Metrics Group
Meeting Handout
October 6, 2009

Potential Effectiveness Monitoring Metrics and Approach for Selected Conservation Measures

Monitoring Metric	Description of Potential Monitoring Metrics and Approach
WOCM1: Preferentially operate a new water diversion facility in the north Delta and maintain sufficient bypass flows for covered fish species.	
To come.	
WOCM2: Modify and operate the Fremont Weir and the Yolo Bypass to provide for a higher frequency and duration of inundation of the Yolo Bypass.	
Metric #1: *Flow rate passing Fremont Weir (cfs) and duration (days)*	
Monitoring approach: A rating curve for water surface elevation and flow rates over the Fremont Weir would be developed and a remote sensor would be installed at the Fremont Weir that would continuously (e.g., hourly) monitor water surface elevations. Data from gage stations in upstream locations in the Sacramento River and its tributaries would be monitored to forecast flows expected at the Fremont Weir over the periods the weir is operated. Monitoring would be conducted over the term of the BDCP.	
Metric #2: *Inundation duration (days) and extent (acres)*	
Monitoring approach: A rating curve for determining the extent and duration of floodplain inundation based solely on flows entering the Yolo Bypass from the Sacramento River would be developed based flow rates and durations passing over the Fremont Weir and estimates of hydraulic residence time within the bypass.	
Metric #3: *Inundation frequency (years in which the Fremont Weir is operated)*	
Monitoring approach: Assessment based on recorded frequency and duration of bypass inundation events.	
Metric #4: *Residence of adult covered fish species within __ mile of the Fremont Weir of greater than __ hours*	
Monitoring approach: Initially, annual visual and/or remote surveys (e.g., hydroacoustics) would be conducted during periods the Fremont Weir is in operation to determine the numbers of adult covered fish species within the reach of the bypass extending ¼ mile downstream of the weir. This information would be evaluated to determine if adult fish are successfully able to pass the Fremont Weir without delays that could increase stranding and harvest risk. If survey data is not sufficient to evaluate the efficacy of fish passage, adult fish may be tagged (e.g., acoustic tag, radio tag, PIT tag, etc.) and monitored within the bypass to monitor the rate and success of upstream migration. Once the ability of adult fish to successfully pass the Fremont Weir is established, monitoring each year of Fremont Weir operation would be discontinued and a more limited monitoring effort to be determined by the Implementing Entity would be conducted every fifth year that the Fremont Weir is operated to confirm that passage success is being maintained.	

Monitoring Metric	Description of Potential Monitoring Metrics and Approach
Metric #5: *Incidences of covered fish species stranding*	
Monitoring approach: Initially, annual visual and other surveys (e.g., beach seining) would be conducted immediately following periods the Fremont Weir is in operation and flows are receding from the bypass floodplain to document stranding locations and magnitude. Once documented, monitoring each year of Fremont Weir operation would be discontinued and a more limited monitoring effort to be determined by the Implementing Entity would be conducted every fifth year that the Fremont Weir is operated to document any changes in stranding location and magnitude that may result from changes in floodplain topography (e.g., formation of scour holes or sedimentation that create isolated pools).	
Metrics #6-7: *Total organic carbon (mg/L), phytoplankton (mg/L chlorophyll a), and zooplankton (number/1,000 m^3)*	
Monitoring approach: Take daily grab samples and measurements for total organic carbon, chlorophyll a, and zooplankton at the Fremont Weir during periods the weir is operated and at the outflow to Cache Slough over the term of bypass inundation. Assess measurements of total organic carbon, chlorophyll a, and zooplankton and performance monitoring results to establish relationships between season, extent, and duration of floodplain inundation and production and export of total organic carbon, chlorophyll a, and zooplankton. Once these relationships have been established, monitoring each year of Fremont Weir operation would be discontinued and a more limited monitoring effort to be determined by the Implementing Entity would be conducted every fifth year that the Fremont Weir is operated to document any changes in production of these constituents over the term of the BDCP.	
Metric #8: *Production of Sacramento splittail (number of larval and early juvenile splittail/10,000 m^3)*	
Monitoring approach: Take daily grab sample (500 um mesh net) measurements of fish eggs and larvae (icthyoplankton) in the inflow to the weir and outflow to Cache Slough. Samples would be processed to identify and enumerate the density of each larval and juvenile Sacramento splittail and other fish species. Assess measurements of larval and juvenile splittail densities and results of performance monitoring to establish relationships between season, extent, and duration of floodplain inundation and splittail production. Once these relationships have been established, monitoring each year of Fremont Weir operation would be discontinued and a more limited monitoring effort to be determined by the Implementing Entity would be conducted every fifth year that the Fremont Weir is operated to document any changes in production over the term of the BDCP.	
Metric #9: *Percent survival of juvenile Chinook salmon and steelhead*	

