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Dear members of the Delta Independent Science Board,

Thank you for the opportunity to review the Delta Independent Science Board's (ISB) draft report, "Exploring scientific and management implications of upper trophic level food webs in the Delta." We appreciate the effort put into the review, including the opportunity for Department of Water Resources (DWR) staff to participate in the interview process and the November 2023 workshop. We also appreciate the perspectives brought forward in the workshop and the draft report on how food web models are used for management in other systems. After reviewing the report, we have several comments that we hope will increase the relevance and feasibility of the recommendations.

1. **The review scope needs additional clarification in the Executive Summary, title, and "Background and Purpose" sections.** The report's title and introduction imply a focus on the "upper trophic level" food web, which the authors define as "fish." Most of the recommendations, however, involve research across multiple trophic levels (e.g., Recommendation #2 involves examining the role of detritus, and linkages between primary producers and secondary consumers). Furthermore, by limiting this definition to fish, the report ignores the role of non-piscine consumers in the system, such as birds, invertebrates, mammals, and humans (which are also mammals, and frequently under-represented in food web models). If the report's goal is a discussion of food web science in the Delta, it should not limit itself to "upper trophic levels" only and instead address the entire food web.
2. **The definition of "food web data" is unclear.** How is food web data different from abundance of the organisms in the food web? If "food web data" refers to food web interactions (e.g., diet composition, predation rates, stable isotopes, carbon flux, etc.) then an explicit list of both currently available data and notable data gaps would substantially improve the report. The Delta ISB's Monitoring Enterprise Review, particularly its inventory of monitoring programs, would likely provide a useful reference on existing data.
3. **Greater specificity and examples for use of food web models is needed.** The report provides many examples of food web models from systems like the Chesapeake but does not specify how those models could be applied to the Delta nor what additional data collection efforts would be needed to implement them. Table 2 in the report includes broad categories of management questions and applications, but greater specificity would be helpful. For example, instead of asking "How do changes to environmental conditions affect food web interactions?" the report could instead say "How will climate change increase predation rates on juvenile salmon, and will the increased production of phytoplankton and zooplankton offset the greater energetic demands of inhabiting a warmer ecosystem?" One of the existing management questions in Table 2 is "How do specific management actions affect key species?" DWR has several

examples of coupled flow-zooplankton-fish models to assess the potential efficacy of management actions already, such as Fall X2, the Suisun Marsh Salinity Control Gates, and North Delta Flow actions (Sommer et al. 2020, Beakes et al. 2021, Frantzich et al. 2021, Davis et al. 2022a, Hassrick et al. 2023, Lee et al. 2023). Defining one or two existing management problems in the Delta and identifying how a food web model would ameliorate the issue(s) would make the report more impactful.

4. **The report needs better recognition of existing work in the Delta.** The report implies that little or no food web data is currently being collected, when that is far from the case. The key gaps in our data collection would be better understood in the context of what *is* currently being collected. For example, it stresses the lack of data on the benthic community, but does not recognize the long-term Environmental Monitoring Program benthic data collection (Wells and Interagency Ecological Program 2022), the Fish Restoration Program data on benthic and epibenthic communities in tidal wetlands (Sherman et al. 2023), and innumerable special studies and reports that have used these data to examine the benthos of the region and how it relates to food web processes (Crauder et al. 2016, Lucas et al. 2016, Zierdt Smith et al. 2023, Mussen et al. 2024). While species interaction data is collected less routinely, CDFW's Diet Study has collected data on fish diets for 20 years, amassing data from thousands of fish including several small species (Slater and Baxter 2014, Burris et al. 2022). Many, many special studies have assessed predation rates, predatory fish abundance, potential for competition, and carbon flow (Whitley and Bollens 2014, Kendall et al. 2015, Weinersmith et al. 2019, Michel et al. 2020, Young et al. 2021, Davis et al. 2022b, Young et al. 2022). Again, the Delta ISB's Monitoring Enterprise Review, particularly its inventory of monitoring programs, would be useful here. These studies and programs already, as the draft report recommends, intentionally collect data about trophic linkages and abundance at different nodes in the food web. If the key recommendation in the report is to develop quantitative models of the food web, this needs increased emphasis and points more to a synthesis of existing studies and data with strategic collection of additional data to fill gaps.
5. **The report should recognize ongoing work on data publication and standardization**. The report calls for greater standardization of data quality assurance and publication, but does not recognize the long-standing work of the IEP Data Utilization Work Group to provide Delta-wide recommendations for data publication and standardization, or the many quality-controlled datasets from Delta monitoring programs that have been published on platforms such as the Environmental Data Initiative (EDI), CNRA portal, CDFW FTP site, and USGS Science Base databases for public access. A number of integrated datasets have been produced with the help of the IEP synthesis team, including zooplankton, fish, water quality, and aquatic vegetation. Additionally, several ongoing initiatives are working to coordinate data management plans for the Sacramento River watershed that will

make food web data compatible among programs. The Spring-run Chinook JPE data management system, for example, has posted interagency, inter-compatible salmon data sets on EDI and is establishing shared interagency data entry applications and cloud computing resources that ensure future data streams are immediately compatible.

