

Interagency Ecological Program Synthesis Team

Food Web Synthesis Proposal

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Summary

The Interagency Ecological Program (IEP) Synthesis Team proposes a food web modeling project to assess effectiveness of tidal wetland restoration and other resource management actions. A food web model will allow quantitative estimates of benefits derived from management actions and will help clarify whether food web factors (food availability, predation) or physical factors (water quality, physical habitat availability) are driving changes to species of concern. **We are asking whether this effort would be useful to resource managers in the system and whether wetland benefits is an appropriate research topic to start with.** We are also soliciting particular management questions within this general topic you that you would find useful.

Background on Food Web science

Quantitative population models have been used extensively in management of at-risk fishes in the Delta (e.g. Polansky et al. 2018, Smith et al. 2021). However, these models tend to focus on only one species, with other components of the food web included as static factors such as “food availability” or “predator abundance”. In contrast, food web models encompass many types of models that explicitly incorporate a range of trophic interactions. This gives them the flexibility to allow for complex interactions between many ecosystem components. These models take many forms, but all serve to provide insight into food web structure and function. For example, food web models can often include complexities such as feedback loops whereby populations of predators are impacted by their prey and visa versa (as reviewed by Naman et al. 2022), less direct population drivers such as competition, or emergent properties such as ecosystem stability to a range of perturbations. Some food web models have been produced in the Delta (Mac Nally et al. 2010, Rogers et al. 2024), and they have provided insights into the functioning and limiting factors of Delta food webs. However, they have been too general to apply to specific management actions, and they have generally been limited to the pelagic habitats of the Delta. Other food web models are purely conceptual in nature and lack quantitative analysis (e.g. Durand 2015) or were limited by data availability (Bauer 2010). A recent review of food web science in the Delta by the Independent Science Board concluded that forming a team to integrate multiple sources of existing data, collaborate on food web models, and guide future research would make food web research more useful for answering resource management questions and potential actions. This proposal directly addresses that recommendation.

Connecting food web models to management actions

There are a number of high-priority management questions that could be explored through food web modeling. Actions designed to increase food supplies for Delta Smelt and Longfin Smelt, including tidal wetland restoration, managed wetland food subsidies, and changes to the Sacramento Deep Water Ship Channel, could be assessed by using a model to predict the timing, magnitude, and spatial scale needed to see a population impact. Actions designed to decrease impacts of predators can also be modeled to

see what level of predator reduction is needed. Because this synthesis effort represents an initial foray into food web modeling for management guidance, the accuracy of the final model is not certain, but we can provide estimates with quantified uncertainty to guide decision-making. Furthermore, the process of developing the models, and the construction of a group of experts to consult on future evaluations, will provide valuable insight for planning improved data collection and future research and monitoring needs.

The IEP Food Web Synthesis Team was formed in the summer of 2024 to see whether food web modeling could be helpful on Delta resource management issues. The team developed a list of potential management questions that could be answered given data availability and knowledge, and a rough order of priority. **The team believes that starting with the question of food web benefits (Research Topic #1 in the table below) provided by tidal wetlands would be the best course of action** because:

1. Tidal wetland restoration is required by environmental permits for the [State Water Project and Central Valley Project](#) is a key component to the proposed [Healthy Rivers and Landscapes Program](#), and is listed in the Delta Science Program’s 2022-2026 [Science Action Agenda](#).
2. Data are now available from the [USGS Physics to Fish Synthesis Report](#) (Brown et al. 2024) and the [Fish Restoration Program Monitoring Team](#), along with many other special studies. These data capture most trophic levels of the food web across the upper estuary, and they have not yet been integrated or analyzed to their full potential.
3. Focusing on wetlands limits the scope of the exercise, ensuring it can be completed in a reasonable time frame.

However, the team wants this project to have the greatest impact possible, so if another research from Table 1 is more useful or relevant to management, they will pivot to meet the greatest need.

Table 1. Research topics that could be addressed using a food web modeling approach. The Food Web Synthesis Team suggested priorities for addressing these topics based on data availability, feasibility, and perceived usefulness, but are seeking feedback if this priority is appropriate and whether there are more specific management questions within these topics we should address.

