Informational Proceeding to Develop Flow Criteria for the Delta Ecosystem

Proposed Questions Regarding Written Testimony and Exhibits

Submitted by The Bay Institute (TBI) and the Natural Resources Defense Council (NRDC) to the State Water Resources Control Board

March 9, 2010

QUESTIONS FOR THE STATE AND FEDERAL WATER CONTRACTORS

1. On page 14, you assert: "Changes in prey density are not related to flow in most cases, and the few relationships that do exist can be explained by flow diluting ammonium discharges that have important effects on the food web."
    a. How does this statement compare to the findings of Kimmerer (2002) that show a significant flow-spring abundance relationship with both *Eurytemora affinis* and *Acartia sp.* (important copepod prey species) as well as *Crangon franciscorum*?
    b. How does this statement compare to the statement by Kimmerer et al (2009) "All but 1 species of nekton [the aggregate of actively swimming animals in a body of water] responded positively to flow, only 2 had clear declines after 1987, and none of the relationships changed in slope after 1987 [abstract].
    c. Aren't longfin smelt, Sacramento splittail, American shad, and starry flounder and other species with established flow-abundance relationships prey species for other public trust species?
    d. You state, on page 32, that: "...we are unaware of any clear lines of evidence that manipulating manageable flows will restore the food web…". Are you unaware of the statistically significant, high magnitude relationship between Delta freshwater flow and spring populations of *Eurytemora affinis* (Kimmerer 2002), spring populations of *Acartia sp.* (Kimmerer 2002) (the only two copepods studied by Kimmerer); phytoplankton-derived particulate organic carbon (Jassby et al. 1995); and Crangon shrimp (Jassby et al. 1995; Kimmerer 2002; Kimmerer et al. 2009)? Do you disagree with all of these peer-reviewed studies?
2. You seem to suggest that the dramatically increased frequency of negative OMR flows and increased export pumping have had no effect on fish abundance. Does this then mean, in the context of the development of the Bay-Delta Conservation Plan, that the proposal to construct an isolated pipeline or tunnel around the Delta, and corresponding reduction in exports from the south Delta, will provide no benefit to salmon, smelt and other Delta fish species?

3. What do you believe constitutes the best available science?

    a. On page 3 of your submission, you write: "…the existence of correlations, by themselves, cannot properly be used to assume that simply forcing a particular level of outflow will result in any improvement in fish abundance. It must first be determined whether flow *per se* causes changes in fish abundance or whether high spring flows are simply correlated to other factors that are the true causal factors." Are you suggesting that the "true causal mechanisms" driving abundance for each and every public trust species in the Delta have co-varied with freshwater flow in the Delta for the past four decades, but are not functionally related to flow?

    b. You describe a new approach to analysis of the causation of fish declines and then state that some of the statistical relationships arising from this approach "...may not be satisfying, in part because of large measurement errors for some factors. In some cases, relationships might be deduced rather than illuminated by statistical analysis." [p. 12] Do you therefore agree that deduced relationships can constitute the best available science, even where statistically significant mechanistic relationships cannot be identified? Do you agree that the professional judgment and deductions of highly trained biologists are an important source of best available science?

4. Re: Ammonium concentrations.

    a. If ammonium pollution/dilution is an important underlying mechanism that drives the flow abundance relationships, why have American shad populations (which spawn in freshwater, nearest the putative sources of ammonium pollution) experienced a step-change of increased abundance for any given flow?

    b. Similarly, why do delta smelt show no statistical relationship between spring NDO and abundance, given that they spend their early life history in the freshwater parts of the Delta that would presumably experience higher concentrations of the putative toxins? If ammonium concentrations are an important factor in the decline of delta smelt, how do you explain how one of your experts (B. Manly, 2008, unpublished) found there is no statistical relationship between ammonia concentrations and delta smelt abundance?

    c. Please explain how, under this hypothetical mechanism, Crangon shrimp have showed no step-change decline in the flow-abundance relationship, despite the fact that they eat many of the same things that Delta smelt and longfin smelt eat (Jassby *et al.* 1995).