Monitoring Metric	Description of Potential Monitoring Metrics and Approach
Monitoring approach: Conduct comparative mark-recapture experiments under a range of Fremont Weir operations (e.g., using CWT, acoustic, radio, PIT tags) using juvenile Chinook salmon and steelhead released into the bypass and in the mainstem Sacramento River downstream of the weir. Monitoring the number of marked fish released from each of the upstream locations as they pass near Rio Vista will provide the data necessary to assess the difference in survival rates between the migration routes. Once a relationship between weir operations and juvenile salmonid survival rates have been established, monitoring each year of Fremont Weir operation would be discontinued and a more limited monitoring effort to be determined by the Implementing Entity would be conducted every fifth year that the Fremont Weir is operated to document any changes in survival over the term of the BDCP.	
Metric #10: *Growth of juvenile Chinook salmon and steelhead (mm/day)*	
Monitoring approach: Conduct comparative mark-recapture experiments under a range of Fremont Weir operations (e.g., using CWT, acoustic, radio, PIT tags) using juvenile Chinook salmon and steelhead released into the bypass and in the mainstem Sacramento River downstream of the weir. Capturing and measuring the length of marked fish released from each of the upstream locations as they pass near Rio Vista will provide the data necessary to assess the difference in growth rates between the migration routes. Once a relationship between weir operations and juvenile salmonid growth rates have been established, monitoring each year of Fremont Weir operation would be discontinued and a more limited monitoring effort to be determined by the Implementing Entity would be conducted every fifth year that the Fremont Weir is operated to document any changes in growth rates over the term of the BDCP.	
Metric #11: *Passage of adult Chinook salmon, steelhead, splittail, sturgeon, and lamprey into the Yolo Bypass*	
[*To come.*]	
HRCM4. Restore at least 5,000 acres freshwater tidal marsh within the Yolo Bypass/Cache Slough Complex Restoration Opportunity Area. **HRCM5:** Restore at least 1,500 acres of freshwater tidal marsh within the Cosumnes/Mokelumne Restoration Opportunity Area. **HRCM6:** Restore at least 2,100 acres of tidal marsh within the West Delta Restoration Opportunity Area. **HRCM7:** Restore at least 5,000 acres of tidal marsh within the South Delta Restoration Opportunity Area. **HRCM8:** Restore at least 1,400 acres tidal marsh within the East Delta Restoration Opportunity Area. **HRCM9:** Restore at least 7,000 acres of brackish tidal marsh within the Suisun Marsh Restoration Opportunity Area.	
Metrics #1-2: *Vegetative structure (percent absolute cover) and composition (percent relative cover of native emergent vegetation)*	

