

Second Draft Other Stressors Conservation Measures

Note to Steering Committee: This handout presents second 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 first draft provided to Steering Committee on September 5, 2008 is displayed in underlined red text; text in black is the same as delivered in the first draft.

Based on scoring and discussion during meetings of the Other Stressors Working Group, the Working Group placed each conservation measure into one of three categories regarding recommendation to the Steering Committee (see Attachment A):

- “Keep” – OSWG recommends that SC consider keeping these measures
- “Uncertain” – OSWG is uncertain about recommending to keep these measures because of uncertainty regarding these measures’ benefits/effectiveness
- “Out” – OSWG does not recommend keeping these measures

This draft includes only those conservation measures in the “Keep” and “Uncertain” categories (except for TOCO7); the descriptions of these conservation measures have been expanded to provide more specificity providing greater assurance that the measures would be implemented and would be effective or discontinued. Note that the titles of the conservation measures have been changed to better reflect the ultimate purpose of the measure; conservation measure code numbers, however, are the same and can be matched to the first draft.

This second draft incorporates comments received from Steering Committee members to first draft conservation measures presented to the Steering Committee at its September 5, 2008 meeting.

These second draft conservation measures will be discussed at the October 17, 2008 Steering Committee meeting. **Written comments are requested prior to October 22, 2008** such that we may incorporate those comments into the next draft of these measures.

1 Attachment A. Other Stressors Working Group Recommended Conservation
2 Measures for Consideration by the BDCP Steering Committee
3

Stressor	Draft Conservation Measure	OSWG Recommendation¹
Non-Native Invasive Species	NNIS1: Fund Implementation of the California Aquatic Invasive Species Management Plan.	Out
	NNIS2: Evaluate Effects of and Implement Actions (If Necessary) to Reduce Commercial Vessel Fouling.	Uncertain
	NNIS3: Fund a CDFG Watercraft Inspection Program in the Delta.	Uncertain
	NNIS4: Recommend Hazard Analysis and Critical Control Points Plans to NEPA/CEQA Lead Agencies.	Out
	NNIS5: Fund Education and Outreach Position in CDFG Invasive Species Program.	Out
	NNIS6: Fund the CDFG Oil Spill Monitoring and Prevention Program and a Volunteer Invasive Early Detection Network to Increase Non-Native Early Detection Capability in the Bay/Delta.	Out
	NNIS7: Fund the Formation of a Delta-Specific Rapid Response Team.	Uncertain
	NNIS8: Fund the Zebra Mussel Rapid Response Plan for California.	Uncertain
	NNIS9: Remove Non-Native Submerged and Floating Aquatic Vegetation from the Delta.	Keep
	NNIS10: Recommend the Relaxation of Fishing Limits on Non-Native Species.	Uncertain
	NNIS11: Reduce Mortality of Released Salvaged Fish by Non-Native Predators.	Uncertain
Toxics and Other Water Quality Issues	TOCO1: Evaluate Effects and Implement (If Necessary) Effluent Ammonia Reduction Actions.	Keep
	TOCO2: Evaluate Effects and Implement (If Necessary) Reduction Actions of Endocrine Disrupting Compounds.	Keep*
	TOCO3: Provide Support Funding to Reduce Methylmercury Loads in the Delta.	Keep*
	TOCO4: Support Development and Implementation of Agricultural Chemical Management Plans.	Keep (combine w/TOCO5)
	TOCO5: Support CVRWQCB Programs to Reduce Toxic Compounds in Agricultural Return Water.	Keep (combine w/TOCO4)
	TOCO6: Support Reassessment of Pesticide Labels and Urban Use Reporting to Reduce Pesticides Reaching the Delta.	Out
	TOCO7: Coordinate with Agencies Regulating Urban Runoff.	Out
	TOCO8: Coordinate with Agencies Regulating Dredging.	Out
	TOCO9: Fund Pollution Prevention Programs for Recreational Boaters.	Out
	TOCO10: Fund the USFWS's Pharmaceutical Disposal Education Program.	Out
	TOCO11: Fund Education and Outreach for Urban Run-Off and Stormwater Pollution Prevention Programs.	Out
	TOCO12: Fund a Comprehensive Real Time Monitoring, Assessment and Response Program for Contaminants.	Keep*
Other Water Quality Issues	OTWQ1: Coordinate with the Army Corps of Engineers and Port of Stockton to Solve Dissolved Oxygen Issues in the Stockton Deep Water Ship Channel.	Keep

Stressor	Draft Conservation Measure	OSWG Recommendation¹
	OTWQ2: Coordinate with Willing Owners and Managers to Improve Quality of Effluent from Managed Seasonal Wetlands.	Uncertain
Hatcheries	HATC1: Fund Development and Implementation of Hatchery and Genetic Management Plans for Central Valley Salmonid Hatcheries to Reduce Adverse Effects on Wild Stocks.	Keep*
	HATC2: Fund Total Marking of Hatchery Produced Fall-Run Chinook Salmon in Support of a Mark-Select Fishery.	Keep
	HATC3: Fund Total Tagging of All Hatchery-Produced Chinook Salmon and Steelhead.	Uncertain
	HATC4: Fund Artificial Propagation Programs for Delta and Longfin Smelt.	Uncertain
Harvest	HARV1: Fund Increased Staffing of DFG’s Delta-Bay Enhanced Enforcement Program.	Keep
	HARV2: Fund Education and Outreach to Prevent Illegal Harvest.	Out
	HARV3: Support the Establishment of Regulations on Sacramento Splittail Harvest.	Uncertain
Non-Project Diversions	NPDI1: Install Fish Screens at Non-Project Diversions to Reduce Entrainment of Covered Fish Species.	Uncertain (combine w/NPDI2)
	NPDI2: Fund Cost-Sharing to Remove, Relocate, Consolidate, Modify and/or Alter Timing of Non-Project Diversions.	Uncertain (combine w/NPDI1)
Commercial/ Recreational Activities	CORA1: Set Low Boating Speeds at Sensitive Habitat Sites.	Uncertain

- 1 ¹Notes:
- 2 • “Keep” – OSWG recommends that SC consider keeping these measures.
- 3 • “Keep*” - (Keep with an asterisk) although the OSWG recommends keeping the
- 4 conservation measure, there were reservations within the group regarding
- 5 certainty and clear benefit to covered species.
- 6 • “Uncertain” – OSWG is uncertain about recommending to keep these measures because
- 7 of uncertainty regarding these measures’ benefits/effectiveness
- 8 • “Out” – OSWG does not recommend keeping these measures

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.

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

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

Monitoring and adaptive management considerations. This section describes monitoring and adaptive management-related elements of the conservation measure, including elements of implementation that may be subject to adaptive management and the types of monitoring that may be appropriate for assessing the effectiveness of the conservation measure in achieving desired ecological benefits and for informing the adaptive management process. [*Note to reviewers: The*

1 content of this section will be expanded for each conservation measure to provide
2 more specificity regarding monitoring actions and metrics and adaptive
3 management triggers and actions, as appropriate, through future iterations of
4 these materials.]

5
6 **Reversibility.** This section qualitatively assesses the likely ability to reverse the
7 environmental outcomes of the conservation measure, if necessary.

8
9 The information described above for each of the draft conservation measures will be
10 expanded upon and incorporated into appropriate sections of the BDCP Conservation
11 Strategy chapter.

14 ***Non-Native Invasive Species***

16 **Introduction**

17
18 This section contains a wide range of conservation measures focused on preventing non-
19 native species from reaching the Delta and controlling non-native species already
20 established in the Delta. Stopping non-native invasive species before they reach the Delta
21 is the most effective way to protect covered species and other native species from
22 additional stressors. Past invasions have documented the substantial effects non-natives
23 can have on covered species and the Delta ecosystem. Conservation measures provided
24 here include measures to increase the detection of invasive species and prevent their entry
25 into California and the Delta, to rapidly respond to stop invasions at early stages, to
26 remove invasive plant species from areas important to covered fish species, and to reduce
27 the effects of non-native predators on covered species.

28
29 **Conservation Measure NNIS2: Reduce the Risk for Future Introductions of Non-**
30 **Native Aquatic Organisms from Commercial Vessels.** [Note to reviewers: This
31 conservation measure addresses the hull fouling program of the California State Lands
32 Commission. As requested by the Steering Committee, SAIC is investigating adding
33 support of the ballast water program to this conservation measure., SAIC is currently in
34 discussions with the U.S. Coast Guard and State Lands Commission to identify any
35 deficiencies in their respective ballast water control programs that could be addressed by
36 the BDCP. In future drafts, this conservation measure would be revised and expanded to
37 include these findings, as appropriate]. To implement this conservation measure, the
38 BDCP Implementing Entity would support the development of the California State Lands
39 Commission's Commercial Vessel Fouling Program at a funding level of \$ [redacted] over the
40 term of the BDCP. Initially, this conservation measure would provide funding for the
41 program to conduct targeted research to characterize the introduction risk posed by
42 commercial vessel fouling and, if necessary, develop and adopt regulations that prevent
43 or minimize introductions via vessel fouling and support the development of hull
44 husbandry technology.

1
2 The BDCP Implementing Entity would enter into a Memorandum of Agreement (MOA)
3 or similar binding instrument with the State Lands Commission that would describe
4 respective roles and obligations for expenditure of BDCP funding. Elements of the MOA
5 would include a description of specific research and other activities that would be funded
6 by BDCP, requirements for preparation of work plans for BDCP funded activities,
7 provisions for documenting work performed, monitoring responsibilities, and provisions
8 for modifying or terminating the MOA. The BDCP Implementing Entity, in coordination
9 with the Fishery Agencies, would review proposed targeted research plans to ensure
10 results would be useful in assessing the likely efficacy of supporting actions to minimize
11 vessel fouling for substantially reducing the risk of introductions of non-native aquatic
12 species.

13
14 The BDCP Implementing Entity would also provide funding to CSLC to develop
15 effective hull husbandry technologies and enforce commercial fouling regulations
16 adopted in response to research results indicating that commercial vessel fouling poses a
17 substantial risk for the introduction of non-native aquatic species into the Delta
18 ecosystem. If results of the initial targeted research do not indicate that there is a
19 substantial risk of species introductions from vessel fouling or that technologies to reduce
20 introduction risk are not cost-effective or feasible, the BDCP Implementing Entity, in
21 coordination with Fishery Agencies, may terminate this conservation measure. The
22 BDCP Implementing Entity, in coordination with the Fishery Agencies, would also
23 terminate this conservation measure if State Lands Commission chooses not to enter into
24 a MOA with the BDCP Implementing Entity. If terminated, remaining funding would be
25 deobligated from this conservation measure and reallocated to augment funding for other
26 more effective conservation measures identified in coordination with the Fishery
27 Agencies through the BDCP adaptive management process.

28
29 **Rationale:** Prevention of non-native species introductions is the most cost effective
30 and environmentally sensitive method to respond to non-native invasive species
31 (CDFG 2008). New introductions of aquatic organisms are often caused by release of
32 organisms in ballast water discharges and by dispersal of organisms growing on the
33 outside surfaces of hulls (Takata et al. 2006). The California State Lands Commission
34 (CSLC) has an existing Ballast Water Program to prevent new non-native species
35 introductions that includes ballast water management tracking, compliance,
36 enforcement, research, education, and outreach (Falkner et al. 2007). According to
37 State Lands Commission staff, the Ballast Water Program is fully funded by a fee
38 system and is >90% successful in gaining compliance of vessel operators (N.
39 Dobroski, pers. comm.). However, hull husbandry to prevent fouling by non-native
40 species introductions into California is not currently regulated by State Lands
41 Commission (Takata et al. 2006). This topic has gained interest among regulators
42 recently but does not have the level of infrastructure, knowledge base, or technology
43 needed to be effective. The State Lands Commission has recommended that the
44 Legislature allow the State Lands Commission to adopt regulations to broaden the
45 State programs to control non-native invasive species to include a Vessel Fouling

1 Program (Takata et al. 2006). Although vessel fouling primarily transports marine
2 species over long distances, the same vessels frequently make multiple stops along
3 the west coast of North America and can move organisms that are adapted to brackish
4 water environments (such as Suisun Bay and Marsh and the West Delta) from port to
5 port. Additionally, many brackish and freshwater species are tolerant of high salinity
6 and other adverse environmental conditions for extended periods, such as those
7 required to travel between North America and Asia (Panov 1996, Mann and Harding
8 2003, Bailey et al. 2004) and could pose a threat to the Delta.

9
10 The Marine Invasive Species Act of 2003 directed the State Lands Commission to
11 analyze the risk of introductions via vessel fouling in consultation with a technical
12 advisory group that produced a list of recommendations (Takata et al. 2006). The
13 highest priorities identified in the analysis include: 1) authorizing the State Lands
14 Commission to develop and adopt regulations that prevent or minimize introductions
15 via vessel fouling; 2) expanding and coordinating targeted biological research
16 directed towards characterizing the introduction risk posed by commercial vessel
17 fouling with other state and federal agencies, and; 3) supporting research promoting
18 technology development (Takata et al. 2006).

19
20 Although it is difficult to predict the potential effects of future introductions of non-
21 native species, there are several well-documented examples of deleterious effects
22 caused by non-natives introductions into the Delta. Two non-native invasive aquatic
23 plants, water hyacinth (*Eichhornia crassipes*) and Brazilian waterweed (*Egeria*
24 *densa*), have reduced habitat quantity and quality for many native fishes in the
25 Planning Area (NMFS 2004), and possibly are providing habitat for non-native
26 predatory centrarchids. The introductions of two clams from Asia, the overbite clam
27 (*Corbula amurensis*) and the Asian clam (*Corbicula fluminea*) have resulted in
28 substantial effects in the Delta in just 20 years. These clams are considered ecosystem
29 modifiers because of their wide ranging effects on the aquatic ecosystem and specific
30 native species. Both are highly efficient filter feeders that reduce phytoplankton and
31 zooplankton in the water column, which can be food for native fishes, such as delta smelt
32 and young Chinook salmon (Kimmerer and Orsi 1996, NMFS 2004, Center for
33 Biological Diversity 2007). Several introduced invertebrate species that are food for
34 several covered fish species have replaced native species in the low salinity zone, and
35 may have led to lower foraging efficiency, starvation, and reduced growth rates of these
36 fishes (Moyle 2002). If the effects of past introductions are an indication of the effects
37 of future introductions, there will likely be large ecosystem scale effects of non-natives
38 introduced in the Delta in the future. Further, although not yet in the Delta, zebra
39 (*Dreissena polymorpha*) and quagga mussels (*Dreissena rostriformis bugensis*) may
40 soon establish. These mussels have caused >90% mortality of native bivalves in other
41 parts of North America (Ricciardi et al. 1996).

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

45

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

4
5 **Resiliency to future changes:** This action would not be influenced by future climate
6 change.

7
8 **Uncertainties/risks:** There are currently no data describing the frequency of
9 introductions of fouling organisms due to short range port-to-port movement of ships
10 (Foss et al. 2007). Therefore, the benefits of this conservation measure cannot be
11 easily predicted. The benefits could be very large depending on the non-native
12 invasive introductions that are prevented by the measures. Existing non-native
13 invasive species in the Delta have a wide range of substantial impacts on covered
14 species and future introductions would be expected to have a similar range of
15 substantial impacts on covered species, if preventative measures are not taken.

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 State Lands Commission would be responsible for monitoring the effectiveness of the
20 Commercial Vessel Fouling Program for reducing the risk of the introduction and
21 establishment of non-native species in the Delta. The BDCP Implementing Entity
22 would review progress reports and other relevant reports prepared by State Lands
23 Commission for the Commercial Vessel Fouling Program to assess the effectiveness
24 of the programs in assessing the importance of hull fouling, formulating regulations,
25 and improving hull husbandry technology. The BDCP Implementing Entity would
26 coordinate with State Lands Commission to adjust strategies and funding levels
27 through the BDCP adaptive management process as appropriate based on review of
28 agency reports.

29
30 If results of the initial targeted research do not indicate that there is a substantial risk
31 of species introductions from vessel fouling or that technologies to reduce
32 introduction risk are not cost-effective or feasible, the BDCP Implementing Entity, in
33 coordination with Fishery Agencies, may terminate this conservation measure.

34
35 **Reversibility:** This conservation measure is considered to be moderately reversible.
36 Possible expenditures in equipment purchases would not be recovered if the program
37 were to not be continued.

38
39
40 **Conservation Measure NNIS3: Reduce the Risk for Future Introductions of Non-**
41 **Native Aquatic Organisms from Recreational Watercraft.** To implement this
42 conservation measure, the BDCP Implementing Entity would support a watercraft
43 inspection program of the California Department of Fish and Game (CDFG) to prevent
44 future invasions of non-natives into the Delta at a funding level of up to \$ [redacted] over the
45 term of the BDCP. Such a program could establish a certificate program whereby all

1 boats and trailers entering Delta waterways would be required to be inspected and, if free
2 of standing water and organisms, would be given a seven-day certificate. Multiple
3 inspection stations would be set up along major driving routes throughout the Delta. The
4 program could be operated under the auspices of CDFG game wardens, potentially as
5 part of DBEEP. Funding would be provided to implement the certificate program and
6 increase the number of watercraft inspections over the level provided under current
7 funding and staffing resources. Initial stages of the program would determine the level of
8 effort and geographical extent needed for the program. Public outreach and education are
9 implicitly necessary for the program to be implemented effectively.

10
11 The BDCP Implementing Entity would enter into a Memorandum of Agreement (MOA)
12 or similar binding instrument with CDFG that would describe respective roles and
13 obligations for expenditure of BDCP funding. Elements of the MOA would include a
14 description of specific activities that would be funded by BDCP, requirements for
15 preparation of work plans for BDCP funded activities, provisions for documenting work
16 performed, monitoring responsibilities, and provisions for modifying or terminating the
17 MOA. CDFG would also be responsible for monitoring the effectiveness of the
18 inspection program and inspection methods to improve their effectiveness over time.

19
20 The BDCP Implementing Entity would review progress or other relevant reports prepared
21 by CDFG to assess the effectiveness of the program in reducing risk of the introduction
22 and establishment of non-native species. The BDCP Implementing Entity would
23 coordinate with the CDFG to adjust inspection strategies and funding levels through the
24 BDCP adaptive management process as appropriate based on review of agency reports.

25
26 If results of effectiveness monitoring indicate that the inspection program does not
27 substantially and cost-effectively reduce the risk of introductions of non-native aquatic
28 species into the Delta aquatic ecosystem, the BDCP Implementing Entity, in coordination
29 with Fishery Agencies, may terminate this conservation measure. This conservation
30 measure would also be terminated if CDFG chooses not to enter into MOAs with the
31 BDCP Implementing Entity. If terminated, remaining funding would be deobligated
32 from this conservation measure and reallocated to augment funding for other more
33 effective conservation measures identified in coordination with the Fishery Agencies
34 through the BDCP adaptive management process.

