Foodweb/Water Quality —Results and Recommendations
03/11/2010

These tables present results of the BDCP "Mini-Effects" Analysis as reported by the SAIC Consultant Team. The purpose of the Mini-Effects Analysis was to help inform decisions of the BDCP participants related to the development of water operations criteria that will be proposed as part of the BDCP Conservation Strategy. Specifically, the analysis was focused on assessing the potential effects of draft water operations conservation measures and covered activities on seven covered fish species and their habitats, and on providing a basis for refinements to those draft measures. Based on the red flags and other issues identified in this analysis, SAIC presented recommended changes to the BDCP Conservation Strategy at the January 29, 2010 Steering Committee meeting.

The information generated through this analysis is intended to help guide the BDCP development process. It does not reflect a decision of any of the BDCP participants. The results are limited in scope and utility, and in no way constitutes the BDCP Effects Analysis that will be conducted for compliance with ESA, NCCPA, NEPA, and CEQA. The draft results of this analysis are the products of SAIC and are meant to reflect the outcome of collaboration with technical experts from DWR, USBR, DFG, USFWS, NMFS, NGOs, and PREs. The information and recommendations summarized in this document, however, should not be attributed to any of the participating state and federal agencies, the state and federal water contractors, or any other member of the BDCP Steering Committee or its Technical Teams.

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Food quantity and quality	Water ops	The subgroup agreed to utilize E. Van Nieuwenhuyse's model for the mini-effects analysis, with the proviso that its results be compared to the results of a more detailed numerical model during the full effects analysis. The model assumed a constant 'apparent generation time' for the algal community as a whole and used that value (10 d) to calculate the effect of increased water residence time on algal standing stock. The residence time metric (RT) came from DSM2 output provided by CH2M-Hill. For the first round of modeling, the model used the 75% retention time for particles injected at Hood to estimate RT for the north Delta and for particles injected at Vernalis for the south Delta. Subsequent runs used 50% retention time for RT. To prevent the model from generating impossibly high standing stocks (measured as chlorophyll concentration, Chl), the imposed an upper limit on Chl by assuming that the ratio of Chl to total phosphorus concentration (Chl:TP) could not go above 1.00. This value was selected because algal biomass on average has a carbon to phosphorus ratio of 41:1 by mass and a reasonable estimate of the ratio	Included in early long-term discussion	Erwin's model shows that under the early long-term, the proposed ops would generally lead to higher phytoplankton standing stock (estimated as seasonal mean chlorophyll concentration), especially during summer and fall in the north Delta and during all seasons in the south Delta. Export of algal carbon from the north to Suisun Bay would increase during summer and fall and during all months from the south Delta. These general conclusions are based on overall average values. There is a great deal of inter-annual variation, however (as shown by the time series plots handed out to the group). Bottom line is that the proposed ops (Scenario 4) will over time result in an increase in Delta Chl and an increase in the amount of Chl exported to Suisun Bay from the north and south Delta. Because most of the outflow to Suisun Bay will still come from the north Delta, north Delta Chl export will still greatly exceed Chl export from the south Delta. Summary of results comparing RPA to Proposed Ops (Means for 1975-2003): RT=50%, Hood injection:

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		of C:Chl is 41. For purposes of comparing alternatives, the assumed an initial Chl:TP of 0.07 because this is the mean value for the freshwater Delta stations monitored by the IEP. The model predicted TP using a simple mass balance calculation that blends P inflow from the Sac at Greens Landing and the SanJ at Vernalis. The model was used to compare seasonal average values of (i) in-Delta Chl and (ii) algal particulate carbon export to Suisun Bay. The seasons were winter (Dec-Feb), spring (Mar-May), summer (June-August) and fall (Sept-November). Export of algal carbon to Suisun from the north Delta was calculated by multiplying Net Delta Outflow by the predicted Delta Chl. Export from the south Delta used QWEST instead of NDO. Cryptophytes and flagellates are smaller phytoplankton and are not optimal for the foodweb. Ideally, the goal is to find a balance of physical and chemical conditions that drive the system towards a diverse algal community dominated by diatom production, without creating blooms of diatoms that can lead to unsustainable biological oxygen demands. In low flow conditions, stagnant water does not allow mixing of diatoms and drives the phytoplankton community towards predominance by less desirable algae. Too lengthy of a residence time is not conducive to diatom production. The average residence time of this system is 28 days; considered to be a rapidly flushed system. Average depth in the Delta is 5.5 m. The shallow depth results in the flushing and suspension of a lot of benthic nutrients. As a result, there are locations in the Delta that are conducive to diatoms blooms. Reducing environments facilitate negative feedback loop. Phytoplankton can double every day. The model suggests that conditions will be		Season Change in Chl Change in Export Spring +1.2-fold No change Summer +2.0-fold +1.9-fold Fall +2.8-fold +1.5-fold Winter +1.2-fold +1.2-fold RT=50%, Vernalis injection: Season Change in Chl Change in Export Spring +2.8-fold +2.2-fold Summer +2.1-fold +4.5-fold Fall +2.1-fold +3.7-fold Winter +4.5-fold +6.5-fold During summer and fall, increased residence time will result in increased Chl; however this Chl may or may not be desirable. The increased Chl may stagnate and lead to episodic and/or sustained hypoxia. Accumulation of Chl biomasses that decay, results in areas of low DO. During summer low flows, the expected type of Chl would include blue-greens, flagellates and other non-diatom Chl that supports the microbial food web (i.e. bacteria rather than a food chain that leads to fish). The form of nutrients may affect the taxonomic composition of phytoplankton communities. This presents a Catch 22: Can diatoms be brought from SJR into the Delta and still reduce residence time? Ammonia causes problems. Ammonia levels in Sac River facilitate a "low" food web. Changes could result in the food web becoming diatom pre-dominated. Too much ammonia could also lead to hypoxia. Nitrate comes from several sources and tertiary treatments could remove a proportional amount from the WWTP. Removal of nitrogen associated with ammonia reduction would have a higher probability of supporting a foodweb that supports native fish. It's possible to use a "strategic