6. **The report misses an opportunity to recommend targeted special studies that will inform the proposed food web models.** Recommendation #2 focuses on adapting existing monitoring programs to better quantify food web dynamics. Expanded long-term monitoring may be important for developing food web models, but some of the most marked progress in understanding food webs in the Delta has come from focused special studies rather than decadal monitoring efforts. For example, stable isotope studies have shed light on the various dietary inputs into the composition of fish biomass (Grimaldo et al. 2009) as well as differences in biomass composition among habitat types and regions (Schroeter et al. 2015, Young et al. 2021). In addition, our impression from the EcoPath with EcoSim models presented in both the draft report and workshop appear very "data hungry." Filling in data gaps is often more easily accomplished with targeted, limited-term special studies than by re-tooling existing monitoring programs with the food web in mind. In addition, long-term monitoring programs are often pulled into multiple competing priorities for compliance and information needs and what is needed for food web modeling may not be what is needed for other potential applications of monitoring programs. For example, if an emerging quantitative food web model needs focused data collection on the detrital node of a food web, it may not be feasible to adapt the relevant long term monitoring programs in that direction if their resources are already completely devoted to water quality and fishes sampling that is required and already part of a long-term record. To reflect this perspective, a new recommendation (or a modification to Recommendation #2) would be to identify special studies that would be responsive to data gaps identified by the collaborative team that works toward the model development.
7. **The report over-simplifies what "success" would look like in ecosystem-based management and should acknowledge that this is not the current approach to management in the system**. The report mentions evaluating management actions and restoration efforts for "usefulness" or success; it is unclear, however, what success is and how it is measured. How will it be determined if a management activity is successful? With the call for a scientific collaboration between agencies, academia, Tribes, and the public, agreeing on a definition of "success" is no small matter. Defining measurable response metrics for an entire food web is challenging for a single entity given the complexity of food web interactions. When multiple groups are collaboratively developing success metrics, complexity increases, and this should be acknowledged, ideally with recommendations for reducing complexity. In addition, in the section on "Potential Applications of Improved Understanding of Upper Trophic Level Food Webs from Case Studies Outside the

Delta," the report makes a case for the value of ecosystem-based management and the importance of understanding food web dynamics to inform this approach. This section advocates for an ecosystem-based management approach in the Delta, which is more of a policy topic than one strictly relevant to a review of the food web science in the system. It would be appropriate here to clarify that currently the regulatory drivers of the system are for single-species management, not ecosystem-based management (Mount et al. 2019). If the system does move toward an ecosystem-based management approach, however, a clear understanding of the food web dynamics, ideally with predictive capacity for comparison of management scenarios, would be needed.

8. **Recognize existing venues for collaborative science in the Delta.** Rather than creating a new "collaboratory," leveraging existing collaborative platforms such as those available in IEP may be more effective. The report proposes a collaboratory that would join managers, scientists, data scientists, and modelers into a team tasked with addressing a specific issue. This structure mirrors existing systems, such as that used by the Delta Coordination Group (DCG) to develop a structured decision model for the Delta Smelt Summer-Fall Habitat Action (CDWR 2023, see CDWR 2024). Other IEP collaborative synthesis teams have been used to evaluate flow alteration actions (FLOAT-MAST 2021), develop a model of salmon entrainment (Gaeta et al, in prep), develop a Spring-Run Chinook Slamon Juvenile Production estimate (Nelson et al. 2022), evaluate potential impacts of climate change on the Delta (CC-MAST 2022, Mahardja et al. 2022, Bashevkin et al. 2023), evaluate the effectiveness and impacts of the Emergency Drought Barriers (CDWR 2022, Hartman et al. 2022), and look broadly at the impact of drought on the ecosystem as a whole (IEP Drought Synthesis Team 2023, Hartman et al. 2024). A food web synthesis team was already developed by the Delta Science Program with support from the National Center for Ecological Analysis and Synthesis (Rogers et al. 2024), and a smaller team led by Dr. Matt Young of USGS is currently developing an EcoPath model for two wetland sites in the Delta.

