June 2021

Science Action Agenda Progress Summary

Reporting Progress on the 2017-2021 Science Action Agenda

Delta Science Program

DELTA STEWARDSHIP COUNCIL

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Why track progress on the 2017-2021 Science Action Agenda?

The Delta Science Program is committed to providing the best possible unbiased scientific information to inform water and environmental decision-making in the Delta. Critical to the success of this mission is funding research, communicating scientific progress, and coordinating with Delta agencies and entities. The Delta Science Program is tracking progress on the 2017-2021 Science Action Agenda (SAA) to further this mission and inform the SAA update for 2022-2026. The SAA for the Sacramento-San Joaquin Delta, is a collaboratively developed document that prioritizes and aligns science actions to meet management needs. The SAA is used to guide science funding—over $36 million during the lifespan of the 2017-2021 SAA—and is updated every four to five years.

The overarching goal of this Progress Summary (Summary) is to determine what progress has been made to address the 25 science actions identified in the 2017-2021 SAA. More specifically, this Summary provides three key benefits: 1) it serves to document progress made on 2017-2021 SAA Science Actions and relevant activities—part of the "evaluation" phase in the adaptive management cycle; 2) the progress documented helps to inform the "response" phase of identifying new actions in the 2022-2026 SAA; and 3) it offers a gauge of the return on investment from the Delta Science Program's and its partners' funding efforts, which are guided by the SAA.

This is the first attempt to formally track progress in addressing the Science Actions outlined in the SAA and feedback is welcomed. A draft Progress Summary was circulated for public review in late Spring 2021 and comments were received via online survey.

2017-2021 SAA

The 2017-2021 SAA was developed collaboratively in 2016 and includes 25 Science Actions grouped into the following five Action Areas:

Action Area 1: Invest in assessing the human dimensions of natural resource management decisions.
Action Area 2: Capitalize on existing data through increasing science synthesis.
Action Area 3: Develop tools and methods to support and evaluate habitat restoration.
Action Area 4: Improve understanding of interactions between stressors and managed species and their communities.
Action Area 5: Modernize monitoring, data management, and modeling.

Summary approach

Information needed to assess progress

Progress was assessed based on the relevant activities addressing the Science Actions and the status of those activities. This Summary only considers projects initiated, ongoing, or completed between 2016-2021. Types of activities included funded research (e.g., through Delta Science Program Proposal Solicitation, California Department of Fish and Wildlife's Prop 1 Restoration Grant Program), monitoring (e.g., efforts collecting needed information), modeling and synthesis (e.g., integrated models), programs (e.g., new or existing programs specifically or indirectly informing an action, such as Wetlands Regional Monitoring Program), projects (e.g., Delta Adapts, CSAMP Structured Decision Making), reviews (e.g., Delta Independent Science Board), publications, and outreach/communications (e.g., symposia). In addition to the type of activity, the Delta Science Program also compiled what part(s) of the Science Action the activity was addressing, the timeline for completion, current status of the activity, and the primary entity performing the work.

Status of progress made

The 25 Science Actions were assigned to one of four general status categories. While in reality there is a gradient of progress, not discrete categories, the progress bins here provide an approach to distill observations from the inventory of completed and ongoing activities.

- Significant progress with management impact: 5+ activities; and/or results from activities are leading to significant gains in knowledge regarding the Science Action and actively informing management decisions.
- Significant progress: 5+ activities; and/or results from activities are leading to significant gains in knowledge regarding the Science Action.
- Moderate progress: 3-4 activities; and/or results from activities are leading to moderate gains in knowledge regarding the Science Action, but important knowledge gaps remain.
- Early progress: 1-2 activities; and/or progress on the action is in early stages, or results from activities are leading to incremental gains in knowledge regarding the Science Action.

After tallying the activities and proportional breakdown by activity type, and considering their contributions to the Science Actions, a progress status was assigned for each of the 25 Science Actions. The general progress for each of the five major Action Areas was then evaluated.

Outreach

The Delta Science Program drafted an initial Summary in early 2021, which included the list of activities contributing to the Science Actions and relevant project details. The draft list of

activities was circulated for targeted input from relevant entities and program leads throughout the Bay-Delta and this step added substantially to the list of completed and ongoing activities. The Delta Science Program then synthesized the feedback to generate a draft Summary for broader public review. Feedback from the public review period is described below.

Disclaimer

It is worth noting that this Summary is an imperfect process and we acknowledge the following caveats: not all activities and activity types are equally comparable (e.g., activities, like restoration, take significant time to see progress); the progress status definitions are used as guides; San Francisco (SF) Bay projects (e.g., Estuary Blueprint (CCMP)) were important to include in this review, but did not contribute to the Science Action status unless directly impacting the Delta (e.g., Suisun Marsh) or providing tools and applicable knowledge for the Delta.

Draft Summary feedback

The draft Progress Summary was circulated for public review between April 27 to May 10, 2021. A total of 33 participants accessed the survey, but individual responses varied by Action Area and Science Action, ranging from 12 to 16 reviews of the status (Table 1).

A total of 32 activities were added to the list following the public review and used to update Science Action progress statuses, as needed. While the degree of familiarity varied by Science Action, most respondents agreed with the draft progress statuses identified by the Delta Science Program in the draft Summary. Only one Science Action progress status was changed. Considering the feedback that there has been moderate progress on laying the groundwork to be able to invest in human dimensions research, but more is needed to actually see 'progress' on the science action of initiating a research program to support the social sciences, the status for Science Action 1C was changed from "Moderate" to "Early Progress." To capture progress made on the Science Actions identified in the 2017-2021 SAA, this **Summary only considers projects initiated, ongoing, or completed between 2016-2021**.

Six participants responded to the question, "Is there anything else we should know?" Key suggestions included expanding on how the types of activities differ (e.g., funded research vs. project) and adding more details to the appendix. Reviewers noted that it would be useful to assess progress in the context of the baseline and challenges ahead.

Ten participants responded to the question, "This is our first attempt at tracking progress on the SAA – do you have any feedback on the process?" Comments were generally positive, encouraging the effort to try to track progress now and in the future (e.g., ideally with a more systemic tracking method in real time). Some reviewers asked for clarification regarding the inclusion of SF Bay activities, and noted specific Delta activities that should

have been included in the draft Summary. As appropriate and if occurring within the timeframe for the Summary, these activities are now included.

Table 1. Public survey responses on the draft progress status for each of the 25 Science Actions in the 2017-2021 SAA.

Science Action	Draft Progress Status	# of reviewers (answered / skipped)	% unfamiliar with specific science action (count)	% Yes (count)	% No. What status do you suggest? (count)
1A	Moderate	12 / 22	25% (3)	75% (9)	0% (0)
1B	Significant	15 / 20	0% (0)	100% (15)	0% (0)
1C	Moderate	14 / 20	~21% (3)	~57% (8)	~21% (3 – Early Progress)
A1A	Early	13 / 21	~39% (5)	~62% (8)	0% (0)
A1B	Moderate	13 / 21	~31% (4)	~69% (9)	0% (0)
A1C	Early	12 / 22	50% (6)	50% (6)	0% (0)
2A	Significant	13 / 21	~8% (1)	~92% (12)	0% (0)
2B	Significant	13 / 21	~23% (3)	~69% (9)	~8% (1 – Moderate progress)
A2A	Early	12 / 22	75% (9)	25% (3)	0% (0)
A2B	Early	12 / 22	~42% (5)	~58% (7)	0% (0)
3A	Significant	14 / 20	~14% (2)	~71% (10)	~14% (2 – Moderate progress)
3B	Early	13 / 21	~31% (4)	~62% (8)	~8% (1)
A3A	Early	14 / 20	~7% (1)	~86% (12)	~7% (1 – Early progress)
A3B	Moderate	13 / 21	~31% (4)	~69% (9)	0% (0)
4A	Significant	14 / 20	~14% (2)	~71% (10)	~14% (2 – Moderate progress)
4B	Significant	14 / 20	~21% (3)	~71% (10)	~7% (1 – Moderate progress)
4C	Significant	14 / 20	~7% (1)	~79% (11)	~14% (2 – Moderate progress)
4D	Significant	14 / 20	~29% (4)	~64% (9)	~7% (1 – Moderate Progress)
A4A	Moderate	13 / 21	~23% (3)	~69% (9)	~8% (1 – Significant Progress)
A4B	Early	13 / 21	~62% (8)	~38% (5)	0% (0)
5A	Moderate	15 / 19	0.00% (0)	100% (15)	0% (0)
5B	Significant	16 / 18	~6% (1)	~81% (13)	~13% (2 – Moderate Progress)
A5A	Moderate	16 / 18	~13% (2)	~81% (13)	~6% (1 – Significant progress with

					management implications)
A5B	Early	16 / 18	~31% (5)	~56% (9)	~13% (2 – Moderate Progress)
A5C	Moderate	16 / 18	~50% (8)	~44% (7)	~6% (1 – Early progress)

A detailed summary of feedback received for each Action Area and Science Action are listed in Appendix B.

Next steps

The Summary will be used to inform a workshop, to be held July 13-14, 2021, focused on identifying Science Actions for the 2022-2026 SAA. Registration is open through` mid-June.

Visit the Delta Stewardship Council's SAA webpage or contact SAA@deltacouncil.ca.gov for any questions or to learn more about the Summary and SAA update.

Action Area 1: Invest in assessing the human dimensions of natural resource management decisions

Moderate progress has been made in investing in assessing the human dimensions of natural resource management decisions as shown in Table 2 and Figure 1.

Table 2. Action Area 1 Summary table of Science Action progress to date.

