California Water Research

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Sent: Wednesday, May 31, 2023 7:29 PM
To: Delta Council ISB disb@deltacouncil.ca.gov

Lisa Wainger, Chair, and
members Delta Independent
Science Board 715 P Street, 15-
300
Sacramento, CA 95814

Re: Comments on Draft Prospectus: Exploring scientific and management implications of upper trophic level interactions in Delta food-webs: An assessment of the scientific needs to improve management action

Thank you for the opportunity to comment on this prospectus.

Suggestions for experts: Bruce Herbold (IEP), Rosie Hart (IEP), David Ostrach (Ostrach Consulting), Jon Rosenfield (SF Baykeeper), Chris Shutes (California Sportfishing Protection Alliance).

Some considerations in defining a top-down conceptual model are below.

Sincerely,

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Recommendations

The 2010 Interagency Ecological Program Pelagic Organism Decline Management and Synthesis Team (IEP POD MAST) conceptual model of top-down effects (Baxter et al. 2010) is also relevant to the prospectus.

The IEP MAST POD conceptual model characterized top-down effects as including mortality both from predation and entrainment and noted that entrainment interacts with other drivers. The IEP POD conceptual model also distinguished predation effects in littoral vs. pelagic habitat. Since the Delta has large alterations in flow in some years and seasons, we recommend that the review of top-down effects use an integrated conceptual model.

Below are some relevant excerpts from (Baxter et al. 2010).

Defining top-down effects (p. 10):

> *Top-down.* In the basic POD conceptual model, top-down effects refer to mortality from predation and entrainment into water diversions. Piscivorous predators in the Delta include native pikeminnows as well as introduced largemouth bass, striped bass, and Mississippi silversides. Striped bass prey on all four POD species. While increasing in abundance, largemouth bass primarily consume littoral, not pelagic prey. New genetic evidence suggests that Mississippi silversides prey on larval delta smelt. Decreasing turbidity may be increasing the vulnerability of pelagic prey to predators. Mortality associated with the State Water Project (SWP) and Central Valley Project (CVP) water diversions is well-documented in the San Francisco estuary. However, mortality estimates based on fish caught in fish screens at these diversions (salvage) are underestimates because small larval fish are not collected at all, other small fish are caught inefficiently, and entrainment-associated mortality that occurs before fish are collected in the screens (pre-screen loss) is not regularly assessed. Shifting of more exports to winter has been accompanied by increased salvage for POD species and other Delta fishes. However, the population-level effects of increased entrainment remain unclear and may vary greatly within and among years and between species. Greater net flow through Old and Middle Rivers toward the SWP and CVP diversions rather than seaward is associated with greater salvage of adult delta smelt, longfin smelt, and striped bass. Overall, entrainment can affect multiple life stages of the POD fishes and often interacts with other drivers affecting the behavior and spawning success of the POD fishes.

On the interaction of predation and salvage (p. 38):

> Predation is a common mechanism by which weakened fish are ultimately killed. Thus, increased predation can be a manifestation of other changes in the ecosystem like decreased habitat suitability, starvation, and disease. However, in the top-down section of our conceptual model, we are referring to elevated mortality of healthy individuals due to predation or removal by water diversions

and associated factors. Thus, the top-down effects are predicated on two hypotheses, which are not mutually exclusive. The first is that consumption or removal of healthy fish biomass by piscivores (principally striped bass and largemouth bass *Micropterus salmoides*) increased around 2000. The second is that mortality due to water diversions (SWP/CVP exports; power plant diversions) increased around 2000. This could have occurred if one or more of the following happened: (1) water diversions and exports increased during periods the POD fishes were vulnerable to them; (2) piscivorous fishes became more abundant relative to the POD fishes; (3) pelagic fish distribution shifted

to locations with higher predation risk (e.g. habitat changes); or (4) the POD fishes became more vulnerable to predation as a consequence of their extremely low population size (i.e., predation could contribute to the Allee effect hypothesized in the Previous Abundance section) or increases in water clarity.

On shifts of vegetation and increase in largemouth bass (p. 40):

Largemouth bass abundance has increased in the Delta over the past few decades (Brown and Michniuk 2007). Largemouth bass were introduced to the Central Valley in the mid-1890s (Dill and Cordone 1997) and were present in the Delta soon after that. Although none of the IEP surveys adequately tracks largemouth bass population trends, a comparison of abundance estimates between intermittent surveys conducted in the early 1980s, late 1990s, early 2000s (CDFG, unpublished data) and from 2009 to 2010 (L. Conrad, DWR, unpublished data) shows that largemouth bass and sunfish populations more than doubled during the years of the POD (Figure 16).