35
36
37 **Rationale:** A primary vector of local introductions of aquatic non-native species is
38 recreational watercraft and trailers used to transport them (CDFG 2008). Non-natives
39 can become attached to the hulls and engines of watercraft or various parts of trailers
40 or be transported in standing bilge water or live bait tanks. Increasing inspection
41 efforts of watercraft by trained experts could increase the identification and
42 subsequent removal of non-natives from watercraft, thereby reducing the risk of
43 introduction into the Delta. Since the invasion of quagga mussels into Southern
44 California waterways in January 2007, the California Department of Food and
45 Agriculture and CDFG boat inspection efforts at California borders have increased

1 and many reservoirs have begun inspection programs. However, there is currently no
2 comprehensive effort to inspect boats entering Delta waterways.

3
4 Inspections have been implemented at reservoirs throughout the state. Although it is
5 difficult to predict the potential effects of future introductions of non-native species,
6 there are well-documented examples of deleterious effects caused by non-natives
7 introduced into the Delta. If the impacts of past introductions are an indication of the
8 impacts of future introductions, there will likely be new large-scale ecosystem effects
9 of non-natives in the Delta. Recent introductions of quagga and zebra mussels into
10 southern California, likely via recreational watercraft, have indicated a need to
11 develop a Delta-specific watercraft inspection program to slow and contain the spread
12 of the mussels across the state, particularly with respect to the Delta. To prevent new
13 aquatic species invasions, a comprehensive inspection program would need to be
14 developed in which all boats are inspected in all locations that could influence the
15 Delta.

16
17 Funding would be sufficient to support up to additional wardens over existing
18 staffing levels and an annual training program (or refresher) on aquatic invasive
19 species identification, disposal, and reporting methods.

20
21 **Implementation timeframe:** It is anticipated that this conservation measure could be
22 implemented in the BDCP near-term implementation period.

23
24 **Implementation considerations:** Significant coordination and funding would be
25 needed for this program to be developed. There would likely be contention among the
26 boating community regarding this conservation measure. Implementation would be
27 accomplished through a funding agreement with CDFG or by the transfer of funds.

28
29 **Resiliency to future changes:** This action would not be influenced by future climate
30 change.

31
32 **Uncertainties/risks:** The benefits of this conservation measure cannot be easily
33 predicted but the benefits could be very large depending on the non-native invasive
34 introductions that are prevented and the control or eradication methods that are
35 implemented. Existing non-native invasive species in the Delta have a wide range of
36 substantial impacts on covered species and future introductions would be expected to
37 have a similar range of substantial impacts on covered species. There will always
38 remain the risk that invasive species propagules on recreational vessels will avoid
39 detection to reach and invade the Delta.

40
41 **Monitoring and adaptive management considerations:** [Note to reviewers: this
42 section is a general summary; more detail will be provided in future iterations] The
43 Department of Fish and Game would be responsible for monitoring the effectiveness
44 of BDCP-funded elements of a watercraft inspection program. The BDCP
45 Implementing Entity would review progress or other relevant reports prepared by the

1 Department of Fish and Game to assess the effectiveness of the program in reducing
2 risk for the introduction and establishment of non-native species. The BDCP
3 Implementing Entity would coordinate with the Department of Fish and Game to
4 adjust inspection strategies and funding levels through the BDCP adaptive
5 management process as appropriate based on review of agency reports.

6
7 **Reversibility:** This conservation measure is expected to be easily reversible.
8
9

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

12 Implementing Entity will support the formation of a CDFG Delta-specific rapid response
13 team for new non-native introductions into the Delta at a funding level of up to \$\$
14 over the term of the BDCP. This conservation measure would contribute funding to form
15 a rapid response team specific to the Delta by specifying that these monies fund actions
16 in the Delta or at locations outside the Delta for species with a high likelihood of
17 invading the Delta.

18
19 The BDCP Implementing Entity would enter into a Memorandum of Agreement (MOA)
20 or similar binding instrument with CDFG that would describe respective roles and
21 obligations for expenditure of BDCP funding. Elements of the MOA would include a
22 description of specific activities and equipment that would be funded by BDCP,
23 preparation of annual work plans for BDCP funded activities, provisions for documenting
24 work performed, monitoring responsibilities, and provisions for modifying or terminating
25 the MOA.

26
27 CDFG would be responsible for:

- 28 ▪ developing annual work plans that specify the extent and types of activities to be
29 implemented by CDFG at funded levels for submittal to the BDCP Implementing
30 Entity;
- 31 ▪ implementing the scope of work and submitting reports as specified in the MOAs
32 that demonstrate that work plans have been successfully implemented; and
- 33 ▪ monitoring the effectiveness of detection and response procedures and improving
34 them as warranted over time.

35
36 The BDCP Implementing Entity in coordination with the Fishery Agencies will
37 periodically review the cost effectiveness of this conservation measure in achieving
38 benefits for covered fish species. If it is determined that this conservation measure does
39 not provide a substantial cost-effective benefit for covered fish species, the BDCP
40 Implementing Entity in coordination with Fishery Agencies may terminate this
41 conservation measure. The BDCP Implementing Entity would also terminate this
42 conservation measure if CDFG chooses not to enter into a MOA with the BDCP
43 Implementing Entity. If terminated, remaining funding would be deobligated from this

1 conservation measure and reallocated to augment funding for other more effective
2 conservation measures identified in coordination with the Fishery Agencies through the
3 BDCP adaptive management process.
4

5 **Rationale:** The CAISMP contains an action recommending the development of
6 “species- and/or location-specific rapid response plans” (CDFG 2008). Immediate
7 response to initial invasions by non-native species can eradicate those species before
8 they become widespread and established in the Delta. Any delay in response could
9 allow for establishment of a non-native species over an area too large for eradication
10 efforts. By stopping invading species before they become well established, this
11 measure could prevent substantial adverse effects on covered species as evinced by
12 past non-native invasions. The CAISMP also contains a Draft Rapid Response Plan
13 for aquatic invasive species in California. The Draft Rapid Response Plan states that
14 “the Plan cannot be implemented without adequate, stable and dedicated funding”
15 (CDFG 2008).
16

17 **Implementation timeframe:** It is anticipated that this conservation measure could be
18 implemented in the BDCP near-term implementation period.
19

20 **Implementation considerations:** Implementation would be accomplished through a
21 funding agreement with CDFG and by the transfer of funds.
22

23 **Resiliency to future changes:** This action would be resilient to future climate change
24 because adaptive management is built into the CAISMP.
25

26 **Uncertainties/risks:** The benefits of this conservation measure cannot be easily
27 predicted but the benefits could be very large depending on the success of the control
28 or eradication methods that are implemented. Existing non-native invasive species in
29 the Bay/Delta have a wide range of impacts on covered species and future
30 introductions would be expected to have a similar range of impacts on covered
31 species.
32

33 **Monitoring and adaptive management considerations:** [Note to reviewers: this
34 section is a general summary; more detail will be provided in future iterations] The
35 BDCP Implementing Entity would review progress reports or other relevant reports
36 prepared by CDFG to assess the effectiveness of the Delta-specific rapid response
37 team in preventing the establishment of new invasive non-native species in the Delta.
38 The BDCP Implementing Entity would coordinate with CDFG to adjust invasive
39 species control strategies and funding levels through the BDCP adaptive management
40 process as appropriate, based on review of agency reports.
41

42 **Reversibility:** This conservation measure is expected to be highly reversible.
43
44

1 **Conservation Measure NNIS8: Reduce the Risk for Establishment of Zebra Mussel**
2 **and Quagga Mussel in Delta Waterways.** The BDCP Implementing Entity would
3 support implementation of the following actions to a funding level of \$\$ [REDACTED] over the
4 term of the BDCP:

5
6 1. Complete annual updates of the Zebra Mussel Rapid Response Plan for California
7 (ZMRRPC) to include quagga mussel (*Dreissena rostriformis bugensis*) and
8 incorporate eradication scenarios that reflect the operations and covered species data
9 that are generated by the development and implementation of the BDCP. The
10 scenarios should include a full range of possible invasion patterns, invasion extents,
11 covered species distributions and life history sensitivities, and water status and
12 operation patterns that represent drought and normal rainfall water years.

13
14 2. Apply to the EPA for the appropriate permits to use potassium salt solution and/or
15 the common soil bacterium, *Pseudomonas fluorescens*, as control measures and
16 develop a draft template Environmental Assessment for USFWS and NOAA that is
17 reviewed annually to incorporate the latest Delta specific data. Similar templates
18 would be developed for the appropriate State agencies' compliance with CEQA.

19
20 3. Conduct mussel control experiments to evaluate a range of potassium chloride salt
21 and *P. fluorescens* solution delivery options in waterways of different sizes and
22 hydrological dynamics.

23
24 4. Conduct research on the effects of potassium chloride salt and *P. fluorescens* on
25 covered fish species.

26
27 5. Endow a control program with permanent funding to cover eradication efforts.

28
29 The BDCP Implementing Entity would enter into Memoranda of Agreement (MOAs),
30 contracts, or other binding instruments with appropriate entities as needed to implement
31 this conservation measure. Agreements with these entities would describe respective
32 roles and obligations for expenditure of BDCP funding. Elements of agreements would
33 include a description of specific activities and equipment purchases funded by BDCP,
34 preparation of annual work plans for BDCP funded activities, provisions for documenting
35 work performed, monitoring responsibilities, and provisions for modifying or terminating
36 agreements.

37
38 Funded entities would be responsible for implementing the scopes of work and
39 submitting reports as specified in the agreements that demonstrate that work plans are
40 successfully implemented. The BDCP Implementing Entity in coordination with the
41 Fishery Agencies will periodically review the cost effectiveness of this conservation
42 measure in achieving benefits for covered fish species. If it is determined that this
43 conservation measure does not provide a substantial cost-effective benefit for covered
44 fish species, the BDCP Implementing Entity in coordination with Fishery Agencies may
45 terminate this conservation measure. If terminated, remaining funding would be

1 deobligated from this conservation measure and reallocated to augment funding for other
2 more effective conservation measures identified in coordination with the Fishery
3 Agencies through the BDCP adaptive management process.
4

5 **Rationale:** The ZMRRPC and its appendices contain a series of rapid response
6 actions and control alternatives that were written specifically for the Delta and
7 intended to be used as a template for other bodies of water (Messer and Veldhuizen
8 2005). In its current form, the ZMRRPC anticipates that control options and permits
9 would be applied after either zebra or quagga mussels are detected and it provides a
10 number of scenarios and potential control responses that are specific to the Delta.
11 Quagga mussel has been detected in Lake Mead in 2007 and subsequently at a
12 number of other locations along the Colorado River and in canals and reservoirs that
13 receive Colorado River water in southern California. A 2003 survey of boaters at the
14 same boat launches on Lake Mead where quagga mussel was detected found that
15 1.2% of all mussels came from zebra mussel infested states and that no boaters had
16 launched in infested waterways within 30 days (Gerstenberger et al. 2003). The
17 response to the Lake Mead infestation has been studied and a number of
18 recommendations for a rapid response program have been proposed (California
19 Science Advisory Panel 2007). The included recommendations provide for a
20 management structure that will permit an efficient response (M. Volkoff, pers.
21 comm.) but does not address control or management methods. The report also notes
22 that the lack of a dedicated rapid response funding source caused many of the Lake
23 Mead managers to spend a significant amount of their time trying to obtain funding
24 and staff instead of responding to the emergency. In 2008, zebra mussels were
25 detected in San Justo Reservoir that receives Delta water; the reservoir has since been
26 quarantined.
27

28 **Implementation timeframe:** It is anticipated that this conservation measure could be
29 implemented in the BDCP near-term implementation period.
30

31 **Implementation considerations:** Implementation would be accomplished through a
32 funding agreement with CDFG and CDWR and by the transfer of funds.
33

34 **Resiliency to future changes:** This action would be resilient to future climate change
35 because adaptive management is built into both rapid response plans.
36

37 **Uncertainties/risks:** Adverse effects of zebra and quagga mussels on freshwater
38 aquatic ecosystems have been documented across the U.S.
39

40 **Monitoring and adaptive management considerations:** [Note to reviewers: this
41 section is a general summary; more detail will be provided in future iterations]. The
42 agencies charged with implementing the ZMRRPC would be responsible for
43 monitoring the effectiveness of BDCP-funded elements of the program. The BDCP
44 Implementing Entity would review progress reports or other relevant reports prepared
45 by the agencies to assess the effectiveness of the program in reducing risk for the

1 introduction and establishment of zebra and quagga mussels. The BDCP
2 Implementing Entity would coordinate with the agencies to adjust mussel control
3 strategies and funding levels through the BDCP adaptive management process as
4 appropriate, based on review of agency reports.

5
6 **Reversibility:** This conservation measure is expected to be highly reversible.
7

8
9 **Conservation Measure NNIS9: Remove Non-Native Submerged and Floating**
10 **Aquatic Vegetation from [REDACTED] Acres of Delta Waterways.** The BDCP Implementing
11 Entity would ensure the removal of Brazilian waterweed (*Egeria densa*), water hyacinth
12 (*Eichhornia crassipes*), and other non-native submerged and floating aquatic vegetation
13 (SAV and FAV) from at least [REDACTED] acres of Delta waterways to increase turbidity
14 conditions and reduce effects of predation on covered fish species (see *Rationale*
15 discussion below). The BDCP Implementing Entity would ensure the maintenance of
16 areas cleared of SAV and FAV over the term of the BDCP. The implementation of the
17 control program would target control efforts on the highest priority fish migration
18 corridors and habitat for the covered fish species and would be coordinated with and
19 integrated into BDCP habitat restoration and flow operations programs. Following initial
20 removal of SAV and FAV, the reestablishment of SAV and FAV in treated waterways
21 would be monitored to determine the need for subsequent treatments to remove SAV and
22 FAV.

23
24 To implement this conservation measure, the BDCP would support the California
25 Department of Boating and Waterways Brazilian waterweed and Water Hyacinth Control
26 Program and applicable future non-native aquatic vegetation control programs to reduce
27 the impacts of SAV and FAV on covered fish species at a funding level of \$[REDACTED] over
28 the term of the BDCP.

29
30 The BDCP Implementing Entity would enter into a Memorandum of Agreement (MOA)
31 or similar binding instrument with the California Department of Boating and Waterways
32 that would describe respective roles and obligations for expenditure of BDCP funding.
33 Elements of the MOA would include a description of specific activities that would be
34 funded by BDCP, preparation of annual work plans for BDCP funded activities,
35 provisions for documenting work performed, monitoring responsibilities, and provisions
36 for modifying or terminating the MOA. The BDCP Implementing Entity would
37 implement this conservation measure if the California Department of Boating and
38 Waterways does not choose to participate in its implementation.

39
40 The BDCP Implementing Entity would be responsible for developing annual work plans
41 in coordination with U.S. Fish and Wildlife Service, National Marine Fisheries Service,
42 and Department of Fish and Game (Fishery Agencies) that specify the extent and
43 locations of SAV and FAV control activities to be implemented by the Department of
44 Boating and Waterways at funded levels. Treatment areas would be focused on removing
45 SAV and FAV from channels that support important juvenile salmonid, delta smelt, and

1 longfin smelt habitat use areas. The Department of Boating and Waterways would be
2 responsible for implementing the scope of work and submitting reports as specified in the
3 MOA that demonstrate that the work plan has been successfully implemented. The
4 Department of Boating and Waterways would also be responsible for monitoring the
5 effectiveness of SAV and FAV control measures and adjusting control methods to
6 improve their effectiveness over time.

7
8 The BDCP Implementing Entity would be responsible for monitoring the effectiveness of
9 the control activities in achieving covered species benefits. This monitoring would be
10 required because of the uncertainties of the effectiveness of SAV and FAV removal in
11 providing covered fish species benefits such as reduction in predators and increase in
12 turbidity (see *Uncertainties/Risks* below). Monitoring would be conducted to assess the
13 effect of removing SAV and FAV on turbidity levels, predator abundance, and abundance
14 of juvenile salmonids, delta smelt, and longfin smelt in treated channels. 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 SAV and FAV control efforts and responses of covered fish species.

18
19 The BDCP Implementing Entity would use results of effectiveness monitoring to
20 determine if controlling SAV and FAV results in measurable benefits to covered fish
21 species and to identify adjustments to funding levels, intensity of control efforts, control
22 methods, or other related aspects of the program that would improve the biological
23 effectiveness of the program. Such changes would be enacted through the BDCP
24 adaptive management process and would be included in the subsequent annual work
25 plans.

26
27 If results of monitoring indicate that control of SAV and FAV does not substantially and
28 cost-effectively benefit covered fish species, the BDCP Implementing Entity in
29 coordination with Fishery Agencies may terminate this conservation measure. If
30 terminated, remaining funding would be deobligated from this conservation measure and
31 reallocated to augment funding for other more effective conservation measures identified
32 in coordination with the Fishery Agencies through the BDCP adaptive management
33 process.