SCIENCE ACTION	STATUS
1A: Investigate the most cost-effective methods to improve **species habitat on working lands**	Moderate Progress
1B: Develop tools to assist **adaptive management** in the Delta	Significant Progress
1C: Initiate a **research program** on the Delta as an evolving place that integrates the physical and natural sciences with the **social sciences**	Early Progress
A1A: Implement studies to understand socio-economic **adaptations to climate change** (e.g., human behavioral response in the agriculture sector to changes in water prices)	Early Progress
A1B: Develop methodology for assessing the long-term **costs and benefits of managed wetlands and ponds**	Moderate Progress
A1C: Initiate **Delta levee risk assessment studies** that address individualized levee fragility curves, identify levee sections most subject to earthquake-induced liquefaction, clarify attenuation of ground motions from Bay Area earthquakes, monitor land-level changes adjacent to levees post-earthquakes, hydrodynamic studies to project magnitude of levee breaches, duration, and severity of disruption	Early Progress

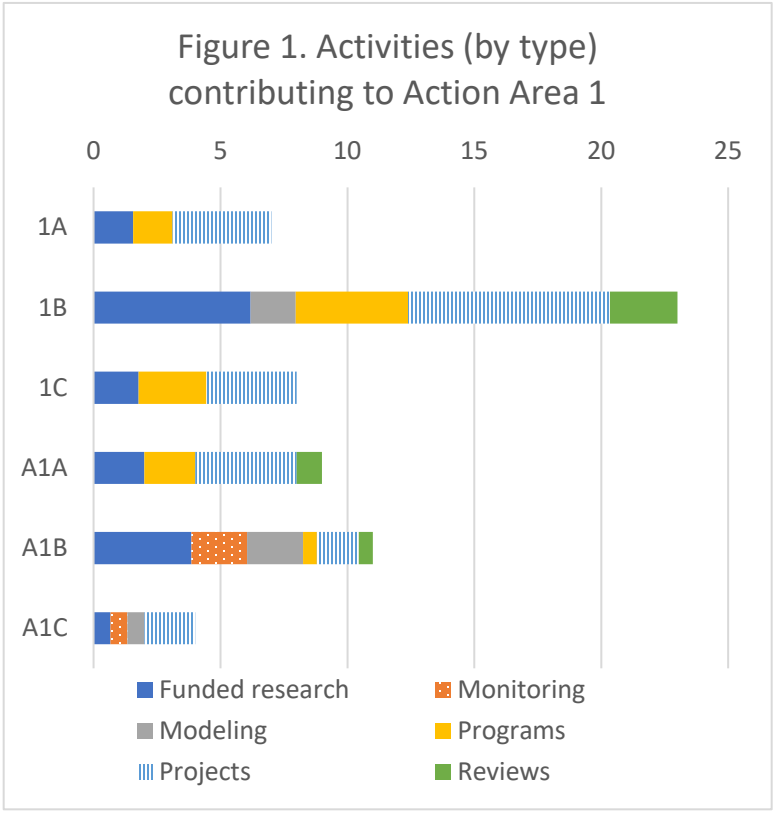

Figure 1. Activities (by type) contributing to Action Area 1

Primary Science Actions

- The majority of activity on investigating the most cost-effective methods to improve **species habitat on working lands (1A)** is from projects, with some funded research and programs. Few activities directly consider and analyze monetary costs or accrued benefits, but do provide tools for evaluation of tradeoffs, best management practices for grazing and pesticide management on working lands in the SF Bay and Delta, carbon sequestration benefits, and more. Many projects are still in progress or not yet completed.
- Many activities provide examples or results to inform **adaptive management (1B)** of resources such as longfin smelt growth and invasive species control, or document progress made in the SF Bay. Some provide tools (e.g., structured decision-making for Delta Smelt, winter run life-cycle model, Adaptation Atlas, Delta Landscape Scenario Planning Tool) more broadly to support adaptive management in the Delta. Many programs were formed and/or continue to support adaptive management (e.g., Interagency Adaptive Management Integration Team, Suisun Adaptive Management Advisory Team, Collaborative Adaptive Management Team). Most activities are funded research efforts and projects, many of which anticipate outreach and publications.
- A few activities, mostly programs and projects, support the development of **social science** understandings of the Delta as an evolving place, with multiple completed and anticipated publications and outreach efforts. A few activities catalyzed (e.g., hiring a Delta Social Science Extension Specialist) and provided the groundwork for an initiated, but early stage, effort to build a more coordinated social and interdisciplinary science **research program (1C)** to understand the Delta as an evolving place and the people within the system.

Additional Science Actions

- Most progress made to implement studies to understand socio-economic **adaptations to climate change (A1A)** are from completed or ongoing projects and programs (e.g., Delta Adapts, Adapting to Rising Tides). Funded research efforts are contributing to adaptation of greenhouse gas emissions and perceptions of risk of Delta levees. Most activities include an outreach component and half have produced or will produce a publication.
- Progress to develop methodology for assessing the long-term **costs and benefits of managed wetlands and ponds (A1B)** include funded research on ecosystem services of restoration, climate benefits and ecosystem functions of managed wetlands (including for waterfowl in the Central Valley and Suisun Marsh), and best management practices for managed wetland habitats throughout the Bay and Delta. A majority of activities have completed or will complete a publication.
- Progress to initiate **Delta levee risk assessment studies (A1C)** and other impacts to earthquake-induced risks include a Delta-wide levee investment strategy, Delta levee risk assessment research, and initial support to incorporate disaster recovery and hazard mitigation planning into the SF Bay Area.

Action Area 2: Capitalize on existing data through increasing science synthesis

Significant progress has been made in capitalizing on existing data through increasing science synthesis as shown in Table 3 and Figure 2.

Table 3. Action Area 2 Summary table of Science Action progress to date.

SCIENCE ACTION	STATUS
2A: Strategically build the capacity to do **collaborative science synthesis** by implementing the science synthesis mechanisms outlined in the Delta Science Plan	Significant Progress
2B: Identify and prioritize important **data sources** that should be **interconnected** to promote collaboration and provide the technology necessary to easily access this information	Significant Progress
A2A: Develop improved **sturgeon abundance estimates** through modeling and synthesizing data from cohort abundances studies, surveys, and report cards	Early Progress
A2B: Produce a **system-wide analysis** of existing **telemetry** results to provide an understanding of fish movement and predation	Early Progress

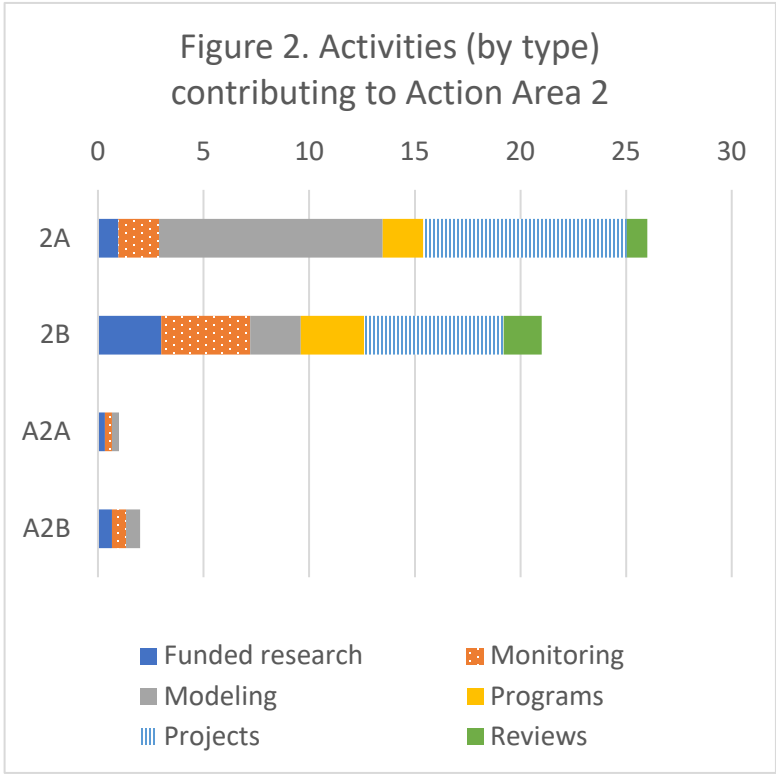

Figure 2. Activities (by type) contributing to Action Area 2

Primary Science Actions

- Building the capacity to do **collaborative science synthesis (2A)** has progressed significantly. Some synthesis efforts are topic-specific and provide examples of how to build capacity (e.g., primary production, fish community resilience, lamprey, nutria forecasting, striped bass, salmon salvage), while others are more comprehensive and cross-cutting across topics and disciplines (e.g., coordinated flow action synthesis, State of Bay-Delta Science). Activities include modeling and projects, and most have produced or anticipate producing publications. Programmatic actions that add general capacity for synthesis work in the form of increased scientific staff resources or established coordination groups (responsive to Delta Science Plan Action 3.11) has seen major progress.
- Significant progress has been made in identifying and prioritizing important **data sources** for **interconnection (2B)**, collaboration, and sharing. Many activities (primarily funded research, synthesis of monitoring data, and projects) are ongoing, completed or partially complete. Some build off of existing efforts or entities, such as the Environmental Data Initiative and IEP Data User Work Group. These include integration of multiple large datasets (e.g., fish and zooplankton sampling, nutrients), topical reviews (non-native species, monitoring enterprise), symposia (e.g., salinization), and online platforms for data sharing (e.g., Bay Delta Live, SacPAS, Shiny pages). Most activities will produce or have produced publications and contain outreach components (e.g., conferences, workshops, meeting presentations).

Additional Science Actions

- Progress to develop improved **sturgeon abundance estimates (A2A)** is ongoing and supported by a funded research effort analyzing existing acoustic telemetry data for improving population size estimates for green sturgeon and helping with the recovery and management of this species. This work is supported by an additional synthesis effort focused on sturgeon and salmon in the Delta, but more work and participation is needed to bring this Science Action to the level of informing management or altering long-term monitoring programs. Existing projects anticipate publications.
- Progress in producing a **system-wide analysis** of **telemetry (A2B)** data to understand fish movement is ongoing and supported by one focused synthesis effort of existing telemetry data. The work of a collaborative group focused on telemetry and integrated studies that utilize telemetry data is also furthering this Science Action. Existing projects anticipate publications. None have focused explicitly on predation.

