

Interim Science Action Agenda



One Delta, One Science

November 7, 2014

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Executive Summary

The vision of the Delta Science Plan – *One Delta, One Science* can be achieved through a sustained commitment to collaborative science and innovation. *One Delta, One Science* means an open Delta science community that works to build a shared body of scientific knowledge with the capacity to adapt and inform future water and environmental decisions. This Interim Science Action Agenda was prepared as an initial step toward achieving this vision and for developing the Science Action Agenda (Delta Science Plan Action 2.2). It takes a first step toward synthesizing the range of multi-agency and organization opportunities for collaborative, transparent, and objective science to address Delta decision-makers' information needs.

The Interim Science Action Agenda identifies opportunities for advancing scientific understanding, strengthening the network of Delta science, and cultivating shared investments in science. It highlights 17 science actions areas (Table 1) needed to advance system-wide understanding of the Delta to support current policy and management decisions and to build the infrastructure and capacity for innovative science needed to provide decision support in the future.

The 17 science action areas are a summary and synthesis of 320 individual science actions identified through focused interviews with agencies and organization that use or produce scientific information about the Delta, the Delta Science Program's review of existing documents (e.g., agency plans and independent review panel reports), and science actions received through public comment on the draft Interim Science Action Agenda. The order of the science action areas and science actions does not indicate any order of priority nor is it a comprehensive inventory of every important science action underway or needed in the Delta. Detailed information (e.g., collaborating organizations, funding status, and relevant mandates) related to the individual science actions is compiled in a companion Excel workbook (<http://deltacouncil.ca.gov/interim-science-action-agenda>) for the purposes of improving the transparency of Delta science and initiating an effort to develop and sustain a web-based tracking system of science activities in the Delta (Delta Science Plan Action 2.3).

This Interim Science Action Agenda sets the stage for identifying science priorities through the full Science Action Agenda building on the process described in the Delta Science Plan. Prioritization processes and criteria will be guided by efforts of the Policy-Science Forum and advice from the Science Advisory Committee. These processes will build on the Interim Science Action Agenda's initial identification of science action areas, collaborative efforts, and opportunities to use the action area framework for prioritizing among and within policy areas and infrastructure needs for science.

The Delta science community's engagement and spirit of cooperation in developing this Interim Science Action Agenda demonstrate progress toward achieving the vision of *One Delta, One Science*. Continued progress toward achieving this vision and success of this action agenda will be realized through shared implementation and its broad incorporation into science work plans and activities of Delta agencies and organizations along with joint funding of priority science activities that build the science capacity, reduce knowledge gaps, and provide relevant, credible, and legitimate science.

Table 1. Summary of Interim Science Action Agenda Science Action Areas.

Science Action Areas to Address Knowledge Gaps
<i>A More Reliable Water Supply for California</i>
Action Area 1. Watershed and water management
Action Area 2. Impacts of climate change on natural resources
Action Area 3. Entrainment of native fishes
<i>Protect, Restore, and Enhance the Delta Ecosystem</i>
Action Area 4. Needs of native species
Action Area 5. Habitat restoration
Action Area 6. Lower aquatic food webs
Action Area 7. Methods to manage and minimize the impacts of non-native species
Action Area 8. Abundance and distribution of predators
<i>Protect and Enhance the Unique Cultural, Recreational, Natural Resource, and Agricultural Values of the California Delta as an Evolving Place</i>
Action Area 9. The Delta economy
<i>Improve Water Quality to Protect Human Health and the Environment</i>
Action Area 10. Sources and drivers of contaminants
Action Area 11. Role of nutrients
<i>Reduce Risk to People, Property, and State Interests in the Delta</i>
Action Area 12. Characterization of risks associated with natural disasters
Science Action Areas to Build Science Infrastructure and Capacity
<i>Adaptive Management for a Complex System</i>
Action Area 13. Tools and resources for adaptive management
<i>Building the Infrastructure for Science</i>
Action Area 14. Data and information accessibility and exchange
Action Area 15. Coordinated monitoring and assessment
Action Area 16. Collaborative modeling approaches
<i>Resources to Implement the Delta Science Plan</i>
Action Area 17. Building science capacity

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Introduction

What is the Interim Science Action Agenda and how does it address management and policy-related science and information needs?

While many agencies are planning and conducting scientific programs and investigations in the Delta, the speed and efficiency of transforming this science into useful management and policy information could be improved through better organization and coordination. The Interim Science Action Agenda will provide this coordination and organization of Delta science by establishing a collaborative road map for addressing the science needs of policy makers and managers faced with making some of California's most challenging decisions. It summarizes and synthesizes 320 science actions identified by multiple organizations into 17 science action areas that contribute to or use scientific information in the Delta.

The Interim Science Action Agenda reaches beyond mission-specific science and furthers the vision of *One Delta, One Science* – which means an open Delta science community that works together to build a shared state of knowledge with the capacity to adapt and inform current and future water and environmental decisions in the Delta. The Interim Science Action Agenda is a key component of implementing the Delta Science Plan¹, a framework called for by the Delta Plan and appendices for conducting science that organizes and integrates Delta science activities and builds an open collaborative science community. It is an expedited and initial version of a full Science Action Agenda in the absence of the prioritization processes described in the Delta Science Plan. Because this is an “Interim” Science Action Agenda, it does not include formal direction from a Policy-Science Forum, but it is guided by advice from the Science Advisory Committee², a multi-disciplinary advisory committee formed by the Delta Lead Scientist to guide and advise the Delta Science Program on Delta science issues.

The Interim Science Action Agenda incorporates the science and information needs associated with several major plans and programs in the Delta, including the Delta Stewardship Council's Delta Plan, the multi-agency Draft Bay Delta Conservation Plan, the State Water Resources Control Board's Bay-Delta Plan, the Collaborative Science and Adaptive Management Program, the Interagency Ecological Program and several others. The 17 science action areas in this action agenda address the need for increased science capacity to provide the best science possible for implementing and updating major plans, mandates, and programs. It is envisioned that implementing actions in these action areas will provide better science to inform key decisions, such as guiding water operations, selecting sites and designs for ecosystem restoration activities, and setting regulations to manage multiple stressors.

¹ Delta Science Program. 2013. Delta Science Plan.

<http://deltacouncil.ca.gov/sites/default/files/documents/files/Delta-Science-Plan-12-30-2013.pdf>. Accessed 29 August 2014.

² Formerly the Science Steering Committee as described in the Delta Science Plan. The change in the committee's name reflects the committee's desire to limit their charge to an advisory capacity.

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The Interim Science Action Agenda also builds on positive examples of collaborative science efforts in the Delta. For example, the Interagency Ecological Program has increased the availability of synthetic assessments of the Bay-Delta related to the pelagic organism decline and the fall low salinity zone. Another example of positive collaborative science efforts includes the advancement of standards for wetland monitoring, assessment, and data sharing through the California Water Quality Monitoring Council's Wetland Monitoring Workgroup. These examples are models for advancing the vision of *One Delta, One Science* to address priority science and information needs.

How was the Interim Science Action Agenda developed?

This summary and synthesis of science actions was developed with the input of the Delta science community and science-aware decision-makers. The cooperation and contributions of these Delta science and management community members during the development process of the Interim Science Action Agenda demonstrated the community's desire and ability for making progress toward achieving the vision of *One Delta, One Science*.

