Annual Update on IEP Synthesis Activities

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The IEP Synthesis Program

Interagency Ecological Program (IEP) is a platform for conducting ecological synthesis across multiple agencies to support environmental mandates, adaptive management of those mandates, and to enhance understanding San Francisco Estuary ecology. This document provides a brief summary of current synthesis projects in progress or recently completed by members of the IEP Synthesis Coordination Team, Science Management Team, Project Work Teams, and related groups. For further details on specific projects, see attached spreadsheet. This overview is an update to the document distributed in the fall of 2024.

Developing Synthesis Foundations

- **Encouraging open data practices,**
- **Integrating data sets,**
- **Improving synthesis skills**

Open data practices, chiefly implemented within the Data Utilization Work Group (DUWG, Sam Bashevkin and David Bosworth, chairs), include a continuing effort to publish IEP data on the Environmental Data Initiative (EDI), with the publication of Fall Midwater Trawl and Bay Study data published for the first time in 2025. A training on package maintenance conducted in February of 2025 increased the roster of staff helping to update integrated data sets, including discrete water quality, zooplankton, vegetation, and fish data sets. To complete the set of integrated datasets, the Phytoplankton Enumeration and Synthesis Project has developed methods to standardize data from existing sources and integrated them into a new dataset along with guidance for use (PI: Perry, DWR)

The Delta Science Program (DSP) is piloting a "Delta Science Collaboratory" designed to increase training and resources for synthesis in the system. The first

pilot effort will focus on three projects – salinity intrusion, harmful algal blooms, and wetland food webs, and each project will develop a prospectus for potential research questions and resource needs to conduct a full synthesis study. DSP has already convened two synthesis training groups (and is planning a third) in collaboration with the National Center for Ecological Analysis and Synthesis (NCEAS) that not only produced integrated data sets to answer important management questions, but also provided training on reproducible research and data science best practices.

Monitoring Reviews

- **Major projects: Monitoring Design Team; Zooplankton Gaps, Strengths, and Redundances**
- **Gaps and synthesis opportunities: Large fish**

Methods piloted in IEP's pilot review of demersal fish surveys are being used in a project evaluating IEP's existing zooplankton monitoring surveys for strengths, gaps, and redundances, which is currently underway (PI: Daniel Ellis, CDFW). The relative fish catchability analyses in for Fall Midwater Trawl, Suisun Marsh Fish Survey, and Bay Study in Huntsman et al. 2022 are being expanded to more surveys along with simulations showing that a catch-ratio approach could be used to estimate biased-corrected abundance if retention efficiency is available, and a manuscript is currently in review (PI: Brock Huntsman, USGS). The Monitoring Design Team added several new stations to the Fall Midwater Trawl to improve spatial balance, and is preparing a report on balance of the San Francisco Bay Study and potential overlap with the Fall Midwater Trawl.

Analysis of large fish data and potential for new surveys is currently paused pending management guidance.

Climate Change and Drought

- **Major projects: State of Bay-Delta Science, Drivers of Harmful Algal Blooms**
- **Gaps and synthesis opportunities: Applying climate change scenarios to existing models.**

Much of the climate change work has shifted from specific analyses of climate

change questions to incorporating climate change into every aspect of Delta ecology. For example, recent publications have analyzed how changes in flow timing in the Yolo Bypass may influence salmon production (Huntsman et al. 2024a) and how changes in water temperature may influence Delta Smelt biology (Huntsman et al. 2024b). The final paper from the original Climate Change MAST team was also published in 2025, evaluating regional differences in temperature regime and relating them to species' tolerances (Pien et al 2025).

The 2025 edition of the State of Bay-Delta science focused on extreme events, which will become more frequent over time, with articles covering the ecological and human impacts of floods, droughts, forest fires, governance, and heat waves, as well as a chapter on decision making during extreme events (contact: Maggie Christman, DSP).

Another consequence of climate change, harmful algal blooms (HABS) and the drivers of blooms have become an important focus. A multi-agency effort to develop a Cyanobacterial HABs Monitoring Strategy includes an inventory of existing HAB observations and toxin data (contact Ellen Preece, DWR). Another analysis, led by the State Water Board is analyzing these data to determine the role of flow and nutrients in driving HABs (contact Laura Twardochleb, State Water Board), and one of the case studies used for the DSP Delta Collaboratory is focusing on HABs.