Action Area 3: Develop tools and methods to support and evaluate habitat restoration

Moderate progress has been made in developing methods to support and evaluate habitat restoration as shown in Table 4 and Figure 3.

Table 4. Action Area 3 Summary table of Science Action progress to date.

SCIENCE ACTION	STATUS
3A: Develop methods for **evaluating long-term benefits of habitat restoration** based on current understanding of how species use restored areas and how use changes over time as habitats evolve.	Significant Progress
3B: Estimate and assess the **system-wide effects of** location and sequence of **tidal marsh habitat restoration projects** in regions where sea level is rising and climate is changing	Early Progress
A3A: Review effort to examine **effectiveness of habitat restoration**	Early Progress
A3B: **Collect environmental, social, and economic baseline data** and develop a **database of pre-project habitat conditions at the landscape scale** (e.g., native species presence/condition, water quality, current food and predator densities, condition in adjacent channels, and socio-economic valuations of management practices and environmental stewardship)	Moderate Progress

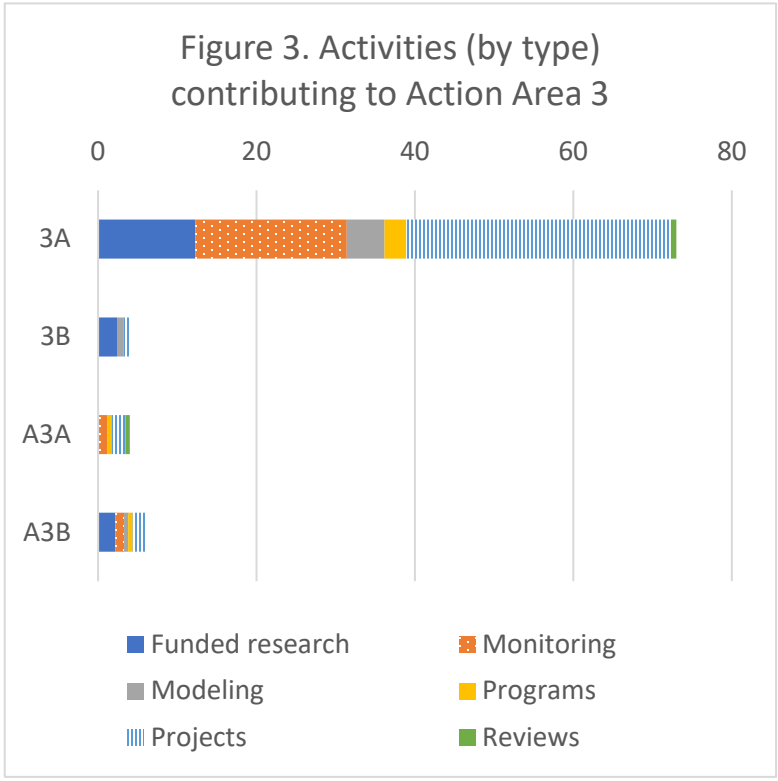

Figure 3. Activities (by type) contributing to Action Area 3

Primary Science Actions

- Efforts to develop methods for **evaluating the long-term benefits of habitat restoration (3A)** have progressed significantly, owing in large part to the development, progress, and completion of five particularly relevant activities, consisting of the Delta Landscapes Scenario Planning Tool, EcoAtlas, Delta Landscapes Primary Production, and the Chinook salmon quantification tool, and the IEP Tidal Project Work Team's conceptual and methodological framework to assess the effectiveness of restoration efforts. A large portion of other activities consist of on-the-ground, (tidal) restoration projects or programs (at varying levels of completion), with a smaller subset of these including funded research and monitoring. Another portion of activities is aimed largely at answering key questions about restoration, including about agricultural floodplain habitat, upstream habitat for salmon, ecological functions of tidal marshes and more, accounting for at least 23 publications (completed or forthcoming).
- With four activities primarily contributing to this science action (all ongoing or initiated), progress toward estimating and assessing the **system-wide effects of tidal marsh habitat restoration projects (3B)** in the context of climate change and sea-level rise has been minimal. While there is a good mix in the type of activities (funded research, monitoring, modeling, etc.) and these activities will undoubtedly help to inform this science action (e.g., better understanding marsh accretion, effects of *Phragmites* in Suisun Marsh, assessing nutrient storage and release in the Delta), few directly address this Science Action.

Additional Science Actions

- With four ongoing activities primarily contributing to this science action, and two activities contributing secondarily, progress reviewing efforts to examine **effectiveness of habitat restoration (A3A)** can be characterized as early. Of the activities, only one synthesis of restoration in the Delta and Suisun Marsh specifically addresses the Science Action, while the other activities—relating to fish restoration monitoring, fish passage, wetlands monitoring, Yolo Bypass tributary flow monitoring—indirectly inform the Science Action. Notably, few restoration projects have been completed and available for evaluation during this period of time evaluated.
- Six activities directly contribute to the **collection of a wide-range of environmental, social and economic baseline data (A3B)** (e.g., Delta Aquatic Resource Inventory for Landscape Scale Evaluation of Wetlands in the Delta and Suisun Marsh, microplastics) across a range of types of activities—including three expected or completed publications—with four of those five activities arguably qualifying as specific examples of a **database of pre-project habitat conditions at the landscape scale** (e.g., Chinook salmon rearing habitat mapping, fish predation on a landscape scale, Ecosystem Enhancement Tool in Coyote Creek). Given the nature and number of these activities and the appreciable gains of knowledge associated with them, the progress in achieving this Science Action can be characterized as moderate.

Action Area 4: Improve understanding of interactions between stressors and managed species and their communities

Significant progress has been made in improving understanding of interactions between stressors and managed species and their communities as shown in Table 5 and Figure 4.

Table 5. Action Area 4 Summary table of Science Action progress to date.

SCIENCE ACTION	STATUS
4A: Implement studies to better **understand the ecosystem response before, during, and after major changes in the amount and type of effluent from large point sources in the Delta** including water treatment facilities	Significant Progress
4B: Identify **areas that act as refugia for species of concern during extreme conditions**, particularly drought and flood, to inform management decisions and priorities during extreme climate events	Significant Progress
4C: Understand mechanisms for observed **relationships between flows and aquatic species**	Significant Progress
4D: Evaluate the **effects of toxicity** (e.g., contaminant mixtures, mercury, pharmaceutical products, HABs) **on aquatic species survival** including possible effects on predation	Significant Progress
A4A: Better understand **salmonid temperature tolerances in streams and rivers**	Moderate Progress
A4B: Identify **effective mechanical and biological control strategies** for established **non-native clams and potential invasive mussels**, including developing effective prevention measures for potential invaders	Early Progress

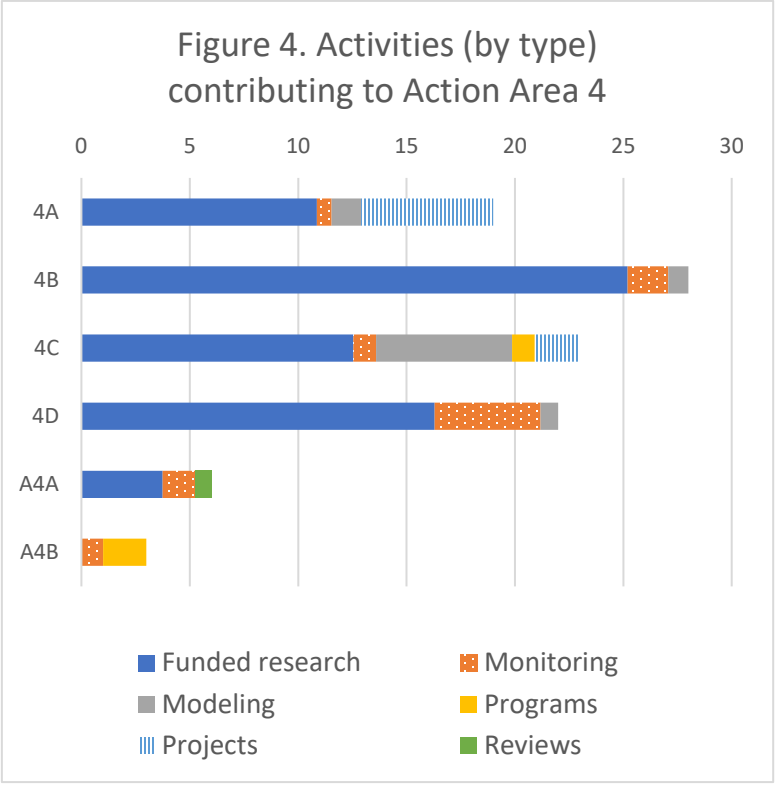

Figure 4. Activities (by type) contributing to Action Area 4

Primary Science Actions

- Most activity to better **understand the ecosystem response to changes in the amount and type of effluent from large point sources in the Delta (4A)** is ongoing. Most completed activities are part of a research effort to establish a baseline before the wastewater treatment facility upgrade. Ongoing activities include synthesis and model development for nutrient sources, sinks and transformations, copepod feeding, reproduction, growth and habitat preferences, in-river wastewater presence vs. absence, and extensive monitoring before and during a regional wastewater facility upgrade.
- Activities to identify **areas that act as refugia for species of concern during extreme conditions (4B)** are evenly split between complete and ongoing. Activities (primarily funded research) address refugia, drought, flow, and toxicity effects for different life stages of smelt and salmon, but also rare terrestrial studies (i.e., salt marsh harvest mouse and transition zones).
- Activities to understand mechanisms for observed **relationships between flows and aquatic species (4C)** are completed and ongoing. Many activities involve synthesis and modeling. Specific topics include longfin smelt/ flow study, salvage model for Delta smelt, climate change effects on estuarine fish, salinity tolerance of overbite clam, plant diversity for waterfowl management, a steelhead behavior model, and more.
- Activities to evaluate the **effects of toxicity on aquatic species survival (4D)** are mostly ongoing. Activities (primarily funded research) are investigating toxicity alone and in combination with temperature, drought, spring outflow, cyanobacteria presence, and herbicide and pesticide stress to species, among others. Additional activities include developing a web-based tool for pesticide contribution, monitoring for harmful algal blooms and contaminants of emerging concern, and developing a model quantifying contaminant group exposure.