In the Interim Science Action Agenda's early development, the Delta Science Program produced a preliminary synthesis of science needs and actions from existing documents. This served as the basis for a public workshop attended by federal, State, and local agencies and programs, members of the Non-Governmental Organization community, private consultants, and members of the public. Based on recommendations and input received at the public workshop the Delta Science Program engaged in focused interviews to gather the science actions of agencies and organizations in the Delta. Interview responses along with science actions identified in existing documents served as the primary inputs that were then organized into 17 science action areas for this action agenda. An Excel workbook including all of the individual science actions (identified through focused interviews or extracted from existing documents) that were used for this synthesis (including detailed information about relevant mandates, lead organizations, collaborating organizations, funding status and more) can be found on the Delta Science Program's Interim Science Action Agenda webpage at <http://deltacouncil.ca.gov/interim-science-action-agenda>. A more detailed explanation of the methods used to determine the list of science actions can be found in Appendix A.

What does success for the Interim Science Action Agenda look like?

The Interim Science Action Agenda represents the science actions, that when taken, will fill many of the most critical gaps in scientific understanding of the Delta and build the science community's capacity to provide credible, relevant, and legitimate science. These actions are opportunities for shared investments in science that will contribute to achieving the coequal goals of a more reliable water supply and a restored, enhanced, and protected Delta ecosystem. They represent science needs where new or sustained investment can build science capacity and reduce uncertainties associated with key decisions aimed at meeting the coequal goals.

Success of the Interim Science Action Agenda relies on the ability of programs and agencies to work together and to provide adequate resources to achieve shared goals. The Interim Science Action Agenda presents an opportunity for achieving integrated, collaborative, and transparent science. The success of this single roadmap will be achieved through coordinated work plans (e.g., State of California Five Year

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Coordinated Work Plan for Wetlands Conservation Program Development³) and joint funding of priority science (e.g., multi-agency funding of Delta Science Fellows⁴). Success also means that decision-makers have access to credible, relevant, and legitimate science, and the Delta science community receives management-relevant guidance on what science actions should be tackled, along with the resources and mechanisms to provide the science support to both anticipated and immediate needs. Success of the Interim Science Action Agenda should be measured by the following attributes:

- 1) Multiple science agencies and organizations support the Interim Science Action Agenda as a collaborative road map for jointly addressing Delta science needs;
- 2) Agency or program science efforts and work plans incorporate the Interim Science Action Agenda;
- 3) Resources are leveraged to accelerate learning and build the science capacity and infrastructure needed to make progress in and across the 17 shared science action areas;
- 4) Strategies to fill funding gaps are guided by the Interim Science Action Agenda;
- 5) Collaborative and individual funding of science actions, proposal solicitations, and science fellowships promote cross-cutting efforts to make progress in and across the 17 shared science action areas;
- 6) An increased transparency of proposed and ongoing science actions exists in the Delta; and
- 7) The Delta Independent Science Board's oversight of Delta scientific research, monitoring, and assessment programs is streamlined through shared implementation of the Interim Science Action Agenda by the many agencies, organizations, and institutions³) engaged in Delta science.

In addition, the Interim Science Action will serve as the starting point for developing a full Science Action Agenda (Appendix B) over the next two years. The Excel workbook developed as part of the Interim Science Action Agenda effort also commences efforts to develop and sustain a web-based tracking system of science activities in the Delta (Delta Science Plan Action 2.3) and will serve as a key component of tracking progress made on achieving the above metrics of success. In addition, information learned from implementing the Interim Science Action Agenda will be synthesized in updates to *The State of Bay-Delta Science* (Delta Science Plan Action 2.6).

How will this effort help with prioritization of science activities in the Science Action Agenda?

Delta Science Plan Action 2.2 calls for the development, implementation, and update of a Science Action Agenda that organizes, integrates, and prioritizes science activities across agencies and programs to address decision-makers' needs in an efficient manner. The Interim Science Action Agenda effort takes an initial step toward achieving this action while a guiding organization that will play an essential role in prioritizing science activities, the Policy-Science Forum, is not yet formed.

³ State of California Five Year Coordinated Work Plan for Wetlands Conservation Program Development (Revised March 2014). Accessed September 2014. <http://water.epa.gov/type/wetlands/upload/california-wpp.pdf>

⁴ Delta Science Fellows Program. Accessed September 2014. <http://deltacouncil.ca.gov/science-program/fellows-program>

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Building on the prioritization approach outlined in the Delta Science Plan (Appendix B), prioritization of science activities for the Science Action Agenda will be developed and updated through an open process led by the Delta Science Program with guidance from the Policy-Science Forum and advice from the Science Advisory Committee. Direction from a Policy-Science Forum will include an identification of the policy and management problems in greatest need of the Delta science communities' efforts and an initial identification of scientific activities applicable to addressing these problems. A subset of the Delta policy and management community (e.g., a subset of the Delta Plan Interagency Implementation Committee) will be engaged to provide input on the prioritization process and criteria (e.g., relevance to management needs and feasibility of funding). The Science Advisory Committee may provide advice on scientific criteria (e.g., likelihood to achieve its objectives, addresses multiple science action areas, supports synthesis activities that cross multiple existing programs or agency missions). The Delta Science Program, working with others, will use and refine the prioritization criteria to prioritize science activities to address decision-makers' science needs. The Delta Lead Scientist will have the responsibility for articulating the rationale for the Action Agenda and its prioritization of the science activities. Details for implementing the Science Action Agenda will be developed with others during the prioritization process.

This Interim Science Action Agenda stimulates transparency among the Delta Science community, agencies, and organizations about science prioritization and associated criteria for the Science Action Agenda. Prioritization efforts of the Policy-Science Forum and the Delta Science Program in collaboration with others will build on the Interim Science Action Agenda's initial identification of science action areas as the range of activities in need of prioritization, collaborative efforts underway, and potential frameworks for prioritizing among and within policy areas and infrastructure needs for science.

Science Action Areas

The following 17 science action areas are an inclusive summary of the 320 individual science actions identified through focused interviews and the Delta Science Program's review of existing documents (Table 2). These science action areas are organized into two main categories: 1) Science Action Areas to Address Knowledge Gaps (organized by the policy areas/chapters in the Delta Plan), and 2) Science Action Areas to Build Science Infrastructure and Capacity (organized by the chapters in the Delta Science Plan). The science action areas are a summary of priority science actions identified by Delta scientists, managers, and decision-makers. They represent the science needed to build the tools, resources, and human capacity to be responsive to decision-maker's science needs.

It is recognized that many of the 17 science action areas cannot be addressed in isolation of one another. There are many overlaps among these science action areas that require cross-cutting and innovative approaches to enable new insights and build a strong science infrastructure. Again, the order of the science action areas and science actions does not indicate any order of priority and there are undoubtedly important Delta science actions that were not captured in this process.

Please note: For each action area a brief description is provided along with example individual science actions. These examples are drawn from the 320 individual actions that were organized into the 17

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science action areas. For each example, the source (either the reference document name or interviewed organization) and a unique number ID is provided. The unique number ID corresponds to the numbering of individual science actions in the associated Excel workbook. More information about each of the 320 individual science actions can be found in the Excel workbook. Visualization and summary tables of the science actions included in the synthesis are provided in Appendix D.

Table 2. The number of individual actions from interview responses and documents that were summarized into one of 17 action areas for the Interim Science Action Agenda. The count of individual science actions is the number of individual science actions identified from interviews or existing documents that were grouped into each science action area.

