effectiveness of dissolved oxygen improvement measures  
2 and, if necessary, adjusting methods to improve their effectiveness over time.

3  
4 The Port of Stockton, the US Army Corps of Engineers, and the Central Valley Regional  
5 Water Quality Control Board would be responsible for monitoring the effectiveness of  
6 dissolve oxygen enhancement measures in improving dissolved oxygen levels. This  
7 conservation measure assumes that the BDCP Implementing Entity would not be required  
8 to monitor covered fish species responses to improving dissolved oxygen levels in the  
9 Stockton Deep Water Ship Channel because the cause and effect relationships between  
10 dissolved oxygen levels and covered fish species responses are well understood (see  
11 *Rationale* discussion below).

12  
13 The BDCP Implementing Entity, in coordination with the Fishery Agencies, would  
14 terminate this conservation measure if the Port of Stockton, the US Army Corps of  
15 Engineers, and the Central Valley Regional Water Quality Control Board choose not to  
16 enter into a MOA with the BDCP Implementing Entity. If terminated, remaining funding  
17 would be deobligated from this conservation measure and reallocated to augment funding  
18 for other more effective conservation measures identified in coordination with the  
19 Fishery Agencies through the BDCP adaptive management process. The BDCP  
20 Implementing Entity, however, would modify this conservation measure in coordination  
21 with the Fishery Agencies as appropriate if an MOA can be entered into with at least one  
22 the agencies of these implementing agencies.

23  
24 **Rationale:** Low dissolved oxygen levels can cause physiological stress and mortality  
25 to fish and other aquatic organisms, can impair both upstream and downstream  
26 migration of fall-run Chinook salmon, and may affect steelhead and white sturgeon  
27 similarly (CRWQCB 2007).

28  
29 The Stockton Deep Water Ship Channel has been identified as an impaired waterway  
30 because of low dissolved oxygen concentrations during late summer and early fall.  
31 The combination of low flows, high loads of oxygen-demanding substances (algae  
32 from upstream, effluent from the City of Stockton Regional Wastewater Control  
33 Facility, and other unknown sources), and channel geometry contribute to low oxygen  
34 levels in the Stockton Deep Water Ship Channel (CVRWQCB 2007b). The Stockton  
35 Deep Water Ship Channel regularly exceeds the water quality standard established by  
36 the Regional Board for dissolved oxygen (CVRWQCB 2007b). The low dissolved  
37 oxygen area of in the ship channel creates a barrier for upstream migration of adult  
38 fall-run Chinook salmon and Central Valley steelhead on the mainstem of the San  
39 Joaquin River.

40  
41 As a temporary solution, DWR is experimenting with dissolved oxygen aeration  
42 techniques to be used when dissolved oxygen concentrations in the Stockton Deep  
43 Water Ship Channel drop below water quality objectives. Additional targeted  
44 research efforts should be made to determine the mechanisms responsible for the  
45 dissolved oxygen sags.

46

1       **Implementation timeframe:** It is anticipated that this conservation measure could  
2       be implemented in the BDCP near-term implementation period.

3  
4       **Implementation Considerations:** This conservation measure may need significant  
5       infrastructure for successful implementation.

6  
7       **Resiliency to future changes:** The effectiveness of this conservation measure could  
8       be affected by future sea level rise and hydrology associated with future climate  
9       change, flow changes resulting from Endangered Species Act litigation, and changes  
10      in Delta conveyance.

11  
12      **Uncertainties/risks:** Although there has been recent research conducted on the  
13      causes and mechanisms of dissolved oxygen sags in the Stockton Deep Water Ship  
14      Channel (see [www.eerp-pacific.org](http://www.eerp-pacific.org)) and CALFED funding for future work, these  
15      causes and mechanisms underlying dissolved oxygen sags need to be better studied.

16  
17      **Monitoring and adaptive management considerations:** *[Note to reviewers: this*  
18      *section is a general summary; more detail will be provided in future iterations.]* The  
19      the Port of Stockton, the US Army Corps of Engineers, and the Central Valley  
20      Regional Water Quality Control Board would be responsible for conducting  
21      monitoring necessary to assess the effectiveness of BDCP supported elements of this  
22      program. The Implementing Entity will provide ongoing review of the Port of  
23      Stockton, the US Army Corps of Engineers, and the Central Valley Regional Water  
24      Quality Control Board monitoring, progress, and other relevant reports related to the  
25      effectiveness the Program for improving dissolved oxygen levels in the Stockton  
26      Deep Water Ship Channel and providing benefit to covered fish species. The  
27      Implementing Entity will coordinate with the Port of Stockton, the US Army Corps of  
28      Engineers, and the Central Valley Regional Water Quality Control Board to adjust  
29      Program dissolved oxygen improvement strategies and funding levels through the  
30      BDCP adaptive management process as appropriate based on review of the Port of  
31      Stockton, the US Army Corps of Engineers, and the Central Valley Regional Water  
32      Quality Control Board monitoring and other reports.

33  
34      **Reversibility:** Reversibility of this conservation measure is expected to be moderate  
35      because major infrastructure may need modification.

36  
37  
38      **Conservation Measure OTWQ2: Improve the Quality of Water Discharged from**  
39      **Managed Seasonal Wetlands into Suisun Bay and Delta Waterways to Prevent**  
40      **Dissolved Oxygen Sags.** The BDCP Implementing Entity would coordinate with willing  
41      owners/managers of seasonal managed wetlands in the Delta and Suisun Marsh to  
42      improve quality of water released from these wetlands by implementing best  
43      management practices. The BDCP Implementing Entity would offer incentive funding to  
44      land owners to test and implement water management measures that are demonstrated  
45      through monitoring to reduce adverse affects on covered fish species habitat in adjacent  
46      channels. This funding could be used to:

- 1 1. Conduct studies to determine the effects of discharge water on covered species;
- 2 2. Develop plans and best management practices designed to address discharge
- 3 water effects on aquatic habitat;
- 4 3. Implement best management practices and modifications of drainage systems to
- 5 allow for wetland management and discharges that minimize adverse effects on
- 6 covered species; and
- 7 4. Acquire and install equipment necessary to implement revised seasonal wetland
- 8 management and discharge (e.g., gates, siphons).
- 9

10 The Implementing Entity would conduct monitoring of fish abundance and water quality  
11 of fish habitat in adjacent and downstream channels to determine the effectiveness of this  
12 measure.

13  
14 The BDCP Implementing Entity, in coordination with the Fishery Agencies, would  
15 terminate this conservation measure if it does not prove effective in increasing habitat use  
16 by covered species in channels receiving managed seasonal wetland discharge. If  
17 terminated, remaining funding would be deobligated from this conservation measure and  
18 reallocated to augment funding for other more effective conservation measures identified  
19 in coordination with the Fishery Agencies through the BDCP adaptive management  
20 process.

21  
22 **Rationale:** The Fall flood-up on managed seasonal wetlands typically consists of one  
23 or more complete flood and drainage cycles followed by consistent circulation  
24 throughout the winter flooded period. The fall flood-up can cause low dissolved  
25 oxygen plumes that can kill covered species in Suisun Marsh and Suisun Bay. These  
26 areas are important habitat to delta smelt, longfin smelt, splittail and rearing juvenile  
27 salmonids. Further, high levels of organic matter increase the biological oxygen  
28 demand in receiving waters. In addition, elevated concentrations of methylmercury  
29 have been associated with effluents from managed seasonal wetlands. With the large  
30 number of privately managed seasonal wetlands in Suisun Marsh contributing  
31 effluent to its channels connected to Suisun Bay, there is the potential for adverse  
32 effects on covered fish species.

33  
34 This conservation measure would allow the BDCP Implementing Entity to coordinate  
35 with owners and managers of managed seasonal wetlands to improve the water  
36 quality of effluent to benefit covered fish species by implementing best management  
37 practices. There are multiple land, water, and vegetation modifying activities that  
38 have been identified to reduce dissolved oxygen plumes and loads of BOD and  
39 methylmercury into receiving waters in Suisun Marsh. These activities include ways  
40 to reduce the amount of organic material in and reduce the residence time of ponded  
41 water. The activities are currently being investigated for efficacy under a CALFED-  
42 funded grant by Wetland and Watershed Sciences and DWR (C. Enright pers.  
43 comm.). This BDCP Implementing Agency will use the results of this study as  
44 guidance for formulating best management practices to implement.