34
35 **Rationale:** This rationale is primarily focused on SAV because of its much greater
36 distribution and coverage in the Bay and Delta and because control programs have
37 been very effective against non-native FAV, such as water hyacinth. Recent simple
38 conceptual models of the Delta ecosystem have hypothesized that SAV may alter
39 ecosystem food web properties in two different ways to the detriment of the covered
40 species. The models propose that the SAV may exert a “top down” reduction of
41 covered fish populations indirectly through increased levels of predation on covered
42 species by non-native fish species in the sunfish family (Centrarchidae) that includes
43 largemouth bass (Brown 2003, IEP 2008a). A “bottom up” reduction of habitat
44 quality is also proposed. In the “bottom up” models, dense stands of SAV are
45 hypothesized to reduce food availability by physically obstructing access (IEP

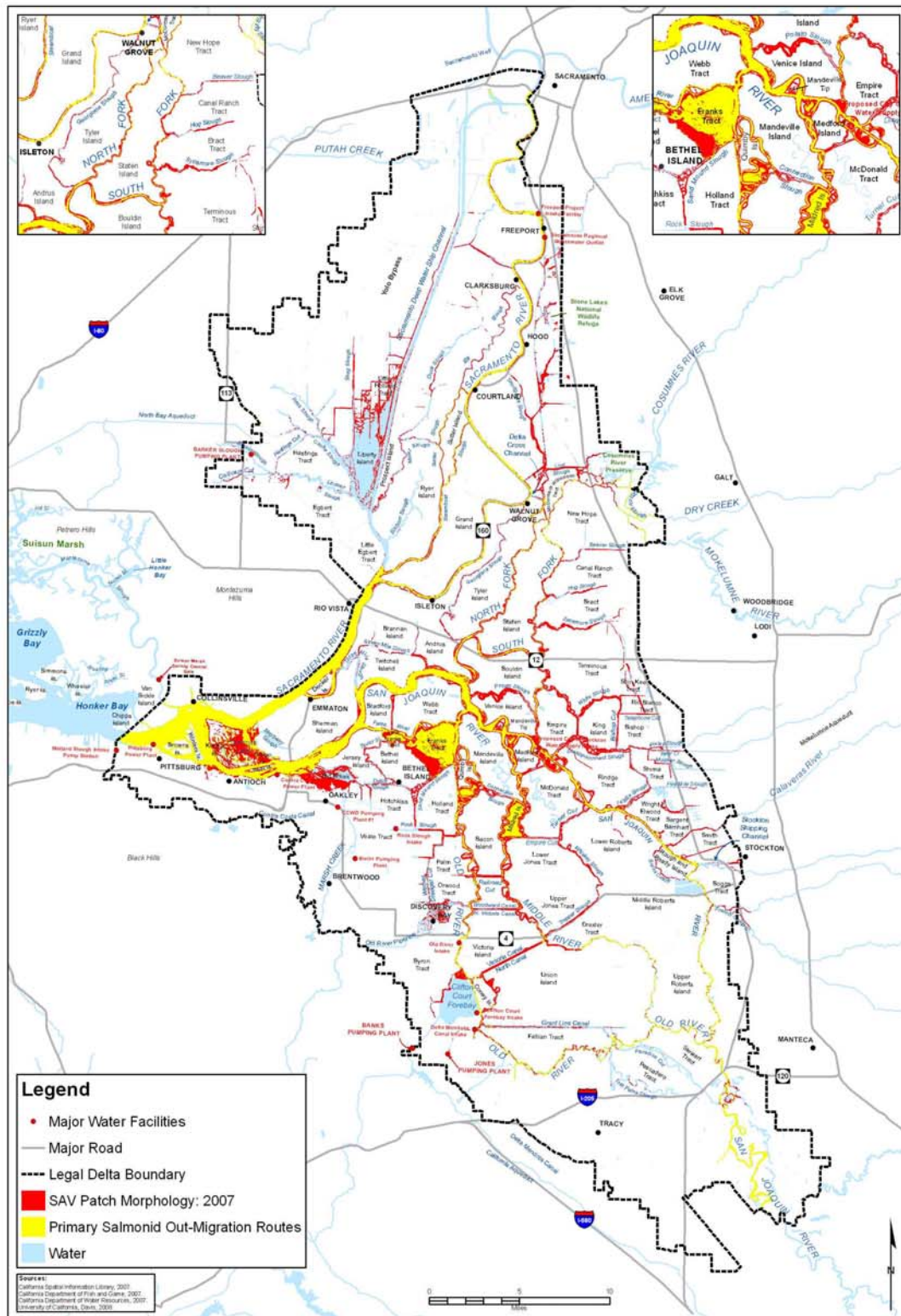
1 2008a). SAV is also hypothesized to impact the amount of invertebrate and
2 planktonic prey available to native fishes, a “bottom up” effect, through its effects on
3 the physical and chemical characteristics of the water column (Scheffer 2004, Brown
4 and Michniuk 2007).

5
6 Top down predation impacts are hypothesized to arise in two ways. First, SAV
7 provides relatively high quality habitat for non-native piscivores that is spread across
8 large portions of the Delta in or adjacent to significant migration corridors and
9 pelagic and subtidal open water habitat for covered species (Figure 1). The interior of
10 SAV stands is hypothesized to be good habitat for largemouth bass larvae and
11 juveniles (Brown 2003, Grimaldo et al. 2004) while adult largemouth bass hunt
12 immediately outside of the SAV bed and feed on juvenile Chinook salmon (Brown
13 2003, IEP 2008a) and, potentially, on pelagic native species (potentially including
14 delta smelt and longfin smelt). Second, it is hypothesized that a SAV driven decrease
15 in turbidity will increase the hunting efficiency of non-native piscivores (Nobriga et
16 al. 2005).

17
18 While it has been clearly demonstrated that SAV is unique and valuable habitat for
19 centrarchids, the hypothesized impacts of *Egeria densa* supported populations of non-
20 native piscivores on the covered species have not been subjected to rigorous testing.
21 The paper frequently cited to support the *Egeria* /non-native piscivore hypothesis
22 concluded that “our data and analysis do not support any particular explanation for
23 the decline in native fish [catch per unit effort]” (Brown and Michniuk 2007).
24 Additionally, the statistical analyses used in this paper may be questionable.

25
26 Bottom up effects of SAV are hypothesized to be due to both physical obstruction and
27 reduced turbidity caused by dense populations of SAV. The dense population can
28 significantly reduce wave energy and current speed, which results in the suspended
29 particles of inorganic and organic matter being trapped on or near the bottom or
30 provides a refuge for zooplankton. These zooplankton can reduce phytoplankton to
31 very low concentrations, resulting in a clear water state (Stacey 2003, Scheffer 2004,
32 Jones et al. 2008). None of these potential effects have been demonstrated as
33 significant overall for the Delta (Jassby 2008).

34
35 Currently, there appear to be few data from Delta studies that directly link the non-
36 native SAV invasion to negative impacts on the covered species but there are strong
37 data showing that the invasion is completely eliminating native SAV and sub-tidal
38 communities. This situation exists because the direct effect of SAV colonizing a new
39 area is relatively easy to (Scheffer 2004) quantify while the potential impacts of the
40 invasion on the food web have only recently been recognized and are very difficult to
41 test. Despite the fact that the impacts of the rapid expansion of *Egeria* and other non-
42 native SAV on the Bay/Delta ecosystem have not yet been rigorously tested, basic
43 principles of ecology suggest that significant impacts have occurred simultaneously
44 Figure 1. Overlap of SAV in 2007 and primary salmonid outmigration routes.



1 with SAV establishment in similar ecosystems (Scheffer 2004) and, by analogy, have
2 also occurred in the Delta. Those basic ecological principles also caution that it will
3 be difficult to detect trends in the SAV impacts due to the possibility of the ecosystem
4 switching between different states in an almost chaotic fashion (Scheffer 2004).
5 Additionally, a management choice to not address the *Egeria* invasion is an
6 affirmative management action that will have irreversible effects. In this case,
7 management actions should (CDBW 2006) be based on the precautionary principle of
8 affirmatively acting to conserve the resources in the face of substantial uncertainty.

9
10 The historical extent of native SAV in the Delta ecosystem is unknown but non-
11 native invasive SAV species have recently invaded large areas of the Delta (Brown
12 2003, CDFG 2008, Ustin et al. 2008) and the invasion is continuing to expand into a
13 greater proportion of channels and to colonize new areas (IEP 2008b). The majority
14 of the surface cover of SAV detected through the recent use of airborne hyperspectral
15 imagery has been shown to be the non-native *Egeria densa*, although the SAV
16 vegetation frequently contains a mixture of three invasive non-native species: *Egeria*
17 *densa*, *Potamogeton crispus* (curlyleaf pond weed), and *Myriophyllum spicatum*
18 (Eurasian watermilfoil) (Ustin et al. 2008). Of the 55,000 acres of the Delta surveyed
19 in 2007, SAV cover has been estimated to be between 5,500 acres (raster data) and
20 10,000 acres (vector data after post processing) (Ustin et al. 2008).

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

1 controlled and modifications to existing control measures may be required for those
2 species (CDBW 2006). Given that curly leaf pondweed and Eurasian watermilfoil are
3 wide spread in the Delta (Ustin et al. 2008) and given that curly leaf pondweed is
4 adapted to higher flow conditions (Champion and Tanner 2000) and produces floating
5 seed dispersed by water and waterfowl (DiTomaso and Healy 2003), these species
6 may become a significant problem.
7

8 The budget for the combined *Egeria densa* and Water Hyacinth Control Program in
9 fiscal years 2005/2006 and 2007/2008 was \$7,000,000 with regulatory costs up to
10 64% of the control costs (CDFG 2007). It is difficult to estimate a per-acre cost for
11 active channels in the Delta as the current control techniques were developed for
12 relatively enclosed and isolated areas such as Franks Tract where the applied
13 herbicide is not rapidly dispersed by currents.
14

15 **Implementation timeframe:** It is anticipated that this conservation measure could be
16 implemented in the BDCP near-term implementation period.
17

18 **Implementation considerations:** The optimal time for SAV control efforts that rely
19 on Fluridone-based products is early April which is at the end of the wet season. If
20 the applied herbicide is found to be doing harm to other ecosystem aspects, its use
21 should be halted.
22

23 **Resiliency to future changes:** One potential changed condition could be a successful
24 invasion of the Delta by either zebra mussel or quagga mussel. Filtering by these
25 mussels could result in rapid reductions in turbidity and potentially allow non-native
26 SAV to grow in much deeper water (due to increased light penetration) leading to
27 much greater extent of SAV and greater impacts on the covered species. If such a
28 changed condition were to occur, the efficacy of this conservation measure would
29 need to be reevaluated.
30

31 **Uncertainties/risks:** There are no well established SAV control methods for channels
32 with substantial currents and new techniques would have to be developed. The
33 continuous use of the same herbicide control method may select for an herbicide-
34 resistance genotype which might render the present control method ineffective. There
35 is a risk that another non-native SAV will invade areas where *Egeria* is controlled and
36 be resistant to control.
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 California Department of Boating and Waterways would be responsible for
41 monitoring the effectiveness of BDCP-funded elements of the non-native aquatic
42 vegetation control programs. The BDCP Implementing Entity would review progress
43 reports or other relevant reports prepared by the Department of Boating and
44 Waterways to assess the effectiveness of the program for controlling non-native
45 aquatic vegetation in the Delta. The BDCP Implementing Entity would coordinate

1 with the Department of Boating and Waterways to adjust inspection strategies and
2 funding levels through the BDCP adaptive management process as appropriate based
3 on review of program reports.

4
5 **Reversibility:** The implementation of the program could be terminated immediately
6 without impacts on covered species. Areas where SAV is controlled may be subject to
7 reinvasion by the same species of SAV or potentially by species with greater
8 ecological impacts that invade the Delta in the future or which are currently present in
9 low numbers.

10
11
12 **Conservation Measure NNIS10: Increase the Harvest of Non-Native Predatory Fish**
13 **to Decrease their Abundance.** The BDCP Implementing Entity would develop, in
14 coordination with the Fishery Agencies, a proposal describing recommended fishing
15 regulations that relax the size and daily bag limits for non-native invasive predatory fish
16 species in the Delta (e.g., centrarchids and striped bass) for submittal to the California
17 Fish and Game Commission for their consideration and adoption. The purpose of
18 relaxing harvest recommendations would be to reduce the abundance and average size of
19 predatory fish sufficiently to improve survivorship of covered fish species. The proposal
20 would include a description of monitoring that would be conducted to assess the
21 effectiveness of the regulations in reducing the abundance and size of non-native
22 predatory fish and reducing predation on covered fish species. Based on monitoring
23 results, if predator abundance and predation levels on covered fish species are not
24 measurably reduced, the BDCP Implementing Entity in coordination with the Fishery
25 Agencies may prepare subsequent proposals requesting that the regulations on size and
26 bag limits be further relaxed or requesting that the original regulations be reinstated. In
27 addition, the proposal would describe the processes, monitoring requirements, and
28 fundings that would be required from the regulation. The BDCP Implementing Entity
29 would conduct ongoing consultation and coordination with the Fish and Game
30 Commission to facilitate consideration of the proposal.

31
32 **Rationale:** Humans have been extremely effective historically at harvesting fish
33 species to very low numbers in many parts of the world. Relaxation of bag limits of
34 non-native invasive fish species could result in a much greater amount of take,
35 contributing to the reduction of their abundance. Relaxing size limits would allow
36 smaller fish to be taken, reducing the reproductive capacity of the population because
37 fewer fish would be at a reproductive size before being taken.

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

1
2 It is anticipated that this conservation measure will result in fewer non-native
3 predatory fish and remaining fish averaging a smaller size. As a result, populations of
4 these non-native predators would likely be better controlled and have lower predation
5 effects on covered species.

6
7 **Implementation timeframe:** It is anticipated that this conservation measure could be
8 implemented in the BDCP near-term implementation period.

9
10 **Implementation considerations:** The conservation measure contributes to the
11 reduction of the recreational fishery for these species. As a result, there will likely be
12 opposition to this conservation measure by the angling community. The effectiveness
13 of this conservation measure may be limited by anglers continuing catch and release
14 practices and trying to preserve the fishery in the Delta.

15
16 By allowing anglers to take as many individuals from these species, anglers may eat
17 more than the recommended number of fish per week to minimize the human health
18 risk of exposure to mercury that has accumulated in the fish tissue.

19
20 **Resiliency to future changes:** This conservation measure is not expected to be
21 affected by future change.

22
23 **Uncertainties/risks:** If fishing pressures on non-native fishes does not substantially
24 increase, this measure may not have a population effect on those non-natives and
25 hence may not result in benefits to covered species through reduced predation. There
26 is low certainty in the magnitude of overall effects of this conservation measure on
27 covered fish species because the relationship between non-native predator species and
28 covered fish species is not well understood.

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.]
32 Monitoring would consist of assessing the abundance, distribution, and size of
33 centrarchid species before and after implementation of new regulations to determine
34 the effectiveness of regulations. Studies would be conducted to determine size-based
35 predation rates of centrarchids on covered fish species to determine whether
36 relaxation of the regulations has an impact on these species.

37
38 If results of fish monitoring indicate that relaxation of regulations have not been
39 sufficient to significantly reduce adverse affects of non-natives on native fish, actions
40 would be modified to be more effective through the adaptive management process.

41
42 **Reversibility:** This conservation measure is expected to be highly reversible.
43
44

1 **Conservation Measure NNIS11: Reduce Mortality of Released Salvaged Fish by**
2 **Non-Native Predators.** The BDCP Implementing Entity would support the strategies
3 under development by DWR to reduce predation mortality of salvaged covered fish
4 species at release sites of CVP/SWP facilities at a funding level of \$\$ over the
5 term of the BDCP.

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

14
15 DWR would be responsible for:

- 16 ▪ developing and submitting to the BDCP Implementing Entity annual work plans
17 that specify the extent and types of activities to be implemented by DWR at funded
18 levels;
- 19 ▪ implementing scopes of work and submitting reports as specified in the MOA that
20 demonstrate that work plans have been successfully implemented;
- 21 ▪ monitoring the effectiveness of salvage procedures and improving them if
22 warranted over time; and
- 23 ▪ monitoring the effectiveness of salvage and release methods for reducing post-
24 release predation mortality on covered fish species.

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

31
32 If results of monitoring indicate that the salvage program does not substantially and cost-
33 effectively benefit covered fish species, the BDCP Implementing Entity, in coordination
34 with Fishery Agencies, may terminate this conservation measure. This conservation
35 measure would also be terminated if DWR chooses not to enter into a MOA with the
36 BDCP Implementing Entity. If terminated, remaining funding would be deobligated
37 from this conservation measure and reallocated to augment funding for other
38 conservation measures identified in coordination with the Fishery Agencies through the
39 BDCP adaptive management process that more effectively provide covered fish species
40 benefits.

41
42 **Rationale:** Anecdotal information indicates that predatory fish, including non-native
43 species, congregate near the four regular release locations of CVP/SWP salvage

1 facilities (DWR 2005). It is thought that these predators have learned to gather near
2 the pipe exits when flushing pumps are activated, resulting in increased risk of
3 predation to salvaged fish. Salvaged fish are released in high concentrations in a
4 relatively small area and, upon release, tend to be disoriented and stressed and are
5 sometimes injured, resulting in higher predation rates.

6
7 The Department of Water Resources' Bay-Delta Office is currently working
8 collaboratively with other state and federal agencies to assess the extent of predation
9 mortality at four SWP salvage release sites (DWR 2005). In the study, DWR is
10 assessing the abundance and composition of predatory fish near release sites and
11 predation movement and behavior before, during, and after releases using standard
12 fish sampling methods (e.g., beach seines), bioacoustics, underwater cameras, and
13 acoustic tagging. It is anticipated that this work will provide the necessary
14 information to assess the importance of predation of salvaged fish. If predation
15 mortality is deemed a significant stressor to salvaged fish, this study will provide
16 information used to identify and evaluate new technologies to reduce or avoid
17 predation of released fish. A report on their findings is expected in December 2008.
18 This conservation measure could fund technologies that are proposed by the
19 December 2008 report.

20
21 This conservation measure is expected to reduce predation of salvaged fish that are
22 typically at higher risk to predation. However, it is unlikely that this measure will
23 have population level effects on the covered species.

24
25 **Implementation timeframe:** This conservation measure will be primarily
26 implemented in the near term until the peripheral canal is operational. Once the
27 South Delta facilities are operated secondarily to the Hood diversion, the effect of
28 non-native predation on the covered species at release sites is expected to be reduced.

29
30 **Implementation considerations:** The conservation measure is dependent on the
31 results of an ongoing study by DWR that is expected to be completed by the end of
32 2008.

33
34 **Resiliency to future changes:** This conservation measure is not expected to be
35 affected by future change.

36
37 **Uncertainties/risks:** Because salvaged fish release locations occur at such a limited
38 spatial scale, it is unlikely that this measure will have population level effects on the
39 covered species.

40
41 **Monitoring and adaptive management considerations:** *[Note to reviewers: this*
42 *section is a general summary; more detail will be provided in future iterations.]* The
43 Department of Water Resources would be responsible for monitoring the
44 effectiveness of BDCP-funded elements of the program. The BDCP Implementing
45 Entity would review progress reports or other relevant reports prepared by the

1 Department of Water Resources to assess the effectiveness of the program for
2 increasing the survival of released salvaged fish. The BDCP Implementing Entity
3 would coordinate with the Department of Water Resources to adjust salvage
4 strategies and funding levels through the BDCP adaptive management process as
5 appropriate based on review of agency reports.

6
7 **Reversibility:** This conservation measure is expected to be highly reversible.
8
9

10 *Toxic Contaminants*

11 **Introduction**

12
13
14 The following conservation measures address the control of substances known to be or
15 potentially toxic to covered species or other aquatic organisms on which covered species
16 depend. These measures address a wide range of chemicals including ammonia,
17 pesticides, herbicides, mercury, endocrine disruptors, and others. The measures include
18 creation of new programs, support and funding of existing programs, and providing input
19 on actions by other agencies, all for the purpose of reducing the adverse effects of toxic
20 contaminants on covered fish species and other aquatic species.

21
22 **Conservation Measure TOCO1: Reduce the Load of Ammonia in Effluent**
23 **Discharged from the Sacramento Regional County Sanitation District into the**
24 **Sacramento River to Less than if Warranted Based on Research. In coordination**
25 **with the Sacramento Regional County Sanitation District (SRCSD), evaluate the need**
26 **and, if demonstrated to be necessary to protect covered fish species, reduce the levels of**
27 **effluent-derived ammonia entering the Delta. The BDCP Implementing Entity would**
28 **work closely with SRCSD in evaluating ongoing research and funding additional**
29 **research to determine the effects of effluent-derived ammonia and ammonium ion on**
30 **covered species. Based on scientific findings, the BDCP and SRCSD will work together**
31 **to determine the appropriate conservation measures (if necessary) and source of funding**
32 **to address substantial adverse effects on covered species.**
33

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

- 1 ▪ a description of specific activities that would be funded by BDCP;
- 2 ▪ preparation of annual research work plans for BDCP funded activities;
- 3 ▪ provisions for documenting work performed;
- 4 ▪ a description of the BDCP Implementing Entity's role in assisting SRCSD to
5 acquire funding necessary to implement measures to eliminate or minimize the
6 discharge of ammonia effluent if the need for such measures is indicated through
7 research results; and
- 8 ▪ provisions for modifying or terminating the MOA.