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		problematic for creating "desirable" algae. A step change in plankton community occurred in 1980's. N/P ratio changed in mid-1990's. DSM2 shows residence time can be very high (>100 days) in certain water year types in certain locations. Pat Glibert's analysis (to be used in the full analysis, but limited use for mini-effects analysis): Shows flow, temperature, and nutrients all affect the composition of the algal community. It further suggests that regulation via bottom-up (nutrient) control is an important factor in the Delta system. Potential issues with Pat's analysis: 1. Correlations among variables complicate these results. For example, one could argue that the decline of diatoms in high ammonia conditions could be related to low flow conditions because these variables are correlated. 2. Phytoplankton that are sampled from Delta may have originated from upstream and may not represent physical conditions that are in the Delta. 3. Biovolume or density as a unit? 4. This approach could be used if we know the dominant algae by season. This information helps to measure the quantity of carbon transferred up the food chain.		knob" at the WWTP to allow the appropriate amount of N2 into the system, given the conditions at that place and time to facilitate the most desirable phytoplankton communities and densities. However, there would still be concerns with respect to the ratio of nitrates to ammonia. Removal of nutrients (such as nitrogen) from the system may lead to unintended and unanticipated results which have not yet been analyzed by this subgroup. The subgroup agrees that it is a positive thing to remove ammonia from the system (i.e. foodwebs that support native fish would benefit from removal of ammonia). HOWEVER: the fraction that should be converted to nitrate or de-nitrified is uncertain. Currently, investigating a full nutrient budget is problematic, as it is unknown if there are good estimates of all the contributions of nutrient loads. It would be helpful to produce a loading map, or a spatially explicit estimate, of the contributions from all the various land-uses. Without knowing the full nutrient budget, it's problematic to quantify details about the potential system-driving influence of nitrogen originating from the WWTP. Removing the nitrogen could support cyanobacteria that are nitrogen fixers. Identifying "knobs" that increase our ability to control the types and concentrations of nutrients within the system is worth pursuing in the full analysis. F. Brewster knows of an RMA model that is calibrated to nutrients. Removing the appropriate amount of ammonia might support a community composition that includes green algae. At high ammonia levels *Microcystis* tends to outcompete other species. There is a viewpoint that the Chl community is depauperate. This problem is not related to water operations. Peggy has data from the SJR that shows that even in

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				higher ammonia conditions (18 micromoles/L) a diverse phytoplankton community can grow. Preliminary recommendation: Residence time is a concern. It might be worthwhile to investigate altering exports from So Delta during the summer, including an increase in preferred pumping from south Delta (to exceed 3,000 cfs). When pumping from south Delta, drawing Sac River water across the Delta, to the south, may improve residence time. However, there is some concern that this would not provide a sufficient opportunity for diatoms to be introduced into the Delta Preliminary Alternative Recommendation - Peggy: It's possible that it would be more desirable to increase the SJ River flow (this would increase the desirable type of phytoplankton). The SJR has a lot of water turnover (highly vertically mixed and is shallow; creating a good diatom environment). It was suggested to investigate the split at Turner Cut. Currently the Stockton DWSC is a barrier which eliminates SJ water from the Delta. Deep channels have low light penetration and poor diatom production. Peggy suggests a strategic focus on diatom production in Feb to March. The mixing and use of SJ water are key factors in diatom production. Patterns of residence time shown in Erwin's model are Sac River residence times. This group also needs to look at regional (intra-Delta) residence times. The group considered a sensitivity analysis of the plan to pump 3000 cfs from south delta during summer. If preferential pumping were removed, how much would residence time increase? Agreement: Full-effects analysis should include a study the effects of no

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				pumping from south during the summer. Are the existing SJR flows enough? If the barrier at the head of Old River were removed then ½ of the diatoms from SJR could be moved into the Delta. This alternative routing could be studied further. Both the type of Chl and the quantity of Chl are important. Even if all the Chl shown in Handout #3 &4 were the desirable type, the sheer amount of excess Chl may still create problems related to hypoxia. Particle tracking model June to October, show that, in general, along the SJR values vary from minimal in October to high in June and July (double residence time). The 20 scenarios on the SJR range from a decrease of 7 days to an increase of 38 days (in Sept 1982 wet water year type). The CH2M Hill PTM model shows an increase in residence time of 16 days under reference case compared to 54 days under proposed ops. There was a recommendation to utilize Francis's analysis which clumped stations to create regional picture. However, there is also a need to consider seasons. See excel file called "Flow Summary_FB.xls". R. Wilder highlighted summer months. The lowest residence time is "2" on the west delta. There is a consistent increase among the 4 model runs and residence time increases 14 times in July. The potential of residence time was investigated within the 20 time periods of the CH2MHill model (i.e. bookends of residence time): • In summer, residence time increases 30 days in OMR corridor, • In fall, residence time increases 9 days on

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				OMR • In winter (Dec to Feb), OMR has 8 day increase. If Erwin updates his model to show San Joaquin input (particle tracking insertion point) on a seasonal basis, then we may see significant differences. It was unknown if there are enough data to quantify how much Chl the clams consume. If the Chl is supporting clams, then it is not supporting fish. Clams and other grazers may preferentially consume desirable Chl that reaches the benthic area. Water may be loaded with pico-cyanobacteria which is not consumed by clams. When cyanobacteria is detected by clams, they may slow down metabolism (i.e. consume less) or spit out the non-desirables. Clams will have a compounding effect because they will 1) remove Chl overall and 2) preferentially leave the cyanobacteria and less desirable Chl in the water column (thereby increasing the relative concentration of less desirable Chl). Actions that could improve this situation include: 1) take measures to reduce *Microcystis*; 2) bring in SJR diatoms; and 3) promote vertical mixing. Three things that promote diatoms (over other algae): • Form of nitrogen coming in. • Residence time and flow (reduced residence time and mixing of water promotes diatoms). Goldilocks principle: flows too high flush out diatoms, flows to low creates stagnation. • Temperature (colder water promotes diatoms) Lisa Lucas is developing a clam model. The distribution of clams in the Delta is spotty. Overall, an increase in Chl will result in an increase in food

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				production for clams. Seasonal factors are important. An increase in residence time during the summer on the Sac River may not be as much of a concern as a summer residence time increase on the SJR. Agreement: Chl production is a red flag especially in the south Delta during summer and fall. No consensus on a recommendation. In general, promote diatom production (over other algae). It was suggested that it would be helpful to create a table organized by region and by season to list all the factors that lead to a food chain supporting native fish. The above conclusions may be prematurely strong. The difference between residence time and flows is a consideration. Residence times predicted by PTM have a location component and areas will still have tidal influence and flow rates. A combination of residence time and flow may be better parameters to model Chl affects. A broader viewpoint would include analysis of specific regions and seasons. A more detailed viewpoint would consider channel geometry and finite models. Erwin's model presents a coarse, volume-weighted picture of Chl in the water column, but what about the Chl associated with macrophytes such as water hyancith/SAV? How would benthic Chl move up to the water column? Benthic production was likely much less in the past. A thought analysis of collective estimates of past levels of Chl on a mass balance basis compared to today's question might be helpful. It's possible there could be the same amount of Chl, just partitioned into a different form (e.g. the benthos is a reservoir of Chl and nutrients). The Delta continues to produce Chl, but some of that form has switched to rooted plants