Analyses of fish salvage data show an abrupt increase in salvage of young largemouth bass in the early 1990s, before the POD, with salvage remaining at high levels since then (Figure 17). This suggests an increase in largemouth bass abundance in the early 1990s. The increase in salvage of largemouth bass occurred during the time period when *E. densa*, an introduced aquatic macrophyte was expanding its range in the Delta (Brown and Michniuk 2007).
Although the historic distributions of native species of SAV are not known, it is possible that their coverage may not have been as extensive or persistent as *E. densa* is today. For example, unlike most native aquatic macrophytes, *E. densa* has a bimodal growth pattern, with peaks in late spring and the early fall. The second growth period in late fall may help existing patches persist through the winter and provide a head start on growth the following spring. These characteristics likely contributed to the expansion of the distribution of *E. densa* in the Delta and perhaps help *E. densa* compete with other aquatic macrophytes (Santos et al. 2011). The invasion of *E. densa* has occurred during highly altered environmental conditions compared to historical conditions. Historical conditions, including dynamic flow and salinity regimes, higher turbidity, and seasonal (rather than perennial) inundation of large portions of shallow-water habitat would likely have

been less favorable for establishment of *E. densa*. The areal coverage of *E. densa* in the Delta has fluctuated from 2004 to 2008, suggesting that this habitat may no longer be expanding (Hestir 2010).

On largemouth bass diet (p. 40):

Largemouth bass have a much more limited distribution in the estuary than striped bass, but a higher per capita impact on small fishes (Nobriga and Feyrer 2007). Conceivably, increases in largemouth bass may have had a particularly important effect on threadfin shad and striped bass, whose earlier life stages occur in littoral habitat (Grimaldo et al. 2004; Nobriga and Feyrer 2007). However, ongoing analyses of largemouth bass diet suggest that the largemouth bass are chiefly consuming common littoral invertebrate and fish species, such as crayfish and juvenile sunfish (L. Conrad, DWR, unpublished data). To date, over 1400 samples collected from sites located throughout the Delta have been examined and these have contained only 12 threadfin shad and 1 juvenile striped bass (L. Conrad, DWR, unpublished data). Furthermore, no salmonid or osmerid species have been found in largemouth bass stomachs. The zero or low frequencies of the POD species in bass stomachs may be due largely to limited spatial overlap with largemouth bass; however, increased abundance of

largemouth bass may still impose an important predation threat in limited instances where they do co-occur.

On interactions with abiotic factors, including flows (p. 41):

A change in predation pressure may, in part, be an effect of interactions between biotic and abiotic conditions. Natural, co-evolved piscivore-prey systems typically have an abiotic production phase and a biotic reduction phase each year (e.g., (Rodríguez and Lewis 1994)). Changing the magnitudes and durations of these cycles greatly alters their outcomes (Meffe 1984). Generally, the relative stability of the physical environment affects the length of time each phase dominates and thus, the importance of each. Biotic interactions like predation will have a stronger influence on the biotic community in physically stable systems (e.g., lakes). Historically in the estuary, the period of winter-spring high flow was the abiotic production phase, when most species reproduced. The biotic reduction phase probably encompassed the low-flow periods in summer and fall. Multi-year wet cycles probably increased (and still do) the overall —abiotic-ness‖ of the estuary, allowing populations of all species to increase.
Drought cycles likely increased the estuary's —biotic-ness (Livingston et al. 1997), with low reproductive output and increased effect of predation on population abundances. Flow management in the San Francisco Estuary and its watershed has reduced flow variation much of the time and in some locations more than others (Moyle et al. 2010). This has probably affected the magnitudes and durations of abiotic and biotic phases (Nobriga et al. 2005). In other words, reduced variability in

environmental conditions of the estuary may have exacerbated predation effects. However, there is no clear evidence that such changes have been abrupt enough to account for the POD.

On the history of harvest (p. 96):

Harvest represents losses of aquatic organisms. It includes the top-down box in the basic POD conceptual model, which includes effects on fishes from physical (abiotic) entrainment into water diversions as well as biotic variables such as predation and fishing. Fishing has occurred in the Delta even in pre-European times. Unlimited fishing during and after the Gold Rush along with destruction of spawning and migration habitat led to strong declines in salmonids. Recreational fishing has replaced once thriving commercial fishing and is regulated. There is overall less fishing by humans now than before, and most of the fishing is for non-native species, especially largemouth bass and striped bass. Recreational fishing for largemouth bass has dramatically increased in recent years with bass derbies now occurring year-round; however, most of these fish are released. Entrainment, especially by the CVP and SWP, has been high in some recent years with maximum salvage numbers for adult delta and longfin smelt during the POD period in 2003 and 2002, respectively (Grimaldo et al. 2009a). Salvage does not account for entrainment-associated losses that occur before fishes are collected by the fish screens, such as predation in CCF. Predation by introduced predatory fish, specifically largemouth bass, on native species has likely gone up with the more recent proliferation of these predators and increased visibility due to declining turbidity levels.

Overall, harvest of native fish species has likely increased over the last 50 years or more, leading to increased top-down control of native fish species.

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