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

18
19 **Rationale:** Wastewater treatment plants can be a large source of ammonia (Jassby
20 2008). The Sacramento Regional County Sanitation District Wastewater Treatment
21 Plant is the largest wastewater treatment plant in the Delta which contributed an
22 average of 158 million gallons of treated effluent into the Delta per day during 2001-
23 2005 (Jassby 2008), although multiple other wastewater treatment plants within the
24 Delta may contribute locally high loads of ammonia. The Sacramento Regional
25 Wastewater Treatment Plant employs primary and secondary treatment processes to
26 meet current waste discharge specifications in its existing NPDES permit, which is
27 protective of beneficial uses and currently meets the USEPA aquatic criteria for
28 ammonia. However, secondary treatment processes may not remove levels of
29 ammonia and/or other toxic compounds to levels below which they affect fish. The
30 technology for such advanced treatment processes exists and has been implemented at
31 other wastewater treatment plants in the Delta where necessary, such as the Stockton
32 Wastewater Treatment Plant. Such advanced treatment processes can be up to 90%
33 efficient at reducing ammonia loads in effluent (Wallace et al. 2006, Chan et al.
34 2008).

35
36 Ammonia is readily converted into its ionized form, ammonium ion, in the water
37 column depending on temperature and pH. The role of ammonium ion in disrupting
38 the uptake of nitrate (NO₃⁻) by phytoplankton during spring in San Francisco, San
39 Pablo, and Suisun Bays has been recently demonstrated in Wilkerson et al. (2006)
40 and Dugdale et al. (2007). Concern has been raised that similar effects may be
41 experienced by phytoplankton in the Delta (IEP 2008), and this topic is the focus of
42 ongoing SWRCB-funded studies by these researchers (IEP 2008). Phytoplankton
43 form the base of the food web from which much of the food energy for the Delta

1 ecosystem is derived (Jassby and Cloern 2000). Ammonia can be directly toxic to
2 fish at elevated levels, although concentrations in the Delta are well below levels at
3 which the U.S. Environmental Protection Agency considers to be toxic (SWRCB
4 2008). Recent research suggests that, in combination with other chemicals (i.e.,
5 pesticides), ammonia at elevated levels can reduce the survival of prey species for
6 delta smelt and longfin smelt (Teh et al. 2008). High concentrations of ammonium
7 ion, although of secondary importance to other factors, may promote blooms of
8 harmful cyanobacteria, *Microcystis aeruginosa*, which produce microcystins that are
9 toxic to other aquatic organisms (Lehman 2008).

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

13
14 **Implementation Considerations:** There could be significant costs associated with
15 this conservation measure for improved treatment facilities.

16
17 **Resiliency to future changes:** This action would not be influenced by future climate
18 change.

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

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

- 43
44
 - monitoring of ammonia in influent and effluent at the treatment facility;

- 1 ▪ In-laboratory exposure of delta smelt and, as appropriate, other covered fish
- 2 species to effluent samples to assess lethality;
- 3 ▪ diatom nitrate uptake inhibition; and
- 4 ▪ Microcystis abundance patterns relative to ammonia effluent loads.

5
6 If results of monitoring of ammonia effects on the covered fish species and their food
7 base indicate that ammonia reduction efforts have not been sufficient to significantly
8 reduce adverse affects, treatment actions would be modified to be more effective
9 through the adaptive management process.

10
11 **Reversibility:** Should studies indicate the need for ammonia removal to protect and
12 enhance covered species populations, due to the high costs and additional
13 infrastructure associated with implementation of ammonia treatment of such a large
14 volume of effluent, this conservation measure would have a low value of reversibility.

15
16
17 **Conservation Measure TOCO2: Reduce the Load of Endocrine Disrupting**
18 **Compounds in Effluent Discharged from Wastewater Treatment Plants into Delta**
19 **Waterways to Less than [redacted] if Warranted Based on Research. In coordination with**
20 agencies that discharge wastewater in the Delta, evaluate the need and, if demonstrated to
21 be necessary to protect covered fish species, improve treatment processes at wastewater
22 treatment facilities to reduce loads of endocrine disrupting compounds (EDCs) into the
23 Delta. The BDCP Implementing Entity would work closely with wastewater treatment
24 districts in the Delta in evaluating ongoing research and funding additional research to
25 determine the effects of effluent-derived EDCs on covered species. Based on scientific
26 findings, the BDCP and wastewater agencies will work together to determine the
27 appropriate conservation measures (if necessary) and source of funding to address
28 substantial adverse effects on covered species.

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

- 42 ▪ a description of specific activities that would be funded by BDCP;
- 43 ▪ preparation of annual research work plans for BDCP funded activities;

- 1 ▪ provisions for documenting work performed;
- 2 ▪ a description of the BDCP Implementing Entity's role in assisting wastewater
- 3 treatment plants to acquire funding necessary to implement measures to eliminate
- 4 or minimize the discharge of EDCs in effluent if the need for such measures is
- 5 indicated through research results; and
- 6 ▪ provisions for modifying or terminating the MOAs.

7 If research results establish a conclusive linkage between EDCs discharged at wastewater
8 treatment plants and substantial adverse effects on covered fish species, the BDCP
9 Implementing Entity would work jointly with each wastewater agency and appropriate
10 state and federal entities to secure sources of funding to identify and implement measures
11 that would eliminate or minimize adverse effects of EDCs on covered fish species. If
12 measures to address the discharge of EDCs are implemented, the BDCP Implementing
13 Entity would also work jointly with the wastewater treatment plants in conducting any
14 subsequent covered fish species-response monitoring that may be required to assess the
15 effectiveness of the those measures in eliminating or minimizing effects of EDCs on
16 covered fish species.

17
18 If wastewater agencies do not choose to participate in implementing this conservation
19 measure, the BDCP Implementing Entity, in coordination with Fishery Agencies, may
20 terminate this conservation measure. If terminated, remaining funding would be
21 deobligated from this conservation measure and reallocated to augment funding for other
22 more effective conservation measures identified in coordination with Fishery Agencies
23 through the BDCP adaptive management process.

24
25 **Rationale:** Wastewater treatment plants can be large sources of EDCs (Sumpter and
26 Jobling 1995, Jobling et al. 1998, Chambers and Leiker 2006, Barber et al. 2007).
27 Treatment processes presently employed by wastewater treatment facilities in the
28 Delta may not remove EDCs to levels below which they affect fish (Huang and
29 Sedlak 2001, Campbell et al 2006)). Advanced treatment facilities have been shown
30 to reduce EDCs by 30-85%, but reduction levels are highly variable depending on the
31 EDC (Hemming et al. 2004, Drewes et al. 2005, Gray and Sedlak 2005).

32
33 There are currently no criteria defined by the EPA for EDCs. EDCs can interact with
34 hormone receptors in fish and, as a result, can interfere with reproduction,
35 development, and other hormonally mediated processes (Pait and Nelson 2002,
36 Falconer et al. 2006). Because natural endogenous endocrines (hormones) occur in
37 extremely low concentrations in fish, it is thought that extremely low concentrations
38 of exogenous endocrine disruptors could affect fish. However, the potency of
39 exogenous EDCs is typically orders of magnitude lower than endogenous endocrines
40 (Pait and Nelson 2002). Endocrine disruption has been observed in fish exposed to
41 wastewater effluents (Sumpter and Jobling 1995, Jobling et al. 1998, Chambers and
42 Leiker 2006, Kidd et al. 2007). In Central Valley stream sampling, up to 38% of
43 male fall-run Chinook salmon showed signs of endocrine disruption in the form of

1 sex reversal (Williamson and May 2002). In 2005, a low level (6%) of adult delta
2 smelt males showed evidence of endocrine disruption (S. Teh, unpubl. data, as cited
3 in IEP 2008). The identity and source of the EDCs causing these effects, however,
4 are not known.

5
6 **Implementation timeframe:** It is anticipated that this conservation measure could
7 be implemented in the BDCP near-term implementation period.

8
9 **Implementation Considerations:** There would be significant costs associated with
10 this conservation measure for improved treatment facilities. Actions could prove
11 inadequate if reductions in fish risk levels are not achievable by wastewater treatment
12 alone.

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

16
17 **Uncertainties/risks:** A major uncertainty associated with this conservation measure
18 is the extent to which EDCs have population level effects on covered fish species at
19 ambient concentrations in the Delta. This uncertainty is not unique to covered fish
20 species in the Delta; the effects on species in other systems is also largely uncertain
21 (Pait and Nelson 2002)

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 EDCs are found to have adverse effects on covered fish species, the BDCP
26 Implementing Entity will coordinate with wastewater treatment districts to develop
27 district-specific adaptive management and monitoring plans for assessing
28 effectiveness of the proposed conservation measures. Adaptive management plans
29 will identify the range of adaptive management responses appropriate to proposed
30 EDC-reduction conservation measures and the process for adaptively adjusting
31 implementation based on monitoring results. The types of monitoring that may be
32 appropriate include monitoring of influent and effluent for EDCs and field sampling
33 and evaluations of endocrine and reproductive systems of covered fish species to
34 assess the effectiveness of conservation measures in reducing EDC effects. If
35 monitoring results indicate that EDC reduction efforts have not been sufficient to
36 significantly reduce adverse affects, treatment actions would be modified to be more
37 effective through the adaptive management process.

38
39 **Reversibility:** Should studies indicate the need for EDC removal to protect covered
40 species populations, the substantial investment in infrastructure associated with
41 implementing EDC treatment for such a large volume of effluent would give this
42 conservation measure a low reversibility.

43
44

1 **Conservation Measure TOCO3: Reduce the Load of Methylmercury Entering**
2 **Delta Waterways by [redacted] Percent from 200[redacted] Levels. Support the Central Valley**
3 Regional Water Quality Control Board's (CVRWQCB) Draft TMDL to reduce the load
4 of methylmercury entering the Delta and in-Delta sources by 50%¹ at a funding level of
5 \$ [redacted] over the term of the BDCP. Four primary actions could be supported: (1) Modify
6 the Cache Creek settling basin to improve mercury and sediment trapping efficiency, (2)
7 remediate inorganic mercury sources upstream of the Delta, including mercury
8 contaminated sediment "hot spots" in stream channels and mercury and gold mines, (3)
9 avoid or minimize transport of loads of methylmercury entering the Delta from floodplain
10 and intertidal marsh restoration actions by the BDCP, and (4) work with the Central
11 Valley Regional Water Quality Control Board to identify best management practices for
12 other sources of methylmercury.

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

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

29
30 The BDCP Implementing Entity would be responsible for monitoring the effectiveness of
31 mercury reduction activities in achieving covered fish species benefits. This monitoring
32 would be required because of the uncertainties surrounding the population level benefits
33 of reducing mercury loads on covered fish species (see *Uncertainties/Risks* discussion
34 below).

35
36 The BDCP Implementing Entity would use results of effectiveness monitoring to
37 determine if reducing mercury loads results in measurable benefits to covered fish species
38 and to identify adjustments to funding levels, control methods, or other related aspects of
39 the program that would improve the biological effectiveness of the program. Such
40 changes would be effected through the BDCP adaptive management process and would
41 be included in the subsequent annual work plans.

42

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

1 If results of monitoring indicate that reducing mercury loads does not substantially and
2 cost-effectively benefit covered fish species, the BDCP Implementing Entity, in
3 coordination with Fishery Agencies, may terminate this conservation measure. The
4 BDCP Implementing Entity, in coordination with the Fishery Agencies, would also
5 terminate this conservation measure if the CVRWQCB chooses not to enter into a MOA
6 with the BDCP Implementing Entity. If terminated, remaining funding would be
7 deobligated from this conservation measure and reallocated to augment funding for other
8 more effective conservation measures identified in coordination with the Fishery
9 Agencies through the BDCP adaptive management process.

10
11 **Rationale:** The Central Valley Regional Water Quality Control Board recently
12 released a Draft Sacramento-San Joaquin Delta TMDL for Methylmercury
13 (CVRWQCB 2008). The Draft TMDL calls for a 50% reduction of methylmercury
14 entering the Delta, sources of which include tributaries from upstream watersheds and
15 within-Delta sources, municipal and industrial wastewater, agricultural drainage, and
16 urban runoff. The largest sources of methylmercury to the Delta are flux from
17 wetland and open water sediments within the Delta and Yolo Bypass (~35% of total
18 load) and upstream tributaries (~58% of total load). The Draft TMDL recommends
19 total mercury load reductions from the Cache Creek, Feather River, American River,
20 and Putah Creek watersheds.

21
22 This conservation measure would support funding of existing efforts by the
23 CVRWQCB to reduce sources of methylmercury. The conservation measure could
24 support staff salaries and/or fund specific actions to reduce these sources (e.g., Cache
25 Creek Settling Basin efficiency improvements).

26
27 **Implementation timeframe:** It is anticipated that this conservation measure could
28 begin to be implemented in the BDCP near-term implementation period. Timing of
29 some actions would be dependent on the timing of other actions (e.g., floodplain and
30 tidal marsh restoration).

31
32 **Implementation Considerations:** Many of the upstream “hot spot” sites are
33 Superfund sites and tied up in legal, funding, and logistical issues. There could be
34 significant costs associated with this conservation measure for improved treatment
35 facilities. Operation of settling basins (i.e., periodic removal of mercury-laden
36 sediment) must occur in perpetuity. Much of this conservation measure is dependent
37 on the Final TMDL.

38
39 **Resiliency to future changes:** This conservation measure is moderately resilient to
40 future climate change, although the location of floodplain and tidal marsh and timing
41 of floodplain inundation are expected to change with climate change.

42
43 **Uncertainties/risks:** Mercury has known adverse effects to humans and wildlife, can
44 bioaccumulate in fish tissue (including sturgeon), and can have sublethal
45 physiological effects to some species (particularly sturgeon) (see Alpers et al. 2008).

1 However, there is limited evidence that mercury causes direct mortality or has
2 significant population level effects on BDCP covered fish species. Therefore, the
3 magnitude of a population-level effect on covered species of this conservation
4 measure has low certainty and is dependent on research to determine whether there
5 are population-level effects.

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.]* The
9 Central Valley Regional Water Quality Control Board would be responsible for
10 conducting monitoring necessary to assess the effectiveness of BDCP supported
11 mercury reduction projects. The Implementing Entity will provide ongoing review of
12 Central Valley Regional Water Quality Control Board monitoring, progress, and other
13 relevant reports to assess the effectiveness of supported projects for reducing mercury
14 loads entering the Delta and providing beneficial to covered fish species. The
15 Implementing Entity will coordinate with the Central Valley Regional Water Quality
16 Control Board to adjust mercury reduction strategies and funding levels through the
17 BDCP adaptive management process as appropriate based on review of Central
18 Valley Regional Water Quality Control Board monitoring and other reports.

19
20 **Reversibility:** Due to the high costs and additional infrastructure associated with
21 implementation, this conservation measure is expected have a low reversibility.

22
23
24 **Conservation Measure TOCO4/5: Reduce the Load of Pesticides and Herbicides**
25 **Entering Delta Waterways from In-Delta Sources that are Believed to be Toxic to**
26 **Covered Fish Species by [redacted] Percent from 200 [redacted] Levels. To implement this**
27 **conservation measure, the BDCP Implementing Entity would develop two tasks:**

- 28 1. Support efforts by the Central Valley Regional Water Quality Control Board
29 (CVRWQCB) under its Irrigated Lands Reuglatory Program to reduce inputs of
30 toxics from agricultural return flows into the Delta and tributaries to levels at
31 which they are not toxic to covered fish species at a funding level of \$ [redacted] over
32 the term of the BDCP; and
- 33 2. Work with groups of farmers or large individual farmers and with reclamation
34 districts and irrigation/drainage districts to develop voluntary agricultural
35 chemical management plans to reduce the amounts of pesticides and herbicides
36 reaching Delta waterways. Plans could include funding conservation easements,
37 cost-sharing programs, and working with farmers and irrigation districts to:
- 38 ▪ Change pesticides and herbicides used to less toxic compounds to aquatic
39 species and provide education on proper use;
 - 40 ▪ Reduce amounts of pesticides and herbicides used through more direct
41 application methods or implementation of integrated pest management
42 techniques;

- 1 ▪ Reduce concentrations of pesticides and herbicides in return flows to Delta
- 2 waterways through specific management practices;
- 3 ▪ Reduce return flows from agricultural fields to the Delta by using water-
- 4 efficient technologies (e.g., drip irrigation); and
- 5 ▪ Reduce wind drift of pesticides and herbicides into Delta waterways.

6
7 To accomplish Task 1, the BDCP Implementing Entity would enter into a Memorandum
8 of Agreement (MOA) or similar binding instrument with CVRWQCB that would
9 describe respective roles and obligations for expenditure of BDCP funding. Elements of
10 the MOA would include a description of specific activities that would be funded by
11 BDCP, preparation of annual work plans for BDCP funded activities, provisions for
12 documenting work performed, monitoring responsibilities, and provisions for modifying
13 or terminating the MOA.

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

23
24 The BDCP Implementing Entity would be responsible for monitoring the effectiveness of
25 agricultural contaminant reduction activities in achieving covered fish species benefits.
26 This monitoring would be required because of the uncertainties surrounding the
27 population level benefits of reducing loads of agricultural pesticides and herbicides on
28 covered fish species (see *Uncertainties/Risks* discussion below). The BDCP
29 Implementing Entity in coordination with the Fishery Agencies may discontinue
30 monitoring in future years if monitoring results indicate a strong correlation between
31 reduction in agricultural pesticides and herbicides entering the Delta and responses of
32 covered fish species.

33
34 The BDCP Implementing Entity would use results of effectiveness monitoring to
35 determine if reducing pesticide and herbicide loads results in measurable benefits to
36 covered fish species and to identify adjustments to funding levels, control methods, or
37 other related aspects of the program that would improve the biological effectiveness of
38 the program. Such changes would be effected through the BDCP adaptive management
39 process and would be included in the subsequent annual work plans.

40
41 If results of monitoring indicate that reducing pesticide and herbicide loads does not
42 substantially and cost-effectively benefit covered fish species, the BDCP Implementing
43 Entity, in coordination with Fishery Agencies, may terminate this conservation measure.

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

7
8 To accomplish Task 2, the BDCP Implementing Entity would enter into binding
9 agreements (e.g., conservation easements, contracts) with participating farmers and
10 irrigation districts that would specify specific actions that would need to be implemented
11 by participants to receive BDCP funding. The BDCP Implementing Entity will
12 coordinate with the Fishery Agencies to identify specific pesticides and herbicides
13 targeted for reduction and a menu of the types of measures that could be implemented
14 that would cost-effectively reduce loads of targeted compounds. Elements of participant
15 agreements would include:

- 16 ▪ a description of specific BDCP funded activities to be implemented by participants;
- 17 ▪ provisions for documenting compliance with the agreements;
- 18 ▪ access to conduct BDCP effectiveness monitoring; and
- 19 ▪ provisions for modifying or terminating participant agreements.