Additional Science Actions

- Activities to better understand **salmonid temperature tolerances in streams and rivers (A4A)** are split between complete and ongoing. Activities investigated and reviewed thermal physiology and temperature effects on salmon at egg stage to the impact of disease and diet availability.
- Three ongoing projects all address invasive species in general, but do not identify **effective mechanical and biological control strategies for** established **non-native clams and potential invasive mussels (A4B)** in particular.

Action Area 5: Modernize monitoring, data management, and modeling

Moderate progress has been made in modernizing monitoring, data management, and modeling, particularly for innovative technologies and cost-effective methods for scientific monitoring and analysis as shown in Table 6 and Figure 5.

Table 6. Action Area 5 Summary table of Science Action progress to date.

SCIENCE ACTION	STATUS
5A: Advance **integrated modeling** through efforts such as an open Delta collaboratory (physical or virtual) that promotes the use of models in guiding policy	Moderate Progress
5B: Explore **innovative** technologies and cost-effective methods for scientific **monitoring and analysis** of flow, water quality, and ecosystem characteristics (e.g., improved tools for fish monitoring, LiDAR, high-resolution bathymetry technology, new measurements for Delta levee hazards, and citizen scientist monitoring programs)	Significant Progress
A5A: Build on existing **models to integrate fish and water quality monitoring data** to report, simulate, and forecast distribution of salmon runs in time and space. These actions should be coordinated with tagging studies and other monitoring data to provide accurate and consistent interpretation of information to support decision-makers (e.g., coupling 3-D hydrodynamic modeling of the Delta with juvenile salmon behavior and survival)	Moderate Progress
A5B: Conduct **baseline surveys** throughout **spawning habitat**, map egg collection and larval rearing habitat, and quantify availability using various characteristics identified through egg sampling (water temperature, depth, velocity, substrate, etc.)	Early Progress
A5C: Develop and implement a Bay Area and Delta **regional wetland monitoring** program	Moderate Progress

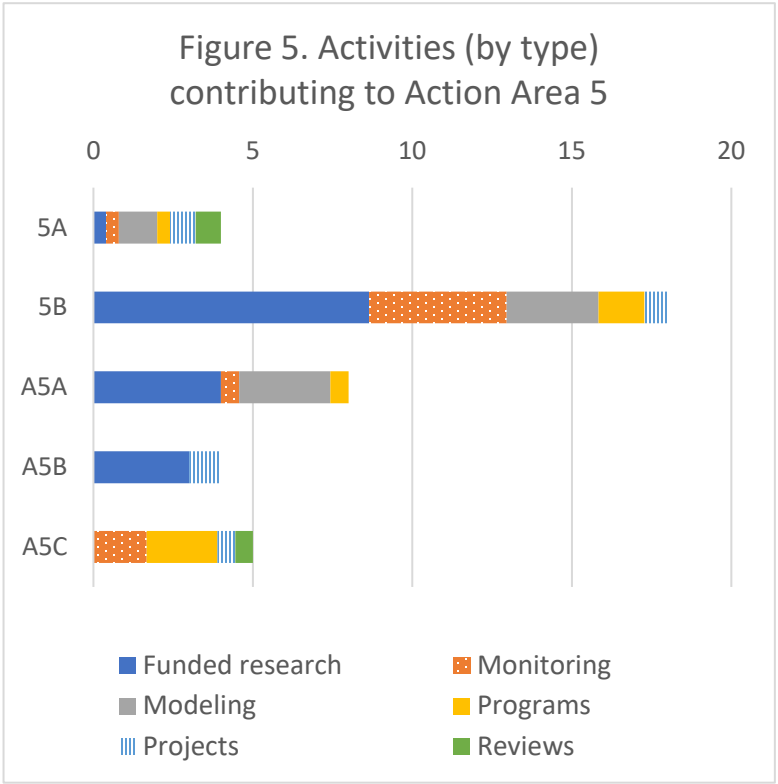

Figure 5. Activities (by type) contributing to Action Area 5

Primary Science Actions

- Most activities contributing to **integrated modeling (5A)** are ongoing or partially complete. Activities directly informing the Science Action include helping to advance integrated modeling by supporting a virtual (or physical) Delta Collaboratory, reviewing the effectiveness of monitoring, and supporting model integration to enhance Delta management. Specific integrated modeling activities (e.g., nutria forecasting, wastewater treatment upgrade effects, and picoplankton baseline data) are supporting this Science Action. All activities have produced or anticipate producing publications.
- Most activities contributing to **innovative monitoring and analysis (5B)** are funded research efforts that are ongoing, completed, or partially complete. Activities range from isotopic food web models and improved methods for supporting life cycle models, rapid fish identification, and eDNA barcoding, to understanding pathogens, mapping aquatic vegetation, and piloting a citizen science project. The Delta Consumptive Use Study and updates to modeling protocols also inform this science action. Most activities anticipate or have produced a publication. A symposium focused on remote sensing for invasive species management was hosted in 2019.

Additional Science Actions

- Primarily funded research and modeling efforts, ranging from initiated to complete, contributed to **models that integrate fish and water quality monitoring data (A5A)**. These activities build off of existing use of real-time data and modeling to inform Science Action A5A by monitoring and modeling salmonid migration (including smolts) and habitat effects, pathogen exposure, and more.
- The efforts (primarily ongoing funded research) helping to address **spawning habitat baseline surveys (A5B)** include the development of a tool for high accuracy identification of juvenile Chinook salmon, examining larval Longfin Smelt habitat, and monitoring Delta rearing contributions for salmonids. The ongoing work to monitor and document and share data (e.g., Central Valley Project Improvement Act (CVPIA) Science Integration Team (SIT)) from multiple agency programs also contributes to A5B.
- Efforts to inform **regional wetland monitoring (A5C)** include ongoing activities to monitor existing and sentinel sites, compile and share data, and synthesize information for wetlands, streams, and water quality throughout the SF Bay and Delta.

Appendix A: List of activities contributing to each Action Area

The below list is sorted alphabetically by activity title. **An activity is only listed once under the Action Area that the activity is contributing to most significantly**, but they may be contributing to multiple Action Areas/Science Actions.

Action Area 1: Invest in assessing the human dimensions of natural resource management decisions.

- A review of the Interagency Ecological Program's ability to provide science supporting management of the Delta
- Adaptation Atlas
- Adapting to Rising Tides Report (part of CCMP Action 15, Task 15.3)
- American Carbon Registry protocol for Delta wetlands
- Assessing the carbon and climate benefit of restoring degraded agricultural peat soils to managed wetlands
- Education, update, progress reporting, and communication of CCMP (part of CCMP Action 32)
- Central Valley Joint Venture - Conserving Bird Habitat - 2020 Implementation Plan
- CSAMP Structured Decision-making model
- CVPIA SIT
- Defining the architecture and recurrence interval for faults in the Sacramento-San Joaquin Delta: Assessing potential geohazards
- Best practices for nature-based shorelines and pilot projects for nature-based shorelines to increase resiliency (part of CCMP Action 14, Task 14.3, 14.4a)
- Assessment of drought planning (part of CCMP Action 19, Task 19.1)
- Delta Conservation Framework
- Delta Levees Investment Strategy (part of CCMP Action 16, Task 16.1)
- Delta Stewardship Council and California Sea Grant Delta Social Science Extension Specialist
- Economic Sustainability Plan update
- Effect of temperature and salinity on physiological performance and growth of longfin smelt: Developing a captive culture for a threatened species in the Sacramento/San Joaquin Delta
- Environmental Justice White Paper
- Hold meetings to collaborate and expand use of recycled water and promote existing outreach activities and info sharing for educating the public about recycled water (part of CCMP Action 22, Task 22.1, 22.2)
- Promote existing outreach activities and info sharing for educating the public about recycled water (part of CCMP Action 22, Task 22.1)
- Facilitation support for CSAMP/CAMT

- Fisheries biologist expertise for Phase II of Delta Smelt Structured Decision Making for CAMT
- Franks Tract Futures
- Grazing best practices for seasonal wetland protection (part of CCMP Action 8, Task 8.3)
- Human Dimensions Research in Delta Environments
- Evaluate BMPs for Suisun to improve water quality (part of CCMP Action 27, Task 27.2)
- Implementation of Best Management Practices in the Delta: A Comprehensive Pesticide Management Project to Improve Water Quality
- Interagency Adaptive Management Integration Team (IAMIT)
- Multi-benefit climate adaptation projects recommendations report (part of CCMP Action 17, Task 17.3a)
- Technical assistance; disaster recovery and hazard mitigation plan development (part of CCMP Action 16, Task 16.2-16.3)
- Integrated science and management of nutrient, salt, and mercury export from San Joaquin River wetland tributaries to the Delta
- Landscape Visioning Pilot Application for Staten Island
- Managing agricultural soils for carbon and water benefits in the California Delta: Understanding influences on decision-making and practice adoption of in-Delta farmers
- Methodology for assessing the long-term costs and benefits of managed wetlands and ponds and study of managed wetland functions (part of CCMP Action 6, Task 6.3-6.4)
- Next Generation Multi-Hazard Levee Risk Assessment
- Perceptions of Risk and Management of the Delta Levee System
- Population and Habitat Objectives for Avian Conservation in California's Central Valley Riparian Ecosystems
- Recreational hunting as an ecosystem service of restoration in the Bay-Delta watershed
- Re-establish vernal pool stewardship to protect, restore, and enhance seasonal wetlands (part of CCMP Action 8, Task 8.1)
- Reevaluating ecosystem functioning and carbon storage potential of a coastal wetland through integration of lateral and vertical carbon flux estimates
- Assistance for climate change planning and adaptation and resiliency update for Plan Bay Area (part of CCMP Action 15, Task 15.1, 15.2)
- Assist with multi-benefits projects (part of CCMP Action 12, Task 12.1)
- Sacramento River Winter-run Chinook salmon life cycle model
- Simulating methylmercury production and transport at the sediment-water interface to improve the water quality in the Delta

