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NEXT STEPS RE: SWRCB COMPREHENSIVE REVIEW (PHASE 2) OF THE 2006 BAY-DELTA WATER QUALITY CONTROL PLAN

Table 1: Overview and rebuttal of some major rationales offered by parties during the Phase 2 workshops arguing that the primacy of freshwater flow as a driver of ecosystem processes and species viability in the San Francisco Bay-Delta estuary is uncertain.

RECURRING ASSERTIONS WITHOUT SCIENTIFIC SUPPORT	DOCUMENT, PAGE NO.	SCIENTIFICALLY SUPPORTED ARGUMENT	SAMPLE OF SUPPORTING EVIDENCE (Literature cited below)	COMMENTS ON LITERATURE
Flow-abundance correlations are based on misuse of datasets; ergo, the basis for flow manipulations is weak.	SJTA Submittal, 2012a, p. 2 SVWU Latour Report, 2012, p. 11-14 SJTA Submittal, 2012b, p. 62 (p. 2 of technical memorandum from Fishbio, D. Demko and others Jan. 30, 2012) SWC Submittal, 2012, p. 7-8 • LFS moving, FMWT SWC Submittal, 2012, p. 13 -18 • Flow-abundance SWC Submittal 2012, p. 58-60 • Am Shad not related to flow	***Flow-abundance correlations are statistically significant and biologically important.***	1. Nislow and Armstrong 2011 2. Zeug 2010 3. Mount et al. 2012 4. Moyle et al. 2012 5. Miller et al. 2010 6. Mac Nally et al. 2010 7. CDFG 2010a 8. Stevens and Miller 1983 9. Jassby et al. 1995 10. Kimmerer 2002a 11. Kimmerer 2002b 12. Rosenfield and Baxter 2007 13. Sommer et al. 2007 14. Kimmerer et al. 2009 15. Rosenfield 2010 16. Thomson et al. 2010	1. Some flow regimes critical to multiple life history stages for juvenile salmon 2. Flow regime one of three significant predictors or extirpation for Spring run Chinook salmon 3. Synthesizes major stressors in the Delta affecting ecosystem, 3 of 5 are flow related. 4. Describes how major stressors have degraded the estuary and harmed native species. The major stressors include flow alteration. 5. Importance of seasonal flows in maintaining life history diversity 6. Analysis of POD decline finds flow the major stressor 9.10. 11-14. Species abundance-Delta outflow correlations 11. Multiple potential mechanisms that could explain strong correlations between freshwater flow and species response 15. Delta outflow drives most of the potential stressors affecting LFS populations
The relationship between spring flow and survival is weak.	SJTA Submittal 2012a., p. 1, 2 SJTA Submittal 2012b., p. 2-5 SVWU Latour report, 2012, p. 3-4	***The relationship between spring flow and survival is strong.***	1. Jassby et al. 1995 2. Sommer et al. 2002 3. Sommer et al. 2001 4. Kimmerer 2002a 5. Miller et al 2010 6. CDFG 2010 7. Thomson et al. 2010 8. TBI et al. 2010; Exh. 2	1. Abundance of organisms increases with flows 2. Splittail benefit from magnitude, timing, & duration of spring flows & floodplain inundation 3. Salmon growth and survival related to flow in the Yolo bypass 4. Winter-spring outflows associated with increased survival of striped bass 5. Salmon juvenile life history diversity supported by freshwater flow 6. San Joaquin salmon survival strongly correlated

				with freshwater flow rates at Vernalis 8. Demonstrates that flow-abundance relationships reflect strong relationship between Delta outflow and inter-generation population growth among longfin smelt and *Crangon* shrimp