20 The BDCP Implementing Entity would develop a pesticide and herbicide reduction
21 monitoring program to assess the effectiveness of funded activities for reducing pesticide
22 and herbicide loads in Delta waterways and providing benefits for covered fish species.
23 The BDCP Implementing Entity, in coordination with the Fishery Agencies, may
24 discontinue monitoring in future years if monitoring results indicate a strong correlation
25 between reduction in pesticide and herbicide loads entering the Delta and responses of
26 covered fish species.

27
28 To address uncertainties related to the effectiveness of reducing pesticide and herbicide
29 loads in achieving population-level benefits for covered fish species (see
30 Uncertainties/Risks discussion below), the BDCP Implementing Entity, in coordination
31 with the Fishery Agencies, will periodically review relevant research to determine if
32 reducing pesticides and herbicides has been shown to provide direct or indirect benefits
33 to covered fish species. If research indicates that specific pesticides and herbicides do
34 not measurably adversely affect covered fish species, funding for programs to reduce
35 loads of those pesticides and herbicides would be discontinued and redirected through the
36 BDCP adaptive management process to increase funding for reduction of pesticides and
37 herbicides that are shown to be harmful to covered fish species.

38
39 **Rationale:** Agricultural runoff has been identified as a source of pesticides and other
40 chemical stressors of covered fish species that adversely effect aquatic biota (Werner
41 et al. 2008, Werner and Oram 2008). Pesticides have known sublethal effects on fish
42 species and direct impacts on invertebrates (Van Wijngaarden et al. 2005), which
43 could serve as prey species for covered fish species. Fertilizers such as ammonia in

1 high concentrations can be directly toxic to fish, although concentrations in the Delta
2 are well below levels the U.S. Environmental Protection Agency considers to be toxic
3 (SWRCB 2008). Ammonium has been shown to inhibit nitrate uptake in diatoms in
4 San Francisco Bay (Wilkerson et al. 2006, Dugdale et al. 2007), although this effect
5 has not been demonstrated in the Delta. High levels of sediment can be released by
6 agricultural return flows (Ebbert et al. 2003). Suspended sediment is the primary
7 attenuator of sunlight in the water column and thus can reduce photosynthesis in
8 phytoplankton and submerged aquatic vegetation and affect fish behavior and health
9 (Schoelhammer et al. 2007). **In contrast, if suspended sediment were to increase**
10 **turbidity in the water column, there may be benefits to some covered species, such as**
11 **delta smelt, whose populations are positively correlated with turbidity levels (Feyrer**
12 **et al 2007).**

13
14 The Irrigated Lands **Regulatory** Program of the Central Valley Regional Water
15 Quality Control Board relieves dischargers of irrigation water and storm water from
16 irrigated lands from the requirement to obtain a permit to discharge, as long as steps
17 are taken to improve water quality. Dischargers must either join an established
18 coalition group or proceed as an individual discharger. Coalitions collect fees to
19 monitor and report water quality in discharges.

20
21 This conservation measure would support and coordinate existing efforts of the
22 Irrigated Lands **Regulatory** Program **in the form of technical assistance, monetary**
23 **support, and encouragement of voluntary actions.**

24
25 There is increasing evidence that some pesticides (e.g., pyrethroids), although very
26 effective at reducing pests on agricultural crops, are highly toxic in the aquatic
27 environment (Werner 2007). Therefore, reduced use of these pesticides and increased
28 use of other less toxic pesticides would reduce risk to the aquatic ecosystem. A more
29 effective way to reduce inputs of toxics to the aquatic ecosystem is to reduce the
30 concentrations of pesticides and herbicides through more direct application. Further,
31 integrated pest management could be used to minimize environmental and human
32 health risks. The use of water-efficient technologies, such as drip irrigation, reduces
33 pesticide and herbicide return flows into the river and reduces water demand (K.
34 Fisher pers. comm.).

35
36 The BDCP Implementing Entity would work with reclamation districts and groups of
37 or individual large farmers to develop pesticide and return water management
38 programs aimed at reducing pesticides entering the Delta channels. At the June 17,
39 2008 State Water Resources Control Board Meeting, the Board approved \$8 million
40 of Proposition 84 money to fund cost-sharing efforts for Central Valley farmers who
41 implement improved management practices to reduce runoff of pesticides, fertilizers,
42 and sediment. This BDCP conservation measure could emulate this cost-sharing
43 effort by providing additional incentive funding to farmers whose improved
44 management of discharge could improve water quality in the Delta.

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:** Working in coordination with willing farmers will
5 be key to the success conservation measure. The Irrigated Lands Regulatory Program
6 is expected to be updated in 2011. Therefore, the efficacy of Task 1 in the
7 conservation measure may need re-evaluation at that time. For Task 2, it will be
8 difficult to determine the extent of benefits until the level of participation has been
9 identified.

10
11 **Resiliency to future changes:** If sea level rise or other market factors make farming
12 in the Delta impractical in the future, this action may be deemed unnecessary.

13
14 **Uncertainties/risks:** The effect of pesticides on covered fish species at a population
15 level is not well known (Werner and Oram 2008). There is much evidence that
16 pyrethroids have sublethal effects on fish species (e.g., Weston et al. 2004) and even
17 more evidence that pyrethroids have direct acute impacts on invertebrates, which
18 could serve as prey species for covered fish species (Van Wijngaarden et al. 2005).
19 There is also evidence that pesticides work synergistically with other stressors to
20 adversely affect fish in the Delta (Clifford et al. 2005).

21
22 It is unknown how many farmers in the Delta that would be willing to participate in
23 this conservation measure.

24
25 **Monitoring and adaptive management considerations:** *[Note to reviewers: this*
26 *section is a general summary; more detail will be provided in future iterations.]* For
27 Task 1, the Central Valley Regional Water Quality Control Board would be
28 responsible for conducting monitoring necessary to assess the effectiveness of BDCP
29 supported elements of its Irrigated Lands Regulatory Program. The Implementing
30 Entity will provide ongoing review of Central Valley Regional Water Quality Control
31 Board monitoring, progress, and other relevant reports related to the effectiveness the
32 Program for reducing contaminant loads in agricultural return flows entering the
33 Delta and providing benefits to covered fish species. The Implementing Entity will
34 coordinate with the Central Valley Regional Water Quality Control Board to adjust
35 Program contaminant reduction strategies and funding levels through the BDCP
36 adaptive management process as appropriate based on review of Central Valley
37 Regional Water Quality Control Board monitoring and other reports.

38
39 For Task 2, the Implementing Entity will monitor the effectiveness of participating
40 farmers/farmer groups in reducing loads of targeted pesticides and herbicides. The
41 types of monitoring that may be appropriate include:

- 42 ▪ monitoring changes in targeted pesticide and herbicide loads in agricultural
43 drain water from participant's farmed lands;

- 1 ▪ monitoring responses of primary and secondary production to reductions in
2 pesticide and herbicide loads;
- 3 ▪ monitoring ambient pesticide levels in effluent and in water samples
4 throughout the Delta; and
- 5 ▪ monitoring for incidences of mortality and sublethal effects of pesticides and
6 herbicides on covered fish species throughout the Delta.

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

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

14
15
16 **Conservation Measure TOCO7: Reduce the Loads of Toxic Contaminants in**
17 **Stormwater Pollution and Urban Runoff by Working with Existing Efforts in the**
18 **Delta.** *[Note to Reviewers: Conservation Measure TOCO7 was previously reviewed and*
19 *removed by the Other Stressors Working Group. However, at the request of DFG, the*
20 *focus of the measure has been revised and detail added. DFG is concerned about the*
21 *large toxic load from urban runoff and its effects on covered species. The measure is*
22 *presented here for SC review.]* The BDCP Implementing Entity would coordinate with
23 the Sacramento Stormwater Quality Partnership, the City of Stockton, the City of Tracy,
24 and other smaller municipalities (“cities”) under National Pollutant Discharge
25 Elimination System (NPDES) MS4 stormwater permits to implement actions from and in
26 addition to their respective stormwater management plans.

27
28 The BDCP Implementing Entity would enter into Memoranda of Agreement (MOAs) or
29 similar binding instruments with the Sacramento Stormwater Quality Partnership, the
30 City of Stockton, the City of Tracy, and other smaller municipalities 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 the 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 stormwater pollution
39 load reduction activities to be implemented by the cities at funded levels. The cities
40 would be responsible for implementing the scope of work and submitting reports as
41 specified in the MOA that demonstrate that the work plan has been successfully
42 implemented. The cities would also be responsible for monitoring the effectiveness of

1 agricultural contaminant reduction measures and adjusting reduction methods to improve
2 their effectiveness over time.

3
4 The BDCP Implementing Entity would be responsible for monitoring the effectiveness of
5 stormwater pollution load reduction activities in achieving covered fish species benefits.
6 This monitoring would be required because of the uncertainties surrounding the
7 population level benefits of reducing stormwater pollution loads on covered fish species
8 (see *Uncertainties/Risks* discussion below). The BDCP Implementing Entity, in
9 coordination with the Fishery Agencies, may discontinue monitoring in future years if
10 monitoring results indicate a strong correlation between reduction in stormwater pollution
11 loads entering the Delta and responses of covered fish species.

12
13 The BDCP Implementing Entity would use results of effectiveness monitoring to
14 determine if reducing stormwater pollution loads results in measurable benefits to
15 covered fish species and to identify adjustments to funding levels, control methods, or
16 other related aspects of the program that would improve the biological effectiveness of
17 the program. Such changes would be effected through the BDCP adaptive management
18 process and would be included in the subsequent annual work plans.

19
20 If results of monitoring indicate that reducing stormwater pollution loads does not
21 substantially and cost-effectively benefit covered fish species, the BDCP Implementing
22 Entity, in coordination with Fishery Agencies, may terminate this conservation measure.
23 The BDCP Implementing Entity, in coordination with the Fishery Agencies, would also
24 terminate this conservation measure if the cities choose not to enter into a MOA with the
25 BDCP Implementing Entity. If terminated, remaining funding would be deobligated
26 from this conservation measure and reallocated to augment funding for other more
27 effective conservation measures identified in coordination with the Fishery Agencies
28 through the BDCP adaptive management process.

29
30 **Rationale:** Stormwater runoff has been identified as the leading source of water
31 pollution in the United States (Lee et al. 2007) and is thought to be a large contributor
32 to toxics in the Delta (Weston et al. 2005, Amweg et al. 2006, Werner et al. 2008).
33 As stormwater runoff returns to the Delta, it accumulates sediment, oil and grease,
34 pesticides, and many other toxic chemicals. Pyrethroids are known to affect aquatic
35 organisms in the Delta, including covered fish species and their food (Weston et al.
36 2005, Werner et al. 2008). Further, suspended sediment is the primary attenuator of
37 sunlight in the water column and thus can reduce photosynthesis in phytoplankton
38 and submerged aquatic vegetation and affect fish behavior and health in the Delta
39 (Schoelhammer et al. 2007). Unlike sewage, stormwater is not treated in any way
40 before entering the Delta.

41
42 Regulation of and reductions in runoff are ongoing (EPA 1993). All major urban
43 centers in the Delta, including Sacramento, Stockton, and Tracy, and multiple smaller
44 cities are under National Pollutant Discharge Elimination System (NPDES) MS4
45 permits to develop and implement a Storm Water Management Plan/Program with the

1 goal of reducing the discharge of pollutants to the maximum extent practicable under
2 Section 402(p) of the Clean Water Act. These permits require development and
3 implementation of a Storm Water Management Plan/Program to meet this goal.

4
5 This conservation measure would help cities develop and implement stormwater
6 management plans and programs and implement actions in addition to these
7 plans/programs with the goal of reducing stormwater pollution loads that can be
8 harmful to covered aquatic species from entering Delta waterways. Actions in
9 addition to those in plans/programs would be implemented if benefits are expected to
10 BDCP covered species.

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

14
15 **Implementation Considerations:** The BDCP Implementing Entity would
16 coordinate with each city separately because each is under a separate NPDES MS4
17 permit.

18
19 **Resiliency to future changes:** This conservation measure is not expected to be
20 affected by future changes.

21
22 **Uncertainties/risks:** The effect of some contaminants in stormwater on covered fish
23 species at a population level is not well known.

24
25 **Monitoring and adaptive management considerations:** [Note to reviewers: this
26 section is a general summary; more detail will be provided in future iterations.]
27 Individual cities would be responsible for conducting monitoring necessary to assess
28 the effectiveness of BDCP supported elements of their stormwater management
29 plans. The Implementing Entity will provide ongoing review of monitoring, progress,
30 and other relevant reports from the cities related to the effectiveness the Program for
31 reducing contaminant loads in stormwater runoff. The Implementing Entity will
32 coordinate with the cities to adjust stormwater pollution reduction strategies and
33 funding levels through the BDCP adaptive management process as appropriate based
34 on review of the cities' monitoring and other reports.

35
36 **Reversibility:** Reversibility of this conservation measure is expected to be moderate
37 due to the possibility of needed infrastructure.

38
39
40 **Conservation Measure TOCO12: Provide for Rapid Detection of and Response to**
41 **Toxic Contaminant Events that could Affect Covered Fish Species.** To implement
42 this conservation measure, the BDCP Implementing Entity would contribute to the
43 development and implementation of a comprehensive real time monitoring, assessment,
44 and response program (CRTMARP) for contaminants in the Delta at a funding level of
45 \$\$ over the term of the BDCP.

1
2 The BDCP Implementing Entity would enter into a Memorandum of Agreement (MOA)
3 or similar binding instrument with the CRTMARP implementing entity that would
4 describe respective roles and obligations for expenditure of BDCP funding. Elements of
5 the MOA would include a description of specific activities (e.g., monitoring for and
6 responding to toxic events of contaminants shown to be harmful to covered fish species)
7 that would be funded by BDCP, preparation of annual work plans for BDCP funded
8 activities, provisions for documenting work performed, monitoring responsibilities, and
9 provisions for modifying or terminating the MOA.

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

19
20 The BDCP Implementing Entity, in coordination with the Fishery Agencies, will
21 periodically review the cost effectiveness of this conservation measure in achieving
22 benefits for covered fish species. If it is determined that this conservation measure does
23 not provide a substantial cost-effective benefit for covered fish species, the BDCP
24 Implementing Entity, in coordination with Fishery Agencies, may terminate this
25 conservation measure. The BDCP Implementing Entity, in coordination with the Fishery
26 Agencies, would also terminate this conservation measure if the CRTMARP
27 implementing entity chooses not to enter into a MOA with the BDCP Implementing
28 Entity. If terminated, remaining funding would be deobligated from this conservation
29 measure and reallocated to augment funding for other more effective conservation
30 measures identified in coordination with the Fishery Agencies through the BDCP
31 adaptive management process.

32
33 **Rationale:** There is currently no comprehensive framework for gathering, compiling,
34 assessing, reporting, and responding to data on a real time basis for contaminants in
35 the Delta. Implementing a comprehensive, well coordinated program would be an
36 efficient way to identify and respond to toxic events in a timely manner to minimize
37 effects on covered species in the Delta as well as to establish temporal and spatial
38 baseline patterns of toxic events. Real-time monitoring and reporting would be
39 conducted for evidence of toxicity in water quality, phytoplankton, invertebrates, and
40 fish. Monitoring would be conducted year-round at multiple locations throughout the
41 Delta, potentially by DFG's Office for Oil Spill Prevention. If a toxic event occurs,
42 the program would allow rapid response to minimize effects of the event on covered
43 fish species and the rest of the ecosystem (BJ Miller, pers. comm.).
44

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

6
7 This conservation measure will provide funding for development and implementation
8 of this program to allow for early detection of and rapid response to toxic events
9 adversely affecting on covered species. The contaminant(s) could be removed (e.g.,
10 filtered out) from the system or the point source could be stopped more quickly.

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

14
15 **Implementation Considerations:** This conservation measure is expected to be
16 implemented with moderate ease. High levels of coordination with agencies will be
17 required.

18
19 **Resiliency to future changes:** This conservation measure is not expected to be
20 affected by future changes.

21
22 **Uncertainties/risks:** None

23
24 **Monitoring and adaptive management considerations:** *[Note to reviewers: this*
25 *section is a general summary; more detail will be provided in future iterations.]* The
26 Implementing Entity will review progress or other relevant reports prepared by the
27 entity(ies) charged with implementing a comprehensive real time monitoring,
28 assessment, and response program to assess the effectiveness of the Program for
29 detecting and responding to toxic events. The Implementing Entity will coordinate
30 with the program entity(ies) to adjust program strategies and funding levels through
31 the BDCP adaptive management process as appropriate based on review of agency
32 reports.

33
34 **Reversibility:** Reversibility of this conservation measure is expected to be high.

35 36 37 ***Other Water Quality Issues***

38 39 **Introduction**

40
41 This section provides conservation measures that address water quality issues other than
42 toxic contaminants. Two conservation measures are provided, one to address low oxygen
43 levels in the Stockton Deep Water Ship Channel and another to address high organic
44 content, low oxygen levels, and methylmercury in water released from managed seasonal
45 wetlands.

1
2 **Conservation Measure OTWQ1: Maintain Dissolved Oxygen Levels of at Least [redacted]**
3 **ppm in the Stockton Deep Water Ship Channel during Periods Covered Fish**
4 **Species are Present.** The BDCP Implementing Entity would coordinate with the Port of
5 Stockton and the US Army Corps of Engineers (USACE) to solve dissolved oxygen
6 problems in the Stockton Deep Water Ship Channel at a funding level of \$\$ [redacted] over
7 the term of the BDCP.

8
9 The BDCP Implementing Entity would enter into Memoranda of Agreement (MOAs) or
10 similar binding instruments with the Port of Stockton and USACE that would describe
11 respective roles and obligations for expenditure of BDCP funding. Elements of the MOA
12 would include a description of specific activities that would be funded by BDCP,
13 preparation of annual work plans for BDCP funded activities, provisions for documenting
14 work performed, monitoring responsibilities, and provisions for modifying or terminating
15 the MOA.

16
17 The BDCP Implementing Entity would be responsible for developing annual work plans,
18 in coordination with Fishery Agencies, that specify the extent of dissolved oxygen
19 improvements to be implemented by the Port of Stockton and USACE at funded levels.
20 The Port of Stockton and USACE would be responsible for implementing the scope of
21 work and submitting reports as specified in the MOA that demonstrate that the work plan
22 has been successfully implemented. The Port of Stockton and USACE would also be
23 responsible for monitoring the effectiveness of dissolved oxygen improvement measures
24 and, if necessary, adjusting methods to improve their effectiveness over time.

25
26 The Port of Stockton and USACE would be responsible for monitoring the effectiveness
27 of dissolve oxygen enhancement measures in improving dissolved oxygen levels. This
28 conservation measure assumes that the BDCP Implementing Entity would not be required
29 to monitor covered fish species responses to improving dissolved oxygen levels in the
30 Stockton Deep Water Ship Channel because the cause and effect relationships between
31 dissolved oxygen levels and covered fish species responses are well understood (see
32 Rationale discussion below).

33
34 The BDCP Implementing Entity, in coordination with the Fishery Agencies, would
35 terminate this conservation measure if the Port of Stockton and USACE choose not to
36 enter into a MOA with the BDCP Implementing Entity. If terminated, remaining funding
37 would be deobligated from this conservation measure and reallocated to augment funding
38 for other more effective conservation measures identified in coordination with the
39 Fishery Agencies through the BDCP adaptive management process.