- Social Science Strategy for the Sacramento-San Joaquin Delta
- Socioeconomic Indicators Report
- Soil type as a driver of agricultural climate change response in the Sacramento San Joaquin Delta
- Support for NGO technical staff participation in the Delta Smelt Structured Decision Making Technical Working Group for CAMT
- The effectiveness of a water hyacinth weevil as a biological control agent of the invasive water hyacinth.
- Trade-offs and Co-benefits of Landscape Change Scenarios on Human and Bird Communities in the Sacramento-San Joaquin River Delta
- Urban Nature Lab
- USGS studies in Suisun Marsh – waterfowl
- USGS-RMA modeling of roaring river distribution system
- Wetland carbon sequestration and impacts of climate change

Action Area 2: Capitalize on existing data through increasing science synthesis

- Bay Delta Live
- Biotic homogenization study
- Carbon contribution from different food web groups
- Central Valley Steelhead Monitoring Inventory
- Changes in and controls on biogeochemistry in the SF Bay-Delta
- Climate Change and the Delta: A Synthesis
- Climate change effects on extent of inundation in Yolo Bypass
- Climate Change Management, Analysis, and Synthesis Team
- Contaminants of Emerging Concern Strategy (part of CCMP Action 25, Task 25.1)
- Cyprinid synthesis
- Delta Data Festival
- Delta Ecosystem Stressors - A Synthesis
- Delta Science Funding and Governance Initiative
- Delta Science Program Shiny page
- Delta Smelt Conditions Report
- Drought Resistance and Resilience
- Ocean acidification conceptual model and convene scientific experts (part of CCMP Action 29, Task 29.1)
- Environmental Data Initiative (datasets adding 2016-2021)
- Evaluation of fluridone treatment on SAV to enhance habitat for Delta Smelt
- Flow Alteration Team, Management, Analysis, and Synthesis Team (MAST)
- Forecasting Nutria presence in the Delta
- IEP Data User Work Group (DUWG)
- Improving Green Sturgeon Population and Migration Monitoring

- Interagency Telemetry Advisory Group (ITAG): Project work team for acoustic telemetry coordination
- Lamprey synthesis
- Landscape-scale efficacy analysis for aquatic vegetation control
- Leveraging Delta Smelt Data for Juvenile Chinook Salmon Monitoring in the San Francisco Estuary
- Longfin Smelt MAST
- Ludwigia project
- Microcystis and phytoplankton community composition DWR/UCD
- Monitoring enterprise review
- NCEAS Working Group to Understand Drivers of the Estuarine Food Supply
- Nutrient Management Program
- Phytoplankton Synthesis
- Track and reduce trash input into the Estuary (part of CCMP Action 30, Task 30.2)
- Review of water supply reliability estimation related to the Sacramento-San Joaquin Delta
- SacPAS: Central Valley Prediction and Assessment of Salmon through Ecological Data and Modeling for In-Season Management
- Salinization symposium
- Salmon and Sturgeon Assessment of Indicators by Life Stage
- Salmon salvage model
- State of Bay-Delta Science: Services and Disservices of Plants and Algae
- State of the Estuary Report
- Striped Bass Migration Timing Synthesis
- Synchrony of native fish movements: synthesis science towards adaptive water management in the Central Valley
- Towards the Protection, Restoration, and Enhancement of the Delta Ecosystem: A Synthesis
- Use of the Enhanced Delta Smelt Monitoring survey to improve Chinook Salmon monitoring
- Wakasagi synthesis
- Zooplankton Symposium and Synthesis

Action Area 3: Develop tools and methods to support and evaluate habitat restoration

- A Delta Renewed
- Arnold Slough Tidal Restoration
- Bay Point Restoration Project
- Bees Lakes Habitat Restoration Plan
- Blacklock Restoration: Phragmites Control Study

- Bradmooor Island Tidal Restoration
- Changes in organic carbon and food resources in response to historical events in the Sacramento-San Joaquin Delta: A synthesis project
- Chinook Salmon Quantification Tool
- Chinook salmon rearing habitat with CAMT
- Chipps Island Tidal Restoration
- Complex Tidal Marsh Dynamics Structure Fish Foraging Patterns in the San Francisco Estuary
- Consequences of Phragmites invasion for community function in Suisun Marsh
- Coyote Creek Native Ecosystem Enhancement Tool (CCNEET)
- Decker Island Tidal Restoration
- Delta Adapts Climate Vulnerability Assessment
- Delta Aquatic Resource Inventory for Landscape Scale Evaluation of Wetlands in the Delta and Suisun Marsh
- Delta Landscape Planning Tool
- Delta Landscape Scenario Planning Tool
- Delta Landscapes Primary Production
- Delta Waterways Habitat Restoration Planning
- Delta Wetlands and Resilience: blue carbon and marsh accretion
- Developing a methodological framework to assess the effectiveness of previous restoration efforts to inform future restoration planning
- Dutch Slough Tidal Marsh Restoration Project: Phase 2 (Revegetation)
- EcoAtlas
- Ecosystem Amendment
- Ecosystem Engineering Impacts of Water Primrose in the Delta
- Effects of Phragmites in Suisun Marsh
- Elk Slough Fish Passage and Flood Improvement
- Estuarine–terrestrial habitat gradients enhance nursery function for resident and transient fishes in the San Francisco Estuary
- Farm to Fish: Lessons from a Multi-Year Study on Agricultural Floodplain Habitat
- Fish Friendly Farming Certification Program for the Sacramento-San Joaquin Delta
- Fish predation on a landscape scale
- Floodplains, Tidal Wetlands, and Dark Carbon: Determining Heterotrophic Carbon Contribution to Higher Level Consumers
- FRP Monitoring Program
- Grizzly Slough Floodplain Restoration Project at the Cosumnes River Preserve
- Hill Slough Tidal Restoration
- Hydrodynamic Influences on the Food Webs of Restoring Tidal Wetlands
- Create regional inventory of transition zones (part of CCMP Action 4, Task 4.2)

- Revise policies for multi-benefit climate adaptation projects and improve regulatory review, permitting, and monitoring processes for multi-benefit climate adaptation projects (part of CCMP Action 17)
- Investigations of restoration techniques that limit invasion of tidal wetlands
- Juvenile salmon distribution, abundance, and growth in restored and relic Delta marsh habitats
- Knightsen Wetland Restoration and Flood Protection Project
- Lookout Slough Tidal Restoration
- Lower Marsh Creek and Sand Creek Watershed Riparian Restoration Planning Project
- Lower San Joaquin Riparian Corridor
- Lower Yolo Ranch Tidal Restoration
- Mapping and Prioritization of Sites for Biological and Integrated Control of Arundo in the Sacramento-San Joaquin Delta
- Mapping of suitable upstream habitat for Chinook salmon
- Marsh Creek Channel Restoration
- Conduct bird surveys, analyze wetland use, and effectiveness of enhancement efforts and study the ability of managed ponds to sustain waterbird numbers in the Bay (part of CCMP Action 6, Task 6.1-6.2)
- McCormick Williamson Tract Tidal Restoration
- Mello-Jensen Heirs Sandhill Crane Preserve Conservation Easement
- Microplastics
- Montezuma Tidal Restoration
- Nutria Eradication Project (and Phase 2)
- Oakley Creekside Park Restoration
- Paradise Cut Conservation and Flood Management Plan (and Phase 2
- Petersen Ranch: Working Waterway Habitat Enhancement Project
- Phase I San Joaquin River Floodplain Restoration and Floodway Enhancement at Banta-Carbona
- Problems and Promise of Restoring Tidal Marsh to Benefit Native Fishes in the North Delta during Drought and Flood
- Reconnecting Delta food webs: evaluating the influence of tidal marsh restoration on energy flow and prey availability for native fishes
- Restoration of Priority Freshwater Wetlands for Endangered Species at the Cosumnes River Preserve
- Restoration Planning at River Garden Farms
- Risk of fish predation within and across tidal wetland complexes
- Sediment for Survival
- Seedling Emergence from Seed Banks in *Ludwigia hexapetala*-Invaded Wetlands: Implications for Restoration

- Sentinel marsh monitoring and stream gauge network as part of WRMP (part of CCMP Action 2, Task 2.4 and 2.5)
- Sherman Island Wetland Restoration Project Phase III
- Spatiotemporal variation of floodplain habitat for restoration management
- Stone Lakes Restoration Project
- Synthesis of Ecosystem Restoration in the Delta and Suisun Marsh
- The ecological functions of tidal marsh for estuarine and migratory fishes in the Suisun Marsh
- The role of wetlands in pelagic food webs: metagenomics reveals how wetland plant detritus may promote zooplankton growth and survival
- Three Creeks Parkway #2: Request for additional funds to implement an expanded version of a project previously funded by the Delta Conservancy
- Three Creeks Parkway Restoration Project
- Tidal wetland support of pelagic food web
- Toward Salt Marsh Harvest Mouse Recovery: A Review
- Tule Red Tidal Restoration and monitoring
- Wildlife Corridors for Flood Escape on the Yolo Bypass Wildlife Area Project
- Wings Landing Tidal Restoration
- Winter Island Tidal Restoration
- Yolo Bypass Fish Passage Annual reporting (2019-2020)
- Yolo Bypass Wildlife Area Habitat and Drainage Improvement Project
- Yolo Flyway Farms Tidal Restoration