Fish communities

Salmonids

- **Major projects: Structured Decision models from the CVPIA's Science Integration Team, Spring-run Juvenile Production Estimate, Salmon entrainment modeling, CSAMP Salmon Reorienting to Recovery models**
- **Gaps and synthesis opportunities: Effects of hatcheries and restoration benefits.**

Salmonids are one of the best-studied groups of fishes on the west coast of North America. Recent work includes an analysis of acoustic telemetry data to determine route use and survival of juvenile salmon (Pope et al. 2025; Buchanan 2022) as well as a report and R package to help analyze predation events from acoustic tag data. Work on the Spring-Run Juvenile Production Estimate includes

publication of data regularly on EDI and integration of existing data sets into a unified database (Contact Brett Harvey, DWR). A machine-learning based model to predict salmon salvage has been developed and regularly applied to predicting impacts of management actions (PI: Jereme Gaeta, CDFW). Another synthesis effort is underway to synthesize current scientific information to understand how interactions of salmon population structure, climate variation, water management infrastructure and actions, temperature, flow regime, predation, habitat, hatcheries and harvest influence the life history diversity of Central Vally Chinook salmon (PI: Brett Harvey, DWR). The CSAMP Reorienting to Recovery project has prepared a report analyzing a portfolio of different potential management actions using structured decision making and it looking for funding to implement these actions. There could be increased research on restoration benefits, flow modification trade-offs and the effects of hatcheries on population resiliency.

Sturgeon and other native fishes

- **Major projects: Data Integration, sturgeon telemetry.**
- **Gaps and synthesis opportunities: Early life stages. Habitat restoration. Effect of flow. Existing monitoring data may be mined for new insights on understudied species.**

Most non-ESA listed native fishes are understudied in the estuary, but some progress has been made when time permits. Efforts to mine existing data sets for cyprinid catch and catfish (Ictaluridae) continues through the Resident Fishes Project Work Team (PI: Adam Nanninga USFWS). A study funded by the Delta Science Program is working to integrate existing acoustic telemetry data on white sturgeon and has resulted in a draft manuscript (PI: Myfanwy Johnston). Sturgeon remain understudied, but some insights may be gained by mining CDFW's sturgeon tagging program (recently published online) and acoustic telemetry surveys.

Smelts

- **Major projects: Longfin life cycle model, CSAMP and DCG structured decision making, SDWSC project, monitoring program reviews**
- **Gaps and synthesis opportunities: Habitat associations and habitat**

benefits.

Delta Smelt continue to drive much of our synthesis on adaptive management of water operations, effects of altered flow regimes, and the Delta food web. Life cycle modeling and bioenergetic modeling continues to develop (Smith and Nobriga 2023, Polansky et al. 2024) and has been used for structured decision making during the summer-fall habitat action. A number of experimental cage studies of cultured smelt were conducted in 2019, and the results of all these studies have been synthesized in a recent paper highlighting best practices and future directions (Davis et al. 2024). A study on habitat benefits of the Sacramento Deep Water Ship Channel has identified importance of local estuarine turbidity maxima in explaining observed distribution of Delta Smelt, and a manuscript is currently in review in the Journal of Endangered Species Management (PI: Rosemary Hartman).

Longfin smelt science continues to develop, with the Longfin Science Plan driving projects including integration of existing data and life cycle modeling (contact: Brian Schreier, DWR, and Vanessa Tobias, USFWS). The LFS Science Plan is currently getting updated to align with the 2024 ITP and to reflect progress and knowledge updates from the first five years of the program. Several recent papers on Longfin Smelt include Tobias and Baxter (2025) which uses IEP catch data to model the population distribution and Young et al. (2024) which analyzes data on coastal habitat for Longfin Smelt during the oceanic phase of their life cycle.

Future efforts should further examine habitat associations and the direct and indirect benefits of different types of habitat for both species of smelt.