45

1     **Implementation timeframe:** It is anticipated that this conservation measure could  
2     be implemented in the BDCP near-term implementation period. Results of the  
3     CALFED study are expected by August 2008 (C. Enright pers. comm.)  
4

5     **Implementation Considerations:** The complexity of implementation of this  
6     conservation is dependent on the specific methods identified for managing black  
7     water with specific landowners. Landowners willing to develop and implement black  
8     water management plans must be found.  
9

10    **Resiliency to future changes:** This conservation measure is not expected to be  
11    affected by future changes.  
12

13    **Uncertainties/risks:** Some best management practices for dealing with managed  
14    seasonal wetland effluent are not yet available.  
15

16    **Monitoring and adaptive management considerations:** *[Note to reviewers: this*  
17    *section is a general summary; more detail will be provided in future iterations.]* The  
18    BDCP Implementing Entity will monitor the effectiveness of participating  
19    diverters/managers in improving water quality and habitat use by covered fish  
20    species. The types of monitoring that may be appropriate include:

- 21       ▪ Changes in dissolved oxygen, biological oxygen demand, and methylmercury  
22       levels in drain water from participant's lands;
- 23       ▪ Biosentinel monitoring of concentrations of mercury in tissue of small fish  
24       species with high site fidelity that are abundant in implementation locations  
25       (e.g., inland silversides); and
- 26       ▪ Abundance of covered fish species in channels receiving managed seasonal  
27       wetland discharge.

28    The Implementing Entity will also conduct ongoing reviews of relevant research  
29    related to the effects of effluent of managed seasonal wetlands on covered fish  
30    species. The Implementing Entity may adjust activities for which coordination is  
31    provided to participants to improve their effectiveness based on monitoring and  
32    research results through the BDCP adaptive management process.  
33

34    **Reversibility:** Reversibility of this conservation measure is expected to be high.  
35  
36

## 37 *Hatcheries*

### 38 **Introduction**

39    This section includes conservation measures that address the proper management of  
40    existing salmon and steelhead hatcheries, marking and tagging programs to improve  
41    tracking and survival of salmon and steelhead, and creation of new hatcheries for delta  
42    and long fin smelt. These measures are designed to reduce the adverse effects of  
43    and long fin smelt. These measures are designed to reduce the adverse effects of  
44



1 hatchery reared fish on wild fish and to reduce the risk of extinction of delta smelt and  
2 longfin smelt.

3  
4 **Conservation Measure HATC1: Develop and Implement Hatchery and Genetic**  
5 **Management Plans to Minimize the Potential for Genetic and Ecological Impacts of**  
6 **Hatchery Reared Salmonids on Wild Salmonid Stocks.** To minimize potential adverse  
7 effects of stocking hatchery reared salmonids on wild salmonid stocks, the BDCP  
8 Implementing Entity would support the accelerated development and implementation of  
9 Hatchery and Genetic Management Plans (HGMPs) for all Chinook salmon and steelhead  
10 hatcheries in the Central Valley of California at a funding level of \$\$\_\_\_\_\_ over the  
11 term of the BDCP. HGMPs would be implemented to reduce adverse ecological and  
12 genetic effects of hatcheries on wild fish.

13  
14 The BDCP Implementing Entity would enter into Memoranda of Agreement (MOAs) or  
15 similar binding instruments with hatchery operators of Fishery Agencies that would  
16 describe respective roles and obligations for expenditure of BDCP funding. Elements of  
17 the MOAs would include a description of specific activities that would be funded by  
18 BDCP, requirement for preparation of annual work plans for BDCP funded activities,  
19 provisions for documenting work performed, monitoring responsibilities, and provisions  
20 for modifying or terminating the MOAs.

21  
22 The BDCP Implementing Entity, in coordination with the Fishery Agencies, would be  
23 responsible for developing annual work plans that specify the extent and types of  
24 activities to be implemented by the Fishery Agencies at funded levels. The Fishery  
25 Agencies would be responsible for implementing the scope of work and submitting  
26 reports as specified in the MOAs that demonstrate that work plans have been successfully  
27 implemented. The Fishery Agencies would also be responsible for monitoring the  
28 effectiveness of HGMP measures and adjusting hatchery management practices to  
29 improve their effectiveness over time.

30  
31 The Fishery Agencies would be responsible for monitoring the effectiveness of HGMPs  
32 in improving the genetic integrity of wild salmonid stocks over time. The BDCP  
33 Implementing Entity would use results of effectiveness monitoring to determine if  
34 implementation of HGMPs results in measurable benefits to covered salmonids and to  
35 identify adjustments to funding levels, management practices, or other related aspects of  
36 the program that would improve the biological effectiveness of the program. Such  
37 changes would be effected through the BDCP adaptive management process and would  
38 be included in the subsequent annual work plans.

39  
40 If results of monitoring indicate that implementation of HGMPs do not substantially and  
41 cost-effectively benefit covered salmonids, the BDCP Implementing Entity, in  
42 coordination with Fishery Agencies, may terminate this conservation measure. This  
43 conservation measure would also be terminated if the Fishery Agencies choose not to  
44 enter into MOAs with the BDCP Implementing Entity. If terminated, remaining funding  
45 would be deobligated from this conservation measure and reallocated to augment funding  
46 for other conservation measures identified in coordination with the Fishery Agencies

1 through the BDCP adaptive management process that more effectively provide covered  
2 salmonid benefits.

3  
4 **Rationale:** The goal of HGMPs is to serve as the foundation of hatchery  
5 management and reform to minimize genetic and ecological impacts to wild fish.  
6 HGMPs are developed to devise and evaluate practices of a hatchery to ensure the  
7 hatchery contributes to the conservation and recovery of listed salmonids.

8  
9 **Implementation timeframe:** It is anticipated that this conservation measure could  
10 be implemented in the BDCP near-term implementation period.

11  
12 **Implementation considerations:** This conservation measure is considered to be  
13 practicable and feasible because efforts to develop HGMPs are already underway.

14  
15 **Resiliency to future changes:** This action would not be influenced by future climate  
16 change, although hatcheries may need to contend with changes in water temperature.

17  
18 **Uncertainties/risks:** It is difficult to determine the benefits of HGMPs. Because  
19 HGMPs are not yet completed for Central Valley hatcheries, the actions that will be  
20 recommended are unknown at this time. However, some specific actions that could  
21 yield measurable benefits can be implemented before completion. The BDCP  
22 Implementing Entity would determine which additional actions to support  
23 implementation of once HGMPs are completed based on their ability to benefit the  
24 BDCP covered species.

25  
26 **Monitoring and adaptive management considerations:** *[Note to reviewers: this*  
27 *section is a general summary; more detail will be provided in future iterations.]* The  
28 National Marine Fisheries Service would be responsible for monitoring the  
29 effectiveness of HGMPs for conserving wild Central Valley salmonid stocks. The  
30 Implementing Entity will provide ongoing review of National Marine Fisheries  
31 Service monitoring, progress, and other relevant reports to assess the effectiveness of  
32 Central Valleys HGMPs for improving wild salmonid stocks. The Implementing  
33 Entity will coordinate with the National Marine Fisheries Service to adjust HGMP  
34 strategies and funding levels through the BDCP adaptive management process as  
35 appropriate based on review of NMFS reports.

36  
37 **Reversibility:** This conservation measure is considered highly reversible.

38  
39  
40 **Conservation Measure HATC2: Reduce Losses of Wild Stocks of Chinook Salmon**  
41 **to Commercial Fishing and Recreational Fishing through a Mark-Select Fishery.**

42 To reduce unintentional harvest of wild stocks of Chinook salmon, the BDCP  
43 Implementing Entity will support total marking of hatchery produced fall-run Chinook  
44 salmon to provide the basis for implementing a mark-select fishery and to contribute to  
45 conservation and recovery of the species at a funding level of \$\$\_\_\_\_\_ over the term of  
46 the BDCP.

1  
2 The BDCP Implementing Entity would enter into Memoranda of Agreement (MOAs) or  
3 similar binding instruments with hatchery operators of Fishery Agencies that would  
4 describe respective roles and obligations for expenditure of BDCP funding. Elements of  
5 the MOAs would include a description of specific activities and equipment purchases that  
6 would be funded by BDCP, preparation of annual work plans for BDCP funded activities,  
7 provisions for documenting work performed, monitoring responsibilities, and provisions  
8 for modifying or terminating the MOAs.

