Bay Delta Conservation Plan
Other Stressors Working Group
June 16, 2009

HANDOUT #4

Draft Monitoring Section for Other Stressors Conservation Measures

OSCM3: Reduce the Load of Methylmercury Entering Delta Waterways.

Preconstruction Surveys

[To come.]

Construction Monitoring

[To come.]

Performance Monitoring

[To come.]

Effectiveness Monitoring

[To come.]

OSCM4: Reduce the Load of Pesticides and Herbicides Entering Delta Waterways from In-Delta Sources that are Believed to be Toxic to Covered Fish Species.

Preconstruction Surveys

[To come.]

Construction Monitoring

[To come.]

Performance Monitoring

[To come.]

Effectiveness Monitoring

For Action 1 of this conservation measure, effectiveness monitoring for BDCP funded elements of CVRWQCB's Irrigated Lands Regulatory Program pesticide/herbicide reduction programs would be conducted by CVRWQCB in accordance with its existing and future protocols and monitoring results would be reviewed by the BDCP Implementing Entity to help inform of the potential need to modify the conservation measure.

Effectiveness monitoring for Action 2 of this conservation measure will be implemented by BDCP and include:

- monitoring changes in targeted pesticide and herbicide loads in agricultural drain water from participants' farmed lands;
- monitoring responses of primary and secondary production to reductions in pesticide and herbicide loads;
- monitoring ambient pesticide levels in effluent and in water samples throughout the Delta; and
- monitoring for incidences of mortality and sublethal effects of pesticides and herbicides on covered fish species throughout the Delta.

Each monitoring metric will be monitored before and after implementation of actions to assess the effect of the action.

OSCM5: Reduce the Loads of Toxic Contaminants in Stormwater Pollution and Urban Runoff by Working with Existing Efforts in the Delta.

Preconstruction Surveys

[To come.]

Construction Monitoring

[To come.]

Performance Monitoring

[To come.]

Effectiveness Monitoring

Effectiveness monitoring for BDCP funded stormwater pollution reduction programs would be conducted by local stormwater agencies in accordance with their existing and future protocols and monitoring results would be reviewed by the BDCP Implementing Entity to help inform of the potential need to modify the conservation measure.

OSCM7: Maintain Dissolved Oxygen Levels for Covered Fish Species in the Stockton Deep Water Ship Channel during Periods when Covered Fish Species are Present.

Performance Monitoring

[To come.]

Effectiveness Monitoring

Anticipated elements of effectiveness monitoring for elements of this conservation measure to be implemented by BDCP include:

- Monitoring the effectiveness of diffusers by measuring the concentration of DO at multiple locations within the low DO zone in the Stockton DWSC. If not effective, the BDCP Implementing Entity would adaptively manage the action by modifying the method used or change to another method, such as speece cones or bubble plumes;
- Monitoring the migration rates of adult fall-run salmon, steelhead, white sturgeon, and splittail near the Stockton Deep Water Ship Channel. When established in the San Joaquin River, spring-run Chinook migration patterns would also be monitored;
- Monitoring sublethal effects (e.g., stress levels, condition, etc.) of adult fall-run Chinook salmon, steelhead, white sturgeon, green sturgeon, splittail, and, once they are re-established in the San Joaquin River, spring-run Chinook salmon; and
- Monitoring the effects of upstream tidal marsh restoration on tidal prism, concentration of oxygen demanding substances, and dissolved oxygen concentrations in and upstream of the SDWSC. If the restoration improves dissolved oxygen to levels above the TMDL objectives, operation of the diffusers could be scaled back or eliminated depending on the level of reduction.

OSCM10: Reduce the Risk for Future Introductions of Non-Native Aquatic Organisms from Recreational Watercraft.

Performance Monitoring

[To come.]

Effectiveness Monitoring

Effectiveness monitoring for BDCP funded risk reduction programs would be conducted by DFG in accordance with their existing and future protocols and monitoring results would be reviewed by the BDCP Implementing Entity to help inform of the potential need to modify the conservation measure.

OSCM11: Provide for Rapid Detection of and Response to New Introductions of Non-Native Species into Delta Waterways.

Performance Monitoring

[To come.]

Effectiveness Monitoring

Effectiveness monitoring for BDCP funded detection and response reduction programs would be conducted by DFG in accordance with their existing and future protocols and monitoring results would be reviewed by the BDCP Implementing Entity to help inform of the potential need to modify the conservation measure.

OSCM13: Remove Non-Native Submerged and Floating Aquatic Vegetation from Delta Waterways.

Preconstruction Surveys

[To come.]

Construction Monitoring

[To come.]