Assessing Flow Actions

- **Major projects: CSAMP and DCG, Summer-fall synthesis, First Flush synthesis**
- **Gaps and synthesis opportunities: Primary need is to increase communication of findings.**

The Delta Coordination Group, which coordinates summer-fall flow actions for Delta Smelt, is currently conducting in-depth synthesis of hydrodynamics, water

quality, zooplankton, and smelt data from all X2 and Suisun Marsh Salinity Control Gate actions 2011-2024 to support adaptive management of summer and fall flow actions (contact: Rosemary Hartman).

DWR put out a comprehensive synthesis report on the effectiveness of the North Delta Flow Action (NDFA; Davis et al. 2023, contact Brittany Davis for a copy), and four related journal articles are currently in development or in review at peer-reviewed journals. The CSAMP Structured Decision Model team has evaluated multiple scenarios of management actions to support Delta Smelt, and their draft final report suggests that actions increasing food supply and summer X2 actions are more beneficial than fall X2 actions (Crawford and Rudd 2024).

There is increasing interest in the cues for Delta Smelt migration, in particular the role of "First Flush" – the first major storm of the season. A team is beginning to analyze the responses of water quality, Delta Smelt, Longfin Smelt, and Salmon to the first major storm of the season (contact: Brian Schreier, DWR)

Food Webs and Habitats

- **Major Projects: State of Bay-Delta Science, Zooplankton PWT, NCEAS work group, Phytoplankton synthesis, Wetland Symposium, Food web synthesis**
- **Gaps and synthesis opportunities: How management actions affect the food web.**

With fish of concern becoming harder to monitor, the focus of monitoring is shifting to assessing the quality of available habitat, including aspects of the food web. Workgroups formed at the National Center for Ecological Analysis and Synthesis (NCEAS) workshop have developed a comprehensive model of foodweb drivers (Rogers et al. 2024) and a second group which analyzed the role of floodplains in productivity has a manuscript in press (Contact Shruti Khanna, CDFW). The Zooplankton project work team continues to discuss further zooplankton analyses, and recently published an analysis using the zooper integrated dataset to examine drivers of zooplankton abundance and change in community structure over time (Hartman et al 2025).

Wetlands and tidal wetland restoration continue to be an important focus, much of the work following recommendations from the 2023 Tidal Wetland Symposium

and resulting essay (Hartman et al 2024). The literature review describing research to date on wetland restoration proposed by Denise Colombano (DSP) will begin early in 2026, and a recent study examining trophic pathways to fishes in restored versus reference sites is now published (Pagliaro et al. 2025). The NCEAS workgroup formed in 2023 is looking at the social dimensions of restoration across the landscape (Contact: Xoco Shinbrot, DSP). Other studies funded by the Delta Science Program are examining sources of primary production and effectiveness of wetland restoration, with journal articles submitted and expected to be published in the December issue of SFWS (Contact: Dylan Chapple, DSP). A new synthesis project is also being proposed to evaluate the effectiveness of the Suisun Marsh plan for both aquatic and terrestrial species across the marsh (Contact: Dylan Chapple, DSP)

Food webs were the focus of a review by the Delta Independent Science Board in 2024, which included a recommendation to increase the use of quantitative food web models to answer resources management questions. Therefore, a new IEP synthesis team has been formed that will use food web models to assess effectiveness of tidal wetlands in providing food for at-risk fishes (PI: Rosemary Hartman). This project will provide a framework for food web models that can be applied to other management questions in future years. In parallel, the Delta Collaboratory is supporting a project profiling effort on food web models that aims to identify resource needs (data sets, data science training, cloud computing, etc) to help advance the state of the science (Contact: Michelle Stern, DSP).

Aquatic Vegetation

- **Major projects: Control efficacy, ecosystem engineering, niche modeling.**
- **Gaps and synthesis opportunities: Effect of aquatic vegetation on restoration, impact and gaps in the current control strategy**

We are increasing our ability to track vegetation change over time and the impact of submerged and floating weeds on the ecosystem. A project assessing the impact of *Ludwigia* as an ecosystem engineer (PI: Shruti Khanna, CDFW) has already resulted in one publication (Drexler et al. 2024) with three more forthcoming. Work by Shruti Khanna, Daniel Ellis, and Erin Hester plans to use satellite data to more readily monitor aquatic vegetation and assess the role of restoration design in limiting its spread (PI: Shruti Khanna, CDFW).

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