17 Science Actions Areas in the Interim Science Action Agenda	Count of Individual Science Actions
Science Action Areas to Address Knowledge Gaps	
<i>A More Reliable Water Supply for California</i>	
Action Area 1. Watershed and water management	27
Action Area 2. Impacts of climate change on natural resources	8
Action Area 3. Entrainment of native fishes	9
<i>Protect, Restore, and Enhance the Delta Ecosystem</i>	
Action Area 4. Needs of native species	58
Action Area 5. Habitat restoration	10
Action Area 6. Lower aquatic food webs	14
Action Area 7. Methods to manage and minimize the impacts of non-native species	13
Action Area 8. Abundance and distribution of predators	17
<i>Protect and Enhance the Unique Cultural, Recreational, Natural Resource, and Agricultural Values of the California Delta as an Evolving Place</i>	
Action Area 9. The Delta economy (i.e., agriculture, recreation, tourism)	11
<i>Improve Water Quality to Protect Human Health and the Environment</i>	
Action Area 10. Sources and drivers of contaminants	23
Action Area 11. Role of nutrients	7
Action Area 12. Characterization of risks associated with natural disasters	9
Science Action Areas to Build Science Infrastructure and Capacity	
<i>Adaptive Management for a Complex System</i>	
Action Area 13. Tools and resources for adaptive management	32
<i>Building the Infrastructure for Science</i>	
Action Area 14. Data and information accessibility and exchange	18
Action Area 15. Coordinated monitoring and assessment	26
Action Area 16. Collaborative modeling approaches	24
<i>Resources to Implement the Delta Science Plan</i>	
Action Area 17. Build science capacity	14
Total	320

Science Action Areas to Address Knowledge Gaps

A More Reliable Water Supply for California

Action Area 1. Watershed and water management

Investigations to better understand how to sustainably manage water from the Sierra to the sea are needed. Watershed and water management includes the development of shared models, monitoring and associated research to understand the effects of reduced outflows on species of concern, improving estimates of water supplies, and exploring options for improving water use efficiency. Implementing actions in this action area provides scientific information and tools to inform decisions, such as changes to operations of the Central Valley Project and State Water Project, determinations related to urban water management plans, and decisions about changing or implementing water-use efficiency and water recycling programs.

<i>Action Area 1 – Example science actions</i>	<i>Source</i>	<i>Unique number ID</i>
1. Implement urban and agricultural water use efficiency research	California Water Action Plan	183
2. Identifying methods and costs for increasing water-use efficiency, water recycling & potable re-use	U.S. Environmental Protection Agency	115
3. Improved projections for and measurement of surface water flows (amounts, timing, quality) and how they may be impacted by environmental regulations, changing land uses, and climate change	Delta Plan	141

Action Area 2. Impacts of climate change on natural resources

Research and modeling that leads to the development of tools to understand the impacts of climate change are needed to inform a number of land use, water, and environmental management decisions. These actions span a range of policy areas and include identification of greenhouse gas reduction benefits from agricultural conservation practices, better understanding of the impacts of climate change on agriculture and habitat for native species, and the development of models to inform operational changes to water management under various climate change scenarios. In addition, implementing these actions will provide information to support decisions about the design of carbon cap and trade programs and site selection for habitat restoration.

<i>Action Area 2 – Example science actions</i>	<i>Source</i>	<i>Unique number ID</i>
1. Develop tools to assess potential impacts of climate change and sea level rise on viability of species in intertidal habitats.	Delta Plan	155
2. Better understand the effects of climate change, especially related to regional down-scaled climate predictions	U.S. Fish and Wildlife Service	123
3. Develop and implement a carbon sequestration protocol for California wetlands, including the implementation of pilot projects	Sacramento-San Joaquin Delta Conservancy	85
4. Understand the impacts of climate change on Delta crop mixes	Delta Protection Commission	62

Action Area 3. Entrainment of native fishes

While several ongoing studies are underway to improve our understanding of factors affecting entrainment of native fish, several knowledge gaps exist. Research, monitoring, modeling, and synthesis are needed to better understand the population level effects of entrainment. This action builds understanding about the causes and effects of entrainment as well as the effects of water management actions (e.g., drought operations) on entrainment of native fishes (i.e., Delta smelt and salmonids) at various life stages. Information learned in this action area provides decision support for biological opinions for operating the Central Valley Project and State Water Project, operational components of the proposed Bay Delta Conservation Plan, and the comprehensive review of the State Water Resources Control Board’s Bay-Delta Plan.

<i>Action Area 3 – Example science actions</i>	<i>Source</i>	<i>Unique number ID</i>
1. Understand entrainment effects on fish populations.	Delta Plan	154
2. [Understand] effects of proposed drought operation plan on entrainment risk of adult Delta smelt in the Interior/South Delta.	Central Valley Project and State Water Project Drought Operations Plan and Operations Forecast	233
3. Understand the relationship between entrainment and Old and Middle River flows	California Department of Fish and Wildlife	6

Protect, Restore, and Enhance the Delta Ecosystem

Action Area 4. Needs of native species

This action area includes investigations to fill knowledge gaps necessary to improve native species management. This includes targeted research and monitoring to understand factors that influence survival of native species at the population level, such as important habitat attributes (e.g., importance of seasonal outflows, physical attributes of key migratory corridors, and temperature requirements). This action area also includes actions aimed at better understanding important pathways of interactions and interrelations among

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species for multi-native species management. Implementing these actions provides the necessary science to inform decisions such as updates to the flow objectives in the State Water Resources Control Board’s Bay-Delta Plan, the selection of properties for habitat restoration that provide adequate migratory corridors for species of concern, and permitting of projects as Natural Community Conservation Plans or Habitat Conservation Plans.

<i>Action Area 4 – Example science actions</i>	<i>Source</i>	<i>Unique number ID</i>
1. Investigate effects of fall outflow on Delta smelt	Collaborative Adaptive Management Team	51
2. Develop spring outflows studies to understand how Spring flows relate to longfin smelt and salmonid survival	California Department of Fish and Wildlife	2
3. Understand the effects of Delta flows on salmonid recovery in the San Francisco Bay watershed	San Francisco Regional Water Quality Control Board	87

Action Area 5. Habitat restoration

Information about the effects of habitat restoration and management actions to address environmental stressors is needed to inform management and policy decisions that aim to protect, restore, and enhance the Delta ecosystem. This action area includes research, monitoring, adaptive management, and synthesis. These activities will contribute to the development of tools to inform restoration designs and assess the results of habitat restoration and management actions to restore native species. Implementing these actions provides science to support decisions such as determining mitigation credits and designing monitoring programs for habitat restoration.

<i>Action Area 5 – Example science actions</i>	<i>Source</i>	<i>Unique number ID</i>
1. Understand landscape-scale effects of wetland restoration activities in the Bay-Delta through integrated monitoring	San Francisco Regional Water Quality Control Board	90
2. Translate the findings of the Delta Historical Ecology Study into the technical designs of on-the-ground restoration projects to increase the likelihood of their proper function and their resiliency to droughts, floods, and climate change	U.S. Environmental Protection Agency	113
3. Develop a spatially explicit decision model that examines where restoration/anti-predator efforts can have the biggest impact on increasing juvenile production	The predation workshop report - <i>Effects of fish predation on salmonids in the Sacramento River – San Joaquin Delta and associated ecosystems</i>	291

Action Area 6. Lower aquatic food webs

Additional studies and targeted monitoring are needed to understand lower aquatic food web dynamics and productivity of the Delta ecosystem. This information will help reduce uncertainties about factors

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that affect food availability for native fishes (i.e., clam grazing limitation and primary production). These actions provide science support for decisions related to designing tidal marsh restoration projects and making changes to the State Water Resource Control Board and Regional Water Boards' water quality control plans.