Priority	Research topic	Why is this important?
1	Food web effects of tidal wetlands for target fish species, and how effects vary in space and time.	This would support evaluation of the scientific basis behind many of our restoration actions, including the proposed Healthy Rivers and Landscapes program and Fish Restoration program.
2	The role of food webs versus abiotic factors in limiting target fish species across regions and/or seasons of the estuary.	This would allow management actions to target improvements to habitats or regions of the estuary where target species are not doing well, and will inform restoration site selection.
3	Climate change impacts on food web structure and function.	Our management options will change with rising temperatures and rising sea levels. This question would be a 'second step' after another question is answered describing the food web.
4	Food web factors limiting salmon survival in the Delta.	Predation is frequently thought to be a major cause of mortality, but how does it compare to other stressors? This will help prioritize mitigation actions.

5	Flux of carbon throughout the food web.	This will help us tell whether management actions designed to increase productivity will make any difference.
6	Predator control actions.	Predation is frequently thought to be a major cause of mortality for salmon, so things like changing fishing regulations has been hypothesized as a management action, would it work?
7	Invasive vegetation and its control.	We spend a lot of money controlling invasive weeds, but does it do any good? How big of an impact do weeds have on fish that we care about?

Timeline and Resource Needs

This project would require staff time from a number of IEP agencies to inventory available data, develop a conceptual model relating data to management questions, translate the conceptual model into a quantitative model, and report out on findings (Figure 1). Data inventory and model selection will be an iterative process where we assess whether data are complete enough to parameterize the chosen model/question and adjust the questions and models as appropriate given data availability and uncertainty. We expect this to take 5-20% of each individual staff member’s time over approximately two years, August 2024-August 2026.

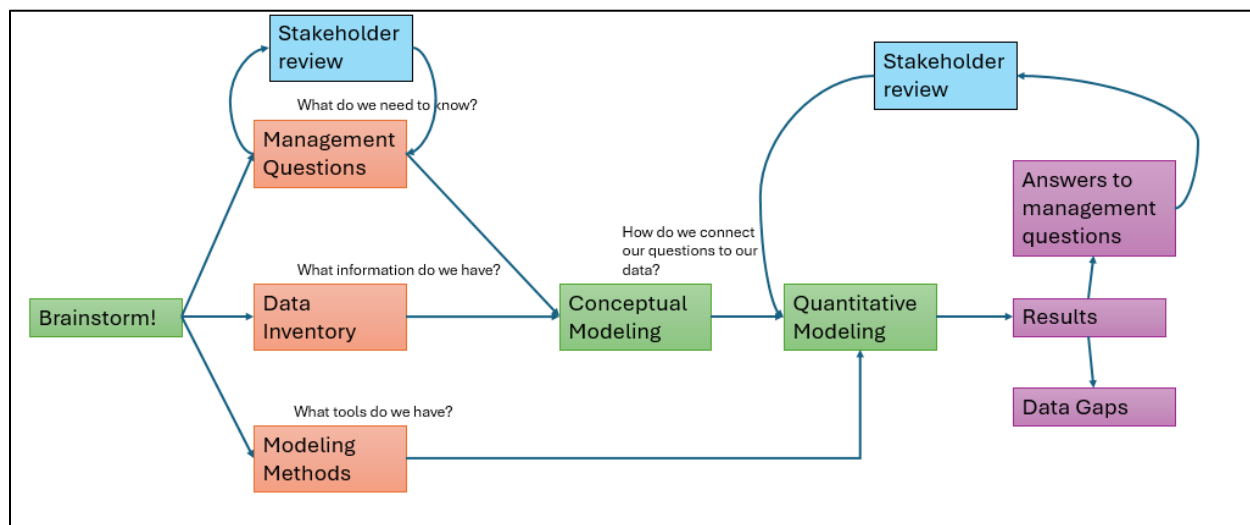


Figure 1. Process diagram showing steps in the food web modeling project.

Deliverables

- Model that can provide quantitative predictions on benefits of tidal wetlands to the food web.
- A gap analysis of existing food web datasets with recommendations for additions to existing monitoring and targeted research studies.
- Modeling framework (methods, datasets, and tools) that can facilitate the analysis of other management questions.

- One or more manuscripts for a submission to a peer-reviewed journal.

Team members (still in development)

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Management Groups Providing Feedback

- IEP Coordinators
- IEP management committee
- Interagency Adaptive Management Integration Team
- Delta Regional Monitoring Program
- Fish Restoration Program

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