Performance Monitoring

Performance Monitoring Metric #1: Acreage of SAV and FAV treated.

Justification: To ensure that BDCP funding is being used properly for the SAV/FAV removal program, the BDCP Implementing Entity would need verification that additional area is treated in the program as a result of BDCP funding.

Target: Treat __acres of SAV and __acres of FAV annually in Delta waterways.

Adaptive management triggers and responses: If less than __acres are treated each year, action will be taken by the BDCP Implementing Entity to determine the factors limiting progress and to resolve these issues as necessary.

Monitoring approach: Annual reports prepared by DBW would be reviewed by the BDCP Implementing Entity.

Performance Monitoring Metric #2: Change in Biovolume of *Egeria densa* relative to Control Areas

Justification: The most direct way to determine whether treatment of Egeria is effective is to compare the change in biovolume of Egeria before and after treatment/removal to a nearby control location. Egeria biovolume is constantly changing with growth and senescence. Egeria growth is highly variable and dependent on many factors, including nutrient status, light intensity, day length, temperature, turbidity, salinity, and flow rate (Department of Boating and Waterways 2006). As a result, it is necessary to compare changes in Egeria biovolume in treatment locations to nearby control sites with similar levels of these variables. Because biovolume in control plots is expected to change during the period, it is necessary to compare changes and not absolute values of biovolume after treatment. The Department of Boating and Waterways contracted ReMetrix, LLC to perform hydroacoustic analyses on Egeria to determine biovolume in the Delta, and this method has been deemed "the best evidence to date of site efficacy" by the Department of Boating and Waterways (2006).

Target: There are two performance targets to be met:

1. Reduce the biovolume of Egeria by __% on average after 90 days of treatment in treated areas relative to control areas. A reduction of __% is suggested based on current known efficacy of existing treatments (Department of Boating and Waterways 2008). The 90 day period is currently used by the Department of Boating and Waterways to measure efficacy.
2. No year-over-year increase in pre-treatment biovolume in a treatment site relative to nearby control site.

Adaptive management triggers and responses: There are two adaptive management targets that, if not met, would trigger a re-evaluation and development of more effective removal techniques:

1. If the biovolume of Egeria in cleared areas is not reduced relative to control areas on average after 90 days post-treatment.
2. If there are increases in year-over-year pre-treatment and post-treatment biovolume in a treatment site relative to a nearby control site in more than __% of years over a 10 year period. A period of 10 years is meant to provide sufficient time to account for high interannual variation in determining whether the treatment technique is adequate.

Monitoring approach: Field surveys would be conducted using hydroacoustic analysis, as has been previously conducted, in treatment locations to estimate the biovolume of plants.

If sufficient evidence indicates that treatment/removal is effective by meeting both performance targets above for __ consecutive years, then monitoring can cease. This period accounts for interannual variation and meeting this requirement would be difficult to achieve if the technique were not effective.

Performance Monitoring Metric #3: Change in Areal Coverage of Water Hyacinth relative to Control Areas

Justification: The most direct way to determine whether treatment and/or removal of water hyacinth are effective is to compare the change in areal cover of water hyacinth before and after treatment/removal to a nearby control location. Areal cover of water hyacinth is constantly changing with growth, senescence, and, because it floats, flow patterns. The Department of Boating and Waterways has contracted UC Davis to employ hyperspectral imagery for estimating areal coverage of water hyacinth (Ustin et al 2008).

Target: There are two targets identified:

1. Reduce the areal cover of water hyacinth by __% on average after 90 days of treatment in treatment/removal areas relative to control areas. The 90 day period is currently used by the Department of Boating and Waterways to measure efficacy of Egeria removal and, given that the Department of Boating and Waterways primarily uses chemicals for treatment of both chemicals, this period is expected to be sufficient.
2. No year-over-year increase in pre-treatment areal cover in a treatment site relative to nearby control site.

Adaptive management triggers and responses: If the areal cover of water hyacinth in treatment/removal areas is not reduced relative to control areas on average after 90 days post-treatment, the action would be re-evaluated and different, more effective removal techniques would be developed. Further, if there are increases in year-over-year pre-treatment areal cover in a treatment/removal site relative to a nearby control site for __ consecutive years, the action would be re-evaluated and different, more effective removal techniques would be developed.

Monitoring approach: Field surveys would be conducted using remote sensing areal cover estimates, such as that used by Susan Ustin's lab at UC Davis, in treatment locations to estimate the biovolume of plants.

If sufficient evidence indicates that treatment/removal is effective by meeting both performance targets above for __ consecutive years, monitoring can cease. This period accounts for interannual variation and meeting this requirement would be difficult to achieve if the technique were not effective.