9  
10 The Fishery Agencies would be responsible for:

- 11     ▪ developing annual work plans that specify the extent and types of activities to be  
12       implemented by the Fishery Agencies at funded levels for submittal to the BDCP  
13       Implementing Entity;
- 14     ▪ implementing the scopes of work and submitting reports as specified in the MOAs  
15       that demonstrate that work plans have been successfully implemented;
- 16     ▪ monitoring the effectiveness of marking techniques and improving those techniques  
17       if warranted over time; and
- 18     ▪ monitoring the effectiveness of the mark-select program for reducing levels of  
19       unintended harvest of wild Chinook salmon.

20  
21 The BDCP Implementing Entity would use results of effectiveness monitoring to  
22 determine if implementation of the marking program and the mark-select fishery results  
23 in measurable benefits to wild Chinook salmon stocks and to identify adjustments to  
24 funding levels, management practices, or other related aspects of the program that would  
25 improve the biological effectiveness of the program. Such changes would be effected  
26 through the BDCP adaptive management process and would be included in the  
27 subsequent annual work plans.

28  
29 If results of monitoring indicate that the mark-select fishery program does not  
30 substantially and cost-effectively benefit covered wild Chinook salmon stock, the BDCP  
31 Implementing Entity, in coordination with Fishery Agencies, may terminate this  
32 conservation measure. This conservation measure would also be terminated if the  
33 Fishery Agencies choose not to enter into MOAs with the BDCP Implementing Entity. If  
34 terminated, remaining funding would be deobligated from this conservation measure and  
35 reallocated to augment funding for other conservation measures identified in coordination  
36 with the Fishery Agencies through the BDCP adaptive management process that more  
37 effectively provide Chinook salmon benefits.

38  
39     **Rationale:** Most hatcheries in the Central Valley are production hatcheries designed  
40     to mitigate for lost habitat from dams constructed in the middle of the twentieth  
41     century (Williams 2006). Hatchery-produced Chinook salmon and steelhead are  
42     thought to have negative effects on wild fish via competition for resources and  
43     genetic effects that can reduce the fitness of wild fish if interbreeding occurs (see  
44     ISAB 2002 for review).

1  
2 The primary benefit of marking 100% of hatchery reared fish is to reduce mortality of  
3 wild Chinook salmon by commercial and recreational fishing. Therefore, the success  
4 of this conservation measure is dependent on implementation of a mark-select fishery.  
5 This type of fishery is designed to reduce the percentage of wild fish retained for  
6 harvest by anglers by providing the ability to visibly distinguish wild from hatchery  
7 reared fish. Because they would be distinguishable, marked (hatchery) fish could be  
8 harvested whereas unmarked (wild) fish would be released. This would allow  
9 hatcheries to fulfill their purpose (provide hatchery fish for anglers) while providing  
10 benefits to wild fish by both reducing their take and reducing competition and genetic  
11 introgression. The technique has been used successfully in the Pacific Northwest to  
12 contribute to the conservation and recovery of wild salmon populations.

13  
14 There are multiple additional benefits to wild Chinook salmon of 100% marking of  
15 hatchery fish. First, managers would be able to determine the effectiveness of  
16 restoration, river management, and recovery programs on wild versus hatchery fish.  
17 Currently, it is not known whether these actions primarily benefit wild fish, hatchery  
18 fish, or both, and in what proportions. Second, there would be the ability for  
19 hatcheries to track and manage the composition of wild versus hatchery origin fish in  
20 breeding programs. Third, 100% marking would streamline, simplify, and reduce  
21 costs for coded wire tag, scale, otolith, and genetics sampling programs that  
22 specifically target wild or hatchery fish because the targeted fish can be easily  
23 distinguished. Fourth, hatcheries could more easily track and manage the  
24 composition of wild versus hatchery origin fish in breeding programs

25  
26 All hatchery reared winter-, spring-, and late fall-run Chinook salmon are currently  
27 marked with an adipose fin clip. DFG has marked and tagged a constant fraction  
28 (25%) of hatchery reared fall-run fish since 2007. Although there could be benefits  
29 of a mark-select fishery at this fraction of marking, these benefits are predicted to be  
30 greatly increased with 100% marking of hatchery fish (D. Fullerton, pers. comm.).

31  
32 **Implementation timeframe:** It is anticipated that this conservation measure could  
33 be implemented in the BDCP near-term implementation period.

34  
35 **Implementation considerations:** This conservation measure is expected to be  
36 moderately practicable and feasible. Marking techniques are currently being  
37 implemented and funding would allow for 100% marking. Agencies must agree to  
38 implement this action at their hatcheries and to implement the mark-select fishery.

39  
40 **Resiliency to future changes:** This action is not expected to be influenced by future  
41 climate change.

42  
43 **Uncertainties/risks:** Although modeling efforts and similar programs in the Pacific  
44 Northwest indicate that a mark select fishery provides benefits to wild fish, there is  
45 still some uncertainty whether this would be beneficial to Central Valley hatcheries.  
46

1       **Monitoring and adaptive management considerations:** *[Note to reviewers: this*  
2       *section is a general summary; more detail will be provided in future iterations.]* The  
3       National Marine Fisheries Service would be responsible for monitoring the  
4       effectiveness of a mark-select fall-run Chinook salmon fishery program for  
5       conserving wild fall-run stocks. The BDCP Implementing Entity would provide  
6       ongoing review of National Marine Fisheries Service monitoring, progress, and other  
7       relevant reports to assess the effectiveness of the mark-select fishery for improving  
8       wild stocks of fall-run Chinook salmon. The BDCP Implementing Entity would  
9       coordinate with the National Marine Fisheries Service to adjust mark-select strategies  
10      and funding levels through the BDCP adaptive management process as appropriate  
11      based on review of National Marine Fisheries Service reports.

12  
13      **Reversibility:** This action is considered moderately reversible. A moderate amount  
14      of equipment would be needed to implement the program.

15  
16  
17      **Conservation Measure HATC4: Establish New and Expand Existing Conservation**  
18      **Propagation Programs for Delta and Longfin Smelt.** The BDCP Implementing Entity  
19      will support: (1) the development of a delta and longfin smelt conservation hatchery by  
20      the USFWS to permanently house a delta smelt refuge population and provide a source of  
21      delta and longfin smelt for supplementation or reintroduction, as necessary, and (2) the  
22      expansion of the refugial population of delta smelt and establishment of a refugial  
23      population of longfin smelt at the University of California, Davis Fish Conservation and  
24      Culture Laboratory in case of a catastrophic event in the wild, at a funding level of  
25      \$\$ \_\_\_\_\_ over the term of the BDCP.

26  
27      The BDCP Implementing Entity would enter into Memoranda of Agreement (MOAs) or  
28      similar binding instruments with the USFWS and University of California, Davis that  
29      would describe respective roles and obligations for expenditure of BDCP funding.  
30      Elements of the MOAs would include a description of specific activities and capital  
31      improvements that would be funded by BDCP, preparation of annual work plans for  
32      BDCP funded activities, provisions for documenting work performed, monitoring  
33      responsibilities, Hatchery and Genetic Management Plan (HGMP) development and  
34      implementation, and provisions for modifying or terminating the MOAs.

35  
36      USFWS and University of California, Davis would provide the BDCP Implementing  
37      Entity with annual work plans that describe activities or capital improvements that would  
38      be funded by BDCP. USFWS and University of California, Davis would be responsible  
39      for implementing the scope of work and submitting reports as specified in the MOAs that  
40      demonstrate that work plans have been successfully implemented. USFWS and  
41      University of California, Davis would also be responsible for demonstrating the  
42      effectiveness of the conservation hatchery operations in maintaining/improving the  
43      genetic integrity of delta smelt and longfin smelt and in propagating sufficient stocks for  
44      stocking purposes, if needed, to supplement or recover the wild population. The BDCP  
45      Implementing Entity in coordination with the Fishery Agencies would use progress  
46      reports to assess program effectiveness and to identify adjustments to funding levels,

1 management practices, or other related aspects of the program that would improve the  
2 biological effectiveness of the program. Such changes would be effected through the  
3 BDCP adaptive management process and would be included in the subsequent annual  
4 work plans.