<i>Action Area 6 – Example science actions</i>	<i>Source</i>	<i>Unique number ID</i>
1. Understand changes in productivity and the food web, relationship to shifts in the amount and type of nutrients available, and the factors influencing pelagic fish distribution and abundance	Comprehensive (Phase 2) Review and Update to the Bay-Delta Plan: Final Bay-Delta Plan Workshops Summary Report	278
2. Understand how phytoplankton biomass is affected by clam grazing	Bay Delta Conservation Plan Appendix 5.F (2013)	213
3. Identify factors affecting the distribution and abundance of fish prey within the Cache Slough Complex (e.g., food web, nutrient cycling, contaminants, and restoration effectiveness)	State and Federal Contractors Water Agency	96

Action Area 7. Methods to manage and minimize non-native species

Science support of invasive species management methods is needed to protect, restore, and enhance the Delta ecosystem. This includes analyzing potential threats of biological invasions, identifying potential invaders, and investigating methods to manage aquatic and terrestrial species with minimal environmental impacts. This science will provide information for making decisions about how to safely apply herbicides to manage aquatic weeds, how to best manage water temperature and flows to minimize conditions that favor the establishment of non-native species, and how to respond to invasions of new non-native species.

<i>Action Area 7 – Example science actions</i>	<i>Source</i>	<i>Unique number ID</i>
1. Continued research on biological control methods to eliminate invasive aquatic vegetation	Bay Delta Conservation Plan Appendix 5.F (2013)	204
2. Understand the timeframe for future invasive species invasions and the management options to prepare for likely but essentially unpredictable impacts	Comprehensive (Phase 2) Review and Update to the Bay-Delta Plan: Final Bay-Delta Plan Workshops Summary Report	279
3. Understand and determine how to manage and minimize invasive aquatic and terrestrial weeds	Delta Protection Commission	60
4. Understand the factors and conditions that facilitate invasive clam colonization	Bay Delta Conservation Plan Appendix 5.F (2013)	216

Action Area 8. Abundance and distribution of predators

Information is needed to understand the abundance and distribution of native and non-native predators, one of many stressors on native fish species in the Delta. This action area includes filling data and information gaps about the population size and distribution of predatory fish, the effects of predation on native fish survival in the Delta, and opportunities to reduce the impacts of predation on native species. Information learned from implementing these actions will inform decisions such as making changes to fishing regulations for striped bass and other predatory fish, how to reroute native fish through the Delta to minimize the effects of predation, and how to design or redesign structures to minimize favorable habitat for predators of native fish.

<i>Action Area 8 – Example science actions</i>	<i>Source</i>	<i>Unique number ID</i>
1. Gain a better understanding of the relationship between tag/fish loss and predation, and specifically, what percentage of tag/juvenile loss is due to predation and what percentage to other forms of mortality	The predation workshop report - <i>Effects of fish predation on salmonids in the Sacramento River – San Joaquin Delta and associated ecosystems</i>	292
2. Predation reduction studies - Sacramento River and Georgiana Slough predation studies	California Department of Water Resources Bay-Delta Office, South Delta Branch	12
3. Study the abundance and distribution of predators in South Delta	National Oceanographic and Atmospheric Administration – Southwest Fisheries Science Center	74
4. Refine system-wide estimates of consumption of juveniles with bioenergetics models for the dominant predator species	The predation workshop report - <i>Effects of fish predation on salmonids in the Sacramento River – San Joaquin Delta and associated ecosystems</i>	288

Protect and Enhance the Unique Cultural, Recreational, Natural Resource, and Agricultural Values of the California Delta as an Evolving Place

Action Area 9. The Delta economy

Decisions that affect the Delta economy rely on science that addresses knowledge gaps such as impacts to agriculture (i.e., effects of habitat restoration on neighboring lands) in the Delta as well as science-based investigations to improve understanding of recreational and tourism use of the Delta. This science-based information is relevant for informing decisions related to designing best management practices for habitat restoration to minimize impacts to agricultural production and strategic planning to increase the recreational and tourism value of the Delta.

<i>Action Area 9 – Example science actions</i>	<i>Source</i>	<i>Unique number ID</i>
1. Implement ecosystems services studies to understand the ecological and economic benefits of agricultural lands	California Department of Food and Agriculture	138
2. Understand what agricultural practices and operations could be implemented to be a good neighbor to restored habitat in the Delta	Delta Protection Commission	61
3. Analysis of land and water use by agriculture, including land ownership (resident vs. absentee; age of owner; size of holding, etc.), cropping patterns, soil types, and other factors to identify the Delta's agricultural regions, their competitive advantages, threats and opportunities	Delta Plan	158

Improve Water Quality to Protect Human Health and the Environment

Action Area 10. Sources and drivers of contaminants

Improved understanding of the sources and drivers of contaminants and their effects is needed to inform decision making about ecosystem management and human health and safety. This includes improving understanding about water quality and species impacts from contaminants such as mercury, selenium, pesticides, and contaminants of emerging concern. This action area also includes science to improve understanding of the sources and drivers of drinking water contaminants for example, organic carbon, bromide, and other constituents of concern such as salinity. Implementing these actions provides science to inform decisions such as the listing or delisting of a body of water as impaired under section 303(d) of the federal Clean Water Act, determining or updating best management practices for dredging activities in the Delta, identifying regulations for the safe application of pesticides, and programs to inform the public about the safe consumption of fish.

<i>Action Area 10 – Example science actions</i>	<i>Source</i>	<i>Unique number ID</i>
1. Assist in the development of Delta Regional Monitoring Program studies, including potential assessments of nutrients, pathogens, methylmercury, and pesticides (with a focus of using toxicity as a tool and determining bioavailability of specific pesticides)	Sacramento Regional County Sanitation District	77
2. Investigate chemical treatment as a method for removing methylmercury from wetland systems	U.S. Environmental Protection Agency	110
3. Conduct temporal experiments that may lead to a better understanding of changes that are reversible, or adaptive, versus those that lead to permanent tissue injury	Independent Scientific Advisory Panel report on biomarkers	312

Action Area 11. Role of nutrients

Research, monitoring, modeling, and synthesis actions are needed to better understand the role of plant nutrients (e.g., nitrogen and phosphorus) in the Bay-Delta system, including their importance to the ecosystem and water supplies. This action area includes targeted efforts to develop a nutrient study plan and synthesize the state of knowledge about the role of ammonium in the system. Science in this action area provides information to inform decisions about changes to National Pollutant Discharge Elimination System permits, managing agricultural discharges, and management of harmful algae blooms.