Effectiveness Monitoring

Effectiveness Monitoring Metric #1: Turbidity

Justification: Evidence suggests that Egeria densa reduces turbidity levels by reducing water motion, thereby allowing material to settle out (Grimaldo and Hymanson 1999). Turbidity levels in the Delta have declined over the past 30 years (Wright and Shoellhamer 2004), which may influence the foraging ability and/or predator avoidance of delta and longfin smelt. Delta and longfin smelt are thought to be attracted to high turbidity levels (Feyrer et al. 2007, USBR 2008).

Target: Increase localized turbidity levels by __% from 1 week prior to treatment/removal to 90 days after treatment within the removal area relative to a nearby control location. The period of 90 days will allow sufficient time for the treatment to take effect.

Adaptive management triggers and responses: If, after __ months/years, turbidity does not increase by __% relative to control locations despite a reduction in areal coverage of aquatic vegetation of __%, the action would be re-evaluated and cessation of the conservation measure would be considered if there were no other benefits to removal.

Monitoring approach: The monitoring will coincide with removal of Egeria to allow an experimental monitoring approach. Turbidity levels would be measured using a turbidity meter 1 week prior to and 90 days after removal of Egeria in areas within and nearby treatment/removal locations (BACI approach).

If sufficient evidence indicates that Egeria removal effectively increases localized turbidity levels in removal locations by meeting the performance targets for __ consecutive years, monitoring the effects of removal on turbidity levels can cease. This period accounts for interannual variation and meeting this requirement would be difficult to achieve if the technique were not effective.

Effectiveness Monitoring Metric #2: Local abundance of non-native predatory fish

Justification: The presence of Egeria is hypothesized to provide habitat for non-native predatory fish, particularly largemouth bass (Brown and Michniuk 2007) that may have adverse effects on covered fish species. Thus, the removal of non-native aquatic vegetation should reduce there local abundance of these fish.

Target: Reduced localized abundance of large mouth bass (and other non-native predators, as necessary) by __% from 1 week prior before to 90 days after removal relative to a nearby control location. The value of __% is used because it is considered sufficient to allow survival of covered fish species to increase by __% according to predation studies of large mouth bass

Adaptive management triggers and responses: If, after __ months/years, localized abundance of large mouth bass does not decrease by __% relative to control locations despite a reduction in areal coverage of non-native aquatic vegetation of __%, the action would be re-evaluated and cessation of the conservation measure would be considered.

Monitoring approach: The monitoring will coincide with removal of Egeria to allow an experimental monitoring approach. Abundance would be measured using electrofishing, pop nets, or other unbiased sampling technique for collecting fish in vegetation (in combination with Effectiveness Monitoring Metric #4) 1 week prior to and 90 days after removal of Egeria in areas both within and nearby removal locations (BACI approach).

If sufficient evidence indicates that local abundances of large mouth bass abundance decreases to __ by removing Egeria, monitoring can cease.

Effectiveness Monitoring Metric #3: Local abundance of juvenile salmonids and Sacramento splittail

Justification: The presence of non-native aquatic vegetation is hypothesized to exclude the presence of rearing juvenile salmonids and splittail from shallow tidal marsh and channels (Brown 2003). If true, the treatment/removal of non-native vegetation in these areas would be expected increase the local abundance of these species.

Target: Increase localized abundance of covered fish species by __% from 1 week prior before to 90 days after treatment/removal relative to a nearby control location.

Adaptive management triggers and responses: If, after __ months/years, localized abundance of both juvenile splittail and Chinook salmon species does not increase after removal of Egeria in at least __% of the sites relative to control locations, the action would be re-evaluated and cessation of the conservation measure would be considered.

Monitoring approach: Monitoring will coincide with removal of Egeria to allow an experimental monitoring approach. Abundance would be measured using electrofishing, pop nets, or other unbiased sampling technique for collecting fish in vegetation (in combination with Metric #5) 1 week prior to and 90 days after treatment/removal of non-native aquatic vegetation in areas both within and nearby treatment/removal locations (BACI approach).

If sufficient evidence indicates that local abundances of juvenile salmonids and splittail increase after Egeria removal by at least as much as the performance criteria for 5 consecutive years, monitoring can cease.

OSCM16: Reduce Illegal Harvest of Chinook Salmon, Central Valley Steelhead, Green Sturgeon, and White Sturgeon in the Delta.

Performance Monitoring

Performance Monitoring Metric #1: Hiring of additional DBEEP staff

Justification: Hiring of additional DBEEP wardens will be necessary to achieve enhanced enforcement of fishery regulations for covered species.