RECURRING ASSERTIONS WITHOUT SCIENTIFIC SUPPORT	DOCUMENT, PAGE NO.	SCIENTIFICALLY SUPPORTED ARGUMENT	SAMPLE OF SUPPORTING EVIDENCE (Literature cited below)	COMMENTS ON LITERATURE
Abundance estimates are based on faulty datasets; ergo, there are more organisms, or they are distributed more widely, etc.	SWC Submittal 2012, p. 7-9, 15-16 • FMWT biased, on sampling population SWC Submittal 2012, p. 58 • Striped bass and FMWT	***Abundance estimates and flow correlations are based on multiple ecological sampling programs with consistent trends of multi-species decline.***	1. Rosenfield and Baxter 2007 2. Rose 2000 3. IEP Report 1999 4. Baxter et al. 2010 5. Matern et al. 2002 6. Feyrer et al. 2007	The SF Bay-Delta Estuary is among the most studied estuaries in the world. 1. Assesses longfin smelt abundance and distribution using three long-term sampling programs that sample different areas of the estuary (two of which sample year-round). Finds similar relationships between longfin abundance and winter freshwater outflow from the Delta in each data set. 2. Discusses importance of long term data sets. 3-6. Each demonstrate declining trends in various fish populations in the estuary using data from different long term sampling programs
Restoring physical habitat diversity not only improves food production but also is a better basis for restoring resilience, providing refugia, etc., than improving flows	SJTA Submittal, 2012a, p. 11-12 SJTA Submittal, 2012b , P. 30-33 SWC Submittal 2012, p. 29-30 • DS SWC Submittal 2012, p. 45 • Green Sturgeon SVWU Vogel 2012, p. 2-3 • Habitat in Delta needs to be fixed	***There is no scientific basis for implementing actions to restore physical habitat as a substitute for improving flow conditions***	1. State Board Flow Criteria Report 2010 2. CDFG 2010 3. SFEP 2011 4. BDCP Effects Analysis 2012 5. Winder et al. 2011 6. BDCP Red Flag Reviews 2012 7. NRC 2010	Relationships between physical habitat and food availability for some species, especially pelagics, poorly understand. Also, functionality of restored habitat dependent to great extent on improved flow conditions, e.g., . floodplains cannot be restored without providing flows to inundate floodplain habitat at sufficient duration and frequency in the necessary seasons.

RECURRING ASSERTIONS WITHOUT SCIENTIFIC SUPPORT	DOCUMENT, PAGE NO.	SCIENTIFICALLY SUPPORTED ARGUMENT	SAMPLE OF SUPPORTING EVIDENCE (Literature cited below)	COMMENTS ON LITERATURE
Other factors (i.e. Ocean conditions, ***or*** *Thermal experience,* ***or*** *Predation,* ***or*** *Habitat alteration,* ***or*** *Invasives,* ***or*** *Floodplains,* ***or*** *Upper watershed,* ***or*** *Contaminants,* ***or*** *Dissolved Oxygen,* ***or*** *Food availability) influence abundance more than flow*	**Predation** SJTA Submittal, 2012b, p. 37-44 • Salmon SWC submittal 2012, p. 23-24 • Delta smelt SVWU Vogel 2012, p. 17-18 **Invasives** SJTA Submittal, 2012b, p. 33 • E. densa SWC Submittal 2012, p. 1, 5, 9-14, 22-23, 55-56 • Decline in northern anchovy, longfin and delta smelt linked to food decline and Amur clam	***Flow is a "master" variable driving numerous other potential stressors; there is no evidence that other stressors are more important than freshwater flow, and many are exacerbated by flow alteration.***	1. Baxter et al. 2010 2. NRC 2010 3. Mac Nally et al. 2010 4. Thomson et al. 2010 5. Lindley et al. 2011 6. Winder et al. 2011	1. Identifies flow as the most important stressor to the ecosystem due to strong effects on fish populations and factors controlling those populations. 2. NRC committee concluded that there was (1) strong support for increasing SJR flows to support SJR salmon survival through the Delta and (2) that the conceptual support for tidal wetland restoration to benefit Delta smelt is "weak." 3. Analyzed numerous factors potentially related to post-2000 decline in multiple pelagic fishes and found that X2 had a profound effect on declining fish species and on their prey. 4. Covariates strongly associated with pelagic fish abundance were X2, water clarity, and export flows, 5. Implicates ocean conditions as proximate cause of recent fall Chinook collapse, but clearly states: "*...anthropogenic effects are likely to have played a significant role in making this stock susceptible to collapse during periods of unfavorable ocean conditions*". See also Figure 18. 6. Reductions in Delta freshwater flow implicated as driver of non-native species invasions.

RECURRING ASSERTIONS WITHOUT SCIENTIFIC SUPPORT	DOCUMENT PAGE NO.	SCIENTIFICALLY SUPPORTED ARGUMENT	SAMPLE OF SUPPORTING EVIDENCE (Literature cited below)	COMMENTS ON LITERATURE
There is no evidence for population level effects of entrainment; ergo, basis for OMR criteria or other measures pertaining to reverse flows is weak. *Tidal flows overwhelm system, so delta outflow is not important*	SWC Submittal 2012, p. 12-13 • LFS - Entrainment not a problem, by-catch from shrimp fishery is bigger problem SWC Submittal 2012, p. 25-27 • Delta Smelt	***There is convincing evidence that entrainment has population level effects and that Old and Middle River criteria or other measures to limit entrainment and reverse flows is justified and appropriate.*** ***Estuaries are by definition tidally influenced, BUT, net (average) flows are, by definition, not negative for long periods***	1. Castillo et al. *in press* 2. FWS 2012b 3. NMFS 2011a and b 4. TBI 2012 5. FWS 2011 6. Kimmerer 2011 7. Kimmerer 2008 8. Mac Nally et al. 2010 9. Rosenfield 2010 10. Thomson et al. 2010 11. Cloern and Jassby 2012 12. Jassby et al. 2002 13. National Research Council 2010	1. Documents much higher levels of pre-salvage mortality at South Delta exports than had been assumed previously. 6. Re-analyzes Kimmerer 2008 (7) & confirms finding that entrainment mortality can and probably has had population-level impacts in the recent past. Also finds that meaningful population-level impacts can occur that cannot be detected by standard statistical analyses. 8. Increases in water exports in both winter and spring associated with decreased abundance of delta smelt. Increases in spring exports negatively associated with abundance of threadfin shad. Delta smelt mortality at pumping facilities may be important to population dynamics under some circumstances, particularly during dry years 12. Significant fraction of estuarine primary productivity exported and/or negatively impacted by changed hydrodynamics 13. "*The committee concludes that the strategy of limiting net tidal flows toward the pump facilities is sound, but the support for the specific flows targets is less certain.*" [p. 58]