Monitoring Metric	Description of Potential Monitoring Metrics and Approach
Monitoring approach: Percent absolute vegetative cover will be determined in years 1, 2, 5, 8, and 10 following restoration through use of aerial photography or other appropriate method that would yield comparable results. Percent relative cover of native emergent vegetation will be determined in years 1, 2, 5, 8, and 10 following restoration using a statistically valid survey sampling design and methods to be determined by the Implementing Entity.	
Metric #3: *Non-native predatory fish abundance (ratio of non-native predatory fish to native fish).*	
Monitoring approach: Conduct monthly fish sampling surveys within Delta channels adjacent to tidal marsh restoration sites for a least one year before restoration is implemented using survey methods consistent with the current Suisun Marsh fishery survey program and additional survey methods as needed (e.g., beach seine, otter trawl, tow net, ichthyoplankton net) to establish baseline conditions. Following restoration, initiate comparable surveys within marsh channels and in adjacent Delta waterways and continue surveys until a relationship is established between the abundance of non-native predatory fish and covered fish species and the extent and function of restored tidal marsh is established. Subsequently, surveys would be conducted at least every five years to document any changes that may occur in use of restored marshes and adjacent Delta waterways over the term of the BDCP.	
Metric #4: *Non-native submerged and floating aquatic vegetation.*	
Monitoring approach: For the first __ years following completion of tidal marsh restoration projects, annually conduct aerial and/or field surveys (e.g., sonar for egeria) in October to map the extent of non-native submerged and floating aquatic vegetation in shallow subtidal habitats adjacent to restored tidal marsh habitats. Subsequently, if supported by survey results and effects of any treatments implemented to reduce the extent of non-native submerged and floating aquatic vegetation, future surveys would be conducted at least every five years to document any changes in the extent of non-native submerged and floating aquatic vegetation adjacent to restored tidal marshes over the term of the BDCP.	
Metrics #5-7: *Total organic carbon (mg/L), phytoplankton (mg/L chlorophyll a), and zooplankton (number/1,000 m^3)*	
Monitoring approach: Take weekly grab samples and measurements for total organic carbon, chlorophyll a, and zooplankton in Delta waterways adjacent to tidal marsh restoration sites for a least one year before marsh is restored to establish baseline conditions in adjacent waterways. Following restoration, annually take weekly grab samples and measurements for total organic carbon within restored marshes and for chlorophyll a and zooplankton in Delta waterways adjacent to restored marshes. Assess measurements of total organic carbon, chlorophyll a, and zooplankton and performance monitoring results to establish relationships between restored tidal marsh extent and structure as restored marsh develops and production and export of total organic carbon, chlorophyll a, and zooplankton. Once these relationships have been established, annual monitoring of would be discontinued and a more limited monitoring effort to be determined by the Implementing Entity would be conducted every fifth year that the Fremont Weir is operated to document any changes in production of these constituents over the term of the BDCP.	
Metric #8: *Abundance of covered fish species (number of covered fish species/10,000 m^3)*	

Monitoring Metric	Description of Potential Monitoring Metrics and Approach
Monitoring approach: Conduct monthly fish sampling surveys within Delta channels adjacent to tidal marsh restoration sites for a least one year before restoration is implemented using survey methods consistent with the current Suisun Marsh fishery survey program and additional survey methods as needed (e.g., beach seine, otter trawl, tow net, ichthyoplankton net) to establish baseline conditions. Following restoration, initiate comparable surveys within marsh channels and in adjacent Delta waterways and continue surveys until a relationship is established between the abundance of each covered fish species and the extent and function of restored tidal marsh is established. Subsequently, surveys would be conducted at least every five years to document any changes that may occur in use of restored marshes and adjacent Delta waterways over the term of the BDCP. Monitoring results would be used to assess the effectiveness of restoring tidal marsh in achieving covered fish species biological goals and objectives relative to other conservation measures.	
Metric #9: *Presence and abundance of tidal marsh-associated covered wildlife species using restored tidal marsh (metrics vary by species)*	
Monitoring approach: *[To come.]*	
Metric #10: *Establishment of tidal marsh-associated covered plant species using restored tidal marsh (new occurrences in restored tidal marsh and channels)*	
Monitoring approach: *[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.	