5. Regarding predator control,

    a. Do the current Delta flow requirements (D-1641) contribute to the growth of invasive species in the Delta?

    b. Given your statement that striped bass are "…much less abundant now than in the early 20th century…" (p. 8), how can striped bass predation rates be responsible for the decline of Central Valley salmon and other estuarine species either in the short term (since 2000) or the medium term (since the late 1960's)?

c. Given that populations of historical salmonid predators have been completely eradicated (e.g. Brown bear) or are also in severe decline (e.g. striped bass), and that commercial and sport fishing was prohibited in 2007 and 2008, what is the evidence that predator control of the types you mentioned would be able to restore populations of wild salmon and steelhead? What evidence is there that predator control has worked in other large ecosystems to boost populations of salmonids?

d. On page 9, you cite places in NMFS' draft Central Valley salmonid recovery plan where predation is indicated as a major stressor to salmon populations. However, the same draft Recovery Plan also rates "flow conditions" (in the Delta and in the lower Sacramento River) and "entrainment" (in particular at the CVP and SWP pumps in the South Delta) as "**Very High**" stressors on the winter-run population ("Winter run Chinook salmon stressor matrix", Attachment A to Threats Assessment) ; spring run Chinook salmon(spring run Chinook salmon stressor matrix", Attachment D to Threats Assessment); and **Very High** or **High** stressors on the steelhead population; ("steelhead stressor matrix"; Attachment C to the Threats Assessment). Is it your position that the NMFS was correct about the predation stressor but incorrect in its assessment of the flow stressor in the Delta and lower mainstem rivers?

6. Given that Cache Slough is only a small fraction of the area that historically supported Delta smelt spawning, what are the advantages and disadvantages of constraining a large fraction of the population to that area as implied by your analysis (p. 4) of your Figure 1?

7. On page 14, you write: "The native fish long ago adapted to the tidal nature of their habitat, with twice daily shifts in flow direction in the channels and the adults are able to hold position in the water column. Thus, until Old and Middle River flows exceed at least -6,100 cfs, they do not cause a higher proportion of adult smelt to be entrained at the export pumps." How many fish are entrained at flows below -6,100 cfs, and how does this -6,100 cfs OMR flow recommendation address the non-entrainment impacts of the pumps, e.g. the fact that higher flows draw greater numbers of fish into the central and south Delta and expose them to greater predation and other stressors? Is it really your position, based on the expertise of your biological consultants and common sense, that entraining increasing quantities of endangered species at the export pumps, when abundance of these species are already at an all time low, has no impact on the abundance and **sustainability** of those species?

8. Regarding the longfin smelt relationship with Delta outflow (and X2), you write on page 30: "A narrow focus on the location of X2 as a management tool is not likely to recover longfin populations, but should rather be considered in the context of a suite of measures designed to benefit fish population."

a. Does this indicate that you believe management of X2 (or Delta outflow) are valid management tools for supporting longfin smelt populations as long as they are used in the context of managing other stressors (e.g. ammonium)?

b. Given that the historic relationship between longfin smelt abundance and spring Delta outflows predated the problems with ammonium that you hypothesize and that the current relationship between abundance is statistically significant and possesses the same slope as the historical relationship, do you believe that solely addressing ammonium pollution is likely to return longfin smelt to their former abundance?

9. In each of your examples, flow is an important driver of the mechanisms you suggest are in control of fish population abundance:

   a. Floodplain inundation is obviously a function of flow magnitude, duration and frequency;

   b. Estuarine habitat increases with increasing NDO for some species (see Kimmerer 2009 and Feyrer *et al.* 2007)

   c. Decreased predation as a result of the flow-turbidity relationship and as a result of the flow-transport mechanism;

   d. Decreased pollution concentrations as a result of increased flows

   Given that freshwater flow volume and timing are factors the SWRCB can affect immediately whereas floodplain modification, fish predators, creation of shallow freshwater habitats in new locations, and pollution concentrations are either not under the Board's direct control and/or may take year's to implement, how should the Board exercise its authority and requirement to take immediate actions to protect the public trust and several critically endangered species in the near-term, and until other stressors can be addressed?