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				from diatoms and water column Chl. What processes in the system drove the changes so that nutrients are now consumed in the benthos needs to be determined with some degree of precision. Invasive plants would only invade if conditions were present that allowed it to do well. There is only a very limited (<10 years) annual record of nonindigenous FAV/SAV occurrence in the system. SAV is consuming nutrients, but how this affects fish is unknown. Caveats about Erwin's model is that the 3 to 5 times increase in Chl may not be what manifests in the future due to the complexity of a multi-variate ecosystem. After, Erwin re-runs model, it will clarify the situation in south Delta. This analysis needs to proceed with caution, as 75% residence time is not a median case. The disparity between RPA and proposed ops in summer and fall in overall mass of Chl remains a concern, because of potential DO issues. If flows are provided to the system, and if system is not stratified, then residence time along the Sacramento River may not be a problem. Calculating the residence time at one station compared to calculating it at an overall river scale or the overall Delta system may be misleading. Taking the average of the whole system is also misleading. Agreement: More Chl in the system would be desirable, within a defined range (e.g. up to 10 µg/L). Adaptive management would be needed to keep the system within a range, including consideration of residence time. Action Item: SAIC will ask Erin Hester at UC Davis about any data about past conditions and past quantity and distribution of SAV. Increasing residence time along the Sacramento River

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				might enhance the growth of green algae and this would be beneficial. The effect of residence time on food availability in Suisun Bay is unknown. The residence time needs to be defined for these waters. Conclusion: Residence time may have benefits or negatives depending on the location (Sac River and SJR) and season.
	WOCM2 Fremont Weir/ Yolo Bypass		Peggy's paper projects diatom production in the Yolo Bypass, with some flux outside of the Bypass. Diatom production would be beneficial locally and may result in zooplankton production. There may be some flux of zooplankton and carbon out of Liberty Island. Food may be exported downstream to Liberty Island, though not much further. Midges and other aquatic/flying insects would occur. Flooding in late winter and early spring (Feb March) will result in higher net primary productivity, partially due to lower temps. Overall, this CM will contribute food production of a desirable type (diatoms) locally and in the Liberty/Cache area. The desired food chain is diatoms→copepods→ native fish.	Same as near term.
	Tidal marsh restoration		Restored tidal marsh has the potential to produce food in the form of Chl (diatoms, greens, and chrysophytes in all seasons) that could be utilized by local marsh species. Peggy sampled at Liberty Island in the main pond. She also evaluated the flux from pond-to-pond over one day. Chl appeared to be produced at an interior pond (Beaver pond?). Liberty DO at 8-11 ppm. Peggy's Table 2, Chl concentrations were stored on the island to provide a local source of food. Food is moved out on the tide and then returns back with the tide. As a result, fish and other organisms can access the food, during some tides. Chl concentration of 15 mg/l daily average were found between July 2004-06 – continuous data. Some production from Liberty Island likely	Same as NT, but more restoration

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			heads northwest towards the North Bay Aqueduct due to net flows in this direction. Was there a difference in flux, when there was a net flow leaving Liberty (i.e. when bypass was open)? It is a tidal area, so there is up to 100,000 cfs in tidal energy. During this ten-day study sheet flow occurred, therefore tidal flow and Bypass flow may have been in sync. General Conclusion: Some marshes have the potential for high benefits, with most of the food produced being available locally. The export of food occurs through tidal dispersion (not advective). Restored marshes will contribute significant net 1° productivity during early spring (Feb-Mar). However, the design is critical to incorporate geomorphic variability with pools isolated during low tidal stages, for "cooking" algae. Pools would then be connected during higher tidal stages. Restoration in Suisun Marsh will produce food (phytoplankton and zooplankton) locally. However, clams would likely consume much of the primary production (including nauplii copepods) before it could be consumed by other locally occurring species. If the copepods can survive past the nauplii stage, then they would be too large to be eaten by clams, and could be exported. Fish would also be exported. Conclusion: overall, restoration in Suisun Marsh would provide benefits to the aquatic food web, both locally and, when exported, on a regional level. Sherman Island contains high levels of SAV. For a few years, *Microcystis* occurred in Yolo Bypass. It is possible that less desirable plant species (i.e., non-food species) detract from the potential benefits of this CM.	
	Floodplain restoration	Floodplains along the SJR would be flooded via overbank flow. Flooding frequency would be low	N/A	Benefits are projected to be minimal. This also assumes that floodplain restoration would be designed

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		(flow issues). Time between flood events would allow for the accumulation of carbon. Frequency of flooding is driven by SJR flows. Historic conditions likely had flooding once every 10 years.		to minimize fish stranding.
	Channel margin restorations	Levee setbacks allow gentle slope for tules. Input of substrate material would allow emergents to propagate (i.e. not rip rap but an earthen material to allow recruitment or planting). Twenty potentially restorable miles of channel margin in San Joaquin River, Steamboat slough, and non-project levees occur.	Heterogeneous habitat (overbank flow) would likely produce benefits for the aquatic food web including the production of insects. It would also provide refuge from predators. Tules, invertebrates, and other carbon sources would be exported from the channel margin into the aquatic channel. Careful design (including low gradient slopes) of the restoration is critical to maximizing area available for desirable vegetation and for achieving proposed functions.	Same as near term.
	Riparian restoration	Slightly higher elevations areas, above tidal influence, could produce woody riparian plants (cottonwoods, oaks).	1300 acres Leaves drop into water and decompose to contribute carbon and to provide a substrate for bacteria/fungi. Terrestrial insects drop into the water and are directly consumed by fish. Branches that fall in the water provide a recruitment structure. Tree canopy provides shading to cool temperatures.	2300 acres Same as near term
	OSCM1	Ammonia. See previous discussion.	See previous discussion. Positive benefits.	
	OSCM3 (Quality only)	Cache Slough Food quality. Methyl mercury is a concern for longer lived species like sturgeon, birds, and humans. Production per day from Chris Foe could be used to compare to baseline conditions. BDCP would provide funding to projects.	The CM is expected to reduce mercury sources into the foodweb and this would improve the quality of the food sources (from a bioaccumulation viewpoint and also from sublethal sensory affects). Mercury in the diet is likely sub-optimal. See also previous discussion on methyl mercury.	Similar to near term, but to a greater extent. This CM would likely be implemented more in the long-term.
	OSCM4	Reduce pesticides and herbicides into the Delta. Application of herb/pesticides on terrestrial areas likely has unintended effects on the aquatic food web. Increasing irrigation efficiency will reduce runoff.	Benefit of this CM is to reduce loads of herb/pesticide into the aquatic Delta system. Lethal and sub-lethal effects of herbicide/pesticide exposure on chlorophyll and invertebrates would be reduced.	Similar to near term, but to a greater extent. This CM would likely be implemented more in the long-term.