Target: Hire 17 wardens within 5 years of BDCP implementation.

Adaptive management triggers and responses: If additional DBEEP wardens are not hired according to targets, action will be taken by the BDCP Implementing Entity to determine the factors limiting progress and to resolve these issues as necessary

Monitoring approach: The BDCP Implementing Entity will review annual reports provided by DBEEP to determine the success in filling the positions described and how positions were attempted to be filled.

Effectiveness Monitoring

Effectiveness Metric #1: Compliance rate

Justification: It is predicted that the compliance rate, calculated as:

% Compliance = 1 - [{(#citations + # warnings)/total # of contacts} x 100]

could remain constant as more wardens are added or could at some level of staffing begin to decline, indicating that the increased number of wardens had reduced the amount of illegal fishing in the Delta.

Target: While keeping a consistent or higher number of contacts per warden, the compliance rate in a given year will decline once the number of wardens patrolling the Delta is sufficient to reduce the rate of illegal harvest of Chinook salmon, Central Valley steelhead, green sturgeon, and white sturgeon in the Delta.

Adaptive management trigger: The BDCP Implementing Entity would consider the number of wardens staffed in DBEEP as a sufficient number to reduce illegal harvest at such time as a __-year average decline in compliance rate begins for all target species (Chinook salmon, Central Valley steelhead, green sturgeon, and white sturgeon), given that the number of contacts per warden is the same or higher than previous years. At this time, the BDCP Implementing Entity would determine whether the number of wardens is optimal. At some point in the future, if the compliance rate begins to increase, the BDCP Implementing Entity could reconsider funding more wardens up to 17. If the number of citations and warnings becomes very low, the BDCP Implementing Entity could consider terminating funding for some positions.

Monitoring approach: The total number of contacts with the public and the total number of citations issued per year would be monitored annually and compared among 3-year increments.

OSCM18: Develop and Implement Hatchery and Genetic Management Plans to Minimize the Potential for Genetic and Ecological Impacts of Hatchery Reared Salmonids on Wild Salmonid Stocks.

Performance Monitoring

[To come.]

Effectiveness Monitoring

[To come.]

OSCM20: Establish New and Expand Existing Conservation Propagation Programs for Delta and Longfin Smelt.

Performance Monitoring

Performance Metric #1: Ability to hold fish successfully in the hatchery

Justification: Establishment of refugial populations of delta and longfin smelt depends upon the ability to house these fish in the hatchery successfully (i.e., maintaining a target effective population size).

Target: Limit mortality of delta and longfin smelt to 50% of those collected for broodstock, and to a level needed to maintain the effective population size of those produced in the hatchery.

Monitoring approach: Determine mortality rates of fish collected for broodstock for each collection and the effective population size of fish produced at the hatchery for each brood.

Adaptive management trigger and response: If mortality rates of hatchery fish and those collected for broodstock exceed the targets listed above, the USFWS or UCD would develop strategies to improve survival.

Effectiveness Monitoring

Effectiveness Monitoring Metrics #1: Maintenance of genetic integrity of hatchery fish

Justification: Genetic diversity in hatcheries is often lower than that in wild populations. Loss of genetic diversity may compromise the ability of fish produced in the hatchery to adapt to varying conditions in the wild and may also reduce the genetic diversity of the wild population if these hatchery produced fish are released into the wild.

Target: Maintain a minimum effective population size of delta and longfin smelt hatchery populations at 500 fish to minimize genetic divergence from wild population. If resources permit, a larger effective population size, N_e, is desirable, possibly as high as 1000 individuals (Franklin & Frankham 1998) to 5000 individuals (Lande 1995).

Monitoring approach: Using standard genetic laboratory techniques, compare the genetic integrity (e.g., heterozygosity, inbreeding coefficients) of subsequent generations of hatchery fish to that of fish collected initially for the broodstock and to the wild population. Also, if fish are released into the wild, measure the genetic integrity of wild delta and longfin smelt collected before and periodically after supplementation is initiated.

Adaptive management triggers and responses: If genetic integrity is not maintained over multiple generations, the genetic management plan would be revised as necessary.

Effectiveness Monitoring Metric #2: Fish production success for refugial population

Justification: In addition to obtaining wild spawners from the wild, the establishment of refugial populations of delta and longfin smelt will depend upon the ability to produce sufficient numbers of hatchery fish to maintain hatchery stocks.

Target: Production of >500 delta smelt to allow for 500 genetically distinct individuals used for mating (N_e=500) and greater than 500 longfin smelt to allow N_e=500 for production of multiple generations with N_e=500.