10. You identify several new stressors to the Delta ecosystem that may impact explain the most recent declines in public trust species including ammonium, predators, pyrethroid pesticides, metals, endocrine disrupting compounds, etc. How do these stressors explain the significant, high magnitude, positive relationships between freshwater flow and the abundance of numerous public trust species that have endured since fish population data collection started over 4 decades ago?

11. On page 8, you argue that ocean conditions are behind recent declines in Central Valley salmon populations. Specifically, you write: *Conditions in 2008 and 2009 have mirrored those of 2007. When unfavorable ocean conditions persist, no amount of freshwater flow can mitigate; the mechanism is not flow but rather the carrying capacity of the ocean*. What is the basis for your statement that ocean conditions in 2008 and 2009 have been the same as those in 2007? In addition, Winter-run Chinook salmon have been listed as federally threatened since 1991 and have never met the CVPIA recovery objective since they were listed. Are you claiming that ocean conditions in the latter half of the last decade caused this species, and/or spring run Chinook salmon, and/or steelhead, and/or Delta smelt (which don't migrate to the ocean), and/or the southern DPS of green sturgeon to become endangered and prevented recovery?

QUESTIONS FOR THE UC DAVIS EXPERTS:

1. What are the most important changes to the Delta (geometry, hydrology) in the past 50 years that have led to the decline of fish species? How much has the delta geometry changed since the 1950s and 1960s, when fish were doing better?
2. What impact did the construction of dams on the San Joaquin River in the 1967-1979 period have on San Joaquin River inflows to the Delta and on public trust resources, including salmon and steelhead from the San Joaquin system? How has this affected water quality conditions in the South Delta?
3. How large of a safety factor is adequate to address the uncertainty around the mechanisms related to flow requirements for fish?
4. In the table on Page 19 of your Functional Flows submission, you identify Sacramento River inflows to support juvenile salmon migration from March through June. What flows are necessary to support late-fall and winter migration of juvenile salmon into and through the Delta?
5. In the table on Page 19 of your Functional Flows submission, you identify San Joaquin River flows intended to benefit outmigrating juveniles from April through June. What flows are necessary to benefit Chinook salmon juveniles and steelhead adults that migrate during Jan-Mar?
6. In the table on Page 19 of your Functional Flows submission, you identify flows from July through January to support migration of adult Chinook salmon. Would flows of this magnitude be required in May and June to support migration of spring-run Chinook salmon when they are reintroduced to the San Joaquin River?

QUESTIONS FOR DEPARTMENT OF FISH AND GAME:

1. For your Delta Habitat Quality Index (DFG Exhibit 2), why is food availability measured as the abundance of mysids only?
2. Given the temperature requirements that DFG identifies as necessary for salmon in the San Joaquin system, are these temperature requirements being met currently, and what flows would be necessary to achieve those temperature requirements?
3. Regarding the benefits to splittail and other species of floodplain inundation (p. 13), what timing, duration and frequency are required to maximize these benefits? Are there thresholds in the timing, magnitude, duration, or frequency of flooding below which benefits to these species are markedly reduced?
4. Regarding your San Joaquin Vernalis flow recommendations, why are your maximum flow recommendations limited to 70 days in wet years? Is there evidence that benefits (life history diversity, abundance) accrue to migrating salmon when peak flows occur over a longer duration?
5. If any, what are the different Delta inflow requirements (in terms of timing, magnitude, duration, and frequency) for San Joaquin River steelhead as compared to Sacramento River Fall run Chinook salmon? How are flow requirements for these species likely to differ from those of spring run Chinook salmon that are reintroduced to the San Joaquin River?

