OSCM 21:
Non-Project Diversions

Scientific Evaluation Worksheets

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Action: Non-Project Diversions

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Action Description and Clarifying Assumptions

Modify or eliminate non-project diversions in the Delta to reduce the entrainment of covered fish species.

Approach

For non-project diversions that are >50 cfs do one of the following:

1. Screen the diversion with a screen that is 99% efficient at screening particles,
2. Remove the diversion,
3. Relocate the diversion to a channel in which its effect would be reduced,
4. Relocate the diversion within a channel to reduce the effect on covered fish species,
5. Consolidate multiple diversions in a single location into one screened diversion, or
6. Alter timing of operation of the diversion (e.g., diel operations) to reduce the effect on covered fish species.

Intended Outcomes as Stated in Conservation Measure

1. Reduce entrainment mortality by non-project diversions of larval and juvenile delta and longfin smelt, juvenile green and white sturgeon, juvenile splittail, and fry and juvenile Chinook salmon (all races) and steelhead.
2. Increase food availability to delta and longfin smelt, green and white sturgeon, splittail, and Chinook salmon (all races) and steelhead.

General Conceptual Model Support for Intended Outcomes

1a. Reduced mortality of larval and juvenile Delta smelt: Unlikely to reduce mortality significantly; Delta smelt Conceptual Model, section 5.1.5.f, page 21

1b. Reduced mortality of larval and juvenile longfin smelt: Implied in Longfin Smelt Conceptual Model, section 5-Diversions, page 22; mortality at diversions may be significant in some years.

1c. Reduced mortality of juvenile green sturgeon: Yes, possibly; Green sturgeon Conceptual Model, section 5, page 13.

1d. Reduced mortality of juvenile white sturgeon: Yes, possibly; Green sturgeon Conceptual Model, page 21.

1e. Reduced mortality of juvenile splittail: Yes, possibly; Splittail model p. 18; power plants have ability to entrain large numbers of fish, YOY have Ucrit near velocities at large pumps and are entrained at the CVP and SWP.

1f. Reduced mortality of fry and juvenile Chinook: Yes, possibly; Salmonid Conceptual Model, page 21.

1g. Reduced mortality of fry and juvenile steelhead: Yes, possibly; Salmonid Conceptual Model, page 21.
2a. Increased food for Delta smelt: Yes, probably; Delta smelt model pp. 27, 32; water diversions constrain copepod standing stocks, could increase food availability via improved water quality management.
2b. Increased food for longfin smelt: Yes, probably; Delta smelt model pp. 27, 32: water diversions constrain copepod standing stocks, could increase food availability via improved water quality management; Longfin smelt model p. 22: water diversions may impact abundance and distribution of longfin smelt prey.
2c. Increased food for green sturgeon: Possibly; Green sturgeon model p. 9, diet of green sturgeon is unknown, but other sturgeons are known to consume drifting invertebrates.
2d. Increased food for white sturgeon: Possibly; White sturgeon model p. 8, diet of larval white may include zooplankton.
2e. Increased food for Chinook: Possibly; Salmonid model p. 47 (stressors table), indirect mortality caused by diversions.
2f. Increased food for steelhead: Possibly; Salmonid model p. 47 (stressors table), indirect mortality caused by diversions.

Assumptions

Provided in BDCP Conservation Measure

1. Willing diverters for this action will be found.
2. Priority on which diversions to focus will be based on criteria developed by DFG and USFWS.

Problem(s) with Action as Written:

1. The approach mentions using screens for particles. Shouldn't fish screens be used? Note: As the screening criteria is based upon particle size, this may increase the amount of screen clogging and require a high-maintenance cleaning regime to maintain intake flows. Farmers may advocate for more than one diversion so that they could alternate the use and cleaning of screens (one in water, one being cleaned).

   Use of screens may results in bio-clogging: "Although invasive, substrate-colonizing mussels (Zebra and Quagga mussels) have not been reported in the Delta, should they appear, it would be necessary to dry out the intakes periodically to kill off any mussel spat which have settled on the screens. To minimize bio-clogging, the intake structure should be kept out of water until needed (again, this might result in having two pumps which could alternate diversion---one drying out, one being used). Also, there is a critical velocity threshold of flow at 1.5 m/sec (Claudi & Macki 1994) that prevents the settling of spat; however, within the diversion pipe, there is a gradation of laminar flow which may still allow spat to colonize within or around the edge of the diversion." (Martha Volkoff, Staff Environmental Scientist, CDFG Invasive Species Program, Quagga-Zebra Mussel Division, pers. comm. to Shirley Witalis).

