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 2023.

Developing Synthesis Foundations

Much of the work of the Synthesis Team in recent years has been on continuing to reinforce the foundations of synthesis work:

- **Encouraging open data practices,**
- **Integrating data sets,**
- **Improving synthesis skills**
- **Developing visualizations,**
- **Improving communication and**
- **Improving reproducibility.**

Open data practices, chiefly implemented within the Data Utilization Work Group (DUWG, Sam Bashevkin and David Bosworth, chairs), in 2024 a guide to publishing data on the Environmental Data Initiative (EDI) using the new user interface and updating guidance for adding data to the CNRA Open Data Platform. The DUWG has also continued to encourage data publication on EDI or similar portals and updated the IEP website with a comprehensive list of data sets. The synthesis

team has continued to support this work by training additional team members to update integrated data sets, including discrete water quality, zooplankton, vegetation, and fish data sets. The spring-run Juvenile Production Estimate (JPE) has improved integration of salmon data sets. The Phytoplankton Enumeration and Synthesis Project is in the process of standardizing data from existing sources so they can be integrated into the primary data set (PI: Sarah Perry, DWR). The synthesis team has also assisted in trainings through the Data Science Project Work Team, a data science training at the 2024 IEP Workshop, and provided communication outlets through the IEP Synthesis Blog, a recent podcast on Maven's Notebook, and presentations at numerous project work team meetings, IEP Stakeholder meetings, and Coordinator team meetings.

Monitoring Reviews

- **Major projects: 6-Agency Redesign; Zooplankton Power analysis;**
- **Gaps and synthesis opportunities: Proposed large fishes analysis.**

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 FMWT, Suisun Marsh 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 6-Agency Redesign effort has resulted in increased spatial balance in the Fall Midwater Trawl, with new stations in Suisun Marsh. The team is currently looking at the spatial balance of the Bay Study and potential overlap with the Fall midwater Trawl.

In 2023 the close-out of the Adult Striped Bass Study and Sturgeon survey led to interest in re-examining how larger-bodied and predatory fishes are monitored in the estuary. This led to proposal of a synthesis effort to combine existing gill net and efishing data to explore status and trends of large fish in the Delta that are not generally caught by trawl surveys. However, due to change in staffing, this project is currently paused.

Climate Change and Drought

- **Major projects: Climate change conceptual models, temperature analysis, State of Bay-Delta Science, drought.**
- **Gaps and synthesis opportunities: Applying climate change scenarios to existing models, impacts of increased floods, wildfires.**

The Climate Change Management Analysis and Synthesis Team, after completing most of their work on long-term temperature changes in 2022 (Bashevkin et al. 2022, Bashevkin and Mahardja 2022, Mahardja et al. 2022), is continuing to looking at changes to salinity and turbidity, and has applied for funding to look at changes in body size of fish and invertebrates under changing thermal regimes (Brock Huntsman, USGS, PI). 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 (Huntsman et al. 2024b).

The 2024 edition of the State of Bay-Delta science will focus on extreme events, with articles covering the ecological and human impacts of floods, droughts, forest fires, and heat waves, as well as a chapter describing governance under extreme events (contact: Maggie Christman, DSP).

The Drought Synthesis Team has completed their products developed during the 2020-2022 drought, including publication of a technical report on drought impacts and a series of journal articles published as a special issue of San Fransisco Estuary and Watershed Sciences (Hartman et al. 2024a, 2024b, Bouma-Gregson et al. 2024, Bosworth et al 2024, Barros et al. 2024). There are still opportunities for greater analysis of other climate change effects, including increasing frequency, intensity and magnitude of floods, and wildfires.

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. 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 Pete Nelson, DWR). A machine-learning based model to predict salmon salvage is also in prep (PI: Jereme Gaeta, CDFW). Another synthesis effort is underway to synthesize recent studies of juvenile salmon rearing and use of Delta and Suisun wetlands (PI: Brett Harvey, DWR). The CSAMP Reorienting to Recovery project is currently applying structured decision models to a portfolio of different potential management 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. Biotic Homogenization. Large Fishes. Cyprinids.**
- **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. A recent effort to integrate all IEP's long-term fish monitoring data led to a publication describing the spatio-temporal history of several important fishes (Stompe et al. 2023). Efforts to mine existing data sets for cyprinid catch and catfish (Ictaluridae) continues through the Resident Fishes Project Work Team (PI: Adam Nanninga USFWS), and a project examining fish community homogenization across littoral habitats in the Delta recently published its results (McKenzie et al. 2024). A study funded by the Delta Science Program is working to integrate existing acoustic telemetry data on white sturgeon (Myfanwy Johnston, PI). 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 science program, CSAMP and DCG structured decision making, 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 to identify best practices and future directions, with a manuscript in review with Conservation Physiology (Brittany Davis, PI). Longfin Smelt have not been studied as extensively as Delta Smelt, however the Longfin Science Plan includes integration of existing data and life cycle modeling (contact: Brian Schreier, DWR, and Vanessa Tobias, USFWS). 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: DOP, CSAMP and DCG, Summer-fall synthesis**
- **Gaps and synthesis opportunities: Primary need is to increase communication of findings.**

Flow actions, including fall X2, the Suisun Marsh Salinity Control Gates and North Delta Flow Action will be coordinated and synthesized by the Delta Coordination Group (DCG). The DCG, in coordination with a monitoring team made up of CDFW, DWR, and Reclamation produced a Summer-Fall Habitat Seasonal Report with a comparison of habitat across action years. In 2025 the team is planning a more in-depth synthesis of modeling and data collection to support adaptive management of summer and fall flow actions.

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

a journal article on the effort is forthcoming. The Directed Outflow Project has produced several reports and journal articles analyzing the impact of fall flow actions on zooplankton and Delta Smelt (Lee et al. 2023; Bertrand et al. 2022; Hassrick et al. 2023), and is now pivoting to further investigate estuarine turbidity maxima. 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).

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. 2023) and a second group is analyzing the role of floodplains in productivity that has a manuscript in review (Contact Shruti Khanna, CDFW). The Zooplankton project work team continues to discuss further zooplankton analyses, identification techniques, and data analysis, and an analysis is currently underway using the zooper integrated dataset to examine drivers of zooplankton abundance and change in community structure over time (Rosemary Hartman, PI).

Wetlands and tidal wetland restoration continue to be an important focus, with an essay describing the outcomes of the 2023 Tidal Wetland Symposium is currently in press at SFEWS. The literature review describing research to date on wetland restoration proposed by Denise Colombano (DSP) will begin early in 2025, and a new NCEAS workgroup formed in 2023 is looking at the social dimensions of restoration across the landscape (Contact: Miranda Tilcock, 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 next six months (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.

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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