<u>QUESTIONS FOR DEPARTMENT OF WATER RESOURCES:</u>

1. What is the evidence that the "food" produced on an inundated Yolo bypass is the type of food eaten by pelagic species, that it will reach the areas where those species live, or that it will be abundant enough in those areas to measurably support the pelagic food web?

2. Will the floodplain be inundated every spring? If not, how will floodplain inundation materially benefit species with a one-year life cycle such as Delta smelt and Crangon shrimp?

3. What evidence is there that "productive tidal water habitat" is a "primary driver" of fish populations whereas "habitat as measured by X2" is not a primary driver, as suggested on p. 4 of your testimony? How do you reconcile this evidence with the findings of Kimmerer et al 2009 (p. 10 "American shad and striped bass had habitat relationships to X2 that appeared consistent with their relationships of abundance (or survival) to X2 … This provides some support for the idea that increasing quantity of habitat as defined by salinity could explain the X2 relationships of these species"), and Feyrer et al 2007 (732 – The long-term declining EQ trends and apparent link to delta smelt abundance detected in this study corroborate previous hypotheses that the area of suitable physical and chemical habitat has played a role in the decline in fish abundance) who found support for a flow-habitat effect of a magnitude sufficient to account for the flow-abundance relationship for American shad, striped bass, and Delta smelt? Didn't Kimmerer 2009 also find that the mechanism driving outflow (or X2) abundance relationships differs for different species based on the ecological requirements and life history of the species in question?

4. Your figure 3 (attributed to an uncited paper by Dr. Kimmerer) relates Delta smelt survival to copepod abundance. Kimmerer (2002) demonstrated significant, high-magnitude positive relationships between Delta outflow (as indexed by X2 position) and spring populations of the two copepods he studied. In light of this, what is the relationship between Delta outflow and food abundance for pelagic fish species?

5. Regarding your statement: "the ecosystem is getting much less "bang for buck" for a given amount of flow than just two or three decades ago [p.6]," what is the evidence that there is decreased population abundance for each increment of increased Delta outflows for populations of splittail, Crangon shrimp, and American shad?

6. Control of Invasive Species: On page 7 of your testimony, you acknowledge that high flow events may help control populations of the invasive clam *Corbula amurensis* but you say that those benefits may be offset by increases of the clam *Corbicula* in newly created freshwater environments. On page 9, you suggest that increasing salinity in the delta may help control *Corbula* – please explain the apparent contradiction between your *Corbula* control recommendations described on pages 7 and 9 and then describe evidence you used to conclude that increasing salinity would have a larger net negative effect on invasive clam biomass than increasing spring freshwater flows. What would be the effect on clam biomass of making more of the northern estuary fresh during the winter and spring of most years and decreasing outflows (increasing salinity) during summer months? What would prevent reduced flows from resulting in merely a shift in distribution of clams, rather than a reduction in introduced clam species?

7. On page 10, you call for "a systematic approach to determining what is necessary to protect the Delta ecosystem"? Using this systematic approach, when do you project we will understand the solutions required to protect all public trust resources that use the Delta? What should be done in the meantime (i.e. now) to protect public trust resources that benefit from freshwater flow through the Delta? What will you recommend if the systematic approach indicates that some public trust resources benefit from flows via mechanisms that cannot be imitated by engineering (e.g., transport via gravitational circulation)?

8. On page 10 of your comments, you remark that freshwater flow should be considered as just one of many drivers of biological populations in the Delta "as opposed to being represented as a primary driver of the Delta ecosystem". Doesn't this position conflict with the position of researchers you have relied on, including Kimmerer (2004), Feyrer (2007), Feyrer and Healy (2003), Grimaldo (2009), and Jassby (1995)?

    a. Kimmerer (2004:13) Estuaries in general are strongly influenced by the physical regime. Important influences include variation in freshwater flow (e.g., Postma 1967; Malone et al. 1988; Livingston et al. 1997), tidal stirring (e.g., Ketchum 1954; Wooldridge and Erasmus 1980; Haas et al. 1981), and salinity distribution (Remane 1971).