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			If bioaccumulation is an issue, reduction of herb/pesticide sources into the foodweb would improve the quality of the food sources.	
	OSCM5	Reduction of loads – urban stormwater runoff. This would occur over all seasons. Flows from summer irrigation of lawns and car washing would be investigated, with a goal of reducing loads. Weston, unpublished study, sampled the drains themselves.	Benefit of this CM is to reduce loads of herb/pesticide into the aquatic Delta system. Lethal and sub-lethal effects of herb/pesticide exposure on chlorophyll and invertebrates would be reduced. If bioaccumulation is an issue, reduction of herb/pesticide sources into the foodweb would improve the quality of the food sources. Scholz, et al (in press) found that there appears to be a link between urban runoff proximal to traffic corridors, which contains contaminants that either singularly or synergistically lead to, or a precursor of, pre-spawn mortality in Coho salmon in the Pacific Northwest.	Similar to near term, but to a greater extent. This CM would likely be implemented more in the long-term.
	OSCM7 (quality only)	Copy from above. Urban runoff	Same as above but greater benefit. More pesticides and contaminants in the water (e.g. brake-shoe pads).	Same as above but greater benefit. More pesticides and gunk in the water (e.g. brake-shoe pads).
	OSCM8(quantity only)	Deep water ship channel. DO issue would be solved via this CM and via City's recent upgrade of its WWTP.	The desirable diatoms that come out of San Joaquin River travel to channel and settle out of the water column to the river bottom. Depth of channel (36 feet deep?) and low flow do not provide the conditions necessary to allow diatoms to continue downstream. Although CM will not improve diatom situation, the overall benefits for the foodweb is positive. Zooplankton, fish, mammals would be able to migrate and actively participate in predator/prey relationships that benefit the foodweb.	
	OSCM10	Zebra and Quagga mussels – postponement of risk. Recreational boats would be screened.	Invasion by these species is potentially devastating to the foodweb. However, the CM likely postpones the risk. Highly uncertain about the likelihood future introductions and the effect that those invasions would have on the system. If this CM is successful at preventing future invasions then it would be a benefit (avoids a harm – avoids degradation of status quo).	The likelihood of the success of this action decreases with time. Otherwise similar to the near term.

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	OSCM11 (for zebra/quagga only)	Improve rapid detection and response. Assumes it is best to stop introduction immediately upon occurrence. "Rapid" needs to be defined. Monitoring frequency should be specified in the CM.	Success of this CM is dependent on the invader. Larger species might more vulnerable to rapid response. Zebra and Quagga mussels have a potential to create large impacts to the foodweb. Benefits would be variable, ranging from post-invasion elimination of the invasive species to reduction of the spatial extent of invasion.	
	OSCM13	Removal of non-native submerged and floating aquatic vegetation would occur via mechanical and herbicide. SAV/FAV support a foodweb of non-native arthropods which are consumed by non-native fish. L. Grimaldo's isotope analysis shows distinct foodwebs. Dept of Boating and Waterways has limits on the acreages that can be treated. Check the regs on this.	Managing SAV/FAV in and near restoration sites would be desirable and would reduce intra-species competition for this location (i.e. shift the habitat). Given the current spatial extent of SAV/FAV, reducing it would offer plus and minuses to the aquatic food web – this is neutral to negative. Application of herbicide/pesticide during management would create negative outcomes per DRERIP analysis.	Similar to near term.
	OSCM21 (quantity only)	This CM proposes to screen, decommission, or aggregate agricultural diversion facilities. It also includes altering the depth and other site specific modifications. Example, moving the facility at the North Bay Aqueduct pump station (intake) to a location in the Sac River, with lower productivity might increase flushing. See Jon Burau's presentation during the restoration workshop.	Diversions often export food. Screens will preclude export of fish, but not necessarily food resources. Closing down or moving the ag water facility may offer some benefits for fish. Moving facility to an area with lower primary production could be helpful; although focus may be moving to areas to benefit fish. Recommendation: CM text should be modified to move the diversion facilities from areas of high primary and secondary productivity to areas with low primary and secondary productivity. As an example, the north bay aqueduct (see methods to left).	
Dissolved oxygen	Water ops	Note: Full analysis should consider how residence time might change with SLR. Michael McWilliams is working on 3-D modeling to determine the effects of sea level rise in the Delta for the long-term analysis. Total inflow minus SJR on an exceedance curve could be informative. Monitors in the Delta could be used to indicate when residence time is high.	Differences in residence time between baseline and NT are negligible (1-2%) (see physical model output that shows July 1990 with 5%-10% on the SJR). RPA has higher residence time, compared to NT in Mar 2001 modeling. Not many changes overall between RPA and NT. Therefore, no difference in DO is expected.	Flows above 1,000 cfs in SJR generally don't create concern, unless water is lost from Old R. (in which case 2,000 cfs is needed to dilute it). Less pumping from the SD may increase incidents of low DO. Residence time has an effect on DO (as a result of algal growth and BOD) and is a balancing act. Increased residence time at the lower end of the scale is thought to be good for algal growth. However, if

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				residence time increases past a certain point, BOD will increase high enough to reduce DO to levels at which a waterway may become "impaired." Unfortunately, the range of residence time that can be considered appropriate for the Delta is not known, and also likely varies spatially and temporally with other physical factors (e.g., temperature, nutrients, light levels). Changes to residence time may also result in less desirable types of algae (cryptophytes, flagellates, and cyanobacteria may be promoted depending on the residence time). If south Delta exports are reduced, Erwin's early results indicate that Chlorophyll will increase. We need to ask RWQCB for a definition of an impaired waterway in terms of frequency, duration, and time of day (regarding DO criteria). If the goal is to increase productivity, periodic circumstances of DO below 5 mg/l during night should be acceptable by the Water Board. PTM modeling output was summarized by F. Brewster and shows the average residence time (number of days) in proposed ops (ELT) minus the baseline by region. Central and south Delta (including SJ, OMR, ND, WD) will see longer residence time under the proposed ops, esp. in wetter years (due to preferential pumping from north Delta). Drier years see a reduction in residence time relative to baseline. Also, in drier years, constraints on operating rules will result in preferential pumping from the south Delta. In south Delta, low pumping results in higher residence time. July 1990 shows lot of water in Sac River, less in SJR. Residence time in central and south Delta will increase

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				when there is high inflow on the Sac River and north Delta pumps are preferentially operated (i.e. the Jul1977 model output). The frequency that this type of situation occurs is not known. Recommendation: in situations with high Sacramento River flows and low San Joaquin River flows, which results in higher pumping in the North and minimal pumping in the south (as well as already low flows in the south), some amount of pumping should occur in the south Delta to reduce residence time. However, climate change could significantly alter conditions such that this recommendation will no longer be valid.
	OSCM 7 Stockton DWSC DO issues	Assumption that this measure would increase DO levels to a point at which they are no longer inhibiting migration of fish. Therefore, Stockton DWSC DO issues are no longer a problem.	In general, the group agreed that we could assume that OSCM 7 would increase DO levels in the Ship Channel to a point at which they are no longer inhibiting migration of fish. Therefore, Stockton DWSC DO issues should no longer be a problem. In addition, there is some limited evidence that the recent upgrade to treatment by the Stockton Wastewater Treatment Plant could also be beneficial.	Same as near-term
Turbidity - Suspended sediment	Water ops	Dave Schoellhamer conversation and PWA. Full analysis should consider climate change.	Proposed near-term water operations will not significantly alter suspended sediment concentrations in the Delta because they are not expected to change the proportion of water exported from the north vs. south Delta or alter residence time within the Delta.	Figure 4 from the DRERIP sediment model shows that some suspended sediment travels out via exports at a rate of 10% of the SJR flows. Figure 4 shows total loads, so no correction for concentration is needed. Loads from the Sacramento River are approximately 5 times higher than those of the San Joaquin River, and even higher when the Yolo Bypass inputs are included. However, flows are also >~5 times higher on average in the Sacramento vs. the San Joaquin River. Therefore, because concentration = load/flow, the concentration does not change much between the ELT and baseline. In addition, much of the water exported under the baseline comes from the Sacramento River already, reducing the difference in concentrations in the Delta between ELT and baseline. Dual conveyance will export both water and suspended sediment. During winter storms with high