Monitoring Metric	Description of Potential Monitoring Metrics and Approach
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.	
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.	
OSCM14: Increase the harvest of non-native predatory fish to decrease their abundance.	
To come.	
OSCM13: Remove Non-Native Submerged and Floating Aquatic Vegetation from Delta Waterways.	
Metric #1: *Acreage of SAV Treated*	
Monitoring Requirements: The BDCP Implementing Entity will verify that additional area of SAV is treated in the program as a result of BDCP funding to ensure that BDCP funding is being used properly for SAV removal. DBW will report acreages and locations of SAV treatment in annual reports that will be reviewed by the BDCP Implementing Entity for verification of meeting targets.	
Metric #2: *Acreage of FAV Treated*	

Monitoring Metric	Description of Potential Monitoring Metrics and Approach
Monitoring Requirements: The BDCP Implementing Entity will verify that additional area of SAV is treated in the program as a result of BDCP funding to ensure that BDCP funding is being used properly for FAV removal. DBW will report acreages and locations of FAV treatment in annual reports that will be reviewed by the BDCP Implementing Entity for verification of meeting targets.	
Metric #3: *Change in Biovolume of Egeria densa Relative to Control Areas*	
Monitoring Requirements: The BDCP Implementing Entity will compare changes in Egeria biovolume in treatment locations to nearby control sites with similar physical conditions to assess the effectiveness of treatments. 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 as a result of 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, a comparison of Egeria biovolume in treatment locations to nearby control sites with similar levels of these variables is the most effective way to control for this variation. 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). If sufficient evidence indicates that treatment/removal is effective by meeting both 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.	
Metric #4: *Change in Areal Coverage of Water Hyacinth Relative to Control Areas*	
Monitoring Requirements: The BDCP Implementing Entity will compare changes in areal cover of water hyacinth in treatment locations to nearby control sites with similar physical conditions to assess the effectiveness of treatments. 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). If sufficient evidence indicates that treatment/removal is effective by meeting both 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.	
Metric #5: *Local Turbidity Levels*	

Monitoring Metric	Description of Potential Monitoring Metrics and Approach
Monitoring Requirements: The BDCP Implementing Entity will monitor turbidity levels to test the hypothesis that the removal of Egeria will increase turbidity. Monitoring will be conducted in the water column within and nearby treatment/removal locations using a turbidity meter 1 week prior to and 90 days after removal of Egeria (before-after/control-impact [BACI] approach). If sufficient evidence indicates that Egeria removal effectively increases localized turbidity levels in removal locations by meeting the 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.	
Metric #6: *Local Abundance of Non-Native Predatory Fish*	
Monitoring Requirements: The BDCP Implementing Entity will monitor local abundances of large mouth bass to test the hypothesis that the removal of Egeria will reduce the local abundance of non-native predatory fish. Abundances will be measured using electrofishing, pop nets, or other unbiased sampling technique for collecting fish in vegetation (in combination with Effectiveness Monitoring Metric #7) 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 Egeria removal effectively reduces the local abundance of large mouth bass by meeting the targets for __ consecutive years, monitoring effects of removal on the abundance of large mouth bass can cease. This period accounts for interannual variation and meeting this requirement would be difficult to achieve if the technique were not effective.	
Metric #7: *Local Abundance of Juvenile Splittail and Salmonids*	
Monitoring Requirements: The BDCP Implementing Entity will monitor local abundances of juvenile splittail, Chinook salmon, and steelhead to test the hypothesis that the removal of Egeria and water hyacinth will increase the local abundance of these species. Abundances will be measured using electrofishing, pop nets, or other unbiased sampling technique for collecting fish in vegetation (in combination with Effectiveness Monitoring Metric #6 for Egeria removal locations) 1 week prior to and 90 days after removal of Egeria/water hyacinth in areas both within and nearby removal locations (BACI approach). If sufficient evidence indicates that Egeria/water hyacinth removal effectively increases the local abundances of juvenile splittail, Chinook salmon, and steelhead by meeting the targets for __ consecutive years, monitoring effects of removal on the abundance these species can cease. This period accounts for interannual variation and meeting this requirement would be difficult to achieve if the technique were not effective.	
OSCM20: Establish New and Expand Existing Conservation Propagation Programs for Delta and Longfin Smelt.	
Metric #1: *Ability to hold fish successfully in the hatchery*	

Monitoring Metric	Description of Potential Monitoring Metrics and Approach
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.	
Metrics #2: *Maintenance of genetic integrity of hatchery fish*	
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.	
Metric #3: *Fish production success for refugial population*	
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.	
Metric #4: *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)	
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.	