40
41 **Rationale:** Low dissolved oxygen levels can cause physiological stress and mortality
42 to fish and other aquatic organisms, can impair both upstream and downstream
43 migration of fall-run Chinook salmon, and may affect steelhead and white sturgeon
44 similarly (CRWQCB 2007).
45

1 The Stockton Deep Water Ship Channel has been identified as an impaired waterway
2 because of low dissolved oxygen concentrations during late summer and early fall.
3 The combination of low flows, high loads of oxygen-demanding substances (algae
4 from upstream, effluent from the City of Stockton Regional Wastewater Control
5 Facility, and other unknown sources), and channel geometry contribute to low oxygen
6 levels in the Stockton Deep Water Ship Channel (Basin Plan 1998). The Stockton
7 Deep Water Ship Channel regularly exceeds the water quality standard established by
8 the Regional Board for dissolved oxygen (CRWQCB 2007). The low dissolved
9 oxygen area of in the ship channel creates a barrier for upstream migration of adult
10 fall-run Chinook salmon and Central Valley steelhead on the mainstem of the San
11 Joaquin River.

12
13 As a temporary solution, DWR is experimenting with dissolved oxygen aeration
14 techniques to be used when dissolved oxygen concentrations in the Stockton Deep
15 Water Ship Channel drop below water quality objectives. Additional targeted
16 research efforts should be made to determine the mechanisms responsible for the
17 dissolved oxygen sags.

18
19 **Implementation timeframe:** It is anticipated that this conservation measure could
20 be implemented in the BDCP near-term implementation period.

21
22 **Implementation Considerations:** This conservation measure is expected to be
23 implemented with moderate ease because significant infrastructure may be needed.

24
25 **Resiliency to future changes:** This conservation measure is not expected to be
26 affected by future changes.

27
28 **Uncertainties/risks:** The mechanisms that cause dissolved oxygen sags in the
29 Stockton Deep Water Ship Channel need to be better studied.

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 Army Corps of Engineers and Port of Stockton would be responsible for conducting
34 monitoring necessary to assess the effectiveness of BDCP supported elements of this
35 program. The Implementing Entity will provide ongoing review of the Army Corps
36 of Engineers and Port of Stockton monitoring, progress, and other relevant reports
37 related to the effectiveness the Program for improving dissolved oxygen levels in the
38 Stockton Deep Water Ship Channel and providing benefit to covered fish species.
39 The Implementing Entity will coordinate with the Army Corps of Engineers and Port
40 of Stockton to adjust Program dissolved oxygen improvement strategies and funding
41 levels through the BDCP adaptive management process as appropriate based on
42 review of the Army Corps of Engineers and Port of Stockton monitoring and other
43 reports.
44

1 **Reversibility:** Reversibility of this conservation measure is expected to be moderate
2 because major infrastructure may need modification.
3
4

5 **Conservation Measure OTWQ2: Improve the Quality of Water Discharged from**
6 **Managed Seasonal Wetlands into Suisun Bay and Delta Waterways to Prevent**
7 **Dissolved Oxygen Sags.** The BDCP Implementing Entity would coordinate with willing
8 owners/managers of seasonal managed wetlands in the Delta and Suisun Marsh to
9 improve quality of water released from these wetlands by implementing best
10 management practices. The BDCP Implementing Entity would offer incentive funding to
11 land owners will to test and implement water management measures that are
12 demonstrated through monitoring to reduce adverse affects on covered fish species
13 habitat in adjacent channels. This funding could be used to:

- 14 1. Conduct studies to determine the effects of discharge water on covered species
- 15 2. Develop plans and best management practices designed to address discharge
16 water effects on aquatic habitat.
- 17 3. Implement best management practices and modifications of drainage systems to
18 allow for wetland management and discharges that minimize adverse effects on
19 covered species
- 20 4. Acquire and install equipment necessary to implement revised seasonal wetland
21 management and discharge (e.g., gates, siphons)

22
23 The Implementing Entity would conduct monitoring of fish abundance and water quality
24 of fish habitat in adjacent and downstream channels to determine the effectiveness of this
25 measure.

26
27 The BDCP Implementing Entity, in coordination with the Fishery Agencies, would
28 terminate this conservation measure if it does not prove effective in increasing habitat use
29 by covered species in channels receiving managed seasonal wetland discharge. If
30 terminated, remaining funding would be deobligated from this conservation measure and
31 reallocated to augment funding for other more effective conservation measures identified
32 in coordination with the Fishery Agencies through the BDCP adaptive management
33 process.

34
35 **Rationale:** The Fall flood-up on managed seasonal wetlands typically consists of one
36 or more complete flood and drainage cycles followed by consistent circulation
37 throughout the winter flooded period. The fall flood-up can cause low dissolved
38 oxygen plumes that can kill covered species in Suisun Marsh and Suisun Bay. These
39 areas are important habitat to delta smelt, longfin smelt, splittail and rearing juvenile
40 salmonids. Further, high levels of organic matter increase the biological oxygen
41 demand in receiving waters. In addition, elevated concentrations of methylmercury
42 have been associated with effluents from managed seasonal wetlands. With the large
43 number of privately managed seasonal wetlands in Suisun Marsh contributing
44 effluent to its channels connected to Suisun Bay, there is the potential for adverse
45 effects on covered fish species.

1
2 This conservation measure would allow the BDCP Implementing Entity to coordinate
3 with owners and managers of managed seasonal wetlands to improve the water
4 quality of effluent to benefit covered fish species by implementing best management
5 practices. There are multiple land, water, and vegetation modifying activities that
6 have been identified to reduce dissolved oxygen plumes and loads of BOD and
7 methylmercury into receiving waters in Suisun Marsh. These activities include ways
8 to reduce the amount of organic material in and reduce the residence time of ponded
9 water. The activities are currently being investigated for efficacy under a CALFED-
10 funded grant by Wetland and Watershed Sciences and DWR (C. Enright pers.
11 comm.). This BDCP Implementing Agency will use the results of this study as
12 guidance for formulating best management practices to implement.

13
14 **Implementation timeframe:** It is anticipated that this conservation measure could
15 be implemented in the BDCP near-term implementation period. Results of the
16 CALFED study are expected by August 2008 (C. Enright pers. comm.)

17
18 **Implementation Considerations:** The complexity of implementation of this
19 conservation is dependent on the specific methods identified for managing black
20 water with specific landowners. Landowners willing to develop and implement black
21 water management plans must be found.

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

25
26 **Uncertainties/risks:** Some best management practices for dealing with managed
27 seasonal wetland effluent are not yet available.

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.]* The
31 BDCP Implementing Entity will monitor the effectiveness of participating
32 diverters/managers in improving water quality and habitat use by covered fish
33 species. The types of monitoring that may be appropriate include:

- 34 ▪ Changes in dissolved oxygen, biological oxygen demand, and methylmercury
35 levels in drain water from participant's lands;
- 36 ▪ Biosentinel monitoring of concentrations of mercury in tissue of small fish
37 species with high site fidelity that are abundant in implementation locations
38 (e.g., inland silversides) ; and
- 39 ▪ Abundance of covered fish species in channels receiving managed seasonal
40 wetland discharge.

41 The Implementing Entity will also conduct ongoing reviews of relevant research
42 related to the effects of effluent of managed seasonal wetlands on covered fish
43 species. The Implementing Entity may adjust activities for which coordination is

1 provided to participants to improve their effectiveness based on monitoring and
2 research results through the BDCP adaptive management process.

3
4 **Reversibility:** Reversibility of this conservation measure is expected to be high.
5
6

7 *Hatcheries*

8 9 **Introduction**

10
11 This section includes conservation measures that address the proper management of
12 existing salmon and steelhead hatcheries, marking and tagging programs to improve
13 tracking and survival of salmon and steelhead, and creation of new hatcheries for delta
14 and long fin smelt. These measures are designed to reduce the adverse effects of
15 hatchery reared fish on wild fish and to reduce the risk of extinction of delta smelt and
16 longfin smelt.

17
18 **Conservation Measure HATC1: Develop and Implement Hatchery and Genetic**
19 **Management Plans to Minimize the Potential for Genetic and Ecological Impacts of**
20 **Hatchery Reared Salmonids on Wild Salmonid Stocks.** To minimize potential adverse
21 effects of stocking hatchery reared salmonids on wild salmonid stocks, the BDCP
22 Implementing Entity would support the accelerated development and implementation of
23 Hatchery and Genetic Management Plans (HGMPs) for all Chinook salmon and steelhead
24 hatcheries in the Central Valley of California at a funding level of \$\$ over the
25 term of the BDCP. HGMPs would be implemented to reduce adverse ecological and
26 genetic effects of hatcheries on wild fish.

27
28 The BDCP Implementing Entity would enter into Memoranda of Agreement (MOAs) or
29 similar binding instruments with hatchery operators of Fishery Agencies that would
30 describe respective roles and obligations for expenditure of BDCP funding. Elements of
31 the MOAs would include a description of specific activities that would be funded by
32 BDCP, requirement for preparation of annual work plans for BDCP funded activities,
33 provisions for documenting work performed, monitoring responsibilities, and provisions
34 for modifying or terminating the MOAs.

35
36 The BDCP Implementing Entity, in coordination with the Fishery Agencies, would be
37 responsible for developing annual work plans that specify the extent and types of
38 activities to be implemented by the Fishery Agencies at funded levels. The Fishery
39 Agencies would be responsible for implementing the scope of work and submitting
40 reports as specified in the MOAs that demonstrate that work plans have been successfully
41 implemented. The Fishery Agencies would also be responsible for monitoring the
42 effectiveness of HGMP measures and adjusting hatchery management practices to
43 improve their effectiveness over time.
44

1 The Fishery Agencies would be responsible for monitoring the effectiveness of HGMPs
2 in improving the genetic integrity of wild salmonid stocks over time. The BDCP
3 Implementing Entity would use results of effectiveness monitoring to determine if
4 implementation of HGMPs results in measurable benefits to covered salmonids and to
5 identify adjustments to funding levels, management practices, or other related aspects of
6 the program that would improve the biological effectiveness of the program. Such
7 changes would be effected through the BDCP adaptive management process and would
8 be included in the subsequent annual work plans.

9
10 If results of monitoring indicate that implementation of HGMPs do not substantially and
11 cost-effectively benefit covered salmonids, the BDCP Implementing Entity, in
12 coordination with Fishery Agencies, may terminate this conservation measure. This
13 conservation measure would also be terminated if the Fishery Agencies choose not to
14 enter into MOAs with the BDCP Implementing Entity. If terminated, remaining funding
15 would be deobligated from this conservation measure and reallocated to augment funding
16 for other conservation measures identified in coordination with the Fishery Agencies
17 through the BDCP adaptive management process that more effectively provide covered
18 salmonid benefits.

19
20 **Rationale:** The goal of HGMPs is to serve as the foundation of hatchery
21 management and reform to minimize genetic and ecological impacts to wild fish.
22 HGMPs are developed to devise and evaluate practices of a hatchery to ensure the
23 hatchery contributes to the conservation and recovery of listed salmonids.

24
25 **Implementation timeframe:** It is anticipated that this conservation measure could
26 be implemented in the BDCP near-term implementation period.

27
28 **Implementation considerations:** This conservation measure is considered to be
29 practicable and feasible because efforts to develop HGMPs are already underway.

30
31 **Resiliency to future changes:** This action would not be influenced by future climate
32 change, although hatcheries may need to contend with changes in water temperature.

33
34 **Uncertainties/risks:** It is difficult to determine the benefits of HGMPs. Because
35 HGMPs are not yet completed for Central Valley hatcheries, the actions that will be
36 recommended are unknown at this time. However, some specific actions that could
37 yield measurable benefits can be implemented before completion. The BDCP
38 Implementing Entity would determine which additional actions to support
39 implementation of once HGMPs are completed based on their ability to benefit the
40 BDCP covered species.

41
42 **Monitoring and adaptive management considerations:** [Note to reviewers: this
43 section is a general summary; more detail will be provided in future iterations.] The
44 National Marine Fisheries Service would be responsible for monitoring the
45 effectiveness of HGMPs for conserving wild Central Valley salmonid stocks. The

1 Implementing Entity will provide ongoing review of National Marine Fisheries
2 Service monitoring, progress, and other relevant reports to assess the effectiveness of
3 Central Valleys HGMPs for improving wild salmonid stocks. The Implementing
4 Entity will coordinate with the National Marine Fisheries Service to adjust HGMP
5 strategies and funding levels through the BDCP adaptive management process as
6 appropriate based on review of NMFS reports.
7

8 **Reversibility:** This conservation measure is considered highly reversible.
9

10
11 **Conservation Measure HATC2: Reduce Losses of Wild Stocks of Chinook Salmon
12 to Commercial Fishing and Recreational Fishing through a Mark-Select Fishery.**

13 To reduce unintentional harvest of wild stocks of Chinook salmon, the BDCP
14 Implementing Entity will support total marking of hatchery produced fall-run Chinook
15 salmon to provide the basis for implementing a mark-select fishery and to contribute to
16 conservation and recovery of the species at a funding level of \$\$ over the term of
17 the BDCP.
18

19 The BDCP Implementing Entity would enter into Memoranda of Agreement (MOAs) or
20 similar binding instruments with hatchery operators of Fishery Agencies that would
21 describe respective roles and obligations for expenditure of BDCP funding. Elements of
22 the MOAs would include a description of specific activities and equipment purchases that
23 would be funded by BDCP, preparation of annual work plans for BDCP funded activities,
24 provisions for documenting work performed, monitoring responsibilities, and provisions
25 for modifying or terminating the MOAs.
26

27 The Fishery Agencies would be responsible for:

- 28 ▪ developing annual work plans that specify the extent and types of activities to be
29 implemented by the Fishery Agencies at funded levels for submittal to the BDCP
30 Implementing Entity;
- 31 ▪ implementing the scopes of work and submitting reports as specified in the MOAs
32 that demonstrate that work plans have been successfully implemented;
- 33 ▪ monitoring the effectiveness of marking techniques and improving those techniques
34 if warranted over time; and
- 35 ▪ monitoring the effectiveness of the mark-select program for reducing levels of
36 unintended harvest of wild Chinook salmon.

37
38 The BDCP Implementing Entity would use results of effectiveness monitoring to
39 determine if implementation of the marking program and the mark-select fishery results
40 in measurable benefits to wild Chinook salmon stocks and to identify adjustments to
41 funding levels, management practices, or other related aspects of the program that would
42 improve the biological effectiveness of the program. Such changes would be effected

1 through the BDCP adaptive management process and would be included in the
2 subsequent annual work plans.

3
4 If results of monitoring indicate that the mark-select fishery program does not
5 substantially and cost-effectively benefit covered wild Chinook salmon stock, the BDCP
6 Implementing Entity, in coordination with Fishery Agencies, may terminate this
7 conservation measure. This conservation measure would also be terminated if the
8 Fishery Agencies choose not to enter into MOAs with the BDCP Implementing Entity. If
9 terminated, remaining funding would be deobligated from this conservation measure and
10 reallocated to augment funding for other conservation measures identified in coordination
11 with the Fishery Agencies through the BDCP adaptive management process that more
12 effectively provide Chinook salmon benefits.

13
14 **Rationale:** Most hatcheries in the Central Valley are production hatcheries designed
15 to mitigate for lost habitat from dams constructed in the middle of the twentieth
16 century (Williams 2006). Hatchery-produced Chinook salmon and steelhead are
17 thought to have negative effects on wild fish via competition for resources and
18 genetic effects that can reduce the fitness of wild fish if interbreeding occurs (see
19 ISAB 2002 for review).

20
21 The primary benefit of marking 100% of hatchery reared fish is to reduce mortality of
22 wild Chinook salmon by commercial and recreational fishing. Therefore, the success
23 of this conservation measure is dependent on implementation of a mark-select fishery.
24 This type of fishery is designed to reduce the percentage of wild fish retained for
25 harvest by anglers by providing the ability to visibly distinguish wild from hatchery
26 reared fish. Because they would be distinguishable, marked (hatchery) fish could be
27 harvested whereas unmarked (wild) fish would be released. This would allow
28 hatcheries to fulfill their purpose (provide hatchery fish for anglers) while providing
29 benefits to wild fish by both reducing their take and reducing competition and genetic
30 introgression. The technique has been used successfully in the Pacific Northwest to
31 contribute to the conservation and recovery of wild salmon populations.

32
33 There are multiple additional benefits to wild Chinook salmon of 100% marking of
34 hatchery fish. First, managers would be able to determine the effectiveness of
35 restoration, river management, and recovery programs on wild versus hatchery fish.
36 Currently, it is not known whether these actions primarily benefit wild fish, hatchery
37 fish, or both, and in what proportions. Second, there would be the ability for
38 hatcheries to track and manage the composition of wild versus hatchery origin fish in
39 breeding programs. Third, 100% marking would streamline, simplify, and reduce
40 costs for coded wire tag, scale, otolith, and genetics sampling programs that
41 specifically target wild or hatchery fish because the targeted fish can be easily
42 distinguished. Fourth, hatcheries could more easily track and manage the
43 composition of wild versus hatchery origin fish in breeding programs
44

1 All hatchery reared winter-, spring-, and late fall-run Chinook salmon are currently
2 marked with an adipose fin clip. DFG has marked and tagged a constant fraction
3 (25%) of hatchery reared fall-run fish since 2007. Although there could be benefits
4 of a mark-select fishery at this fraction of marking, these benefits are predicted to be
5 greatly increased with 100% marking of hatchery fish (D. Fullerton, pers. comm.).
6

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

10 **Implementation considerations:** This conservation measure is expected to be
11 moderately practicable and feasible. Marking techniques are currently being
12 implemented and funding would allow for 100% marking. Agencies must agree to
13 implement this action at their hatcheries and to implement the mark-select fishery.
14

15 **Resiliency to future changes:** This action is not expected to be influenced by future
16 climate change.
17

18 **Uncertainties/risks:** Although modeling efforts and similar programs in the Pacific
19 Northwest indicate that a mark select fishery provides benefits to wild fish, there is
20 still some uncertainty whether this would be beneficial to Central Valley hatcheries.
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.]* The
24 National Marine Fisheries Service would be responsible for monitoring the
25 effectiveness of a mark-select fall-run Chinook salmon fishery program for
26 conserving wild fall-run stocks. The BDCP Implementing Entity would provide
27 ongoing review of National Marine Fisheries Service monitoring, progress, and other
28 relevant reports to assess the effectiveness of the mark-select fishery for improving
29 wild stocks of fall-run Chinook salmon. The BDCP Implementing Entity would
30 coordinate with the National Marine Fisheries Service to adjust mark-select strategies
31 and funding levels through the BDCP adaptive management process as appropriate
32 based on review of National Marine Fisheries Service reports.
33

34 **Reversibility:** This action is considered moderately reversible. A moderate amount
35 of equipment would be needed to implement the program.
36
37

38 **Conservation Measure HATC4: Establish New and Expand Existing Conservation**
39 **Propagation Programs for Delta and Longfin Smelt.** The BDCP Implementing Entity
40 will support: (1) the development of a delta and longfin smelt conservation hatchery by
41 the USFWS to permanently house a delta smelt refuge population and provide a source of
42 delta and longfin smelt for supplementation or reintroduction, as necessary, and (2) the
43 expansion of the refugial population of delta smelt and establishment of a refugial
44 population of longfin smelt at the University of California, Davis Fish Conservation and

1 Culture Laboratory in case of a catastrophic event in the wild, at a funding level of
2 \$\$ over the term of the BDCP.