5  
6 If the program assessments indicate that operation of the conservation hatcheries is not  
7 effective in achieving delta smelt and longfin smelt conservation objectives, the BDCP  
8 Implementing Entity in coordination with Fishery Agencies may terminate this  
9 conservation measure. This conservation measure would also be terminated if the  
10 USFWS and University of California, Davis decides not to enter into MOAs with the  
11 BDCP Implementing Entity. If terminated, remaining funding would be deobligated  
12 from this conservation measure and reallocated to augment funding for other  
13 conservation measures identified in coordination with the Fishery Agencies through the  
14 BDCP adaptive management process that more effectively provide benefits for delta  
15 smelt and longfin smelt.

16  
17 **Rationale:** Populations of both delta and longfin smelt have dramatically declined  
18 recently (IEP 2008). Although a variety of stressors are suspected, yet there is not yet  
19 a clear understanding of why these populations have declined (IEP 2008). There is  
20 evidence that delta smelt continue to decline and that very low population size could  
21 result in an Allee effect causing an even more rapid decline of the species (Mueller-  
22 Solger 2007). As a result, the risk of extinction of delta smelt is likely increasing.  
23 Longfin smelt may follow a similar trend as delta smelt. For these reasons, artificial  
24 propagation has been proposed to protect these two species from extinction.  
25 Although there are criticisms of the effectiveness of artificial propagation in  
26 maintaining proper genetic diversity and integrity, there may be no alternative at this  
27 point. State-of-the-art genetic management practices should be implemented to avoid  
28 hatchery produced fish becoming genetically different from wild fish.

29  
30 A new facility proposed by the USFWS would house genetically-managed refuge  
31 populations of delta and longfin smelt (Clarke 2008). Further, the facility would  
32 provide fish stocks to supplement the wild population and provide fish stocks for  
33 reintroduction, as necessary and appropriate. The facility is expected to be designed  
34 for the ability to add other species if necessary in the future. Construction and start-  
35 up costs are estimated to be \$19.5 million. Annual operating costs are estimated to be  
36 \$1.5-2.0 million. If and when populations of these species are considered recovered,  
37 specific rules could be established to close the conservation hatchery.

38  
39 The UC Davis Fish Conservation and Culture Laboratory is in need of additional  
40 space to expand the refugial population of delta smelt and establish a refugial  
41 population of longfin smelt. The goal of the laboratory's refuge program is to  
42 preserve populations and genetic diversity of smelt. The laboratory also provides  
43 delta smelt for multiple research efforts.

44  
45 **Implementation timeframe:** It is anticipated that this conservation measure could  
46 be implemented in the BDCP near-term implementation period.



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**Implementation considerations:** Delta smelt have been reared in smaller-scale facilities, but a full-scale refugia population has never been supported in a hatchery facility. The ability to maintain genetic diversity and integrity in a smelt hatchery necessary for wild survival is unknown. An important consideration would be development of appropriate criteria for determining under what conditions support of smelt hatchery production and maintenance of refuge populations is no longer necessary.

**Resiliency to future changes:** Because delta smelt are thought to be near their temperature threshold, additional warming may require an increase reliance on refuge populations.

**Uncertainties/risks:** Causes of delta and longfin smelt decline are not well understood. As a result, although this conservation measure would produce more fish, it may not be effective in producing functional fish that are able to survive and reproduce in the wild. The ability to maintain genetic diversity and integrity in a smelt hatchery necessary for wild survival is unknown. The ecological and genetic effects of adding hatchery fish to the wild population are unknown.

**Monitoring and adaptive management considerations:** *[Note to reviewers: this section is a general summary; more detail will be provided in future iterations.]* The U.S. Fish and Wildlife Service would be responsible for monitoring the effectiveness of BDCP supported delta smelt and longfin smelt hatchery and refuge population programs. The BDCP Implementing Entity would provide ongoing review of U.S. Fish and Wildlife Service progress and other relevant reports to assess the effectiveness of rearing smelt in hatcheries and maintaining refuge populations. The BDCP Implementing Entity would coordinate with the U.S. Fish and Wildlife Service to adjust hatchery and refuge population management strategies and funding levels through the BDCP adaptive management process as appropriate based on review of U.S. Fish and Wildlife Service reports.

**Reversibility:** Because this action requires a large amount of infrastructure it has low reversibility.

## *Harvest*

### **Introduction**

This section includes conservation measures that address the control of harvest activities on covered species. Measures include increased levels of enforcement to reduce illegal harvesting of covered fish species and the creation of a regulated Sacramento splittail fishery where none presently exists.

1 **Conservation Measure HARV1: Reduce Illegal Harvest of Chinook Salmon,**  
2 **Central Valley Steelhead, Green Sturgeon, and White Sturgeon in the Delta by** ■  
3 **Percent from Estimate 200** ■ **Levels.** To reduce the adverse effects of illegal harvest of  
4 adult covered salmonids and sturgeon, the BDCP would increase the enforcement of  
5 fishing regulations for these species in the Delta. The BDCP Implementing Entity would  
6 provide funds to CDFG to support and equip the addition of 17 field wardens and 5  
7 supervisory and administrative staff in support of the field wardens assigned to the Delta-  
8 Bay Enhanced Enforcement Program (DBEEP) over the term of the BDCP. BDCP-  
9 supported DBEEP staff would be tasked specifically with enforcing laws and regulations  
10 regarding harvest of the covered fish species. Estimated funding would be **\$8.7 million**  
11 for the first year of implementation and an estimated annual cost of **\$6.7 million** in  
12 subsequent years without inflation.

13  
14 The BDCP Implementing Entity would enter into a Memorandum of Agreement (MOA)  
15 or similar binding instrument with CDFG that would describe respective roles and  
16 obligations for expenditure of BDCP funding. Elements of the MOA would include a  
17 description of specific law enforcement and supporting positions and the types and levels  
18 of field law enforcement activities that would be funded by BDCP; preparation of annual  
19 work plans for BDCP funded activities; provisions for documenting work performed; and  
20 provisions for modifying or terminating the MOA.

21  
22 CDFG would be required to monitor and annually report the activities and results of  
23 DBEEP activities funded by BDCP including an accounting of the specific benefits to  
24 covered fish species as a result of enforcement actions.

25  
26 The BDCP Implementing Entity would review progress reports and other relevant reports  
27 prepared by the DBEEP to assess the Program's ongoing effectiveness in decreasing the  
28 adverse effects of illegal harvest on covered fish species. The BDCP Implementing  
29 Entity would coordinate with the CDFG to adjust enforcement strategies and funding  
30 levels through the BDCP adaptive management process as appropriate based on review of  
31 Program reports.

32  
33 **Rationale:** California has the lowest game warden to population ratio in the nation  
34 with fewer than 200 field wardens for the entire state. The Delta is a particular hot  
35 spot for poaching because of the large number of sport fish, particularly gravid female  
36 white sturgeon, whose roe are used for caviar (Lt. L. Schwall, pers. comm.). Illegal  
37 harvest is thought to have high impacts on sturgeon populations, particularly white  
38 sturgeon.

39  
40 The Delta-Bay Enhanced Enforcement Program (DBEEP) is a 10 warden squad that  
41 was formed specifically to increase enforcement on poaching of anadromous fish  
42 species in Bay-Delta waterways. The program is funded by water contractors through  
43 the 4-Pumps Agreement Advisory Committee. The BDCP would contribute directly  
44 to this existing program by expanding its size to improve enforcement on poaching of  
45 covered species.

46

1       **Implementation timeframe:** It is anticipated that this conservation measure could  
2       be implemented in the BDCP near-term implementation period.

3  
4       **Implementation considerations:** This conservation measure is considered to be  
5       readily implementable because it would involve the expansion of an existing  
6       program.

7  
8       **Resiliency to future changes:** This action would not be influenced by future climate  
9       change.

10  
11       **Uncertainties/risks:** The effect of illegal harvest on covered fish species, other than  
12       white sturgeon, is relatively unknown.