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				turbidity, water and associated sediment will be diverted via north Delta diversion. This will reduce input loads of sediment to the Delta from the Sacramento River. Is the Delta accumulating sediment? Yes, dredging occurs which removes bedload sediment. Two third of the suspended sediment drops out, according DRERIP sediment model Figure 4. But, a report by Dave Schoellhamer, available via USGS website, indicates a decline in new sediment being transported into the Delta (historical gold mine inputs are declining). The report indicates that, in 1999, we changed from a Delta that was accumulating sediment to a Delta that was eroding sediment. Contra Costa Water Agency report indicates that sediment has increased in the Delta. Sediment load to the Delta will be reduced during moderate-sized storm events because north Delta exports will be high during these storms, and sediment concentrations will be high. At the highest flow events, the proportion of water in the Sac River that is taken in the north Delta is lower. North Delta exports will divert loads, but the concentration may not change. Although a decrease in the tidal range at Rio Vista is shown in modeling it may be due to reduction in Sac River flow, where tidal node moves upstream. DSM2 flow results on a monthly time period indicate that seasonal flows will be reduced by 10-20% during wetter years in the Sac River and some sloughs, as a result of ND diversions. In drier conditions, model results show similar results. Flows downstream of the diversions will be lower in the Sacramento River, which will promote sediment

Parameter	Conservation measures affecting parameter	Methods for analysis	Conclusions and Recommendations	
			Near-term	Early Long-term
				precipitating out of the water column. In the south Delta, sediments loads may increase due to reduced export of sediment, although this increase is expected to be 10% (if no pumping at all in south Delta) or less (DRERIP sediment mode Fig. 4). In summary, there will be an increase in deposition of sediment (at least temporarily) as a result of proposed ops in the south Delta. Sediment load will be reduced in the Sac River, depending on timing of diversion (i.e. winter has higher sediment loads).
	Tidal Marsh Restoration HRCMs	Figure 4 in DRERIP sediment model and R. Wilder conversation with PWA. Full analysis should consider that restored tidal marsh, once established, may adjust to sea level rise (via elevation and deposition) if designed and managed properly. Tidal exchange must continue to occur. Restoration must include a landscape with appropriate elevations, fringe areas, and upward migration areas. Tidal marsh plants may accumulate sediment. Mud flats are also sediment dependent habitat.	In general, restored tidal habitats may act as either a source or a sink depending on inputs from upstream and other physical factors. For site-specific predictions, see Anadromous Fish notes.	Restored tidal marsh and floodplains tend to be sediment sinks. Wind tends to stir up sediment (e.g. Liberty Island restoration contributes to turbidity). Geometry, orientation to wind, and ratio of depth (shallow) to length are also factors in generation of suspended sediment. Tidal marsh restoration areas may be neutral in terms of bulk sediment movement over the long-term (i.e. 10 to 20 years) as tidal marshes shift towards equilibrium. Breach size and orientation recommendations: • If wind wave re-suspension of sediments is a desired outcome, then incorporate longer wind fetch by designing marshes parallel to the wind, within reason (consideration must be given to downwind levees and habitat). • Avoid control structures and use natural features where possible (i.e. avoid weirs and breakwalls and use serial degradation of levees where possible); • Minimize boat wakes near restoration areas to avoid erosion and to retain vegetation. • Recognize that function of tidal habitats takes many (15 to 20) years to develop.
	WOCM2 Yolo	Discussions with PWA and Dave Shoellhamer on	PWA indicates very little understanding of floodplain	Same as near-term

Parameter	Conservation measures affecting parameter	Methods for analysis	Conclusions and Recommendations	
			Near-term	**Early Long-term**
	Bypass/Fremont Weir	sediment.	restoration on turbidity. See other results from Anadromous Fish Subgroup. Yolo Bypass will be an active agricultural area during non-flood seasons and this could increase the amount of suspended sediment lifted up. The velocity of flows will also influence rate of suspension and deposition. Agricultural tilling (rice straw decomposition) may also be a management strategy to increase organic and inorganic material in suspension and act as a lattice to trap sediments for deposition. The processes of resuspension and accretion may equalize. The DRERIP sediment model indicates that the Yolo Bypass is the second largest source of sediment loads into the Delta). Also Lehman et al (2008) indicate higher concentrations of sediment in Yolo Bypass water compared to the mainstem Sacramento River. Therefore, this measure will increase suspended sediment loads into the Delta. BREACH 3 study will inform this issue, but is years away.	
	Floodplain Restoration HRCMs	Along SJR between Mossdale to Vernalis has wide area inside of levees, but low flows. Levee setbacks. Floods every 10-20 years.	Not applicable because restoration would not start until Year 15.	Site specific details are important. Vegetated areas may be a sediment sink. Bare soil is a sediment source. SJR does not carry a lot of sediment and low flood frequency. Effect on suspended sediment would be negligible.
Turbidity	Water ops	<u>Near-term</u> Two-gates modeling results were deemed inadequate for this analysis because they are too preliminary, do not have the same assumptions as model runs for the mini-analysis, and are too variable (i.e., ranging from benefit to detriment) with high uncertainty. Therefore, compare residence time differences and relate to chl a production <u>Long-term</u>	No change in residence time in near-term ops or Chl a production is anticipated. Turbidity will not change as a result of proposed BDCP actions.	Seasonal turbidity may change as a result of: changes in residence time; changes in the amount of water pumped via ND during high turbidity time periods (i.e., winter storms); and differences in loads entering the Delta. Modeling of residence time suggests that the organic component of turbidity will increase as Chl a increases in the spring and summer.

Parameter	Conservation measures affecting parameter	Methods for analysis	Conclusions and Recommendations	
			Near-term	Early Long-term
		Organic component: Analyze changes in Chl a during each season Inorganic component: See "Turbidity: suspended sediment" above		Some changes in turbidity via diversion into the new ND diversion facility Water ops could be a contributing driver of seasonal turbidity levels during transient storm events (see "Turbidity: Suspended sediment" above). However, the difference between Sacramento River vs. SJR sediment contributions is so large that seasonal differences that arise due to changes in operation will be overwhelmed. DRERIP model, page 29, states that the SJR can not have a significant effect on suspended sediment concentration in the Western Delta These conclusions are important because, besides effects to fish (to be addressed by fish subgroups): 1) some contaminants (trace metals etc) adsorb to sediment; and 2) if the Delta food web is light-limited then we would expect lower productivity of the food web, due to the increases in turbidity. With respect to the difference between RPA and BDCP proposed ops in terms of the Fall X2 component, X2 location swamps out the other turbidity effects because the flows are so low.
	Generalized effects of water ops to toxics	Source fingerprinting will address relative contribution of concentrations of toxics and dilution from water coming from those sources from different sources -Mass balance approach by taking existing concentrations of each toxic in different basins Sources of data: --MeHg-Regional Board data --Pesticides-Regional (Irrigated Lands) and State (SWAMP) Board --Ammonia-Existing (Fullerton) --Unknown-Sac Regional, others? --Endocrine disruptors (not quantitative but source is	See below.	See below.