RECURRING ASSERTIONS WITHOUT SCIENTIFIC SUPPORT	DOCUMENT, PAGE NO.	SCIENTIFICALLY SUPPORTED ARGUMENT	SAMPLE OF SUPPORTING EVIDENCE (Literature cited below)	COMMENTS ON LITERATURE
"Regime shift": changes have occurred in the system to such an extent there is now a new "regime"; implying previous flow correlations are no longer valid.	SJTA Submittal 2012a., p. 5 and SJTA Submittal 2012b., p. 16 • Flows don't explain survival since 2003 SWC Submittal 2012, p. 46 • Green Sturgeon	***The concept of an irreversible shift in an ecosystem stable state ("regime shift", as it is used here) is neither consistent with scientific understanding of ecosystem dynamics nor an appropriate basis for determining that a healthy native ecosystem cannot be restored.***	1. E.g. Clements 1936 v. Gleason 1926 2. Meffe and Carroll 1994, p. 216-217 3. Suding and Gross 2006, pp. 190-209	1. The "Gleasonian vs. Clementsian" debate. Clements was a proponent of ecological "climax" (stable states) and treating communities as complex organisms. Gleason was the first to argue that communities are largely formed by chance, that they are not predictable and are subject to continual change (i.e. ecosystems are not fixed on a deterministic course). 2. Describes more recent ecological theory; populations and species interactions are influenced by various elements (e.g. disturbance, patch dynamics, stochastic processes) and suggests "nature in disequilibrium" is a more accurate model. 3. Reviews different theories of how ecosystems change. Relates theories to improving restoration efforts of degraded systems.

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April 2013

Table 2: Selected areas of uncertainty germane to management of flows and estuarine habitat that may be relevant to Phase 2

AREA OF UNCERTAINTY	POTENTIAL NEXT STEPS
Can levels of flow, salinity, and/or other water quality parameters be directly manipulated to help control the abundance and distribution of certain invasive species (e.g. Egeria, Corbula, etc.) in the SF Bay-Delta estuary? What specific levels (magnitude, duration, timing, frequency/variability) of flow, salinity, etc., are necessary to control/contain each target invasive species?	Laboratory studies to address tolerance of target species to specific levels of flow, salinity, etc., may provide initial results during Phase 2. Results from actual field tests of the hypotheses generated from those studies could be incorporated during implementation using the AM process.
Can substantial fish prey items (e.g., zooplankton) from restored wetlands and floodplains be exported to the Low Salinity Zone and/or other habitats in the estuary? If so, what factors (e.g. location and design features of restored sites, salinity at those sites, transport flows, etc.) most strongly affect this capacity?	Modeling during Phase 2; incorporation of results from restored sites during implementation using the AM process. Analyses using particle tracking models would need to address whether food prey items are consumed by target organisms rather than predators on those organisms or invasives.
How will the potential for restored shallow water rearing habitats in the Delta be affected by climate change in terms of (a) sea level rise, (b) increased temperatures, and (c) changes in the seasonal timing of freshwater flow events? What do these changes suggest about the selection of and/or importance	Modeling during Phase 2 and continuing through implementation. Because increased productivity as a result of large-scale physical habitat restoration is proposed by many as a major potential factor in the AM of flows in the SF Bay-Delta Estuary, better understanding and predicting the efficacy and functionality

of these restoration sites to different species and the manipulation of flow, salinity and other water quality parameters to maintain the functionality of these sites?	of restoration sites (in toto) is a prerequisite for making future decisions.
How do the interactions between flow (from different sources), exports from the South Delta , and turbidity affect rates of salmon, DS, and LFS entrainment? Most importantly, what is the relevant resolution (time step) for each of these variables?	Use existing data to better understand resolution (the relevant time step = averaging period, lag between variable manipulation and response) and model interactions between parameters.