13  
14       **Monitoring and adaptive management considerations:** *[Note to reviewers: this*  
15       *section is a general summary; more detail will be provided in future iterations.]* The  
16       BDCP Implementing Entity would review progress reports and other relevant reports  
17       prepared by the DBEEP to assess the Program’s ongoing effectiveness in decreasing  
18       the adverse effects of illegal harvest on covered fish species. The BDCP  
19       Implementing Entity would coordinate with the Department of Fish and Game to  
20       adjust enforcement strategies and funding levels through the BDCP adaptive  
21       management process as appropriate based on review of Program reports.

22  
23       **Reversibility:** This conservation measure is considered to be easily reversible.

24  
25       **Conservation Measure HARV3: Reduce Adverse Effects of Harvest on Sacramento**  
26       **Splittail Abundance.** The BDCP Implementing Entity will develop, in coordination  
27       with the Fishery Agencies, a proposal describing recommended Sacramento splittail  
28       harvest regulations for submittal to the California Fish and Game Commission for their  
29       consideration and approval. The proposal would describe recommend regulations on bag  
30       and size limits for Sacramento splittail throughout its native range to maintain and  
31       enhance splittail populations. In addition, the proposal would describe the processes,  
32       monitoring requirements, and funding that would be required from the regulation. The  
33       BDCP Implementing Entity will conduct ongoing consultation and coordination with the  
34       Fish and Game Commission to facilitate consideration of the proposal.

35  
36       Initial regulations would be based on a pilot study to assess the impact on splittail by both  
37       the bait fishery and recreational fishery. Initial regulations would be lenient but, as more  
38       knowledge on extent and effect of splittail harvest on the overall population is gained  
39       through results of the DFG’s creel surveys, regulations would be refined as appropriate.

40  
41       **Rationale:** There are currently no regulations on the Sacramento splittail fishery.  
42       However, the fishery may be considerable despite its poor documentation (Moyle et  
43       al. 2004). This conservation measure would establish legal limits for splittail based  
44       on known abundance and harvest rates. Although harvest is not thought to have  
45       significant effects on the population currently, this conservation measure would  
46       protect the species if harvest pressure increases in the future.

1  
2 **Implementation timeframe:** It is anticipated that this conservation measure could  
3 be implemented in the BDCP near-term implementation period.  
4

5 **Implementation considerations:** This conservation measure is considered to be  
6 moderately practicable and feasible. There may be contention by the angling  
7 community for new regulations. Further, educating the public about new regulations  
8 and creel surveys may require additional resources from the Department of Fish and  
9 Game.  
10

11 **Resiliency to future changes:** This action would not be influenced by future climate  
12 change.  
13

14 **Uncertainties/risks:** Because documentation of this fishery is poor, it is difficult to  
15 assess the potential effectiveness of this conservation measure in the near term. There  
16 is low certainty that harvest has a population level effect on splittail.  
17

18 **Monitoring and adaptive management considerations:** *[Note to reviewers: this*  
19 *section is a general summary; more detail will be provided in future iterations.]* The  
20 Department of Fish and Game would be responsible for monitoring of the  
21 effectiveness of regulations in conserving Sacramento splittail while providing for a  
22 recreational fishery and for revising regulations as needed to improve their  
23 effectiveness. The BDCP Implementing Entity would coordinate with the  
24 Department of Fish and Game to identify and support needed adjustments in  
25 regulations in future years.  
26

27 **Reversibility:** This conservation measure is considered to be easily reversible.  
28  
29

## 30 *Non-Project Diversions*

### 31 **Introduction**

32  
33  
34 This section contains one conservation measure that addresses improvements to non-  
35 project diversions (mainly for agricultural uses) to reduce the level of entrainment  
36 mortality of covered fish species. The measure includes installation of fish screens on  
37 non-project diversions and removal, relocation, consolidation, design modification, and  
38 altered operations of non-project diversions in coordination with specific landowners and  
39 managers operating these diversions.  
40

41 **Conservation Measure NPDI1/2: Screen, Remove, Relocate, Consolidate, Modify**  
42 **and/or Alter Timing of      Non-Project Diversions to Reduce Entrainment of**  
43 **Covered Fish Species at within the Delta.** To implement this conservation measure, the  
44 BDCP Implementing Entity would support the U.S. Bureau of Reclamation's  
45 Anadromous Fish Screen Program and Department of Fish and Game's Fish Screen and  
46 Passage Program to screen non-project diversions, thereby reducing entrainment risk of

1 covered fish species at non-project diversions, at a funding level of \$\_\_\_\_\_ over the term  
2 of the BDCP. In addition, the BDCP Implementing Entity, in cooperation with willing  
3 non-project diverters, would share costs to remove, relocate, consolidate, modify design,  
4 and alter operations of individual non-project diversions to reduce the risk of entrainment  
5 of covered fish species at a funding level of \$\$\_\_\_\_\_ over the term of the BDCP.

6 Relocation and consolidation would involve moving diversions from high quality habitat  
7 for covered fish species to lower quality habitat.

8  
9 The conservation measure could focus on the largest diversions (greater than 250 cfs)  
10 under the assumption that larger diversions entrain fish at a disproportionately larger rate  
11 than smaller diversions. Alternatively the conservation measure could focus on the many  
12 smaller diversions, which are cheaper to screen per unit capacity. Implementation would  
13 use outcomes of studies by CDFG (or other entities) on fish entrainment by non-project  
14 diversions as a basis for decisions on which diversions to screen to achieve the greatest  
15 entrainment reductions for covered fish species.

16  
17 Decisions regarding which diversions to focus on would rely on information from a  
18 comprehensive study by DFG to determine the distribution of fish in the Delta relative to  
19 non-project diversions and to determine entrainment rates of at least 27 diversions  
20 throughout the Delta (C. Armor pers. comm.). Funding for this study is anticipated to  
21 come from Assembly Bill 2938, which is currently in the State Assembly. If not funded,  
22 the BDCP Implementing Entity would fund a similar study to gain this information.

23  
24 For screening diversions, the BDCP Implementing Entity would enter into a Memoranda  
25 of Agreements (MOAs) or similar binding instrument with The Bureau of Reclamation  
26 and CDFG that would describe respective roles and obligations for expenditure of BDCP  
27 funding. Elements of the MOAs would include a description of specific activities that  
28 would be funded by BDCP, preparation of annual work plans for BDCP funded activities,  
29 provisions for documenting work performed, monitoring responsibilities, and provisions  
30 for modifying or terminating the MOA.

31  
32 The BDCP Implementing Entity would be responsible for identifying the diversions to be  
33 screened in coordination with the Fishery Agencies. The Bureau of Reclamation and  
34 CDFG would be responsible for implementing their respective scopes of work and  
35 submitting reports as specified in the MOA that demonstrate that the work plan has been  
36 successfully implemented.

37  
38 It is anticipated that fish screen technologies for small diversions are substantially  
39 developed that monitoring will not be required to assess screen effectiveness in reducing  
40 entrainment of covered fish species. There is uncertainty, however, regarding the  
41 population level effects of non-project entrainment on covered fish species.

42 Consequently, the BDCP Implementing Entity would conduct monitoring to determine if  
43 screening non-project diversions provide substantial benefits for covered fish species.

44  
45 The BDCP Implementing Entity would use results of effectiveness monitoring to  
46 determine if screening non-project diversions results in measurable benefits to covered

1 fish species and to identify adjustments to funding levels or other aspects of the program  
2 that would improve the biological effectiveness of the program. Such changes would be  
3 effected through the BDCP adaptive management process and would be included in the  
4 subsequent annual work plans.

5  
6 If results of monitoring indicate that screening of non-project diversions does not  
7 substantially and cost-effectively benefit covered fish species, the BDCP Implementing  
8 Entity in coordination with Fishery Agencies may terminate this conservation measure.  
9 This conservation measure would also be terminated if Reclamation and CDFG choose  
10 not to enter into MOAs with the BDCP Implementing Entity. If terminated, remaining  
11 funding would be deobligated from this conservation measure and reallocated to augment  
12 funding for other more effective conservation measures identified in coordination with  
13 the Fishery Agencies through the BDCP adaptive management process.

14  
15 For all other actions in this conservation measure, the BDCP Implementing Entity would  
16 enter into contracts or similar binding instruments with non-project diverters that would  
17 describe respective roles and obligations for expenditure of BDCP funding. Elements of  
18 the contracts would include a description of specific actions that would be funded by  
19 BDCP, preparation and approval of project designs, BDCP funding levels, provisions for  
20 documenting work performed, access to conduct effectiveness monitoring, and provisions  
21 for modifying or terminating the contracts.