Monitoring approach: Evaluate frequency of successful pair crosses and number of fish produced relative to that needed to maintain refugial populations with appropriate genetic integrity and N_e.

Adaptive management trigger and response: If the numbers of fish produced in the hatchery are not sufficient to support production of multiple generations with N_e >500,hatchery practices or capacity would be modified to decrease mortality or increase N_e.

Effectiveness Monitoring Metric #3: Fish production success for supplementation
(Note: this metric would only be monitored if and when supplementation to the natural population was deemed necessary for the survival of the species by Fishery Agencies)

Justification: Supplementation of wild populations of delta and longfin smelt with sufficient genetic integrity will depend upon production of sufficient numbers of fish needed to maintain N_e in the refugial population while reintroducing a portion of these fish to the wild to help recover/increase the wild population size.

Target: Production of a sufficient number of delta smelt and longfin smelt with sufficient genetic integrity to help the population size of these species from the conservation hatchery to allow for supplementation of the wild population while maintaining N_e in the refuge population. This target would be adaptively managed based upon the census size of the wild population and number of breeders in the wild and in the hatchery.

Monitoring approach: Evaluate the number of fish with sufficient genetic integrity successfully produced by the hatchery relative to the appropriate number of reintroduced fish with sufficient genetic integrity (determined by ratio of reintroduced fish to wild fish). Identify and monitor factors limiting production.

Adaptive management triggers and responses: If the numbers of fish produced in the hatchery are not sufficient to help recover/increase the wild population size, hatchery practices or capacity would be modified to decrease mortality or increase production.

OSCM21: Screen, Remove, Relocate, Consolidate, Modify and/or Alter Timing of Non-Project Diversions to Reduce Entrainment of Covered Fish Species at within the Delta.

Preconstruction Surveys

[To come.]

Construction Monitoring

[To come.]

Performance Monitoring

Performance Monitoring Metric #1: Number of diversions or capacity of diversions screened, removed, relocated, consolidated, or modified, or with altered operations for fish protection.

Justification: Reducing entrainment mortality of covered fish species will depend on successful screening, removal, relocation, consolidation, modification, and altered timing of non-project diversions.

Target: Successfully modify __ diversions or __ cfs of diversion capacity per year.

Adaptive management trigger and response: The BDCP Implementing Entity will review these reports and work in consultation with the responsible entities to evaluate program success and determine if adjustments in funding levels are warranted.

If there are an insufficient number of diverters willing to participate in the program, the BDCP Implementing Entity will work with diverters to determine which changes should be implemented to enhance their willingness, while still providing significant benefit to covered species, thus increasing the likelihood that the alterations will be completed.

Monitoring approach: The responsible entities under the MOAs will prepare annual reports describing the work done with BDCP funds, relating those expenditures to the annual scope of work prepared under the MOA.

Effectiveness Monitoring

Effectiveness Monitoring Metric #1: Entrainment mortality of covered fish species.

Justification: Because reducing entrainment mortality of covered species is the goal of this conservation measure, determining entrainment mortality before and after screening, removal, relocation, consolidation, modification, or altered timing of selected diversions will indicate whether the measure has been successful.

Target: Reduce entrainment mortality of covered fish species in individual non-project diversions by __%.

Adaptive management triggers and responses: To assess the efficacy of screening changes, the BDCP Implementing Entity would review progress and

other relevant reports prepared by the Anadromous Fish Screen Program and the Fish Screen and Passage Program. The BDCP Implementing Entity would coordinate with the Bureau of Reclamation and DFG to adjust screening strategies and funding levels through the BDCP adaptive management process as appropriate is review of funded program reports indicates that target reductions in entrainment mortality are not being met. The BDCP Implementing Entity may adjust its strategies for selecting diversions to be relocated, consolidated, or modified or to have altered operations or adjust funding levels through the BDCP adaptive management process if monitoring results and other relevant information (e.g., monitoring and research conducted by others) indicate that entrainment mortality is not sufficiently reduced to the defined targets.

Monitoring approach: With respect to screening diversions, the Bureau of Reclamation and the DFG would be responsible for monitoring the effectiveness of their respective fish screening programs in reducing the entrainment of covered fish species at non-project diversions. This would involve monitoring of entrainment mortality before and after the proposed changes to non-project diversions are implemented. With respect to relocating, consolidating, modifying, or altering the timing of diversions, the BDCP Implementing Entity would monitor entrainment mortality before and after the proposed changes to non-project diversions are implemented. Under both monitoring programs, diverted water would pass through a sampling device (e.g., a net) immediately after taken from the channel to enumerate the number of fish entrained.