<i>Action Area 11 – Example science actions</i>	<i>Source</i>	<i>Unique number ID</i>
1. Develop and implement a nutrient study plan to determine whether nutrient objectives are needed to protect beneficial uses in the Delta	Central Valley Regional Water Quality Control Board	44
2. Quantify nutrient levels and phytoplankton health throughout the lower Sacramento River and Delta	Sacramento Regional County Sanitation District	80

Reduce Risk to People, Property, and State Interests in the Delta

Action Area 12. Characterization of risks associated with natural disasters

Research, monitoring, and modeling actions that reduce gaps in knowledge about risks and hazards associated with earthquakes, floods, drought, sea-level rise, and levee integrity can help inform management and policy decisions to reduce risk to people and property. These actions include assessments of seismic risks, improved flood management, and the exploration of new technologies to evaluate levee integrity. These science actions provide information for supporting risk analyses, determining emergency drought operations, and updating emergency response plans for levee failures and earthquakes that impact the Delta.

<i>Action Area 12 – Example science actions</i>	<i>Source</i>	<i>Unique number ID</i>
1. Assess and monitor earthquake hazards	U.S. Geological Survey	131
2. Update flood stage-probability functions	Delta Plan	174
3. Improve water supply and demand forecasting models that incorporate vulnerability to extreme events (droughts, floods, earthquakes) and to the impacts of climate change	Delta Plan	143

Science Action Areas to Build Science Infrastructure and Capacity

Adaptive Management for a Complex System

Action Area 13. Tools and resources for adaptive management

This action area includes the development of science tools and frameworks to inform adaptive management of habitat restoration and water management activities. For example, it includes coordinated and long-term monitoring actions that facilitate adaptive management of ecosystem restoration and the implementation of adaptive management of specific habitat restoration projects. Implementing these types of science actions will support decisions such as flow adjustments to meet the objectives of the State Water Resources Control Board’s Bay-Delta Plan and deciding how and when to restore wetlands within priority restoration areas.

<i>Action Area 13 – Example science actions</i>	<i>Source</i>	<i>Unique number ID</i>
1. Develop and implement the Delta Restoration Network and Delta Restoration Hub that provides a big data platform, supports landscape-scale visions and develops restoration models	Sacramento-San Joaquin Delta Conservancy	82
2. Support the development of standardized base maps of California's water resources that link existing State and federal efforts (e.g., California Aquatic Resources Inventory (CARI))	California Water Quality Monitoring Council	40
3. Implement adaptive management of the Lower Yolo Ranch restoration project	State and Federal Contractors Water Agency	94

Building the Infrastructure for Science

Action Area 14. Data and information accessibility and exchange

Improving data and information accessibility and exchange includes the development of standard approaches, tools, and platforms for data and information sharing. This action area includes individual agency and organization efforts to enhance data sharing, improve data quality assurance and quality control procedures and documentation, and efforts to integrate a broader range of data types and assessments across agencies and organizations. Implementing these science actions will improve the transparency and accessibility of data needed to make decisions such as implementing incidental take provisions in existing biological opinions and determining water contract allocations.

<i>Action Area 14 – Example science actions</i>	<i>Source</i>	<i>Unique number ID</i>
1. In conjunction with the Environmental Data Summit [June 2014], develop standard approaches and tools to streamline the aggregation and sharing of data among agencies, organizations, and other stakeholder groups	California Water Quality Monitoring Council	39
2. Improve data availability, communication procedures, and analytical methods used to monitor and communicate risks to listed fish species and to water supplies when making regulatory decisions associated with implementation of incidental take provisions in the existing biological opinions	California Water Action Plan	185
3. Improve data and information exchange - Develop the Water Planning Information Exchange (Water PIE)	California Department of Water Resources-Integrated Water Management	20

Action Area 15. Coordinated monitoring and assessment

Improving and promoting coordinated monitoring and assessment includes collaborative approaches to unify monitoring activities. This includes inter-calibration exercises to coordinate and integrate field measurements, employ modern monitoring techniques, and assess existing monitoring efforts. This action area covers monitoring of the biological and physical conditions of the Delta.

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<i>Action Area 15 – Example science actions</i>	<i>Source</i>	<i>Unique number ID</i>
1. Review and improve existing fisheries monitoring programs	California Department of Water Resources- Division of Environmental Services	128
2. Improve our ability to monitor and assess ecological changes in the Delta (e.g., understand gear efficiency and distribution)	U.S. Fish and Wildlife Service	124
3. Evaluate the cost of purchasing, installing, operating, and maintaining an array of bottom salinity monitoring stations and adding two additional outflow measurement stations	U.S. Environmental Protection Agency	109

Action Area 16. Collaborative modeling approaches

Collaborative modeling approaches are needed to characterize and simulate the physical, biological, and chemical components of the Bay-Delta system. This includes the development of diverse yet interactive models to inform water management decisions related to water operations to meet human and environmental needs.

<i>Action Area 16 – Example science actions</i>	<i>Source</i>	<i>Unique number ID</i>
1. Establish standard inputs for modeling selected problems to test model performance and validation of restoration design and implementation	California Water and Environmental Modeling Forum	33
2. Develop a comprehensive model for hydrologic and species assessment and forecasting under various climate change, hazards and operational scenarios	U.S. Geological Survey	133
3. Develop Life Cycle Model for Chinook Salmon	National Oceanographic and Atmospheric Administration – Southwest Fisheries Science Center	72
4. Develop and enhance models: CalSIM3 enhancements that incorporate groundwater hydrology	California Department of Water Resources, Bay-Delta Office	17

Resources to Implement the Delta Science Plan

Action Area 17. Building science capacity

Building the capacity, infrastructure, and institutional support needed for science to be nimble and responsive to new demands means dedicating adequate human resources, time, and dollars for science. It includes employing collaborative approaches to achieve the vision of *One Delta, One Science*, increasing the capacity to do science synthesis, and creating sufficient organizational flexibility to capitalize on learning opportunities related to emerging management priorities (i.e., drought, floods, and toxic spills).

<i>Action Area 17 – Example science actions</i>	<i>Source</i>	<i>Unique number ID</i>
1. Continue support of collaborative science efforts (i.e., CAMT, CWQMC, Estuaries Monitoring Workgroup, IEP, Delta RMP, San Francisco Bay Nutrient Management Strategy)	State and Federal Contractors Water Agency	98
2. Test collaborative approaches to conducting science in the Bay-Delta	Collaborative Adaptive Management Team	48
3. Increase the capacity for science synthesis	Interagency Ecological Program	64

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Appendix A: Methods

Preliminary Document Synthesis

Initially, the Delta Science Program collated 26 plans and documents and searched for science needs, questions, and actions (<http://deltacouncil.ca.gov/sites/default/files/documents/files/Preliminary-Synthesis-to-Inform-the-Interim-Science-Action-Agenda.pdf>). The outcome represented priority science and information needs of 25 agencies/ programs. The information was organized in a matrix and a preliminary synthesis was performed to identify commonalities among the science needs and actions of various agencies and entities. However, the identification and reporting of science needs, questions and actions was highly variable among plans and documents. For this reason, the focus of the preliminary synthesis was on science needs and science actions by policy area and agency/ entity because the information was most accessible or discernible.

May 6, 2014 Workshop

To receive community input on the Delta Science Program's preliminary efforts to develop the Interim Science Action Agenda, a public workshop was held on May 6, 2014. Members of the scientific community and general public were encouraged to attend and provide input. A total of 37 people participated in the workshop, representing about 22 different organizations and agencies. During the workshop, initial efforts and methods were described, and several small group discussions were facilitated to gather community feedback. Feedback from the community included numerous suggestions, comments, and critiques. Community recommendations generally included feedback on what was missing in the preliminary synthesis, examples of priority science actions, and strategies for moving forward, such as the concept of focused interviews of various agencies and organizations. More information on the workshop can be found here: <http://deltacouncil.ca.gov/science-event/10572>.