2. How was the cutoff of >50 cfs determined?

3. Relative to the >50 cfs cutoff, does this refer to the maximum capacity of the diversion? If so, this should be stated.

Scale of Action:

Medium

Rationale:

Information from CDFG indicates that there are 69 unscreened diversions with a capacity greater than 50 cfs in the Delta. Excluding Banks and Jones pumping plants, the combined capacity of these diversions exceeds 7,000 cfs

The entrainment of larvae and juveniles of covered fish species by non-project diversions >50 cfs is poorly documented. The only empirical studies of this potential impact found low rates of entrainment for listed fish (Nobriga et al. 2004, Cook and Buffaloe 1998). These studies evaluated few diversions and suffered from a lack of staffing, funding and coordination with the diverters. Most of the fish entrained were non-native fish, benthic oriented fish, observed in high numbers. These authors, however, do hypothesize that the cumulative effect of these diversions could be large. This is corroborated in a literature review by Moyle and White (2002). Impacts to any of the other covered species are likely to be even smaller than what has been estimated for Delta smelt. Results of the PTM modeling completed for the BDCP suggests that DICU entrainment is low, ranging from 3% under high flow conditions, to about 20% under low flow conditions (BDCP 2009).

Note: with a north Delta diversion these numbers increased to 20 to 50%.

Evaluation Summary

Summary tables listing magnitude and certainty scores for each outcome, by species are provided in the Outcome Summary Table Appendix at the end of this worksheet. Details regarding each of the listed scores, and the rationales for the scores are provided in the discussion of positive and negative outcomes herein.

Relation to Existing Conditions:

Would the action result in a change to system dynamics (either within the Delta or as inputs to the Delta) such that the current understanding of how the system works may no longer hold?

NO. The scale of this action is medium.

Potential Positive Ecological Outcome(s)

Outcome P1: Reduce entrainment mortality by non-project diversions

P1a. Larval and juvenile Delta smelt

Magnitude = 2

Empirical study (Nobriga et al. 2004) indicates low entrainment of Delta smelt by non-project Delta diversions. Low entrainment of listed species (Cook and Buffaloe 1998)

Certainty = 2

Two empirical studies (Nobriga et al. 2004, Cook and Buffaloe 1998). Nobriga et al. (2004) found that the presence of screens significantly reduced entrainment of unlisted species, even when the individual fish present in the surrounding environment were small enough to pass through the screens.

P1b. Larval and juvenile longfin smelt

Magnitude = 1

No empirical studies for this species, but given the low entrainment found for another Delta fish (Delta smelt; Nobriga et al. 2004) this outcome is likely to have little or no effect at the population level. Many of the diversions would also be located outside of the geographic range for this species.

Certainty = 1

No empirical studies for this species.

P1c. Juvenile green sturgeon

Magnitude = 1

Empirical studies do not report entrainment for this species (Nobriga et al. 2004, Cook and Buffaloe 1998). Other benthic fish (i.e. catfish, sculpin) have been observed to be entrained (Cook and Buffaloe 1998), establishing that entrainment is possible, but would be low and this outcome is likely to have little or no effect at the population level.

Certainty = 1

No empirical studies for this species.

P1d. Juvenile white sturgeon

General Observations

Magnitude = 1

Empirical studies do not report entrainment for this species (Nobriga et al. 2004, Cook and Buffaloe 1998). Other benthic fish (i.e. catfish, sculpin) have been observed to be entrained (Cook and Buffaloe 1998), establishing that entrainment is possible, but would be low and this outcome is likely to have little or no effect at the population level.

Certainty = 1

No empirical studies for this species.

P1e. Juvenile splittail

Magnitude = 1

Empirical studies report low entrainment for this species (Nobriga et al. 2004, Cook and Buffaloe 1998). Other benthic fish (i.e. catfish, sculpin) have been observed to be entrained (Cook and Buffaloe 1998), establishing that entrainment is possible, but would be low and this outcome is likely to have little or no effect at the population level.

Certainty = 1

No empirical studies for this species.

P1f. Fry and juvenile Chinook salmon (all races)

Magnitude = 1

Little empirical studies for this species, but given the low entrainment found by Cook and Buffaloe (1998) and for another Delta fish (Delta smelt; Nobriga et al. 2004) this outcome is likely to have little or no effect at the population level.

Certainty = 1

No empirical studies for this species.

P1g. Fry and juvenile steelhead

Magnitude = 1

Little empirical studies for this species, but given the low entrainment found by Cook and Buffaloe (1998) and for another Delta fish (Delta smelt; Nobriga et al. 2004) this outcome is likely to have little or no effect at the population level.

Certainty = 1

No empirical studies for this species.