Parameter	Conservation measures affecting parameter	Methods for analysis	Conclusions and Recommendations	
			Near-term	Early Long-term
		WWTP in the Delta with Sac Regional WWTP being one of the largest). --Copper-SWAMP, Sac Regional Monitoring Program, DWR --Selenium-USGS --Urban runoff-Kathy Kuivila (USGS), Don Weston F. Brewster provided water quality data from BDAT. Get data from Pat -Look for changes Erwin will calculate mass balances. Assumptions include that the project influences blending of water and contaminant loads. Mixing and dilution occurs in the Delta. The equation would be a proportion (of SacR to SJR) multiplied by loads at point upstream of the Delta such as Sac River at Emmaton or the SJR at Collinsville/Mossdale. For mercury, the monitoring station should be further downstream to pick up the Cache Slough confluence, perhaps at the station located at: "Cache Slough near Ryer Island Ferry". Don Weston sampled urban drains, wastewater effluent etc to calculate pesticide loads. Weston's units are in pounds per day and poundage per ag drain. Combine Weston's estimates with a land-use/area to develop a relative contribution from the Sac River to the SJR. It is possible that some constituents have effects below the detection limit. Dave and Pat will provide data and will e-mail a data summary. For the Sac River, use data from past five years. For SJR, use data from 2006 and later.		
Toxics-MeHg	Water ops	See "Generalized effects of water ops to toxics above." Mercury Sac River at Freeport: n=192 182 kg/yr or mean conc. 8.29 ng/L	Water operations will not significantly change the contributions of the two rivers.	Although loads are different, the concentration within the two rivers is similar. The proposed ops will not have a significant effect. The proportion of Sac River water reaching Cache Slough will be lower. Since flows will be lower downstream of the north Delta

Parameter	Conservation measures affecting parameter	Methods for analysis	Conclusions and Recommendations	
			Near-term	Early Long-term
		SJR at Vernalis: n=79 28.3 kg/yr or mean conc. 7.75 ng/L Yolo Bypass at Prospect Sl n=66 167.8 kg/yr or mean conc. 24.1 ng/L. methyl mercury (load from Table 11 and 17 and concentration from Table 2 of: Task 2. Methyl mercury Concentrations and Loads in the Central Valley and Freshwater Delta http://mercury.mlml.calstate.edu/wp-content/uploads/2008/10/04_task2mmhg_final.pdf Load: Sac R at Freeport 8.06 g/day (calculated from data on page 90, table 11) Vernalis 4.0 g/day (calculated from data on page 96, table 17) Concentration Sac R 0.11 ng/L SJR 0.18 ng/L Prospect Sl 0.26 ng/l Also, this report calculates methyl mercury production (g/day) in Yolo Bypass as 0.0042*flow^0.782 (r^2=0.90) (figure 32 on page 73) Based upon the numbers presented above, the proposed operations would not affect methyl mercury. To compare total Hg removed via settling pond to hg produced in floodplains - Rick will provide flow numbers to F. Brewster. F. Brewster will calculate methyl mercury production (g/day) in Yolo Bypass. Methylmercury has been demonstrated to affect birds and humans. The effect of methylmercury on fish is not known, although limited data suggests sublethal effects for some species.		diversions (due to exports) there is a reduction in dilution flows for Yolo Bypass mercury concentrations at Rio Vista and downstream. The proposed settling basin in Cache Creek contributes to mitigating the effects of reduced Sac River flow on mercury. On the whole, the proposed conservation strategy will increase MeHg via tidal wetlands, reduce Hg via Cache Settling Basin and reduce MeHg via seasonal wetland management, although combined effects on MeHgwere not calculated due to lack of time during the mini-effects analysis.
	HRCMs		There are design elements in the Conservation Strategy chapter (Chapter 3) that indicate that BMPs will be used to minimize mercury methylation. One idea is that high marshes that are dry more frequently may promote methylation of Hg. However, there is very	

Parameter	Conservation measures affecting parameter	Methods for analysis	Conclusions and Recommendations	
			Near-term	Early Long-term
			low certainty about this hypothesis. On the whole, the proposed conservation strategy will increase MeHg via tidal wetlands, reduce Hg via Cache Settling Basin and reduce MeHg via seasonal wetland management. The net affect may be an overall increase in MeHg in the near-term.	
	WOCM2 Fremont Weir/Yolo Bypass		Modeling shows that modifications of Fremont Weir will increase frequency of flooding in Yolo Bypass from 8 times to 19 times during a 23 year period (84-07). Although this doesn't include flooding originating from the west end. When Yolo is flooded, it is the largest source of Hg into the system (source?)	Same as near-term
	OSCM3		OSCM3 to maintain the efficiency of the Cache Creek The settling Basin offers benefits to habitat areas in Yolo. Flows into Cache Creek are flashy and when this watershed receives rain, the Creek's flows can be quite high. -See also draft TMDL for Hg. Mercury TMDL data for the Cache Creek Settling Basin indicates that the basin traps 50% of sediment and 64% of Hg load. Proposed Basin Plan Amendments (similar to OSCM3) would increase efficiency of Hg trapping up to 75%. OSCM3 will also improve the Basin such that its duration and efficiency over the long-term is improved. Cache Creek accounts for 60% of Hg entering the Yolo Basin.	Same as near-term
	OSCM8		OSCM8, managed seasonal wetlands, will improve the wetting and drying cycles by keeping the sediments wetter throughout the year and reducing exposure of bacteria to aerobic conditions. This will reduce opportunities for methylation of Hg.	Same as near-term
Toxics-	Water ops	See "Generalized effects of water ops to toxics	Operation will not have significant changes to relative	Sources of pesticides are similar in the SJR Basin and

<table>
<tr><th rowspan="2">Parameter</th><th rowspan="2">Conservation measures affecting parameter</th><th rowspan="2">Methods for analysis</th><th colspan="2">Conclusions and Recommendations</th></tr>
<tr><th>Near-term</th><th>Early Long-term</th></tr>
<tr><td>Pesticides</td><td></td><td>above”. BPJ.</td><td>contribution of water from the 2 rivers.</td><td>Sac River Basins.</td></tr>
<tr><td></td><td>OSCM4 Reduce pesticide loads from ag lands</td><td>OSCM4 – BPJ (similar to OSCM13 below)

Note: For purposes of mini-effect analysis, Subgroup assumed that OSCM4 could also be implemented in areas upstream of Delta.