22  
23 Because there is uncertainty regarding the population level effects of non-project  
24 entrainment on covered fish species, the BDCP Implementing Entity will conduct  
25 effectiveness monitoring to determine if funded projects provide substantial benefits for  
26 covered fish species. The BDCP Implementing Entity would also use results of  
27 effectiveness monitoring to identify adjustments to funding levels or other aspects of the  
28 program that would improve the biological effectiveness of the program. Such changes  
29 would be effected through the BDCP adaptive management process and would be in  
30 subsequent contracts with program participants.

31  
32 If results of monitoring indicate that projects implemented under this conservation  
33 measure does not substantially and cost-effectively benefit covered fish species, the  
34 BDCP Implementing Entity, in coordination with Fishery Agencies, may terminate this  
35 conservation measure. The BDCP Implementing Entity, in coordination with the Fishery  
36 Agencies, would also terminate this conservation measure if participation by non-project  
37 diverters is insufficient to achieve this objective. If terminated, remaining funding would  
38 be deobligated from this conservation measure and reallocated to augment funding for  
39 other more effective conservation measures identified in coordination with the Fishery  
40 Agencies through the BDCP adaptive management process.

41  
42 **Rationale:** There are approximately 2,200 water diversions within the Delta (Figure  
43 2) and an additional 1,000 in place along the Sacramento and San Joaquin Rivers and  
44 their tributaries outside of the Delta and the Suisun Marsh (Herren and Kawasaki  
45 2001). The majority divert water to agricultural fields between April-August  
46 depending on the crop. This diversion timing partially overlaps with the presence of



1 many covered species in the Delta (generally January-July). Over 95% of these water  
2 diversions are not screened to reduce fish entrainment (Herren and Kawasaki 2001).  
3 A coarse estimate of 22,000 cfs has been calculated for the total amount of water  
4 diverted from these diversions. These diversions are often located in small channels,  
5 potentially increasing the influence of the diversion on the channel relative to channel  
6 capacity. Given this information, the potential for significant entrainment of fish is  
7 high (Hallock and Van Woert 1959 as cited Moyle and White 2002). Limited studies  
8 indicate that self-cleaning screens have been at least 99% effective in reducing fish  
9 entrainment at non-project diversions, even for larval fish <25 mm (Nobriga et al.  
10 2004).

11  
12 The U.S. Bureau of Reclamation's Anadromous Fish Screen Program (AFSP) was  
13 formed in the 1990s as part of the CVPIA. With limited funds and the high cost of  
14 screening, the program has been forced to prioritize diversions on which to install  
15 screens. This list of criteria includes size, location, number of species impacted, and  
16 cost. To date, most screens have been installed on the largest diversions upstream of  
17 the Delta under the assumption that larger diversions entrain a disproportionately  
18 higher number of fish than smaller diversions, although there is some uncertainty  
19 regarding this assumption.

20  
21 The Department of Fish and Game's Fish Screen and Passage Program is also  
22 involved with screening diversions in the Central Valley. As with the AFSP, limited  
23 funds have required prioritization of screening of diversions, primarily based on  
24 estimates of the likelihood and level of impact on federal and state listed endangered  
25 species. Both programs have relied on internal and CALFED ERP funds and  
26 regularly partner with the Family Water Alliance, a non-profit organization that has  
27 acted as the program manager of the Sacramento River Small Diversion Fish Screen  
28 Program since 1996.

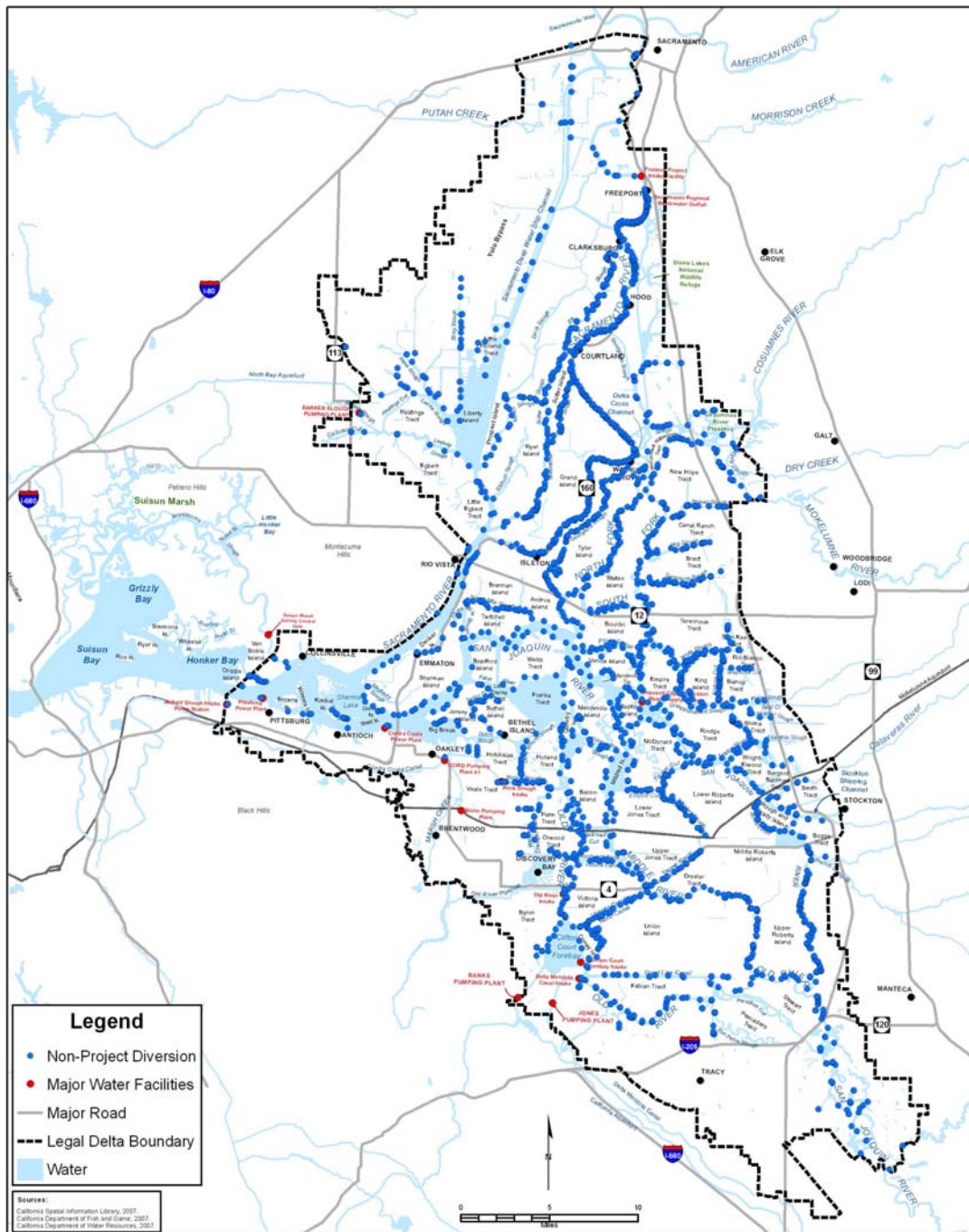
29  
30 If approved, Assembly Bill 2938, currently in the State Assembly, would provide  
31 three years of funding for a comprehensive DFG study of fish distribution patterns  
32 and entrainment rates of at least 27 non-project diversions throughout the Delta (C.  
33 Armor pers. comm.). If funding for AB 2938 is not approved by the Legislature, the  
34 BDCP Implementing Entity will fund a similar study to determine distribution  
35 patterns and entrainment rates of non-project diversions throughout the Delta.

36  
37 Removal of individual diversions with large impacts on covered fish species would be  
38 an effective way to reduce overall entrainment of covered fish species, but would not  
39 be practicable without identifying alternative sources of water at similar cost. If  
40 removal of diversions is not practical, diversions with large effects on covered species  
41 could be relocated from high quality to lower quality habitat. In locations with  
42 multiple diversions effecting covered species, the consolidation to a single or fewer  
43 diversions placed in lower quality habitat could reduce entrainment.