Outcome P2: Increase food availability

P2a. Delta smelt

Magnitude = 1

Supported by conceptual model (Delta smelt model pp. 27, 32; water diversions constrain copepod standing stocks. No empirical studies for this species. Volume is more than 7,000 cfs. Results of the PTM modeling completed for the BDCP suggests that DICU entrainment is low, ranging from 3% under high flow conditions, to about 20% under low flow conditions (BDCP 2009).

Certainty = 1

No empirical studies for this species.

P2b. Longfin smelt

Magnitude = 1

Same as Delta smelt.

Certainty = 1

No empirical studies for this species.

P2c. Green sturgeon

Magnitude = 1

Likely little impact on food resources for this species, which is mainly a benthic feeder.

Certainty = 1

No empirical studies for this species.

P2d. White sturgeon

Magnitude = 1

Same as green sturgeon

Certainty = 1

No empirical studies for this species.

P2e. Splittail

Magnitude = 1

Mainly a benthic feeder

Certainty = 1

No empirical studies for this species.

P2f. Chinook salmon (all races)

Magnitude = 1

Possibly; Salmonid model p. 47 (stressors table), indirect mortality caused by diversions.

Certainty = 1

No empirical studies for this species.

P2g. Steelhead

Magnitude = 1

Possibly; Salmonid model p. 47 (stressors table), indirect mortality caused by diversions.

Certainty = 1

No empirical studies for this species.

Important Gaps in Information and/or Understanding

Data Needs

- Evaluation of entrainment risks due to non-project diversions in a quantitative fashion that can be linked to population levels.
- Evaluation of entrainment risks due to non-project diversions that focuses on the geography – namely, the location of diversions relative to the location of covered fish species and the timing of diversions relative to fish distributions.
- Evaluation of entrainment risks due to non-project diversions that focuses on temporal overlap between diversion pumping and proximity of covered fish species to the diversions.

Research Needs

- GIS analysis of geographical questions mentioned above.
- Investigation of the pumping schedules associated with non-project diversions in different locations and of different sizes and types.

Assess Reversibility and Opportunity for Learning

Reversibility

Yes/easy

Comments: Screened diversions could be reversed simply by removing the installed screens. Reversing the action would simply require removal of screens. The cost of this reversal would likely be much lower than the original cost of installing screens. For diversions that were eliminated or moved, the cost of reversal would likely be equivalent to the original action.

Opportunity for Learning

Low

Comments Without long-term, rigorous monitoring programs for all of the non-project diversions that receive screens, determining the impact of this action would be difficult.

References Cited

BDCP (2009) Summary of Preliminary modeling of DRAFT BDCP Conservation strategy- core elements. Draft prepared for Integration team. Feb 2009.

Cook L, Buffaloe L (1998) Delta Agricultural Diversion Evaluation Summary Report, 1993 – 1995. IEP Tech Rept 61.

Claudi R, Mackie G (1994) Practical Manual for Zebra Mussel Monitoring and Control. CRC Press, Inc., Boca Raton Florida

Moyle P, White D (2002) Effects of screening diversions on fish populations in the Central Valley: What do we know? A report for the Science Board, CALFED Ecosystem Restoration Program. January 2002.

Nobriga ML, Matica Z, Hymanson ZP (2004) Evaluating entrainment vulnerability to agricultural diversions: A comparison among open-water fishes. American Fisheries Society Symposium 39:281-295.

Outcome Code	Covered Spp.	Description	Magnitude	Certainty
Positive Outcomes				
P2f	Chinook Salmon	Increased Food Availability	1	1
P1f	Chinook salmon-Fry and juvenile	Reduce entrainment mortality by non-project diversions	1	1
P2a	Delta smelt	Increased Food Availability	1	1
P2c	Green Sturgeon	Increased Food Availability	1	1
P1c	Green Sturgeon-juvenile	Reduce entrainment mortality by non-project diversions	1	1
P1a	Larval and juvenile delta smelt	Reduce entrainment mortality by non-project diversions	2	2
P2b	Longfin smelt	Increased Food Availability	1	1
P1b	longfin smelt- Larval and juvenile	Reduce entrainment mortality by non-project diversions	1	1
P2e	Splittail	Increased Food Availability	1	1
P1e	Splittail- Juvenile	Reduce entrainment mortality by non-project diversions	1	1
P2g	Steelhead	Increased Food Availability	1	1
P1g	steelhead-Fry and juvenile	Reduce entrainment mortality by non-project diversions	1	1
P2d	White Sturgeon	Increased Food Availability	1	1
P1d	White Sturgeon-Juvenile	Reduce entrainment mortality by non-project diversions	1	1