3
4 The BDCP Implementing Entity would enter into Memoranda of Agreement (MOAs) or
5 similar binding instruments with the USFWS and University of California, Davis that
6 would describe respective roles and obligations for expenditure of BDCP funding.
7 Elements of the MOAs would include a description of specific activities and capital
8 improvements that would be funded by BDCP, preparation of annual work plans for
9 BDCP funded activities, provisions for documenting work performed, monitoring
10 responsibilities, Hatchery and Genetic Management Plan (HGMP) development and
11 implementation, and provisions for modifying or terminating the MOAs.

12
13 USFWS and University of California, Davis would provide the BDCP Implementing
14 Entity with annual work plans that describe activities or capitol improvements that would
15 be funded by BDCP. USFWS and University of California, Davis would be responsible
16 for implementing the scope of work and submitting reports as specified in the MOAs that
17 demonstrate that work plans have been successfully implemented. USFWS and
18 University of California, Davis would also be responsible for demonstrating the
19 effectiveness of the conservation hatchery operations in maintaining/improving the
20 genetic integrity of delta smelt and longfin smelt and in propagating sufficient stocks for
21 stocking purposes, if needed, to supplement or recover the wild population. The BDCP
22 Implementing Entity in coordination with the Fishery Agencies would use progress
23 reports to assess program effectiveness and to identify adjustments to funding levels,
24 management practices, or other related aspects of the program that would improve the
25 biological effectiveness of the program. Such changes would be effected through the
26 BDCP adaptive management process and would be included in the subsequent annual
27 work plans.

28
29 If the program assessments indicate that operation of the conservation hatcheries is not
30 effective in achieving delta smelt and longfin smelt conservation objectives, 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 USFWS and University of California, Davis decides not to enter into MOAs with the
34 BDCP Implementing Entity. If terminated, remaining funding would be deobligated
35 from this conservation measure and reallocated to augment funding for other
36 conservation measures identified in coordination with the Fishery Agencies through the
37 BDCP adaptive management process that more effectively provide benefits for delta
38 smelt and longfin smelt.

39
40 **Rationale:** Populations of both delta and longfin smelt have dramatically declined
41 recently (IEP 2008). Although a variety of stressors are suspected, yet there is not yet
42 a clear understanding of why these populations have declined (IEP 2008). There is
43 evidence that delta smelt continue to decline and that very low population size could
44 result in an Allee effect causing an even more rapid decline of the species (Mueller-
45 Solger 2007). As a result, the risk of extinction of delta smelt is likely increasing.

1 Longfin smelt may follow a similar trend as delta smelt. For these reasons, artificial
2 propagation has been proposed to protect these two species from extinction.
3 Although there are criticisms of the effectiveness of artificial propagation in
4 maintaining proper genetic diversity and integrity, there may be no alternative at this
5 point. State-of-the-art genetic management practices should be implemented to avoid
6 hatchery produced fish becoming genetically different from wild fish.

7
8 A new facility proposed by the USFWS would house genetically-managed refuge
9 populations of delta and longfin smelt (Clarke 2008). Further, the facility would
10 provide fish stocks to supplement the wild population and provide fish stocks for
11 reintroduction, as necessary and appropriate. The facility is expected to be designed
12 for the ability to add other species if necessary in the future. Construction and start-
13 up costs are estimated to be \$19.5 million. Annual operating costs are estimated to be
14 \$1.5-2.0 million. If and when populations of these species are considered recovered,
15 specific rules could be established to close the conservation hatchery.

16
17 The UC Davis Fish Conservation and Culture Laboratory is in need of additional
18 space to expand the refugial population of delta smelt and establish a refugial
19 population of longfin smelt. The goal of the laboratory's refuge program is to
20 preserve populations and genetic diversity of smelt. The laboratory also provides
21 delta smelt for multiple research efforts.

22
23 **Implementation timeframe:** It is anticipated that this conservation measure could
24 be implemented in the BDCP near-term implementation period.

25
26 **Implementation considerations:** Delta smelt have been reared in smaller-scale
27 facilities, but a full-scale refugia population has never been supported in a hatchery
28 facility. The ability to maintain genetic diversity and integrity in a smelt hatchery
29 necessary for wild survival is unknown. An important consideration would be
30 development of appropriate criteria for determining under what conditions support of
31 smelt hatchery production and maintenance of refuge populations is no longer
32 necessary.

33
34 **Resiliency to future changes:** Because delta smelt are thought to be near their
35 temperature threshold, additional warming may require an increase reliance on refuge
36 populations.

37
38 **Uncertainties/risks:** Causes of delta and longfin smelt decline are not well
39 understood. As a result, although this conservation measure would produce more
40 fish, it may not be effective in producing functional fish that are able to survive and
41 reproduce in the wild. The ability to maintain genetic diversity and integrity in a
42 smelt hatchery necessary for wild survival is unknown. The ecological and genetic
43 effects of adding hatchery fish to the wild population are unknown.

44

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 U.S. Fish and Wildlife Service would be responsible for monitoring the effectiveness
4 of BDCP supported delta smelt and longfin smelt hatchery and refuge population
5 programs. The BDCP Implementing Entity would provide ongoing review of U.S.
6 Fish and Wildlife Service progress and other relevant reports to assess the
7 effectiveness of rearing smelt in hatcheries and maintaining refuge populations. The
8 BDCP Implementing Entity would coordinate with the U.S. Fish and Wildlife Service
9 to adjust hatchery and refuge population management strategies and funding levels
10 through the BDCP adaptive management process as appropriate based on review of
11 U.S. Fish and Wildlife Service reports.

12
13 **Reversibility:** Because this action requires a large amount of infrastructure it has
14 low reversibility.

15 16 17 *Harvest*

18 19 **Introduction**

20
21 This section includes conservation measures that address the control of harvest activities
22 on covered species. Measures include increased levels of enforcement to reduce illegal
23 harvesting of covered fish species and the creation of a regulated Sacramento splittail
24 fishery where none presently exists.

25
26 **Conservation Measure HARV1: Reduce Illegal Harvest of Chinook Salmon,**
27 **Central Valley Steelhead, Green Sturgeon, and White Sturgeon in the Delta by**
28 **Percent from Estimate 200** **Levels.** To reduce the adverse effects of illegal harvest of
29 adult covered salmonids and sturgeon, the BDCP would increase the enforcement of
30 fishing regulations for these species in the Delta. The BDCP Implementing Entity would
31 provide funds to CDFG to support and equip the addition of 17 field wardens and 5
32 supervisory and administrative staff in support of the field wardens assigned to the Delta-
33 Bay Enhanced Enforcement Program (DBEEP) over the term of the BDCP. BDCP-
34 supported DBEEP staff would be tasked specifically with enforcing laws and regulations
35 regarding harvest of the covered fish species. Estimated funding would be \$8.7 million
36 for the first year of implementation and an estimated annual cost of \$6.7 million in
37 subsequent years without inflation.

38
39 The BDCP Implementing Entity would enter into a Memorandum of Agreement (MOA)
40 or similar binding instrument with CDFG that would describe respective roles and
41 obligations for expenditure of BDCP funding. Elements of the MOA would include a
42 description of specific law enforcement and supporting positions and the types and levels
43 of field law enforcement activities that would be funded by BDCP; preparation of annual

1 work plans for BDCP funded activities; provisions for documenting work performed; and
2 provisions for modifying or terminating the MOA.

3
4 CDFG would be required to monitor and annually report the activities and results of
5 DBEEP activities funded by BDCP including an accounting of the specific benefits to
6 covered fish species as a result of enforcement actions.

7
8 The BDCP Implementing Entity would review progress reports and other relevant reports
9 prepared by the DBEEP to assess the Program's ongoing effectiveness in decreasing the
10 adverse effects of illegal harvest on covered fish species. The BDCP Implementing
11 Entity would coordinate with the CDFG to adjust enforcement strategies and funding
12 levels through the BDCP adaptive management process as appropriate based on review of
13 Program reports.

14
15 **Rationale:** California has the lowest game warden to population ratio in the nation
16 with fewer than 200 field wardens for the entire state. The Delta is a particular hot
17 spot for poaching because of the large number of sport fish, particularly gravid female
18 white sturgeon, whose roe are used for caviar (Lt. L. Schwall, pers. comm.). Illegal
19 harvest is thought to have high impacts on sturgeon populations, particularly white
20 sturgeon.

21
22 The Delta-Bay Enhanced Enforcement Program (DBEEP) is a 10 warden squad that
23 was formed specifically to increase enforcement on poaching of anadromous fish
24 species in Bay-Delta waterways. The program is funded by water contractors through
25 the 4-Pumps Agreement Advisory Committee. The BDCP would contribute directly
26 to this existing program by expanding its size to improve enforcement on poaching of
27 covered species.

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

31
32 **Implementation considerations:** This conservation measure is considered to be
33 readily implementable because it would involve the expansion of an existing
34 program.

35
36 **Resiliency to future changes:** This action would not be influenced by future climate
37 change.

38
39 **Uncertainties/risks:** The effect of illegal harvest on covered fish species, other than
40 white sturgeon, is relatively unknown.

41
42 **Monitoring and adaptive management considerations:** [Note to reviewers: this
43 section is a general summary; more detail will be provided in future iterations.] The
44 BDCP Implementing Entity would review progress reports and other relevant reports
45 prepared by the DBEEP to assess the Program's ongoing effectiveness in decreasing

1 the adverse effects of illegal harvest on covered fish species. The BDCP
2 Implementing Entity would coordinate with the Department of Fish and Game to
3 adjust enforcement strategies and funding levels through the BDCP adaptive
4 management process as appropriate based on review of Program reports.
5

6 **Reversibility:** This conservation measure is considered to be easily reversible.
7

8 **Conservation Measure HARV3: Reduce Adverse Effects of Harvest on Sacramento**
9 **Splittail Abundance.** The BDCP Implementing Entity will develop, in coordination
10 with the Fishery Agencies, a proposal describing recommended Sacramento splittail
11 harvest regulations for submittal to the California Fish and Game Commission for their
12 consideration and approval. The proposal would describe recommend regulations on bag
13 and size limits for Sacramento splittail throughout its native range to maintain and
14 enhance splittail populations. In addition, the proposal would describe the processes,
15 monitoring requirements, and funding that would be required from the regulation. The
16 BDCP Implementing Entity will conduct ongoing consultation and coordination with the
17 Fish and Game Commission to facilitate consideration of the proposal.
18

19 Initial regulations would be based on a pilot study to assess the impact on splittail by both
20 the bait fishery and recreational fishery. Initial regulations would be lenient but, as more
21 knowledge on extent and effect of splittail harvest on the overall population is gained
22 through results of the DFG's creel surveys, regulations would be refined as appropriate.
23

24 **Rationale:** There are currently no regulations on the Sacramento splittail fishery.
25 However, the fishery may be considerable despite its poor documentation (Moyle et
26 al. 2004). This conservation measure would establish legal limits for splittail based
27 on known abundance and harvest rates. Although harvest is not thought to have
28 significant effects on the population currently, this conservation measure would
29 protect the species if harvest pressure increases in the future.
30

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

34 **Implementation considerations:** This conservation measure is considered to be
35 moderately practicable and feasible. There may be contention by the angling
36 community for new regulations. Further, educating the public about new regulations
37 and creel surveys may require additional resources from the Department of Fish and
38 Game.
39

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

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

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.] The
4 Department of Fish and Game would be responsible for monitoring of the
5 effectiveness of regulations in conserving Sacramento splittail while providing for a
6 recreational fishery and for revising regulations as needed to improve their
7 effectiveness. The BDCP Implementing Entity would coordinate with the
8 Department of Fish and Game to identify and support needed adjustments in
9 regulations in future years.

10
11 **Reversibility:** This conservation measure is considered to be easily reversible.

12 13 14 *Non-Project Diversions*

15 16 **Introduction**

17
18 This section contains one conservation measure that addresses improvements to non-
19 project diversions (mainly for agricultural uses) to reduce the level of entrainment
20 mortality of covered fish species. The measure includes installation of fish screens on
21 non-project diversions and removal, relocation, consolidation, design modification, and
22 altered operations of non-project diversions in coordination with specific landowners and
23 managers operating these diversions.

24
25 **Conservation Measure NPDI/2: Screen, Remove, Relocate, Consolidate, Modify**
26 **and/or Alter Timing of [redacted] Non-Project Diversions to Reduce Entrainment of**
27 **Covered Fish Species at within the Delta.** To implement this conservation measure, the
28 BDCP Implementing Entity would support the U.S. Bureau of Reclamation's
29 Anadromous Fish Screen Program and Department of Fish and Game's Fish Screen and
30 Passage Program to screen non-project diversions, thereby reducing entrainment risk of
31 covered fish species at non-project diversions, at a funding level of \$ [redacted] over the term
32 of the BDCP. In addition, the BDCP Implementing Entity, in cooperation with willing
33 non-project diverters, would share costs to remove, relocate, consolidate, modify design,
34 and alter operations of individual non-project diversions to reduce the risk of entrainment
35 of covered fish species at a funding level of \$\$ [redacted] over the term of the BDCP.
36 Relocation and consolidation would involve moving diversions from high quality habitat
37 for covered fish species to lower quality habitat.

38
39 The conservation measure could focus on the largest diversions (greater than 250 cfs)
40 under the assumption that larger diversions entrain fish at a disproportionately larger rate
41 than smaller diversions. Alternatively the conservation measure could focus on the many
42 smaller diversions, which are cheaper to screen per unit capacity. Implementation would
43 use outcomes of studies by CDFG (or other entities) on fish entrainment by non-project
44 diversions as a basis for decisions on which diversions to screen to achieve the greatest
45 entrainment reductions for covered fish species.

1
2 Decisions regarding which diversions to focus on would rely on information from a
3 comprehensive study by DFG to determine the distribution of fish in the Delta relative to
4 non-project diversions and to determine entrainment rates of at least 27 diversions
5 throughout the Delta (C. Armor pers. comm.). Funding for this study is anticipated to
6 come from Assembly Bill 2938, which is currently in the State Assembly. If not funded,
7 the BDCP Implementing Entity would fund a similar study to gain this information.

8
9 For screening diversions, the BDCP Implementing Entity would enter into a Memoranda
10 of Agreements (MOAs) or similar binding instrument with The Bureau of Reclamation
11 and CDFG that would describe respective roles and obligations for expenditure of BDCP
12 funding. Elements of the MOAs would include a description of specific activities that
13 would be funded by BDCP, preparation of annual work plans for BDCP funded activities,
14 provisions for documenting work performed, monitoring responsibilities, and provisions
15 for modifying or terminating the MOA.

16
17 The BDCP Implementing Entity would be responsible for identifying the diversions to be
18 screened in coordination with the Fishery Agencies. The Bureau of Reclamation and
19 CDFG would be responsible for implementing their respective scopes of work and
20 submitting reports as specified in the MOA that demonstrate that the work plan has been
21 successfully implemented.

22
23 It is anticipated that fish screen technologies for small diversions are substantially
24 developed that monitoring will not be required to assess screen effectiveness in reducing
25 entrainment of covered fish species. There is uncertainty, however, regarding the
26 population level effects of non-project entrainment on covered fish species.
27 Consequently, the BDCP Implementing Entity would conduct monitoring to determine if
28 screening non-project diversions provide substantial benefits for covered fish species.

29
30 The BDCP Implementing Entity would use results of effectiveness monitoring to
31 determine if screening non-project diversions results in measurable benefits to covered
32 fish species and to identify adjustments to funding levels or other aspects of the program
33 that would improve the biological effectiveness of the program. Such changes would be
34 effected through the BDCP adaptive management process and would be included in the
35 subsequent annual work plans.

36
37 If results of monitoring indicate that screening of non-project diversions does not
38 substantially and cost-effectively benefit covered fish species, the BDCP Implementing
39 Entity in coordination with Fishery Agencies may terminate this conservation measure.
40 This conservation measure would also be terminated if Reclamation and CDFG choose
41 not to enter into MOAs with the BDCP Implementing Entity. If terminated, remaining
42 funding would be deobligated from this conservation measure and reallocated to augment
43 funding for other more effective conservation measures identified in coordination with
44 the Fishery Agencies through the BDCP adaptive management process.

45

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

8
9 Because there is uncertainty regarding the population level effects of non-project
10 entrainment on covered fish species, the BDCP Implementing Entity will conduct
11 effectiveness monitoring to determine if funded projects provide substantial benefits for
12 covered fish species. The BDCP Implementing Entity would also use results of
13 effectiveness monitoring to identify adjustments to funding levels or other aspects of the
14 program that would improve the biological effectiveness of the program. Such changes
15 would be effected through the BDCP adaptive management process and would be in
16 subsequent contracts with program participants.