Action Area 4: Improve understanding of interactions between stressors and managed species and their communities

- A Data Synthesis to Calibrate and Validate Linked Hydrological-Biogeochemical Models
- An evaluation of sublethal and latent pyrethroid toxicity across a salinity gradient in two Delta fish species
- Application of cutting-edge tools to retrospectively evaluate habitat suitability and flow effects for Longfin Smelt
- Aquatic Toxicity and Current Use Pesticides Monitoring Using a Rotating Basin Probabilistic Design
- Assessing sediment nutrient storage and release in the Delta: linking benthic nutrient cycling to restoration, aquatic vegetation, phytoplankton productivity, and harmful algal blooms
- Assessment of Nutrient Status and Trends in the Delta in 2001-2016: Effects of drought on ambient concentrations and trends
- Biological Goals Scientific Advisory Panel
- Brackish Tidal Marsh Management and the Ecology of a Declining Freshwater Turtle

- Central Valley Pilot Study for Monitoring Constituents of Emerging Concern (CECs)
- Climate change implications for tidal marshes and food web linkages to estuarine and coastal nekton
- Conceptual Model of Ecological Outcomes from the Regional San WWTP Upgrade (Operation Baseline 1.0)
- Contaminant Effects on Two California Fish Species and the Food Web That Supports Them
- Counting the Small Guys: Ensuring Picocyanobacteria and Other Small Phytoplankton are Measured Prior to, During, and Following the Sacramento Wastewater Treatment Plant Upgrade
- Cyanotoxin Monitoring in the Delta: Leveraging existing USGS and DWR field efforts to identify cyanotoxin occurrence, duration, and drivers
- Defining habitat quality for young-of-year longfin smelt: Historical otolith-based reconstructions of growth and salinity history in relation to geography, climate, and outflow
- Defining the fundamental niche of Longfin Smelt (*Spirinchus thaleichthys*): Physiological mechanisms of environmental tolerance
- Delta Cross Channel Study 2020
- Delta RMP Mercury Monitoring
- Do light, nutrient, and salinity interactions drive the "bad Suisun" phenomenon? A physiological assessment of biological hotspots in the San Francisco Bay-Delta
- Drought-Related High Water Temperature Impacts Survival of CA Salmonids through Disease, Increasing Predation Risks
- Effects of copper exposure on the olfactory response of Delta smelt (*Hypomesus transpacificus*): Investigating linkages between morphological and behavioral anti-predator response
- Effects of Multiple Environmental Stressors on Ecological Performance of Early Life Stage Sturgeon
- Environmental geochemistry and tidal wetland support of pelagic food webs
- Estimation of Adult Delta Smelt Distribution for Hypothesized Swimming Behaviors Using Hydrodynamic, Suspended Sediment, and Particle-Tracking Models
- Estuarine fish community responses to climate, flow, and habitat
- Evaluating Juvenile Salmonid Behavioral Responses to Hydrodynamic Conditions in the Sacramento-San Joaquin Delta
- Evaluating the effects of wastewater-derived nutrients on phytoplankton abundance and community structure in the San Francisco Estuary and Delta
- Evaluation of a large-scale flow manipulation to the upper San Francisco Estuary: Response of habitat conditions for an endangered native fish
- Expand invasive species prevention programs (part of CCMP Action 9, Task 9.1)
- External reviewer for the IEP monitoring survey review

- Factors associated with salvage
- Hydrodynamics of backwater conditions at Fremont Weir
- Identifying Cyanobacterial Harmful Algal Bloom Toxins in Delta Invertebrates: Implications for Native Species and Human Health
- Impact of Climate Variability on Surface Water Quality: Cyanobacteria and Contaminants
- Impact of Temperature and Contaminants on Chinook Salmon Survival: A Multi-Stressor Approach
- Impacts of climate change on pesticide bioavailability and sublethal effects on juvenile Chinook salmon in the Delta: Potential benefits of floodplain rearing
- Impacts of Spatial and Temporal Dynamics of Water Flows on Migratory Behavior of Chinook Salmon Smolts in the South Delta
- Impacts of Storm-Driven Contaminants on Larval Delta Smelt and the Community Scale Adaptive Capacity
- Impacts of Storm-Driven Contaminants on Larval Delta Smelt and the Community Scale Adaptive Capacity
- In search of refuge: Investigating the thermal life history of Delta Smelt through in-situ oxygen isotope ratio analysis of otolith
- Increase EDRR programs (CCMP Action 9, Task 9.2)
- Invasive species review
- Investigating the Factors that Affect Distribution, Abundance, and Recruitment of Age-0 Longfin Smelt in the Upper San Francisco Estuary
- Investigation of the resilience of the salt marsh harvest mouse and best management practices in response to climate change
- Large-Scale Flow Management Action Drives Estuarine Ecological Response
- Longfin Smelt Science Plan
- Long-Term Surveys Show Invasive Overbite Clams (*Potamocorbula amurensis*) are Spatially Limited in Suisun Marsh, California
- Mechanisms underlying the flow relationship of longfin smelt: I. Movement and feeding
- Modeling of Longfin Smelt distribution in the coastal ocean
- Multiple Stressors in the San Francisco Estuary and Watershed: Effects of high temperature and low oxygen on the survival and physiology of early life stage Chinook salmon
- Nitrogen cycling and ecosystem metabolism before and after regulatory action
- Nutrients mitigate the impacts of extreme drought on plant invasions
- One size does not fit all: variation in thermal eco-physiology among Pacific salmonids
- Operation Baseline 1.0 (Pilot Studies)
- Pesticide risk analyses and management actions, chemical fate, and transport

- Phytoplankton and cyanobacteria growth and response to stressors
- Primary Production for Operation Baseline
- Primary Productivity, Nutrient Uptake, and Nitrogen Kinetics by Resident Phytoplankton under Reduced Nutrient Loads and Changed Nitrogen Forms in Response to the Sacramento Wastewater Treatment Plant Upgrade
- Quantifying Genetic and Epigenetic Variation in Delta Smelt that may Enable Adaptation to Future Environments
- Quantifying the contribution of tidal flow variation to survival of juvenile Chinook salmon
- Rapid response to increase our understanding of the origins of thiamine deficiency in Central Valley Chinook salmon
- Real time tool to detect salmon entrainment
- Relative contributions of contaminant groups to environmental risk in the upper SFE
- Resolving contradictions in food web support for native pelagic fishes
- Revise raw sewage discharges ordinances in SF Estuary (part of CCMP Action 26, Task 26.1)
- Role of freshwater floodplain-tidal slough complex in the persistence of the endangered delta smelt
- Sacramento River Nutrient Change Study
- Sacramento River Phytoplankton Bioassay 2016
- Sacramento River Phytoplankton Study 2016
- Sacramento River winter-run Chinook salmon life history diversity, growth, and habitat use among varying hydroclimatic regimes
- Salinity and inundation effects on productivity of brackish tidal marsh plants in the San Francisco Bay-Delta Estuary
- Sampling in small coastal Northern California streams for the presence of Longfin Smelt
- Science communication of findings on Longfin Smelt
- Science communication of findings on the Delta Outflow Project
- Seasonal impoundment alters patterns of tidal wetland plant diversity across spatial scales
- Source characterization and biogeochemical consequences of wastewater and agricultural C, N, and P inputs to the Sacramento-San Joaquin Delta region
- Source Tracking of Cyanobacteria Blooms in the Sacramento-San Joaquin Delta
- Statistical Evaluation of Particle-Tracking Models Predicting Proportional Entrainment Loss for Adult Delta Smelt in the Sacramento-San Joaquin Delta
- Steering committee and TAC for transition zones around the SF Estuary (part of CCMP Action 4, Task 4.1)
- Synthesis of juvenile salmon growth, condition, and Delta habitat use among extreme hydrologic conditions

- The Effect of Drought on Delta Smelt Vital Rates
- The effect of temperature on predation of juvenile salmonids
- The effects of early hypersaline acclimation due to climate change on the toxicity of pyrethroid, an insecticide, in salmonids
- Tidal effects on marsh habitat use by three fishes in the San Francisco Estuary
- Time-lagged impacts of extreme, multi-year drought on tidal salt marsh plant invasion
- Tracking toxicity in spring for comparison to fall outflow project toxicity
- Water quality science in the Sacramento-San Joaquin Delta: chemical contaminants and nutrients
- Waterfowl Management and Diet of the Salt Marsh Harvest Mouse

Action Area 5: Modernize monitoring, data management, and modeling

- A Next-generation Model of Juvenile Salmon Migration through the Sacramento-San Joaquin Delta
- Agent-based modeling of outmigrating Chinook salmon smolts
- An improved genomics tool for characterizing life history diversity and promoting resilience in Central Valley Chinook salmon
- Assessing the spatial variability of nutrients, phytoplankton, and related water quality constituents in the California Sacramento-San Joaquin Delta at the landscape scale: 2018 high resolution mapping surveys
- Complete CARI for Delta and upload inventories to EcoAtlas (part of CCMP Action 2, Task 2.3)
- Conservation Planning Foundation for Restoring Chinook Salmon (Oncorhynchus Tshawytscha) and O. mykissin the Stanislaus River
- CWEMF Modeling Protocols Update
- Delta Consumptive Use Study
- Delta Hydrodynamic-Biogeochemical Monitoring Development
- Delta Regional Monitoring Program
- Developing a new molecular isotopic tool to examine Delta food webs
- Developing an eDNA metabarcoding protocol to improve fish and mussel monitoring in the San Francisco Estuary
- Development of a tool to track conservative constituents based on hydrodynamics (Constituent Tracker)
- Development of monitoring program to support the Sacramento River Spring-Run Juvenile Production Estimate
- DIISC Symposium - Remote Sensing for Invasive Species Management
- Enhancing Predictive Capability for Phytoplankton Response to Natural and Operational Induced Variability of Phytoplankton Blooming in the Delta