Focused Interviews

Based on input and recommendations received at the May 6, 2014 workshop, the Delta Science Program conducted focused expert interviews to further develop the Interim Science Action Agenda. The focused interviews were intended to streamline the collection of various agencies' and organizations' current high-priority science actions. A core set of questions was asked at each interview (Appendix C), and the responses were compiled into a spreadsheet. Shortly after each interview, the interviewee(s) were provided the opportunity to review, clarify, edit, or comment on the Delta Science Program's summary of their responses. Interviewee(s) were also informed that full interview responses would likely be appended, and may or may not be included in full within the Interim Science Action Agenda. Of the agencies and organizations that were invited to participate in the interview process, approximately 81% responded and were interviewed. In total, 22 interviews were conducted (Table A-1).

Compilation of Interview Responses and Preliminary Synthesis Document

Upon completion of the focused interviews, the Delta Science Program synthesized and summarized interview responses and the science actions identified in existing documents to develop the list of science action areas in the Interim Science Action Agenda. Existing documents included in this synthesis differ from the documents assessed as part of the Delta Science Program's preliminary synthesis (May 2014). In this synthesis, documents were excluded when they reflected priorities limited to pre- or during-2014 actions and for whom the lead organization participated in a focused interview. An Excel workbook with the full range of science actions used for this synthesis (including detailed information about relevant mandates, lead organizations, collaborating organizations, and more) can be found on

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the Delta Science Program's Interim Science Action Agenda webpage at <http://deltacouncil.ca.gov/interim-science-action-agenda>. Blank cells within the final spreadsheet indicate where information was either not available or not provided. Throughout the development of the Interim Science Action Agenda, advice was sought from the Science Steering Committee, an advisory committee formed by the Delta Lead Scientist to guide and advise the Delta Science Program (Delta Science Plan, Appendix D).

The resulting list of science actions is characterized by a wide range of topics and scales. To efficiently summarize the list of science actions, the Delta Science Program binned science actions by policy areas in the Delta Plan, and by chapter topics in the Delta Science Plan. Interviewees provided input on the selection of the Delta Plan topic for each of their actions; however, several of the actions span multiple topics so interviewees often selected multiple Delta Plan topics. As a result, the final topics selected for each science action was done by the Delta Science Program. The list of science actions was further summarized by identifying common themes, and summarizing individual science actions to produce a list of broader, over-arching science action areas (Table 1 in the Executive Summary). Action areas were crafted to be inclusive of the full range of actions heard during interviews and identified in existing documents. The compilation served as the foundation for the descriptions of the 17 science action areas and the examples found in the Interim Science Action Agenda.

The Delta Science Program recognizes that other syntheses of the reviewed science actions could result in alternate interpretations. It is acknowledged that this synthesis was limited by who was interviewed and what documents were reviewed, and acknowledge that a full inventory of individual science actions was not produced. The inventory of individual science actions includes the range of responses received without screening (with the exception of the removal of non-science actions). It is recognized that some alternative and additional priority science actions may not be included in this inventory and synthesis. It is further recognized that interviews with additional organizations and the review of additional documents could lead to different synthesis outputs.

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Table A- 1. Agencies and Organizations Interviewed.

Agencies and Organizations Interviewed
California Department of Fish and Wildlife (CDFW)
California Department of Food and Agriculture (CDFA)
California Department of Water Resources- Bay Delta (DWR-Bay Delta)
California Department of Water Resources- Division of Environmental Services (DWR-DES)
California Department of Water Resources- Integrated Water Management (DWR-IWM)
California Water and Environmental Modeling Forum (CWEMF)
California Water Quality Monitoring Council (CWQMC)
Central Valley Regional Water Quality Control Board (CVRWQCB)
Collaborative Adaptive Management Team (CAMT)
Delta Protection Commission (DPC)
Interagency Ecological Program (IEP)
NOAA - South West Science Center (NOAA-SWSC)
Public Water Agencies
Sacramento Regional County Sanitation District
Sacramento-San Joaquin Delta Conservancy
San Francisco Regional Water Quality Control Board (SFRWQCB)
State and Federal Contractors Water Agency (SFCWA)
State Water Resources Control Board (SWRCB)
U.S. Bureau of Reclamation
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
U.S. Geological Survey

Appendix B: Process for developing and updating the Science Action Agenda (Delta Science Plan Appendix C)

Science Action Agenda content

The Action Agenda will contain prioritized science activities for addressing decision-makers' grand challenges and other management issues on a four-year cycle. The Action Agenda will include multiple-directed science activities and open competitive solicitations. It will include activities to predict potential outcomes of various management and intervention options, often referred to as "alternative futures." The Action Agenda will support coordinated and transparent adaptive management. It will retain flexibility to conduct science around unanticipated specific events such as a flood, earthquake, levee failure, salt-water intrusion into the Delta, major releases of hazardous materials, or unforeseen declines in Delta species.

Identifying and prioritizing science activities

The Action Agenda will be developed and updated through an open process by the Delta science community (including federal and State agencies, local agencies, academics, and interested public) and the Science Steering Committee (Action 2.4) under the leadership of the Delta Science Program. The Policy-Science Forum (Action 2.1) will provide high-level guidance for the Action Agenda through the identification and setting of decision-makers' grand challenges and other management issues including statements about major problems, goals, and objectives. The Science Steering Committee will translate the grand challenges and other management issues into science questions to be addressed through priority science activities. These science questions will be used to guide the development and updates to the Action Agenda. Priorities for science actions identified at summits (i.e., the adaptive management forum (Action 3.1) and through collaborative efforts for developing community tools (i.e., data management (Action 4.3.1.) and shared models (Action 4.4.1.)) will also be incorporated into the list of prioritized science activities. Input from agencies, the science community and interested public on priority science activities will be gathered through forums such as the Annual IEP/CWEMF Workshop, State of the Estuary Conference, Delta Stewardship Council meetings, and the Biennial Bay-Delta Science Conference, as well as through written public comments.

The Science Steering Committee is responsible for applying scientific criteria (i.e., scientific likelihood to achieve its objective) to prioritize science activities to address the grand challenges and other high priority management issues. The Delta Science Program will use the prioritized list of science activities to assemble the Action Agenda. The Delta Lead Scientist has the responsibility for articulating the rationale for the Action Agenda and prioritizing the actions.

Review Process

The Action Agenda will be reviewed by the Delta Independent Science Board, consistent with its responsibility to provide oversight of the scientific research, monitoring, and assessment programs that support adaptive management of the Delta.

Use

The Action Agenda will be the shared science priority actions for the Delta. It will provide the overarching agenda and direction for developing and updating individual science programs' work plans. The Delta Science Program and agency directors will coordinate the implementation of the Action Agenda through an open process that connects agencies and interested parties to collectively fund priority actions. Collective implementation of the Action Agenda will build the knowledge base and science tools necessary to address decision-makers' needs. New knowledge gained through implementation of the Action Agenda will inform updates to *The State of Bay-Delta Science* as well as the Action Agenda.