44  
45 High quality habitat includes potential spawning areas, important migration  
46 pathways, or known centers of distribution. Low quality habitat includes back

1  
2

Figure 2. Extent of non-project diversions in the Delta and Suisun Marsh.



3

1 channels with limited connectivity to main Delta channels or areas that are close to  
2 other sources of stress. In addition, diversions in small capacity channels have a  
3 proportionally larger effect on the fish in the channel. Diversions could be moved to  
4 larger channels to avoid this effect.

5  
6 Small-scale modifications to individual diversions in high quality habitat may be an  
7 effective and cheaper way to reduce entrainment of covered fish species than  
8 screening or making large scale location changes. This approach would take  
9 advantage of small scale spatial patterns and behavior of covered fish species relative  
10 to the location of individual diversions in the channel. For example, if the diversion  
11 were located in an area with high abundance of sturgeon, the diversion should be off  
12 the bottom. If the diversion is located in an area of high Chinook salmon or splittail  
13 abundance, the diversion should be off shallow slopes. Other aspects that could be  
14 modified include proximity to non-native predator habitat and orientation, shape, and  
15 design of the distal end, or movement of the intake to a groundwater well location  
16 adjacent to the channel.

17  
18 Altering the intra-annual timing of irrigation and therefore diversions may also be an  
19 effective way to reduce entrainment of covered fish species, although the  
20 practicability of this approach is dependent on the crop being grown. The agricultural  
21 irrigation period in the Delta is generally between April and August, depending on the  
22 crop. The early part of this season coincides with the presence of juveniles of all nine  
23 covered fish species in the Delta. Combined with a comprehensive monitoring plan  
24 determining the spatio-temporal patterns on a real-time basis (see below), diversion  
25 operations could be altered when covered species are in the vicinity of a diversion.

26  
27 Many covered fish species appear to exhibit diel patterns of activity (Grimaldo 2006,  
28 Webb et al. 2006, Wilder and Ingram 2006) that could be used to determine diel  
29 timing of diversion operations. The goal would be to divert when covered fish  
30 species are not near the in-channel location of the diversion. There is potential that  
31 diel activity patterns of covered fish species encompass the entire diel cycle such that  
32 there is no time of day to avoid all covered species. For example, Grimaldo (2006)  
33 reported that delta smelt are active primarily during the day. Wilder and Ingram  
34 (2006) reported that late-fall Chinook salmon were active primarily at night, whereas  
35 fall-run Chinook salmon were active primarily during the day. Webb et al. (2006)  
36 reported that delta smelt are active primarily both during the day and during  
37 crepuscular (near sunrise and sunset) periods, splittail are active primarily at night  
38 and during crepuscular periods, and longfin smelt exhibit no diel activity patterns.  
39 These patterns of activity need to be determined for other covered fish species before  
40 this conservation concept could be implemented. If fish activity patterns are  
41 distinctive, most pumping could occur at a certain time of day when fish are inactive  
42 and curtailed when fish are active.

43  
44 This conservation measure could provide financial and logistical support for willing  
45 diverters to alter the timing of pumping to reduce entrainment by their diversion.  
46

1       **Implementation timeframe:** It is anticipated that this conservation measure could  
2       be implemented in the BDCP near-term implementation period by screening,  
3       removing, relocating, consolidating, modifying the design, or altering the timing of  
4       diversions already identified as high priorities. Long-term implementation would be  
5       responsive to new information developed regarding screening prioritization of  
6       particular diversions and to changes in Delta conditions created by physical habitat  
7       restoration and changes in operations with dual conveyance.

8  
9       **Implementation considerations:** This conservation measure is considered to be  
10      practicable because screening efforts already underway have proven effective.  
11      Construction and maintenance costs, however, are high (\$7500/cfs construction costs  
12      for smaller diversions and >\$50,000/cfs for larger diversions) and the existing  
13      programs require additional funding (D. Meier pers. comm.).

14  
15      The effectiveness of the conservation measure is dependent on the number of  
16      diverters willing to remove, relocate, and consolidate their facilities, which has been  
17      historically difficult to obtain. Removal of a legal diversion could be accomplished  
18      through acquisition of lands in fee-title or conservation easement from willing sellers,  
19      which would result in the cessation of water diversion and removal of individual  
20      diversions. Water rights of these diverters must be addressed. The removal of illegal  
21      diversions could be accomplished through enforcement and other legal remedies.

22  
23      An important component to the effectiveness of this conservation measure will be the  
24      development and application of criteria for identifying which diversions, if removed,  
25      relocated, or consolidated, would result in the greatest reductions in non-project  
26      entrainment losses of covered fish species.

27  
28      Relocation of diversions and consolidation of multiple diversions could incur  
29      significant costs if substantial additional infrastructure is required to reach a more  
30      distant diversion site. Diversion design modification is considered to be moderately  
31      difficult to implement. It would require knowledge of in-channel distributions of  
32      covered fish species near the diversion. Regardless, it would likely be much cheaper  
33      than screening, relocating, or consolidating diversions. Also, diverters may be more  
34      willing to make smaller changes to their diversions than screening, relocating, or  
35      consolidating. Altering diversion timing could also be difficult to implement.

36  
37      The magnitude of effect of this conservation concept is difficult to predict because the  
38      effect that non-project entrainment has on covered species is relatively unknown and  
39      highly variable. However, the effect could be larger during times when the species  
40      are present in the Delta system. The effect is dependent on the success of real-time  
41      monitoring of the presence of covered species and on the ability to discern clear diel  
42      or seasonal patterns in fish activity. Seasonal diversion patterns could be affected by  
43      the crop type grown by the diverter.

44  
45      **Resiliency to future changes:** Because the distribution of covered fish species could  
46      change in the Delta with sea level rise, the effect of individual diversions on

1        entrainment of covered species and therefore, effectiveness of screening, relocation,  
2        consolidation, design modification, and alteration of timing of diversions could  
3        change with future climate change.  
4

5        **Uncertainties/risks:** It is difficult to assess the effectiveness of this conservation  
6        measure because the effect of non-project diversions on the entrainment of covered  
7        species is relatively unstudied. Entrainment is highly variable among diversions. If  
8        approved, Assembly Bill 2938, currently in the State Assembly, would provide three  
9        years of funding for a comprehensive DFG study of fish distribution patterns and  
10        entrainment rates of at least 27 diversions throughout the Delta (C. Armor pers.  
11        comm.). If funded, this study would provide needed information on the effects of  
12        non-project diversions on covered fish species.  
13

14        Understanding the effect of variation of parameters related to diversion size, location,  
15        pumping patterns, etc. on entrainment rates of covered species would allow better  
16        informed decisions regarding priorities for removal, relocation, and consolidation of  
17        diversions. Patterns of diel and seasonal activity and distribution of covered fish  
18        species would provide necessary information to determine the alterations in timing of  
19        diversions.  
20

21        There is evidence that diversions entrain large numbers of non-native species (Brown  
22        1982, Nobriga et al. 2004). Therefore, screening diversions could be more beneficial  
23        to non-native fish species than native fish species, potentially increasing competition  
24        with and predation by non-natives on natives. Understanding the effect of variation  
25        of parameters related to diversion size, location, pumping patterns, etc. on  
26        entrainment rates of covered species would allow better informed decisions regarding  
27        screening priorities and would improve screening success.  
28

29        **Monitoring and adaptive management considerations:** *[Note to reviewers: this*  
30        *section is a general summary; more detail will be provided in future iterations.]*  
31        With respect to screening actions, the Bureau of Reclamation and the Department of  
32        Fish and Game would be responsible for monitoring the effectiveness of their  
33        respective fish screening programs in reducing the entrainment of covered fish  
34        species at non-project diversions. The BDCP Implementing Entity would review  
35        progress and other relevant reports prepared by the Anadromous Fish Screen Program  
36        and the Fish Screen and Passage Program. The BDCP Implementing Entity would  
37        coordinate with Reclamation and the Department of Fish and Game to screening  
38        strategies and funding levels through the BDCP adaptive management process as  
39        appropriate based on review of funded program reports.  
40

41        Prior to relocating or consolidating diversions, the BDCP Implementing Entity would  
42        conduct surveys to determine the existing habitat use by covered fish species near the  
43        effected diversions and fish use at locations where diversions would be relocated or  
44        consolidated. Following completion of a relocation or consolidation, fish use would  
45        be monitored in the same locations to determine the effectiveness of the relocation or  
46        consolidation in reducing entrainment levels. The BDCP Implementing Entity may

1 adjust its strategies for selecting diversions to be relocated or consolidated, modify  
2 intake designs, or adjust funding levels through the BDCP adaptive management  
3 process based on monitoring results and other relevant information (e.g., monitoring  
4 and research conducted by others).