- Evaluating contributions of hatchery-origin fish to conservation of endangered Sacramento River winter-run Chinook salmon during a drought
- Eyes and Ears: Using Lens and Otolith Isotopes to Quantify Critical Rearing Habitats for Salmon Viability
- Green infrastructure work
- High Resolution Temporal and Spatial Mapping of Mercury in Surface Waters of the San Francisco Estuary
- IMSC efforts on modeling collaboratory
- Interagency Ecological Program: Long-term Monitoring Element Review: Pilot approach and methods development (2020)
- Interior Delta Export Effects Study
- Low-cost satellite remote sensing of the Sacramento-San Joaquin Delta to enhance mapping for invasive and native aquatic vegetation
- Monitoring and Modeling Pathogen Exposure in Salmon Migrating to the Delta
- Pathogen Screening and Health Status of Outmigrating Chinook Salmon in the California Delta
- Probabilistic Length at Date to distinguish different races of Chinook salmon
- Pumpout Nav pilot program to decrease raw sewage discharge into the SF Estuary (part of CCMP Action 26, Task 26.4a)
- Quantifying Biogeochemical Processes through Transport Modeling: Pilot Application in the Cache Slough Complex
- Rapid and accurate species identification for ecological studies and monitoring using CRISPR-based SHERLOCK
- Reconstructing juvenile salmon growth, condition, and Delta habitat use in the 2014-15 drought and beyond
- Regional Monitoring Program for water quality
- Revealing the invisible contributors to the diets of larval longfin smelt and striped bass in the San Francisco Estuary
- Sampling Uncharted Waters: Examining Rearing Habitat of Larval Longfin Smelt (*Spirinchus thaleichthys*) in the Upper San Francisco Estuary
- Science Needs Assessment
- Seasonal floodplain-tidal slough complex supports size variation for juvenile Chinook salmon (*Oncorhynchus tshawytscha*)
- SFEI Regional Data Center (for SWAMP)
- Tidal wetland restoration in the Bay-Delta Region: Developing tools to measure carbon sequestration, subsidence reversal, and climate resilience 2021
- Wetlands Regional Monitoring Program in the Bay
- Yolo Bypass Westside Tributaries Flow Monitoring Project

Appendix B: Draft Progress Summary Feedback

Feedback from the Spring 2021 public review period for the Draft Porgress Summary are summarized below for individual Action Areas and Science Actions.

Action Area 1

Action Area 1 was reviewed by a total of 28 participants, ranging in familiarity from "Not familiar at all" to "Expert", with most rating themselves as being "aware of issues, but not knowledgeable" or having "Some Knowledge". The type of work most commonly listed was "Manager for science and resources related to this topic".

Science Action 1A: Most survey participants, 9 out of 12, agreed with the "Moderate Progress" status assigned to the Science Action; three noted that they were "Unfamiliar with the specific science action."

Feedback on progress included the suggestion that economic tradeoffs be considered in restoration activities, a question about how "programs, project, etc." were counted in the Summary, thoughts on improving communication of the Summary and the recommendations to describe the work/progress in the context of the starting point, not just the "output." No missing activities were noted.

Barriers to progress included that there is a lack of interdisciplinary teams that involve social scientists, acknowledgement of the new focus on social science (and encouragement for inclusion in RFPs and conferences), clarification on the list fo relevant activities, and the suggestion for greater cohesion in efforts.

Science Action 1B: All 15 participants agreed with the the "Significant Progress" status assigned to the Science Action.

Feedback included acknowledgement of the progress made with adaptive management, but what's lacking is progress towards refining governance structures and processes to identifying the best use of tools to support adaptive management, and the suggestion for more quantitative models. Commenters noted projects and collaborative groups to be added to the list, including the IAMIT.

Barriers to progress include the need to acknowledge that adaptive management encompasses areas beyond biological and physical systems and includes the human dimension, and limitations to consensus and compromise in existing processes with differing viewpoints. Specific barriers include a lack of understanding by management, institutional barriers, use of quantitative models, regulatory issues, different stakeholder perspectives, environmental variation (e.g., drought), and general confusion about what is adaptive management.

Science Action 1C: Of the 14 respondents, 3 selected "Unfamiliar with specific science action," 8 agreed with the "Moderate Progress" status assigned to the Science Action, and 3 disagreed with the status and suggested "Early Progress" as an alternative.

Feedback on progress acknowledged that it's early to tell how much progress really has been made, especially with upcoming PSN funding opportunities, encouraged promoting the use of social science, and noted the value of comparing progress "relative to past." Missing projects included the Delta Conservation Framework, hiring of social scientists at the Council, and the Yolo Bypass Economic and Waterfowl modeling.

Barriers to progress include the relatively recent push for more social sciences (progress will take time), the challenge with agency and academic researchers lacking genuine working relationships with Delta community members, a lack of consensus on open source modeling and data reporting, too few social scientists working in the Bay-Delta, and a lack of understanding about how exactly to use social science data.

Science Action A1A: Of the 13 respondents, 5 selected "Unfamiliar with specific science action," 8 agreed with the "Early Progress" status assigned to the Science Action.

Feedback on progress included a note that the true status is likely somewhere between early and moderate, a specific clarification regarding water prices in the context of the science action, and a push for more projective, participatory applied research (not just documenting current perceptions).

Barriers to progress include limited understanding of the potential socio-economic adaptations to motivate more integrated research, limited funding and capacity, the ease in documenting the issues, but difficulty in providing solutions that don't require substantial social and economic commitment, and a lack of understanding people's perceptions and values related to climate risk.

Science Action A1B: Of the 13 respondents, 4 selected "Unfamiliar with specific science action," 9 agreed with the "Moderate Progress" status assigned to the Science Action.

Feedback on progress included the suggestion to include metrics to prioritize managed wetlands and ponds and potentially missing waterfowl related items for this science action. Two activities were suggested for inclusion. Putting costs and benefits in the context of existing agricultural activities was suggested.

Barriers to progress include the speed of change and uncertainties of the future, a general reluctance to change long-term activities, permitting issues related to water quality and discharge from managed wetlands, and a lack of good-quality publicly available date from wetland monitoring.

Science Action A1C: Of the 12 respondents, 6 selected "Unfamiliar with specific science action," 6 agreed with the "Early Progress" status assigned to the Science Action.

Feedback on progress note that this is an important research component, but there needs to be more research on perceptions of risk, acceptable levels of risk, and valuation factors. Both physical and social sciences need to be combined.

Barriers to progress include potential conflicting goals between flood protection and habitat or economic development, needing better understanding of people's perceptions of risk and values regarding adaptation strategies for hazards, floods, and levee failure, and acknowledgement of the ease in identifying issues, but challenge of making costly and socially distrupitve solutions.

Action Area 2

Action Area 2 was reviewed by a total of 17 participants, ranging in familiarity from "Not applicable" to "Expert", with most rating themselves as "Very Knowledgeable". The type of work most commonly listed was "Manager for science and resources related to this topic".

Science Action 2A: Of the 13 respondents, 1 selected "Unfamiliar with specific science action," 12 agreed with the "Significant Progress" status assigned to the Science Action.

Feedback on progress include that progress on synthesis has been made, but more time is needed to focus more continuously on fewer research topics, a suggestion to improve how activities are referenced in the appendix, and the acknowledgement of the more time for synthesis and the need to help integrate the findings of synthesis activities – so they don't just sit on a shelf. Some activities and programs were suggested for inclusion.

Barriers to progress build off of the above comments, calling for more funding, staff time, reward for collaboration, capacity (e.g., strong technical, project leads), disciplinary and technical trainings, and workshops to make tools and datasets for accessible.

Science Action 2B: Of the 13 respondents, 3 selected "Unfamiliar with specific science action," 9 agreed with the "Significant Progress" status assigned to the Science Action, and 1 suggested that the status be changed to "Moderate Progress."

Feedback on progress include the need to do more outreach on what has been done and is available with regard to this Science Action. Multiple activities were suggested for inclusion, such as the IEP Data User Work Group (DUWG).

Barriers to progress include funding and capacity, improving access to available data sources, resource availability to continue technical and collaborative advancements in the long-term, data consistency to enhance integration, strengthening workforce expertise and scientific management, and greater value for data integration.

Science Action A2A: Of the 12 respondents, 9 selected "Unfamiliar with specific science action," and 3 agreed with the "Early Progress" status assigned to the Science Action.

No feedback on progress or missed activities were noted.

Barriers to progress included that sturgeoun are challenging species to study and limitations of the use of angler data in sampling programs.

Science Action A2B: Of the 12 respondents, 5 selected "Unfamiliar with specific science action," and 7 agreed with the "Early Progress" status assigned to the Science Action.

Feedback on progress was limited to one commenter not finding the list of activities contributing to the Science Action.

Barriers to progress included coordination (though groups are addressing that barrier), funding structure, data integration and sharing, and costly and time consuming analysis.

Action Area 3

Action Area 3 was reviewed by a total of 16 participants, ranging in familiarity from "Aware of issues, but not knowledgeable" to "Expert", with most rating themselves as having "Some Knowledge". The type of work most commonly listed was "Manager for science and resources related to this topic".

Science Action 3A: Most survey participants, 10 out of 12, agreed with the "Significant Progress" status assigned to the Science Action, while 2 out of 12 suggested "Moderate Progress."