Updating the Action Agenda

The four-year cycle of the Action Agenda will be aligned with the Biennial Bay-Delta Science Conference so that the update of one or the other will occur every two years to maximize opportunities for openly engaging the science community, policymakers, managers, and interested public. Discussions on and releases of Action Agenda updates will be timed to gather input through the Annual IEP Workshop, State of the Estuary Conference, Delta Stewardship Council meetings, and the Biennial Bay-Delta Science Conference. The four-year cycle was selected in order to alternate the use of the Biennial Bay-Delta Science Conference to gather input and rolling out major publications of *The State of Bay-Delta Science* [Appendix E]. The Action Agenda may be updated more regularly in response to major changes in the Delta (e.g., major flood or invasion of non-native species) that require science support.

Box C-1 Interim Science Action Agenda

To initiate implementation of the Delta Science Plan, an Interim Science Action Agenda will be completed in 2014. It will include a list of priority science actions and questions from existing documents (see below) and collaboration with other agencies and programs that produce and utilize scientific information. The process for developing the Interim Science Action Agenda is an expedited and scaled-back version of the process described in this appendix. The Interim Science Action Agenda will include near-term priority science questions and needs from existing agency and program plans and documents, synthesis and review panel reports, Delta ISB memos, and more. It will not include a comprehensive analysis of current applied research, monitoring, data exchange, and modeling efforts that are relevant to the grand challenges of the Delta (Chapter 2) and will be limited to interim actions to be addressed within a two-year time frame.

Example sources of priority science actions include:

1. Delta Plan
2. *The State of Bay-Delta Science 2008*
3. Bay Delta Conservation Plan
4. Ecosystem Restoration Program Conservation Strategy
5. IEP Work Plans and Proposal Solicitations
6. Delta Science Program and Ecosystem Restoration Program PSPs
7. Independent Review Panel Reports
8. Workshop and Synthesis Documents (e.g., SWRCB Delta Flow Objective Workshops)
9. Monitoring Plans and Proposals (e.g., Delta Regional Monitoring Program: A Proposal for a Regional Monitoring and Assessment Framework and its Implementation)
10. CAMT Science Questions and Work Plans

Appendix C: Guidance Provided to Focused Interviewees

Focused Interviews to Inform the Interim Science Action Agenda

Background on the Interim Science Action Agenda

Based on input and recommendations received at the May 6, 2014 Interim Science Action Agenda workshop, the Delta Science Program is conducting focused expert interviews to develop the Interim Science Action Agenda. The Interim Science Action Agenda will be a shared list of near-term common science actions to be addressed within a 2-year time frame. It will identify Delta-wide science needs and gaps and be a shared action agenda for science collaboration among agencies and programs. It will be the basis for the full Science Action Agenda that will cover a four-year time frame as called for in the Delta Science Plan.

The Interim Science Action Agenda will be used by the Delta science community to:

1. Unify science needs for the Delta – provide a common playbook for actions that build and provide best possible science to inform water and environmental decisions in the Delta.
2. Advise Proposal Solicitation Packages – motivate coordinated and individual program’s focused proposal solicitation package research grants and science fellowships to advance our knowledge of the Delta.
3. Guide strategies to fill funding gaps – highlight opportunities and inform strategic pathways for filling funding gaps for priority science activities.
4. Inform updates to the State of Bay-Delta Science – outline the key actions necessary to fill knowledge gaps and address key uncertainties to update our understanding of the Bay-Delta system.
5. Design a web-based tracking system of science activities – informs the development of an inventorying and tracking system that improves the transparency of science activities in the Delta.

What to Expect During and After the Interview

The focused interviews are intended to streamline the collection of your program’s current high-priority science actions. These are science activities (e.g., studies, monitoring, data management, modeling, synthesis) that you are undertaking, anticipate starting within the next two years, or would undertake if the resources were available.

Interviews are expected to take approximately one hour. Individual interview responses will be aggregated to form the basis for the Interim Science Action Agenda. Please notify the interviewer if any of the information provided is sensitive or confidential.

Attached is a preview of the interview questions you will be asked. We encourage you to consult with your colleagues. Please let us know if you would like them to participate in a joint interview to help us capture the breadth of your program’s priority science activities.

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After the interview we will provide you with our interview response matrix to give you a chance to review, clarify, edit or comment on our summary of your responses. Once the interviews are complete we will develop a draft Interim Science Action Agenda with an invitation to provide comments on the draft.

The interview responses and information gathered from existing documents will be foundational inputs for the Interim Science Action Agenda. The Delta Science Program will synthesize and summarize interview responses and science actions identified from these sources to develop the list of priority science actions in the Interim Science Action Agenda. Full interview responses will likely be appended, but may or may not be included in full within the Interim Science Action Agenda.

Interview template

We are providing the attached interview template to help you prepare. We will complete it at the interview. You are welcome to provide any of the requested information in writing before or at the interview.

Attachment - Interim Science Action Agenda (ISAA) Focused Interview Template

1. What are the top 5 priority science actions your organization will undertake, anticipate starting, or would undertake if the resources were available in the next 2 years? For each, please identify the rationale and any appropriate documentation for these actions.
2. What is the status of each science action? Please select one of the following for each science action:
 - a. Proposed (The action has been identified, but no action has been taken. This includes actions in various stages of planning.)
 - b. Ongoing (The action has been initiated, but not completed.)
3. Of the following, please select the most relevant topic and subtopics for each science action:
 - a. A more reliable water supply for California
 1. Water efficiency and conservation
 2. Groundwater management
 3. Conveyance and storage
 4. Water management information
 - b. Protect, restore, and enhance the Delta ecosystem
 1. Delta flows
 2. Habitat restoration
 3. Ecosystem water quality
 4. Nonnative species
 5. Hatcheries and harvest management
 - c. Delta as a place
 1. Designation of the Delta as a special place
 2. Land use and community planning
 3. Agriculture
 4. Recreation and Tourism
 5. Delta Economy
 - d. Improve water quality to protect human health and the environment
 1. Water quality protection
 2. Managing salinity
 3. Drinking water quality
 4. Environmental water quality
 - e. Reduce risk to people, property, and State interests in the Delta
 1. Flood risk (floods, earthquakes, high tides and sunny-day risks)
 2. Land subsidence
 3. Levees and ecosystem function

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4. For each priority science action identify the associated management need(s). If applicable, what, legislative/regulatory mandates are these actions aimed at complying with or providing decision support?
5. Please select one of the following funding categories for each science action:
 - a. Currently funded (in full)
 - b. Will be funded in the future
 - c. Funding is needed
 - d. Currently funded, but in need of future funds
6. If applicable, who is or will be the primary implementing organization for each science action?
7. Please list collaborating organizations involved in each science action.
8. Please include contact information for the lead person per science action.

Appendix D: Visualization and Summary Tables

This appendix includes a visualization of organizations that have an interest in the 17 science actions areas and summary tables for the full range of science actions assessed as part of the Interim Science Action Agenda synthesis. It provides tabular summaries of 1) the most frequently referenced relevant mandates and the associated number of individual science actions associated with each mandate (Table D-1), and 2) the agencies and organizations most frequently engaged in individual science actions (Table D-2).