Quantitative food web modeling is certainly an underutilized tool in the Delta Science community, and a dedicated team interested in developing food web models would be a useful addition. However, this report would carry more weight if it recognized existing data collection/analysis and was more specific in terms of where we have data and modeling gaps.

Sincerely,

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Specific Comments

Page 8. "*Many improvements have been made over the years. For example, the Interagency Ecological Program has a data depository, which allows users to access or request data*" – The correct term for a data storage platform is a "data repository", not a "data depository". However, the IEP website has a data access page, but it does not actually store the data, therefore it is not a data repository. However, there are several areas where data is published (e.g. EDI, CDFW FTP site).

Page 9: "Developing a food web implementation plan" – Unsure as to what would be implemented in such plan. The phrase implies a food web would be implemented.

Page 10. "*Examining roles of detritus*" – If this report is specifically about the 'upper trophic levels', including detritus as one of the main data gaps is confusing.

Page 10. "*Better characterizing the processes important to maintaining the vitality of benthic communities and early life stages of ecologically key species*" – What does it mean to "maintain the vitality of benthic communities"? Including benthic communities in a list of major gaps in the 'upper trophic level food web' is confusing.

Page 10. "Nutritional/energetic quality of food moving through food webs" – How is quality defined? Calories? Fatty Acid Content? "Quality varies by species and trophic levels.

Page 12. First bullet under "Integral to all four recommendations…" says, "Evaluating the usefulness of the activity…". It's not clear whether "activity" refers to the research activities" to support food web modeling, or the "management actions" taken based on food web modeling.

Page 34. "*Implement long-term monitoring that quantifies all major aspects of the food web. Examples: Large predators, Benthic invertebrates, Quality of food*" – What does it mean to monitor food quality? Is this caloric content? Nutritional content? Contaminants? Many of these topics are better assessed through laboratory experiments rather than long-term monitoring.

Page 34. "*Begin with discrete, short-term management changes designed using an experimental method*" – How is this different from the work currently being done with the summer-fall habitat action for Delta Smelt? Or the North Delta Flow Action? Both these actions have used integrated models to predict potential responses, collected data across the food web, and assessed results. The North Delta Flow Action, in particular, is using stable isotopes to trace the flow of carbon through the food web.

Page 36. *Row: Ecosystem Restoration; Column: Benefits of Food Web Approach*. – An additional benefit would be: Evaluate the relative response of native vs non-native competitors or apparent competitors (via support for a shared predator). This could be especially important in the context of seasonal timing of trophic subsidies relative to

migration/movement into area of interest or developmental stage of species of management interest (e.g. protected species).

Page 36. "*Accurately monitor biomass of primary producers in the system, not just chlorophyll which can overestimate accessible prey.*" – Biomass of primary producers can also overestimate accessible prey, since not all sources of primary production are equally available for consumption (for example, the diatom *Alocasia* forms long chains that are difficult for copepods to consume (Jungbluth et al. 2021), and the cyanobacteria *Microcystis* is toxic (Ger et al. 2010)).

Page 37. "Restoration performance measures often jump from primary production to abundance of fish." – This is not true of the Fish Restoration Program sites (8000 acres of tidal wetland restoration being built for fish in the Delta). They include secondary production (zooplankton and wetland-associated invertebrates) as well as primary production (Sherman et al. 2023).

Page 43. Ecosystem restoration – The Fish Restoration Program is taking a food web based approach to monitoring wetland restoration, and that should be acknowledged in this section (IEP Tidal Wetland Monitoring PWT 2017, Sherman et al. 2017).

Page 45. Contaminants – Research from the NOAA Northwest Fish Sci Center has made this sub-lethal behavioral connection for some contaminants coming from roads, which we are beginning to understand is one of (if not the) major contributor of key contaminants affecting salmonids and likely other fishes as well (Hecht et al., 2007).

Page 51. "Development of mechanisms for effectively sharing data, ideas, and insights" – The interagency ecological program has TONS of mechanisms for effectively sharing data and insights. From formal workshops and conferences (IEP annual workshop, Bay-Delta Science Conference, Delta Science Program workshops), to less formal project work teams, technical teams, and newsletters, there are many forums to share insights. The IEP Data Utilization work group (https://iep.ca.gov/Data/Data-Utilization-Working-Group) has many guidelines and standards for sharing data, as well as a data publication subteam that helps programs with publishing data.

Page 51. "For example, sampling locations should all be consistently geo-referenced." – This implies that data published currently are not consistently geo-referenced. Almost every data point published by any IEP survey is accompanied by GPS coordinates, either with the sampling information or in an accompanying lookup table.

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