Feedback on progress and missing activities we received included projects that were not fully included, in particular those of the Fish Restoration Program tasked with sampling invertebrate communities, primary producers, nutrients in addition to fish for many of the tidal restoration projects in the Delta. Another survey participant pointed out that currently we seem to know more about floodplain restoration than tidal marsh restoration.

One of the barriers to progress listed was different aspect of time. Restoration projects take time to plan, permit, implement, monitor, and then analyze the data before progress in some areas can be measured. The hurdle of permitting was mentioned by several participants, and the cost of data collection. The need for spatially-explicit modeling, such as wider integration of multi-dimensional hydrodynamic and particle-tracking models to ecological studies.

Science Action 3B: Most survey participants, 8 out of 9 agreed with the "Early Progress" status assigned to the Science Action, and no other status was suggested.

Feedback on progress and missing activities pointed out there are studies with reports that are not always published in journals. Some of the work suggested to be added for this Science Action was already added elsewhere (i.e., Science Action 2 on science synthesis).

The barriers to progress mentioned were land availability for upland migration of tidal wetlands and that the acreage requirements for endangered species biological opinions don't incentivize using acquired land for non-tidal land cover. Also uncertainty in human responses to sea level rise and climate change (especially in terms of levee protection vs deterioration) , which leads to a poor understanding of what the Estuary of the future may look like.

Science Action A3A: Most survey participants, 12 out of 13 agreed with the "Early Progress" status assigned to the Science Action; one participant pointed out the work is not 'minimal.'

Feedback on progress and any missing activities added two additional projects, and a reminder to keep project objectives in mind when assessing effectiveness.

The barriers to progress mentioned limited dedicated funding and resources for research and monitoring of restored habitat, which leads to staff shortages, delayed data analysis and learning. Time to collect and analyze data to address this Science Action was again mentioned. Additional monitoring and data from in and near restored wetlands was also mentioned as a need, which may come with time.

Science Action A3B: All survey participants agreed with the "Moderate Progress" status assigned to the Science Action.

Feedback on progress and any missing activities included additional information on the Fish Restoration Program data upload to EDI and UCSC predator hot spot modeling.

Barriers to progress for this Science Action mentioned are availability of georeferenced data sets and open data files of results, as well as social data due to previous lack of focus. Other barriers mentioned were ecological data with high variability in abundance and community structure as well as the restrictions on sampling the fish tidal wetland restoration is intended to benefit.

Action Area 4

Action Area 4 was reviewed by a total of 17 participants, ranging in familiarity from "Not familiar at all" to "Very knowledgeable", with most rating themselves as "Very knowledgeable". The type of work most commonly listed was "Manager for science and resources related to this topic".

Science Action 4A: Of the 12 respondents, 10 agreed with the "Significant Progress" status assigned, while the remaining 2 suggested "Moderate Progress" instead.

Feedback on progress and missing activities included the need for more monitoring, to supplement research projects. Several participants mentioned the importance of tracking waste water tertiary treatment upgrade, which has been ongoing. The need for examining stressors on benthic and detrital foodwebs and developing response curves was also mentioned.

Barriers mentioned were funding and development of infrastructure (i.e field labs, continuous monitoring stations) and lack of continuous data for inorganic nitrogen. Climate change and the rapidly changing stressor landscape were also mentioned as barriers and that tools and actions need to be more resilient to change which is difficult due to regulatory limitations.

Science Action 4B: Of the 11 respondents, 10 agreed with the “Significant Progress” status assigned, while the remaining 1 suggested “Moderate Progress” instead.

Feedback on progress and missing activities mentioned there is significant progress in terms of research, but not action and that one good example would be synthesis activities to evaluate potential temperature refuges.

Barriers to progress highlighted were the localized infrastructure and the need for additional monitoring and verification as well as refuges may not be detectable in many of the long-term data sets.

Science Action 4C: Of the 13 respondents, 11 agreed with the “Significant Progress” status assigned, while the remaining 2 suggested “Moderate Progress” instead.

Feedback on progress and missing activities brought up the active research in this area and the need to assess what research has been done so far to better inform future work and that many of the relationships used are correlative, not mechanistic so there is more work to do.

Among the barriers to progress mentioned was the overlap of this Science Action and regulatory requirements making it difficult to assess studies and identify next steps and implementing flow experiments to test the predictions. Other issues mentioned were the difficulty in disentangeling the effects of flow from the multiple other drivers and the need for evaluation of these relationships in a controlled laboratory environments.

Science Action 4D: Of the 10 respondents, 9 agreed with the “Significant Progress” status assigned, while the remaining 1 suggested “Moderate Progress” instead.

Feedback on progress and missing activities acknowledged significant progress in number of studies, modeling and monitoring activities, but also points out it is still limited in terms of spatial coverage and remains a priority area of study. Also mentioned was the

knowledge gaps for response curves, contaminant interactions and the effect on species and the foodweb.

Barriers to progress mentioned were the number of ever changing contaminants and their interactions. Actions can quickly become out of date as a contaminant is phased out and replaced. Also mentioned was a need for infrastructure to allow for more regular monitoring and chemical analyses of fish rearing habitat in addition to diverse stakeholder groups and funding resources

Science Action A4A: Of the 10 respondents, 9 agreed with the "Moderate Progress" status assigned, while 1 suggested "Significant Progress" instead.

Feedback on progress and missing activities wondered about the lack of salmon models mentioned, with research and monitoring as the only activities listed and a web-based management tool was highlighted.

Barriers to progress include permitting constraints limiting study scope, methods and timely implementation and assessing indirect effects of temperature (i.e. via disease and predation) is challenging, life history and prior acclimation and adaptation needs to be understood. Another barrier is the lack of consideration of the watershed as a whole, by splitting it in to the legal Delta, mainstem and tributaries at times hindering using population genetics as a way to understand adaptation to streams and rivers.

Science Action A4B: Of the 5 respondents, all agreed with the "Early Progress" status assigned.

Feedback on progress and missing activities pointed out that non-native clams and invasive mussels could be used as monitoring organisms for Science Action 4D in conjunction with the mechanical control methods mentioned in Science Action A4B, as they accumulate the contaminants in the water.

Barriers to progress mentioned the invasive bivalves themselves as they are widespread and very prolific.

Action Area 5

Action Area 5 was reviewed by a total of 19 participants, ranging in familiarity from "Not familiar at all" to "Expert", with most rating themselves as having "Some Knowledge". The type of work most commonly listed was "Manager for science and resources related to this topic".

Science Action 5A: Of the 15 respondents, all 15 agreed with the "Moderate Progress" status assigned to the Science Action.

Feedback on progress acknowledge that some model integration has occurred and models are used to inform decision-making, though the work is decentralized. It was also pointed

out that additional focus should be on sharing more models, but attention should also be given to sharing modeling tools.

Barriers to progress included the challenge of bringing the private sector and public agencies together to work jointly, the time needed to really see progress, funding to make existing models open source, and the need to make the end goal of models integration or linking to others, not publication. The lack of open-source, documented models, and too few people who can bridge the gap between modelers, managers, and biologists were also mentioned.

Science Action 5B: Of the 16 respondents, 1 selected "Unfamiliar with specific science action," 13 agreed with the "Significant Progress" status assigned to the Science Action, and 2 suggested "Moderate Progress" as a more appropriate status.

Feedback on progress include the suggestion to explore more citizen science and potential survey bias, the need to move toward using or trying new technologies for long-term monitoring, additional applications of bioacoustics, and support for the compiled set of ongoing activities. Mutliple activities, such as the Delta Consumptive Use Study and SHERLOCK fish identification, were suggested for inclusion.

Barriers to progress included funding specifically for method development and validation, support for a repository of remote sensing and other monitoring data for use by many disciplines, acknowledgement of insufficient infrastructure, field monitoring stations, and access to sites for long-term research with monitoring (e.g., build more research stations also for monitoring). Lack of agreement on the importance of innovation within this topic, survey biases affecting trust, the challenge or hestitation of adopting new technologies, and the need to add funds when incorporating new technolgoies to expand monitoring programs (i.e., rather than forcing a trade-off) were also mentioned.

Science Action A5A: Of the 16 respondents, 2 selected "Unfamiliar with specific science action," 13 agreed with the "Moderate Progress" status assigned to the Science Action, and 1 suggested "Significant Progress with management implications" as a more appropriate status.

Feedback on progress note that this is a needed effort and payoffs will likely be noticed in a few years. Multiple activities were suggested for inclusion (e.g., BOR use of real-time data).

Barriers to progress included lack of knowledge and certainty in smolt vertical distributions, acceptance of models, continued division among different salmon groups, and the lack of open-source and documented 3D hydrodynamic models.

Science Action A5B: Of the 16 respondents, 5 selected "Unfamiliar with specific science action," 9 agreed with the "Early Progress" status assigned to the Science Action, and 2 suggested "Moderate Progress" as a more appropriate status.

Feedback on progress included clarifying between the list of projects and narrative (e.g., just salmonids?), making more existing baseline data publicly available, and noting that this is an emerging topic with potential to inform habitat and water management and policy. Reviewers suggested ongoing monitoring programs from CDFW and other entities, among other activities to be included in the list of activities.

No additional barriers were provided.

Science Action A5C: Of the 16 respondents, 8 selected "Unfamiliar with specific science action," 7 agreed with the "Moderate Progress" status assigned to the Science Action, and 1 suggested "Early Progress" as a more appropriate status.

Feedback on progress note that a diversity of activities have taken place, details in the summary are thin, yet that may be due to the lack of restoration projects that have been implemented, and suggestions to clarify the activity type for WRMP and consider applicability for RMP and FRP.

Barriers to progress included the slow rate of wetland restoration and a lack of organization of information from existing monitoring programs.