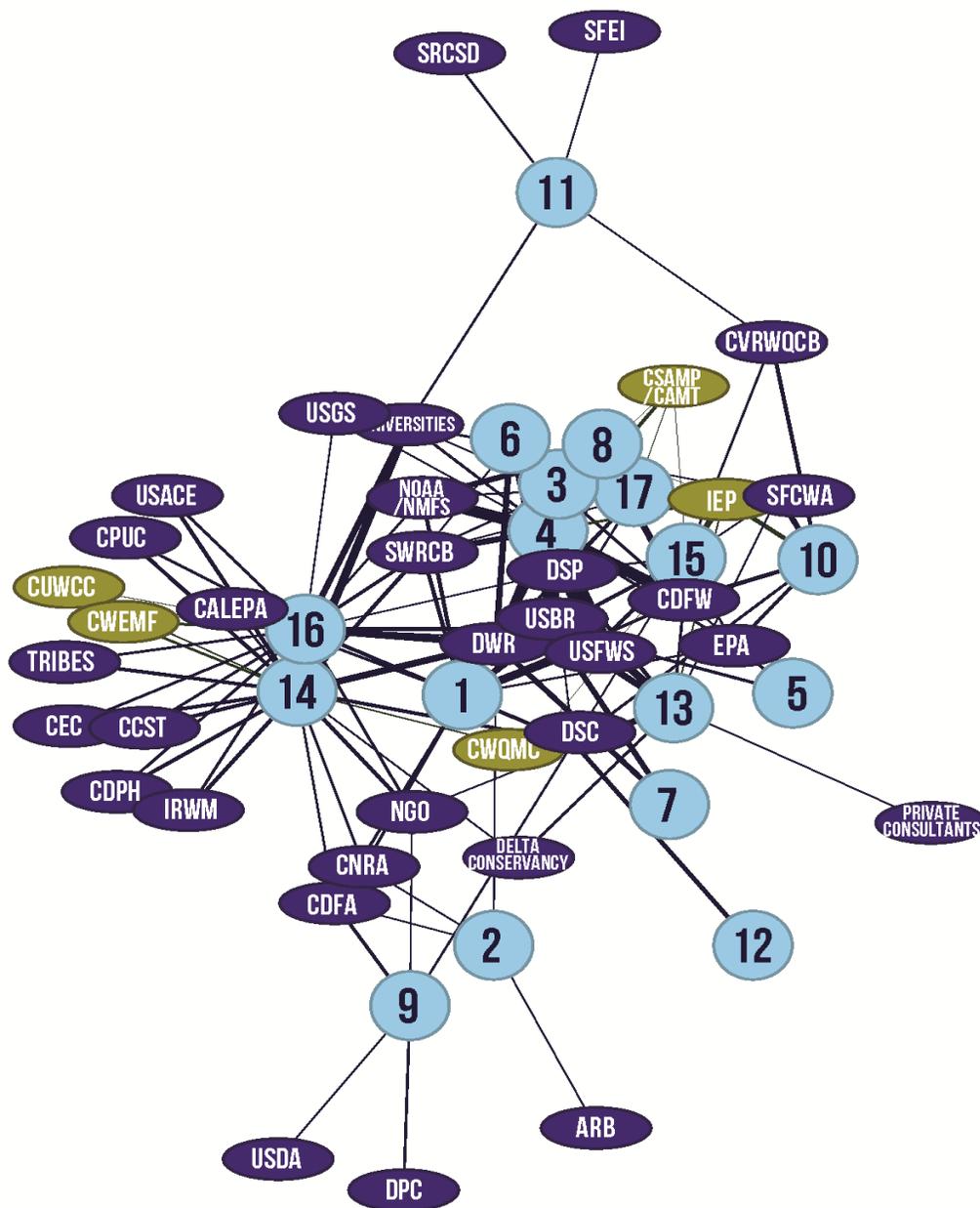


Figure D-1. Organizations by action area network map. This network map illustrates the relationships between the organizations (dark blue) including collaborative efforts/organizations (green) and the 17 science action areas (light blue). In this figure, relationships between organizations and action areas are limited to those organizations that identified and/or are participating in at least three individual science actions within a specific science action area. The connecting lines between organizations and action areas indicate a relative interest/participation in a science action area by an organization. The thicker the connecting line the greater the level of interest/participation of the organization in that action area.

Science Action Areas: 1) Watershed and water management; 2) Impacts of climate change on natural resources; 3) Entrainment of native fishes; 4) Needs of native species; 5) Habitat restoration; 6) Lower aquatic food webs; 7) Methods to manage and minimize the impacts of non-native species; 8) Abundance and distribution of predators; 9) The Delta economy; 10) Sources and drivers of contaminants; 11) Role of nutrients; 12) Characterization of risks associated with natural disasters; 13) Tools and resources for adaptive management; 14) Data and information accessibility and exchange; 15) Coordinated monitoring and assessment; 16) Collaborative modeling approaches; 17) Building science capacity.

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Abbreviations for Organizations in Figure D-1

Organizations (including collaborative efforts/organizations)	Abbreviations
California Council for Science and Technology	CCTS
California Department of Food and Agriculture	CDFA
California Department of Fish and Wildlife	CDFW
California Department of Public Health	CDPH
California Energy Commission	CEC
California Environmental Protection Agency	CalEPA
California Natural Resources Agency	CNRA
California Public Utilities Commission	CPUC
California State University	CSU
California Urban Water Conservation Council	CUWCC
Central Valley Regional Water Quality Control Board	CVRWQCB
California Water and Environmental Modeling Forum	CWEMF
California Water Quality Monitoring Council	CWQMC
Collaborative Science and Adaptive Management Program/ Collaborative Adaptive Management Team	CSAMP/CAMT
Delta Protection Commission	DPC
Delta Stewardship Council	DSC
Delta Science Program	DSP
Department of Water Resources	DWR
Interagency Ecological Program	IEP
Integrated Regional Water Management	IRWM
National Oceanic and Atmospheric Administration, National Marine Fisheries Service	NOAA/ NMFS
Non-Governmental Organizations	NGOs
Sacramento Regional County Sanitation District	SRCSD
San Francisco Estuary Institute	SFEI
State and Federal Contractors Water Agency	SFCWA
State Water Resources Control Board	SWRCB
United States Army Corp of Engineers	USACE
United States Bureau of Reclamation	USBR
United States Environmental Protection Agency	EPA
United States Fish and Wildlife Services	USFWS
United States Geological Survey	USGS

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Table D- 1. The top 10 most frequently identified mandates per individual science action identified in interviews or existing documents.

Mandates	Count of Individual Science Actions
Federal Endangered Species Act (including Reasonable and Prudent Alternative Actions and Biological Opinions)	145
Delta Plan	98
State Water Resources Control Board Bay-Delta Plan	90
Bay Delta Conservation Plan	79
Federal Clean Water Act	46
California Natural Community Conservation Planning Act	39
Habitat Conservation Plans	33
Central Valley Project Improvement Act	32
California Water Code	30
[No mandates identified]	25

Table D- 2. The top ten organizations and agencies engaged in individual science actions. "Engaged" means involved in identifying or participating in implementation of the individual science actions. **indicates collaborative entities.

Organizations/ Agencies Engaged in Science Actions	Count of Individual Science Actions
U.S. Bureau of Reclamation	66
Delta Stewardship Council and Delta Science Program	59
Interagency Ecological Program**	50
State Water Resources Control Board	30
Department of Water Resources	29
Independent Review Panel	28
U.S. Environmental Protection Agency	25
California Department Fish and Wildlife	23
California Water and Environmental Modeling Forum**	19
State and Federal Contractors Water Agency	18