Annual Update on IEP Synthesis Activities

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The IEP Synthesis Program

Interagency Ecological Program (IEP) conducts ecological synthesis 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 2022.

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 2023 included creating additional guidance on quality assurance procedures and developing a review of electronic data entry software. The DUWG has also continued to encourage data publication on the Environmental Data Initiative website 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, and fish data sets, as well as the new integrated vegetation dataset. 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, and provided communication outlets through the IEP Synthesis Blog, the Seasonal Monitoring Report, and a session at the 2023 IEP Workshop.

Monitoring Reviews

- **Major projects: Pilot Review effort; Zooplankton Power analysis**
- **Gaps and synthesis opportunities: Better integration with 6-agency redesign.**

IEP's pilot review of demersal fishes resulted in a technical report and several publications (IEP Long-term Survey Review Team 2021; Huntsman et al. 2022; Bashevkin 2022). Methods piloted in that effort 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 (PI: Brock Huntsman, USGS). This will be critical in developing better abundance estimates and informing how existing surveys can be adapted to improve these estimates.

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), has pivoted to looking at changes to salinity and turbidity, with plans to examine the impact of these changes on the biota in the near future. Analyses started by Dr. Larry Brown on flow inundation in the Yolo Bypass are being expanded by Marissa Wulf and Brock Huntsman (USGS) to include projected changes in timing of flows on the Bypass from climate change and the Freemont Weir Notch project and incorporating potential changes to juvenile salmonid production.

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 been completing products developed during the 2020-2022 drought, including publication of a technical report on drought impacts and a series of journal articles to be published as a special issue of San Fransisco Estuary and Watershed Sciences (estimated publication date, spring of 2024, contact: Rosemary Hartman, DWR). 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. The Central Valley Project Improvement Act (CVPIA)'s Science Integration Team (SIT) has created several decision support tools to evaluate the impact of management actions on salmon. Work on the Spring-Run Juvenile Production Estimate includes integration of existing data sets, and includes a

recent publication on methods for developing the JPE (PI: Peter Nelson, DWR), as does an effort to improve modeling of salmon salvage (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 continues through the Resident Fishes Project Work Team (PI: Eric Huber USFWS), and a project examining fish community homogenization across littoral habitats in the Delta is wrapping up (PI: Ryan MacKenzie, USFWS). 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. With the piloting of the new Enhanced Large Fishes Survey (CDFW), a new effort is beginning 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 (PI: Dylan Stompe, CDFW).

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) and has been used for structured decision making during the summer-fall habitat action. A number of experimental cage studies of cultured smelt have been conducted from 2019-2022, and the results of all these studies are currently being synthesized to identify best practices and future directions (Brittany Davis, PI). Longfin Smelt have not been studied as extensively as Delta Smelt, however a Longfin Smelt MAST report is forthcoming (PI: Christina Burdi, DWR), and 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**
- **Gaps and synthesis opportunities: Primary need is to increase communication of findings.**

Flow actions, including the Suisun Marsh Salinity Control Gates and North Delta Flow Action will be coordinated and synthesized by the Delta Coordination Group (DCG) with assistance from the FLOAT MAST team. The FLOAT MAST has contributed to the DCG's structured decision making in 2022 and 2023, results of which are included in the Summer-Fall Habitat Seasonal Report. DWR recently finished 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). The CSAMP Structured Decision Model team, while not included in the IEP workplan, is working to merge these and other management actions with smelt life cycle models to develop specific predictions for the impact of flow

management on smelt. Synthesis teams are working to streamline reporting of the results from monitoring of these actions and associated research, allowing for faster identification of trends and assessment of outcomes from management decisions.

Food Webs and Habitats

- **Major Projects: State of Bay-Delta Science, Zooplankton PWT, NCEAS work group, Phytoplankton synthesis, Wetland Symposium**
- **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. The 2022 issue of the State of Bay-Delta Science focused on primary producers, highlighting the need for greater understanding of harmful algal blooms and aquatic vegetation (Larson et al. 2023 and associated papers). Operation Baseline continues to study the impact of nutrient reduction on phytoplankton and zooplankton in the Delta (See Thompson et al. 2023). The Phytoplankton and Water Quality Project Work Team has also been revitalized as a forum for integration of phytoplankton data and observations.

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 (Contact: Pascale Goertler, DWR). The Zooplankton Synthesis Team formed a new project work team to discuss further zooplankton analyses, identification techniques, and data analysis, and a recent paper uses the zooper integrated dataset to track long-term changes in species distribution (Bashkevkin et al. 2023).

Wetlands, and tidal wetland restoration have had increased focus in 2023, with the organization of a Wetland Symposium to develop a list of high-priority science actions regarding restoration in the Delta. A proposed project lead by Denise Colombano (DSP) will provide a comprehensive literature review on the state of the science in Wetland Restoration, and a new NCEAS workgroup formed in 2023 is looking at the social dimensions of restoration across the landscape (Contact:

Pascale Goertler, DWR). 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).

Aquatic Vegetation

- **Major projects: Dataset integration, control efficacy, ecosystem engineering, State of Bay-Delta Science.**
- **Gaps and synthesis opportunities: Effect of aquatic vegetation on restoration, impact and gaps in the current control strategy**

We are gaining in our ability to understand the effectiveness of vegetation control techniques with publication of the State of Bay Delta Science (Larson et al. 2023 and related papers), publication of a journal article on a special study of fluridone effectiveness (Rasmussen et al. 2022), and a landscape-scale analysis of fluridone effectiveness (Khanna et al. 2023). The aquatic vegetation PWT has integrated five vegetation surveys into an single database of rake samples to allow for increased analytical power (Rasmussen et al. 2023). Another project has completed several manuscripts assessing the impact of *Ludwigia* as an ecosystem engineer (PI: Shruti Khanna, CDFW). However, the effect of invasive aquatic vegetation on wetland restoration, and the potential to design restoration sites to exclude invasive vegetation are understudied, and will be one of the topics discussed at a Wetland Symposium in fall of 2023. In addition, science-based evaluation of newly-implemented and proposed control techniques is needed to maximize efficacy and minimize negative ecological impacts.

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