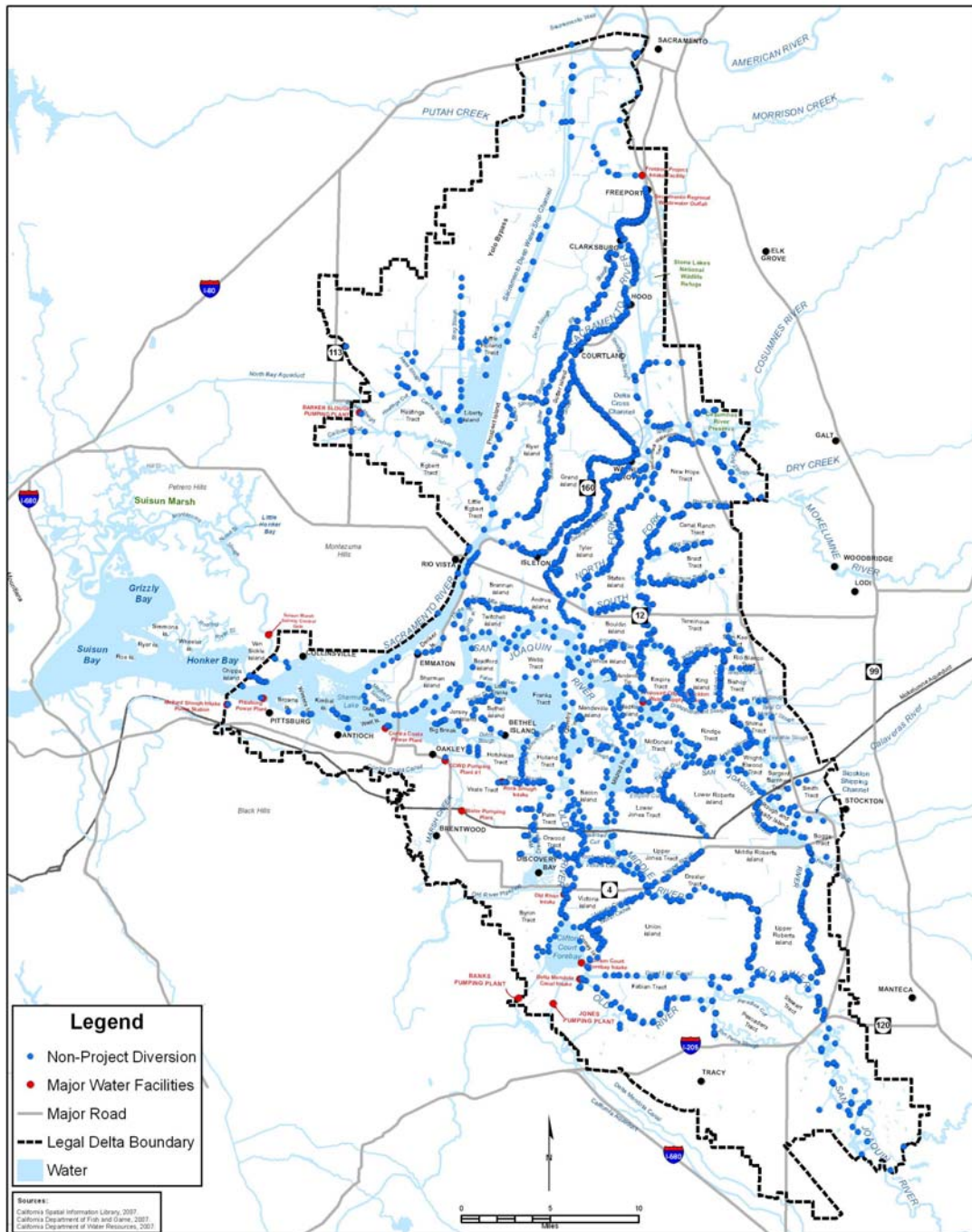
17
18 If results of monitoring indicate that projects implemented under this conservation
19 measure does not substantially and cost-effectively benefit covered fish species, the
20 BDCP Implementing Entity, in coordination with Fishery Agencies, may terminate this
21 conservation measure. The BDCP Implementing Entity, in coordination with the Fishery
22 Agencies, would also terminate this conservation measure if participation by non-project
23 diverters is insufficient to achieve this objective. If terminated, remaining funding would
24 be deobligated from this conservation measure and reallocated to augment funding for
25 other more effective conservation measures identified in coordination with the Fishery
26 Agencies through the BDCP adaptive management process.

27
28 **Rationale:** There are approximately 2,200 water diversions within the Delta (Figure
29 2) and an additional 1,000 in place along the Sacramento and San Joaquin Rivers and
30 their tributaries outside of the Delta and the Suisun Marsh (Herren and Kawasaki
31 2001). The majority divert water to agricultural fields between April-August
32 depending on the crop. This diversion timing partially overlaps with the presence of
33 many covered species in the Delta (generally January-July). Over 95% of these water
34 diversions are not screened to reduce fish entrainment (Herren and Kawasaki 2001).
35 A coarse estimate of 22,000 cfs has been calculated for the total amount of water
36 diverted from these diversions. These diversions are often located in small channels,
37 potentially increasing the influence of the diversion on the channel relative to channel
38 capacity. Given this information, the potential for significant entrainment of fish is
39 high (Hallock and Van Woert 1959 as cited Moyle and White 2002). Limited studies
40 indicate that self-cleaning screens have been at least 99% effective in reducing fish
41 entrainment at non-project diversions, even for larval fish <25 mm (Nobriga et al.
42 2004).

43
44 The U.S. Bureau of Reclamation's Anadromous Fish Screen Program (AFSP) was
45 formed in the 1990s as part of the CVPIA. With limited funds and the high cost of

1
2

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



3

1 screening, the program has been forced to prioritize diversions on which to install
2 screens. This list of criteria includes size, location, number of species impacted, and
3 cost. To date, most screens have been installed on the largest diversions upstream of
4 the Delta under the assumption that larger diversions entrain a disproportionately
5 higher number of fish than smaller diversions, although there is some uncertainty
6 regarding this assumption.

7
8 The Department of Fish and Game's Fish Screen and Passage Program is also
9 involved with screening diversions in the Central Valley. As with the AFSP, limited
10 funds have required prioritization of screening of diversions, primarily based on
11 estimates of the likelihood and level of impact on federal and state listed endangered
12 species. Both programs have relied on internal and CALFED ERP funds and
13 regularly partner with the Family Water Alliance, a non-profit organization that has
14 acted as the program manager of the Sacramento River Small Diversion Fish Screen
15 Program since 1996.

16
17 If approved, Assembly Bill 2938, currently in the State Assembly, would provide
18 three years of funding for a comprehensive DFG study of fish distribution patterns
19 and entrainment rates of at least 27 non-project diversions throughout the Delta (C.
20 Armor pers. comm.). If funding for AB 2938 is not approved by the Legislature, the
21 BDCP Implementing Entity will fund a similar study to determine distribution
22 patterns and entrainment rates of non-project diversions throughout the Delta.

23
24 Removal of individual diversions with large impacts on covered fish species would be
25 an effective way to reduce overall entrainment of covered fish species, but would not
26 be practicable without identifying alternative sources of water at similar cost. If
27 removal of diversions is not practical, diversions with large effects on covered species
28 could be relocated from high quality to lower quality habitat. In locations with
29 multiple diversions effecting covered species, the consolidation to a single or fewer
30 diversions placed in lower quality habitat could reduce entrainment.

31
32 High quality habitat includes potential spawning areas, important migration
33 pathways, or known centers of distribution. Low quality habitat includes back
34 channels with limited connectivity to main Delta channels or areas that are close to
35 other sources of stress. In addition, diversions in small capacity channels have a
36 proportionally larger effect on the fish in the channel. Diversions could be moved to
37 larger channels to avoid this effect.

38
39 Small-scale modifications to individual diversions in high quality habitat may be an
40 effective and cheaper way to reduce entrainment of covered fish species than
41 screening or making large scale location changes. This approach would take
42 advantage of small scale spatial patterns and behavior of covered fish species relative
43 to the location of individual diversions in the channel. For example, if the diversion
44 were located in an area with high abundance of sturgeon, the diversion should be off
45 the bottom. If the diversion is located in an area of high Chinook salmon or splittail

1 abundance, the diversion should be off shallow slopes. Other aspects that could be
2 modified include proximity to non-native predator habitat and orientation, shape, and
3 design of the distal end, or movement of the intake to a groundwater well location
4 adjacent to the channel.

5
6 Altering the intra-annual timing of irrigation and therefore diversions may also be an
7 effective way to reduce entrainment of covered fish species, although the
8 practicability of this approach is dependent on the crop being grown. The agricultural
9 irrigation period in the Delta is generally between April and August, depending on the
10 crop. The early part of this season coincides with the presence of juveniles of all nine
11 covered fish species in the Delta. Combined with a comprehensive monitoring plan
12 determining the spatio-temporal patterns on a real-time basis (see below), diversion
13 operations could be altered when covered species are in the vicinity of a diversion.

14
15 Many covered fish species appear to exhibit diel patterns of activity (Grimaldo 2006,
16 Webb et al. 2006, Wilder and Ingram 2006) that could be used to determine diel
17 timing of diversion operations. The goal would be to divert when covered fish
18 species are not near the in-channel location of the diversion. There is potential that
19 diel activity patterns of covered fish species encompass the entire diel cycle such that
20 there is no time of day to avoid all covered species. For example, Grimaldo (2006)
21 reported that delta smelt are active primarily during the day. Wilder and Ingram
22 (2006) reported that late-fall Chinook salmon were active primarily at night, whereas
23 fall-run Chinook salmon were active primarily during the day. Webb et al. (2006)
24 reported that delta smelt are active primarily both during the day and during
25 crepuscular (near sunrise and sunset) periods, splittail are active primarily at night
26 and during crepuscular periods, and longfin smelt exhibit no diel activity patterns.
27 These patterns of activity need to be determined for other covered fish species before
28 this conservation concept could be implemented. If fish activity patterns are
29 distinctive, most pumping could occur at a certain time of day when fish are inactive
30 and curtailed when fish are active.

31
32 This conservation measure could provide financial and logistical support for willing
33 diverters to alter the timing of pumping to reduce entrainment by their diversion.

34
35 **Implementation timeframe:** It is anticipated that this conservation measure could
36 be implemented in the BDCP near-term implementation period by screening,
37 removing, relocating, consolidating, modifying the design, or altering the timing of
38 diversions already identified as high priorities. Long-term implementation would be
39 responsive to new information developed regarding screening prioritization of
40 particular diversions and to changes in Delta conditions created by physical habitat
41 restoration and changes in operations with dual conveyance.

42
43 **Implementation considerations:** This conservation measure is considered to be
44 practicable because screening efforts already underway have proven effective.
45 Construction and maintenance costs, however, are high (\$7500/cfs construction costs

1 for smaller diversions and >\$50,000/cfs for larger diversions) and the existing
2 programs require additional funding (D. Meier pers. comm.).
3

4 The effectiveness of the conservation measure is dependent on the number of
5 diverters willing to remove, relocate, and consolidate their facilities, which has been
6 historically difficult to obtain. Removal of a legal diversion could be accomplished
7 through acquisition of lands in fee-title or conservation easement from willing sellers,
8 which would result in the cessation of water diversion and removal of individual
9 diversions. Water rights of these diverters must be addressed. The removal of illegal
10 diversions could be accomplished through enforcement and other legal remedies.
11

12 An important component to the effectiveness of this conservation measure will be the
13 development and application of criteria for identifying which diversions, if removed,
14 relocated, or consolidated, would result in the greatest reductions in non-project
15 entrainment losses of covered fish species.
16

17 Relocation of diversions and consolidation of multiple diversions could incur
18 significant costs if substantial additional infrastructure is required to reach a more
19 distant diversion site. Diversion design modification is considered to be moderately
20 difficult to implement. It would require knowledge of in-channel distributions of
21 covered fish species near the diversion. Regardless, it would likely be much cheaper
22 than screening, relocating, or consolidating diversions. Also, diverters may be more
23 willing to make smaller changes to their diversions than screening, relocating, or
24 consolidating. Altering diversion timing could also be difficult to implement.
25

26 The magnitude of effect of this conservation concept is difficult to predict because the
27 effect that non-project entrainment has on covered species is relatively unknown and
28 highly variable. However, the effect could be larger during times when the species
29 are present in the Delta system. The effect is dependent on the success of real-time
30 monitoring of the presence of covered species and on the ability to discern clear diel
31 or seasonal patterns in fish activity. Seasonal diversion patterns could be affected by
32 the crop type grown by the diverter.
33

34 **Resiliency to future changes:** Because the distribution of covered fish species could
35 change in the Delta with sea level rise, the effect of individual diversions on
36 entrainment of covered species and therefore, effectiveness of screening, relocation,
37 consolidation, design modification, and alteration of timing of diversions could
38 change with future climate change.
39

40 **Uncertainties/risks:** It is difficult to assess the effectiveness of this conservation
41 measure because the effect of non-project diversions on the entrainment of covered
42 species is relatively unstudied. Entrainment is highly variable among diversions. If
43 approved, Assembly Bill 2938, currently in the State Assembly, would provide three
44 years of funding for a comprehensive DFG study of fish distribution patterns and
45 entrainment rates of at least 27 diversions throughout the Delta (C. Armor pers.

1 comm.). If funded, this study would provide needed information on the effects of
2 non-project diversions on covered fish species.

3
4 Understanding the effect of variation of parameters related to diversion size, location,
5 pumping patterns, etc. on entrainment rates of covered species would allow better
6 informed decisions regarding priorities for removal, relocation, and consolidation of
7 diversions. Patterns of diel and seasonal activity and distribution of covered fish
8 species would provide necessary information to determine the alterations in timing of
9 diversions.

10
11 There is evidence that diversions entrain large numbers of non-native species (Brown
12 1982, Nobriga et al. 2004). Therefore, screening diversions could be more beneficial
13 to non-native fish species than native fish species, potentially increasing competition
14 with and predation by non-natives on natives. Understanding the effect of variation
15 of parameters related to diversion size, location, pumping patterns, etc. on
16 entrainment rates of covered species would allow better informed decisions regarding
17 screening priorities and would improve screening success.

18
19 **Monitoring and adaptive management considerations:** *[Note to reviewers: this*
20 *section is a general summary; more detail will be provided in future iterations.]*

21 With respect to screening actions, the Bureau of Reclamation and the Department of
22 Fish and Game would be responsible for monitoring the effectiveness of their
23 respective fish screening programs in reducing the entrainment of covered fish
24 species at non-project diversions. The BDCP Implementing Entity would review
25 progress and other relevant reports prepared by the Anadromous Fish Screen Program
26 and the Fish Screen and Passage Program. The BDCP Implementing Entity would
27 coordinate with Reclamation and the Department of Fish and Game to screening
28 strategies and funding levels through the BDCP adaptive management process as
29 appropriate based on review of funded program reports.

30
31 Prior to relocating or consolidating diversions, the BDCP Implementing Entity would
32 conduct surveys to determine the existing habitat use by covered fish species near the
33 effected diversions and fish use at locations where diversions would be relocated or
34 consolidated. Following completion of a relocation or consolidation, fish use would
35 be monitored in the same locations to determine the effectiveness of the relocation or
36 consolidation in reducing entrainment levels. The BDCP Implementing Entity may
37 adjust its strategies for selecting diversions to be relocated or consolidated, modify
38 intake designs, or adjust funding levels through the BDCP adaptive management
39 process based on monitoring results and other relevant information (e.g., monitoring
40 and research conducted by others).

41
42 **Reversibility:** Reversibility of the screening of diversions is expected to be low due
43 to the large amounts of infrastructure associated with screens, particularly for larger
44 diversions. Reversibility of the removal of diversions is expected to be moderate,
45 depending on the extent of facilities removed or modified (versus left in place without

1 operation). Land use changes associated with the land acquisition would result in low
2 reversibility. Reversibility of consolidating and/or relocating of diversions is
3 expected to be low or moderate depending on the level of infrastructure modification
4 required. Reversibility of design modifications is expected to be moderately high
5 because modifications could be simple and inexpensive relative to screening,
6 relocating, and removing diversions. Reversing alterations in the timing of diversions
7 is expected to be easily accomplished.

10 ***Commercial/Recreational Activities***

12 **Introduction**

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

17 **Conservation Measure CORA1: Establish No Wake Boating Zones in Delta**
18 **Waterways to Protect Sensitive Covered Species Shoreline Habitat.** The BDCP
19 Implementing Entity would coordinate with the Department of Boating and Waterways
20 and local governing entities to establish low boat speeds regulations (no wake zones) and
21 post signs in locations with high ecosystem function and sensitive habitat for covered
22 species at a funding level of \$\$ [redacted] over the term of the BDCP.

24 The BDCP Implementing Entity would enter into Memoranda of Agreement (MOA) or
25 similar binding instruments with the Department of Boating and Waterways and local
26 governing entities that would describe respective roles and obligations for expenditure of
27 BDCP funding. Elements of the MOA would include a description of specific activities
28 that would be funded by BDCP, preparation of annual work plans for BDCP funded
29 activities, provisions for documenting work performed, monitoring responsibilities, and
30 provisions for modifying or terminating the MOA.

32 The BDCP Implementing Entity would be responsible for developing annual work plans,
33 in coordination with the Fishery Agencies, that specify the location and extent of
34 additional no wake zones to be implemented by the Department of Boating and
35 Waterways and local governing entities at funded levels. The Department of Boating and
36 Waterways and local governing entities would be responsible for implementing the scope
37 of work and submitting reports as specified in the MOA that demonstrate that the work
38 plan has been successfully implemented. The Department of Boating and Waterways and
39 local governing entities would also be responsible for monitoring the effectiveness of
40 additional no wake zones on covered fish species habitat use and, if necessary, adjusting
41 methods to improve their effectiveness over time.

43 If results of monitoring indicate that projects implemented under this conservation
44 measure does not substantially and cost-effectively benefit covered fish species, the
45 BDCP 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 Department of Boating
3 and Waterways and local governing entities choose not to enter into a MOA with the
4 BDCP Implementing Entity. If terminated, remaining funding would be deobligated
5 from this conservation measure and reallocated to augment funding for other more
6 effective conservation measures identified in coordination with the Fishery Agencies
7 through the BDCP adaptive management process.

8
9 **Rationale:** Boat wakes from recreational boats can damage intertidal marsh habitat
10 and disturb shallow waters in which splittail and salmonids may be rearing or delta
11 smelt may be spawning. The Department of Boating and Waterways and local
12 ordinances currently restrict boat speeds to 5 mph in specific areas of the Delta, such
13 as near boat docks and landings. These limits have been set primarily for human
14 safety concerns and protection of infrastructure. This conservation measure would
15 direct the BDCP Implementing Entity to work with the Department of Boating and
16 Waterways and local governing entities to limit boat speeds to 5 mph in areas of high
17 importance to the ecosystem and covered species, including such as areas of known
18 or suspected spawning, major migration corridors for covered fish species, and BDCP
19 intertidal habitat restoration locations. Reduced boat wake size at 5 mph speed
20 substantially diminishes vegetation and substrate damage and removal relative to the
21 larger wakes created at higher speeds.

22
23 **Implementation timeframe:** It is anticipated that that this conservation measure
24 could be implemented in the BDCP near-term implementation period.

25
26 **Implementation considerations:** This conservation measure should be readily
27 implemented at minimal cost. The measure may not be easily enforceable if there is a
28 substantial extent of waterways in which reduced boat speeds would be posted. An
29 important component to the effectiveness of this conservation measure will be the
30 development and application of criteria for identifying which intertidal and aquatic
31 habitat and fish use areas would most benefit from establishment and enforcement of
32 low boat speed regulations.

33
34 **Resiliency to future changes:** Because the distribution of covered fish species could
35 change in the Delta with sea level rise, locations in which low boat speeds are set may
36 have to be altered with future climate change.

37
38 **Uncertainties/risks:** The effect that boat wakes have on shallow water habitat is
39 unknown and, as a result, the potential benefit of this conservation measure to
40 covered fish species is unknown. The effects of boat wakes on marsh vegetation is
41 well documented (Nordstrom 1992).

42
43 **Monitoring and adaptive management considerations:** [Note to reviewers: this
44 section is a general summary; more detail will be provided in future iterations.]
45 Local law enforcement agencies would be responsible for monitoring compliance of

1 boaters in established low boat speed zones. As part of agreements with the
2 Department of Boating and Waterways, the BDCP Implementing Entity would
3 monitor the effectiveness of slow boat speed zones for improving covered fish species
4 habitat use and habitat conditions. In coordination with the Department of Boating
5 and Waterways, the BDCP Implementing Entity would recommend revisions to low
6 speed zone regulations through the BDCP adaptive management process based on
7 results of effectiveness monitoring.

8
9 **Reversibility:** This conservation measure is expected to be easily reversible.

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