5  
6 **Reversibility:** Reversibility of the screening of diversions is expected to be low due  
7 to the large amounts of infrastructure associated with screens, particularly for larger  
8 diversions. Reversibility of the removal of diversions is expected to be moderate,  
9 depending on the extent of facilities removed or modified (versus left in place without  
10 operation). Land use changes associated with the land acquisition would result in low  
11 reversibility. Reversibility of consolidating and/or relocating of diversions is  
12 expected to be low or moderate depending on the level of infrastructure modification  
13 required. Reversibility of design modifications is expected to be moderately high  
14 because modifications could be simple and inexpensive relative to screening,  
15 relocating, and removing diversions. Reversing alterations in the timing of diversions  
16 is expected to be easily accomplished.

## 17 18 19 *Commercial/Recreational Activities*

### 20 21 **Introduction**

22  
23 This section contains a conservation measure to reduce boat speeds, and hence wake size,  
24 in areas of sensitive habitat to reduce impacts on covered species.

25  
26 **Conservation Measure CORA1: Establish No Wake Boating Zones in Delta**  
27 **Waterways to Protect Sensitive Covered Species Shoreline Habitat.** The BDCP  
28 Implementing Entity would coordinate with the Department of Boating and Waterways  
29 and local governing entities to establish low boat speeds regulations (no wake zones) and  
30 post signs in locations with high ecosystem function and sensitive habitat for covered  
31 species at a funding level of \$\$ over the term of the BDCP. Low boat speed zones  
32 would only be established in Delta waterways that support habitats and use areas of high  
33 importance to covered fish species and that are being substantially degraded by boat  
34 wakes. The BDCP Implementing Entity would be responsible for undertaking  
35 investigations necessary to identify sensitive covered fish species habitats and use areas  
36 that would benefit from establishing low boat speed zones.

37  
38 The BDCP Implementing Entity would enter into Memoranda of Agreement (MOA) or  
39 similar binding instruments with the Department of Boating and Waterways and local  
40 governing entities that would describe respective roles and obligations for expenditure of  
41 BDCP funding. Elements of the MOA would include a description of specific activities  
42 that would be funded by BDCP, preparation of annual work plans for BDCP funded  
43 activities, provisions for documenting work performed, monitoring responsibilities, and  
44 provisions for modifying or terminating the MOA.



1 The BDCP Implementing Entity would be responsible for developing annual work plans,  
2 in coordination with the Fishery Agencies, that specify the location and extent of  
3 additional no wake zones to be implemented by the Department of Boating and  
4 Waterways and local governing entities at funded levels. The Department of Boating and  
5 Waterways and local governing entities would be responsible for implementing the scope  
6 of work and submitting reports as specified in the MOA that demonstrate that the work  
7 plan has been successfully implemented. The Department of Boating and Waterways and  
8 local governing entities would also be responsible for monitoring the effectiveness of  
9 additional no wake zones on covered fish species habitat use and, if necessary, adjusting  
10 methods to improve their effectiveness over time.

11  
12 If results of monitoring indicate that projects implemented under this conservation  
13 measure does not substantially and cost-effectively benefit covered fish species, the  
14 BDCP Implementing Entity in coordination with Fishery Agencies may terminate this  
15 conservation measure. The BDCP Implementing Entity, in coordination with the Fishery  
16 Agencies, would also terminate this conservation measure if the Department of Boating  
17 and Waterways and local governing entities choose not to enter into a MOA with the  
18 BDCP Implementing Entity. If terminated, remaining funding would be deobligated  
19 from this conservation measure and reallocated to augment funding for other more  
20 effective conservation measures identified in coordination with the Fishery Agencies  
21 through the BDCP adaptive management process.

22  
23 **Rationale:** Boat wakes from recreational boats can damage intertidal marsh habitat  
24 and disturb shallow waters in which splittail and salmonids may be rearing or delta  
25 smelt may be spawning. The Department of Boating and Waterways and local  
26 ordinances currently restrict boat speeds to 5 mph in specific areas of the Delta, such  
27 as near boat docks and landings. These limits have been set primarily for human  
28 safety concerns and protection of infrastructure. This conservation measure would  
29 direct the BDCP Implementing Entity to work with the Department of Boating and  
30 Waterways and local governing entities to limit boat speeds to 5 mph in areas of high  
31 importance to the ecosystem and covered species, including such as areas of known  
32 or suspected spawning, major migration corridors for covered fish species, and BDCP  
33 intertidal habitat restoration locations. Reduced boat wake size at 5 mph speed  
34 substantially diminishes vegetation and substrate damage and removal relative to the  
35 larger wakes created at higher speeds.

36  
37 **Implementation timeframe:** It is anticipated that that this conservation measure  
38 could be implemented in the BDCP near-term implementation period.

39  
40 **Implementation considerations:** This conservation measure should be readily  
41 implemented at minimal cost. The measure may not be easily enforceable if there is a  
42 substantial extent of waterways in which reduced boat speeds would be posted. An  
43 important component to the effectiveness of this conservation measure will be the  
44 development and application of criteria for identifying which intertidal and aquatic  
45 habitat and fish use areas would most benefit from establishment and enforcement of  
46 low boat speed regulations.

1  
2 **Resiliency to future changes:** Because the distribution of covered fish species could  
3 change in the Delta with sea level rise, locations in which low boat speeds are set may  
4 have to be altered with future climate change.

5  
6 **Uncertainties/risks:** The effect that boat wakes have on shallow water habitat is  
7 unknown and, as a result, the potential benefit of this conservation measure to  
8 covered fish species is unknown. The effects of boat wakes on marsh vegetation is  
9 well documented (Nordstrom 1992).

10  
11 **Monitoring and adaptive management considerations:** *[Note to reviewers: this*  
12 *section is a general summary; more detail will be provided in future iterations.]*  
13 Local law enforcement agencies would be responsible for monitoring compliance of  
14 boaters in established low boat speed zones. As part of agreements with the  
15 Department of Boating and Waterways, the BDCP Implementing Entity would  
16 monitor the effectiveness of slow boat speed zones for improving covered fish species  
17 habitat use and habitat conditions. In coordination with the Department of Boating  
18 and Waterways, the BDCP Implementing Entity would recommend revisions to low  
19 speed zone regulations through the BDCP adaptive management process based on  
20 results of effectiveness monitoring.

21  
22 **Reversibility:** This conservation measure is expected to be easily reversible.

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### 33 34 35 **Personal Communications**

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37 P. Adams, Fish Biologist, NMFS, Phone call, 6/6/08.

38  
39 C. Armor, Bay-Delta Regional Manager, DFG, Presentation to the Other Stressors  
40 Working Group, 8/19/08.

41  
42 N. Dobroski, State Lands Commission, Ballast Water Program, Telephone conversation,  
43 7/3/08.

44  
45 C. Enright, Senior Engineer, DWR, Telephone conversation, 8/26/08.



- 1
- 2 K. Fisher, Associate Counsel, California Farm Bureau Federation, Email, 8/25/08.
- 3
- 4 S. Foott, Biologist, USFWS Fish Health Center, Telephone conversation, 4/29/08.
- 5
- 6 D. Fullerton, Principal Resource Specialist, MWD, Presentation to the Other Stressors
- 7 Working Group, 5/27/08
- 8
- 9 R. Hedrick, Professor, UC Davis, Personal meeting, 5/8/08.
- 10
- 11 J. Horenstein, Invasive Species Coordinator, DFG, Email, 8/13/08.
- 12
- 13 M. Marshall, Supervisory Fish Biologist, USFWS, Stockton, California. Personal
- 14 meeting, 2/9/07.
- 15
- 16 D. Meier, Anadromous Fish Screen Program Manager, USFWS, Telephone conversation,
- 17 4/29/08.
- 18
- 19 BJ Miller, Private Consultant. Presentation to the Other Stressors Working Group,
- 20 5/27/08.
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DRAFT