For full analysis: Dan Oros, Inge Werner white paper, shows how much pesticides go into waterways.</td><td>OSCM4 would begin implementation in the near-term. This will be difficult to quantify. These actions would likely result in some amount of environmental benefit. These actions and associated benefits are independent of water operations.

Subgroup members also discussed:
• Breakdown of herb/pesticides into harmful compounds.
• Settling of herb/pesticides in substrate.
• Winter-time stone fruit spray.
• Extrapolation of wild salmon exposure to spray (see NOAA Washington study).

On the whole, OSCM4 would likely reduce input of herb/pesticides. To the extent that residence time increases and exposure time increases. Use of herbicide to control SAV/FAV is a localized effect but is independent of water operations. On balance, OSCM 4 reduces terrestrial herb/pesticides that are not approved for aquatic use (i.e. may be more harmful in an aquatic environment)</td><td>OSCM4 would likely result in some reduction in pesticide inputs. More efficient irrigation techniques would reduce leachate. These actions would likely result in some amount of environmental benefit. These actions and associated benefits are independent of water operations. Most ag return flows and pesticide spraying seem to occur upstream of the point of diversion and therefore concentration does not change as a function of water diversion.</td></tr>
<tr><td></td><td>OSCM13 SAV/FAV removal</td><td>OSCM13 SAV/FAV removal – use of pesticides likely results in negative environmental effects. However, we can’t analyze it past that.

Other sources of information include:
• DRERIP evaluation of SAV.
• OCAP BO NMFS, section on effects analysis, describes pesticide use for SAV/FAV removal.
• Dept of Boating and Waterways Aquatic Weed Control Program.</td><td>The surfactant (allows the pesticide to “stick”) applied to emergent plants (i.e. hyancinth) generally causes more environmental harm than the herbicide itself.

On balance, the combination of OSCM4 and OSCM13 would like result in a net benefit.</td><td>Potential recommendations were considered but rejected by the group including:
• Limit application to periods in mid to late summer. However, during spring, the plant may be more vulnerable.
• Disperse treatment over a geographic area. But this may not be effective from a treatment perspective.</td></tr>
<tr><td></td><td>HRCMs</td><td>how much pesticide goes into the waterways.

-HRCM acreages that are farmland. Restoration will convert agricultural land to habitat and thereby reduce</td><td>5828 acres of irrigated ag plus pasture converted to tidal-habitat in near term (plus 18 acres in Suisun Marsh). (2948 acres of this is irrigated ag). This will result in less pesticide application and water demand.</td><td>10,623 acres of irrigated agricultural plus pasture will be converted to tidal-habitat. (4498 acres of this is irrigated agricultural land). This will result in less pesticide application and water demand. There may</td></tr>
</table>

Parameter	Conservation measures affecting parameter	Methods for analysis	Conclusions and Recommendations	
			Near-term	Early Long-term
		herb/pesticide loads, assuming no harmful chemical mosquito control is required. See map showing agricultural types and see spreadsheet "NearTerm_DWR_Ag_types_Summary12162009.xls" shows 5828 acres of ag land removed in near term (plus 18 acres in Suisun Marsh).	There may be an initial spike in pesticides due to flooding of existing agricultural lands. (Conclusion – less pesticides = good)	be an initial spike in pesticides due to flooding of existing agricultural lands. (Conclusion – less pesticides = good)
	OSCM6 Urban Runoff reduction		On the whole, the conservation measure would likely reduce input of pesticides in urban runoff to the Delta, particularly during high flow events when urban drainage is expected to be greatest. There are expected to be net decreases in urban runoff contamination. On balance, OSCM 5 is expected to result in a net reduction of urban run-off.	See near-term
Toxics-Ammonia	Water ops	See "Generalized effects of water ops to toxics above". C3 is Sac at Hood/Greens Landing C10 is SJR Data from Pat: Ammonia C3: 320.5 (+/-158.2; n=69), 287 (+/- 116.7; n=11) C10: 59.7 (+/1 58.2; n=71), 67.9 (+/- 62.5; n=11) Nitrate mean in 2000 to 2005 inclusive: C3=157 ug/l, C10=1,680 Phosporous TP C3=93 PO4 C3 mean =54 TP C10 = 230 Po4 C10 mean = 117	To the extent that outflows do not change significantly, the effect of WWTP ammonia contributions would not shift. Fall X2 changes as a result of BDCP water ops could make effect of WWTP ammonia contributions worse. High ammonia tends to promote cyanobacteria growth and can inhibit the uptake of nitrate by diatoms, in Suisun Bay. High ammonia may have toxic effects on Delta native fish and prey items, depending on pH levels, temperature, water hardness. Central Sanitation District WWTP contributes 25 mg/l of ammonia. City of Stockton upgraded their WWTP in 2006 and this reduced ammonia contributions. Cities of Fairfield and Martinez also have WWTP (perhaps tertiary or secondary treatment) but Frances indicates contributions are very low - not significant. Ammonia load is 6x higher in the Sac River compared to the SJR. The ratio of ammonia to nitrate is also	High ammonia tends to promote cyanobacteria growth and can inhibit the uptake of nitrate by diatoms, in Suisun Bay. High ammonia may have toxic effects on Delta native fish and prey items, depending on ph levels, temperature, water hardness. By reducing ammonia, these negative factors would be reduced. A cost effective treatment is to oxidize ammonia to drive it to nitrate, but too much nitrate leads to other issues (i.e see methods). Tertiary treatment is one way to de-nitrify the system. Overall mass balance of ammonia: the proposed north delta intakes would be located downstream of Sac WWTP. Ammonia is mixed in River, assuming the Sac Regional Model is accurate. Proposed water ops will remove water with fairly high ammonia concentrations. So, ammonia loading to the Delta will be reduced. Full-effects analysis could use a mixing model to quantify loads etc of ammonia diverted.