    b. Kimmerer (2004:13-14] Estuaries are defined by the mixing between rivers and oceans. Variability in freshwater flow can influence the physical, chemical, and biological components of estuaries in numerous ways (Drinkwater and Frank 1994; Kimmerer 2002a, 2002b). The response of estuaries to variation in freshwater flow has received considerable attention … the biota of the San Francisco Estuary may have one of the strongest and most consistent responses to flow among large estuaries (Kimmerer 2002a).

    c. Feyrer et al (2007:723) : The abiotic components of habitat often strongly influence the biotic components, particularly in estuaries where freshwater inputs and associated salinity effects are important community-structurein mechanisms (e.g. Bulger et al 1993; Jassby et al. 1995)

    d. Feyrer and Healey (2003:123): In many systems, especially in California's Central Valley, natural flow regimes are critically important to maintaining native fish communities (Meng et al. 1994, Brown 2000, Marchetti & Moyle 2001).

    e. Grimaldo et al. (2009:1253): Estuaries are particularly sensitive to water diversions because reduced freshwater inflows can alter sediment budgets (Wright and Schoellhamer 2005), water quality (Lane et al. 1999; Monsen et al. 2007), biological productivity (Jassby and Cloern 2000; Jassby 2005), and distribution of invertebrates (Stora and Arnoux 1983; Rodriguez et al. 2001; Kimmerer 2002a; Massengill 2004) and fishes (Kimmerer 2002a; Feyrer et al. 2007).

    f. Jassby et al (1995:284): Relationships between X2 (or freshwater discharge) and year-to-year variability in estuarine resources are not unique to the Bay/Delta, particularly if we include coastal currents and marginal seas.

9. Figure 1 shows ammonium loading in the San Francisco Estuary over time. You seem to suggest that ammonium concentrations may explain the POD. If ammonium concentrations are indeed responsible for the POD declines, how does that affect interpretation of the pre-

POD correlations between freshwater flow and abundance of public trust resources? How does ammonium loading affects pelagic species like starry flounder and longfin smelt, when there has been no apparent step-change in the flow-abundance relationship of shared food items such as *Crangon spp* and there is no apparent relationship between ammonium concentrations and Delta smelt populations? Is it DWR's position that reduction of ammonium loadings will completely restore populations of Public Trust pelagic organisms? What your degree of certainty for that assertion?

QUESTIONS FOR THE DEPARTMENT OF THE INTERIOR

1. You reference recommendations made in previous DOI submissions to the Board. Would public trust species still benefit from the flow recommendations DOI previously made to the Board, or have conditions changed so much that those recommendations are no longer valid? If subsequent changes in the Delta do affect the amount and timing of flows, in general, would more flows or less flows be needed to protect public trust species today? Would those flows be required earlier, later, or for a longer period today as opposed to the past? Are the flows included in the 2008 delta smelt BO and 2009 salmonid BO the minimum required to protect public trust species?

2. Can you specify the frequency and duration of floodplain inundation required to support minimal levels of public trust benefit? Are there thresholds of inundation duration, frequency, or magnitude that support different public trust benefits?

3. You describe attraction flows for San Joaquin river fall run Chinook salmon – would similar flows be necessary to support adult migration of steelhead or spring run Chinook salmon? If so, when would those flows occur and what would be the required duration and magnitude?

4. On page 8, you indicate that "*the most recent period of relatively robust annual abundance numbers for several species of concern should be used to guide the development of Delta flow criteria needed to protect the public trust resources*". Can you state for what period (span of years) the viability criteria should be referenced to (population abundance, spatial extent, diversity, and productivity)? What would successful protection of the public trust look like in terms of public trust species' population biology?

5. On page 9, you state that "*Timing, magnitude and variability of flow are the primary drivers of physical habitat conditions including: turbidity, temperature, particle residence time, nutrient loading, etc*." What is the benefit to the public trust of each of these physical habitat conditions?