Parameter	Conservation measures affecting parameter	Methods for analysis	Conclusions and Recommendations	
			Near-term	Early Long-term
			higher in the Sac River. Phosphorus is higher in the SJR, perhaps due to different soil types or fertilizer application or other.	
	OSCM1	BPJ -OSCM1 is currently written as a future study, so not able to evaluate. Therefore, the Subgroup assumed the actions resulting from the study would result in specific reductions in ammonia (from SRCSD). Non-river disposal of effluent (i.e. spray irrigation seasonally or year-round) could occur, but this allows nitrate to get into ground water. It is also limited by the capacity of land to absorb the effluent. A general rule of thumb is that micromole of nitrogen makes a microgram of chlorophyll. Currently the algae community is dominated by cryptophytes, blue-greens, and others. -Full analysis: Look into use of RMA ammonia model.	Modified OSCM1 (i.e. with assumptions) will provide a positive benefit to the Delta Two issues: 1) reduce ammonia and 2) reduce nitrogen If ammonia is oxidized, diatoms would be preferred because they can deal with nitrate. While blue-greens can take up nitrate, they do better with ammonia (i.e. under conditions with ammonia blue-greens will out-compete other species). -Most evidence is that foodweb would be affected, but less is known about these toxic effects. See also Stockton bio-towers where they change ammonia to nitrate? A reduction in ammonia and ammonium could be recommended. Excess nitrogen would need to be removed via outgassing or other methods. Keeping the ratio of ammonia to nitrate to phosphorous in the right balance that favors diatoms. Reducing nitrate will reduce risk of eutrophication downstream. There is a trade-off between increasing primary productivity and decreasing eutrophication. N/P ratio (total nitrogen to total phosphate or other?). TN to TP is not filtered and includes biomass. Currently there is no good measure of organic nutrients in the system. Molar DIN to DIP ratio ranges from 5-30 and is not skewed. Mass N/P is 5.2. Dissolved N/P is 3.7. Could the system absorb more inorganic nitrate? Diatoms, blue algae, and blue-green can do well with even higher N/P ratio. If all the ammonia were converted to nitrate, it would not change the N/P ratio. There is currently a lot of nitrogen in the system. Lowering the N/P ratio even more would drive the food	Same as near-term

Parameter	Conservation measures affecting parameter	Methods for analysis	Conclusions and Recommendations	
			Near-term	Early Long-term
			web away from diatoms. In 1994 there was a step decline in phosphorous in the central Delta and an associated shift in algae composition. Under existing conditions, the inputs of nitrogen from WWTP and other sources would likely increase due to human population growth and is not sustainable. There is a projected 40% increase by year 2020. One hypothesis is that oxidizing the nitrogen (creating nitrate) would promote diatom growth, but adding too much nitrate would result in eutrophication and lead to hypoxia. For example, diatom blooms could get out of phase with zooplankton, in which case diatom decomposition would create BOD.	
Toxics in wastewater-Unknown		-Cannot analyze effects but could be important to toxicity of wastewater.	Direction of the effect of applying advanced treatment to SRCSD is a benefit (reduction in toxic loads), but the magnitude is not currently predictable.	Same as near-term
Toxics-Endocrine disruptors	Water ops	See "Generalized effects of water ops to toxics above" Pesticides, dairies, rangeland (pastures), and urban areas. Pharmaceuticals drained into WWTP contribute to the problem.	Reducing pesticides and removing ammonia also have secondary effect of reducing endocrine disruptors. No change in the near-term (similar to other contaminants – water ops will not change relative contribution from Sac River and SJR)	Effect of water ops is unknown because there are ubiquitous sources of endocrine disruptors, and they are not quantified.
	OSCM2	BPJ Currently written as a study, so not able to evaluate -So, we assumed we WOULD do something (reduce endocrine disruptors from SRCSD) -Also look at DRERIP results	Direction of the effect of applying advanced treatment to SRCSD is a benefit (reduction in EDC loads), but the magnitude is not currently predictable. Agricultural pesticides and urban runoff are also concerns because some pesticides are also endocrine disruptors.	Same as near-term
Toxics-Copper	Water ops	See "Generalized effects of water ops to toxics above" SJR: Units Avg Of Result Min Of Result Max Of Result Count Dissolved µg/L 1.64676259 1 4.6 240	N/A -Operations will not change significantly.	Water ops would not change copper concentrations in the Delta because the concentrations on the Sac River and SJR are fairly similar.

Parameter	Conservation measures affecting parameter	Methods for analysis	Conclusions and Recommendations	
			Near-term	Early Long-term
		Total Unfiltered µg/L 3.55794702 1 45 317 SR: Dissolved Copper Units Avg Of Result Min Of Result Max Of Result Count RM44 ug/L 1.427264151 0.29 2.94 53 Sacramento R R1 ug/L 1.453970588 0.27 5.1 68 Combined ug/L 1.442272727 0.27 5.1 121 Total Copper Sacramento R R1 ug/L 3.570526316 1 20.4 91		
	OSCM1/2, OSCM4 pesticide reduction; OSCM5 Urban run-off load reduction	BPJ Water quality data from BDAT provided by F. Brewster. Urban runoff is the largest source of copper because it often comes from car brakes (Sandahl et al. 2007). Some pesticides contain as copper sulfate. NMFS in WA found that a low concentration of copper could disrupt the sensory system of salmonids (Hecht et al. 2007). This disruption negatively affects their ability to seek prey and avoid predators. Swee Teh found that *Pseudodiaptomus*, a prey item for Delta and longfin smelt, is sensitive to copper. Hillyer researched copper effects on crayfish and found that anticipated levels of copper in agricultural would not be high enough to cause a hypoxic event from lethal exposures.	On the whole, the conservation measures would likely reduce the input of copper. Net decreases in copper, on balance with OSCM 4 and 5, would likely result in a net benefit. These conservation measures are independent of water operations.	On the whole, the conservation measures would likely reduce input of copper. Net decreases in copper on balance OSCM 4, and 5 would likely result in a net benefit. Water operations can influence the loads of copper, primarily through increased residence time and exposure to copper in the south Delta. OSCM 5 - Urban runoff management would reduce copper input during high flow events (when draining urban areas) (Laetz et al. 2007) and the concentration of this source might not be influenced by water operations.
Toxics-Selenium	Water ops	Selenium was not analyzed because neither fish subgroup needed this information to complete the mini-effects analysis. See “Generalized effects of water ops to toxics above”	N/A	N/A
		Selenium was not analyzed because neither fish	N/A	N/A

Parameter	Conservation measures affecting parameter	Methods for analysis	Conclusions and Recommendations Near-term	Early Long-term
		subgroup needed this information to complete the mini-effects analysis. Look for form of selenium coming in from SJR – is it more toxic than other forms? Selenium DRERIP model-Neil Suggest that Anadromous Subgroup review report by Mike Sisky. More information about copper toxicity effects and urban control measures can be found at: SF Bay Regional Monitoring Program. OSCM1/2 may not be applicable here because WWTP may not always remove copper. However, it can be removed via precipitation.		
Toxics-Urban Run-off	Water ops	BPJ See "Generalized effects of water ops to toxics above" For the full ELT analysis, compare urban area extent in San Joaquin vs. Sacramento basins to determine how much will be exported with water. Also, look at urban area extent upstream vs. downstream of new diversions in ND and existing diversions in SD to determine how changed flows will affect dilution.	There would be little effect of near-term facilities on this toxic.	Long-term water operations can influence the concentrations of contaminants by reducing Delta inflow on the Sac River but could also take more contaminants out from the Sac River upstream of the new diversions, primarily through increased residence time and exposure to contaminants in the south Delta.
	OSCM5 Urban runoff reduction	BPJ	On the whole, the conservation measures would likely reduce input of contaminants in urban runoff to the Delta, particularly during high flow events when urban drainage is expected to be greatest. There are expected to be net decreases in urban runoff contamination. On balance, OSCM 5 is expected to result in a net reduction of urban run-off.	Same as near-term