Draft Interim Science Action Agenda

Prepared by the Delta Science Program

A program of the Delta Stewardship Council

September 9, 2014

DRAFT INTERIM SCIENCE ACTION AGENDA

This is the first draft of the Interim Science Action Agenda, which will be presented to the Delta Stewardship Council in late-September 2014. This Draft Interim Science Action Agenda will be reviewed by the Delta Independent Science Board in October 2014. The Final Interim Science Action Agenda will be presented to the Delta Plan Interagency Implementation Committee in November 2014

The Draft and Final versions of the Interim Science Action Agenda will be presented publicly by the Delta Lead Scientist (or designee) to receive information and comments from the Delta Stewardship Council, Delta Plan Interagency Implementation Committee and the public. These presentations will be simulcast on the Council website at www.deltacouncil.ca.gov.

SUBMITTING PUBLIC COMMENT

Public comments are welcome during the Interim Science Action Agenda development process. The Delta Science Program encourages written public comments to be submitted to science@deltacouncil.ca.gov. Please organize written comments by section title, heading, appendix, page number, line number, table number, and spreadsheet name/tab, and row/column numbers as appropriate.

For public comment on the Draft Interim Science Action Agenda to be considered for incorporation in the Final Interim Science Action Agenda, **comments must be received no later than Tuesday, October 7, 2014**.

Executive Summary

While many agencies are planning and conducting scientific investigations in the Delta, this science is not always well organized and coordinated. The Interim Science Action Agenda will improve the 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 organizes a range of science actions identified by multiple organizations that contribute to or use scientific information about the Delta. These actions go beyond mission-specific science and further the vision of *One Delta, One Science* – which means an open Delta science community that works together to build a shared body 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 an important element of a Delta Science Program designed to meet the Delta Reform Act's mandate that key decisions be based on the best available science.

The Interim Science Action Agenda is a major component of the Delta Science Plan, as an expedited initial version of a full Science Action Agenda (See the Delta Science Plan, Appendix C). It also incorporates the science and information needs associated with or identified in several major Delta-specific plans and programs, including the Delta Stewardship Council's Delta Plan, the multi-agency Draft Bay Delta Conservation Plan, science recommendations associated with the State Water Resources Control Board's Bay-Delta Plan, the Collaborative Science and Adaptive Management Program, Interagency Ecological Program, and several others.

The Interim Science Action Agenda identifies a list of 17 science action areas. These summarize 315 individual science actions identified by the Delta science community, managers, and decision makers through focused interviews with agencies and organizations that use or produce scientific information about the Delta and review of existing documents (e.g., agency plans and independent review panel reports). The 17 science action areas are organized into two main categories: 1) Science Designed to Address Knowledge Gaps (organized by the policy areas/chapters in the Delta Plan), and 2) Science that Builds the Infrastructure and Capacity to Achieve *One Delta, One Science*[1] (organized by the chapters in the Delta Science Plan) (Table 1). While the full Science Action Agenda will result in a prioritized list of areas for investment in science, the order of science action areas and actions in this interim document does not indicate priority.

Implementation of the Interim Science Action Agenda and the Delta Science Plan means taking common steps to reduce knowledge gaps, accelerate scientific discovery to inform management decisions, and build the science infrastructure and capacity to achieve the vision of *One Delta, One Science*. Success of the Interim Science Action Agenda relies on the ability of programs and agencies to work together. It means that there is a single roadmap guiding investments in science (people and dollars) to inform decision making in the Delta. Success also means that decision makers have access to credible, relevant,

[1] "One Delta, One Science" is the Delta Science Plan vision for an open Delta science community that works collaboratively to build a shared body of scientific knowledge with the capacity to adapt and inform future water and environmental decisions.

and legitimate science and the Delta science community has management-relevant guidance for what science actions should be tackled.

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

Science Action Areas Designed to Address Knowledge Gaps
A More Reliable Water Supply for California
Action Area1. Investigate and characterize watershed and water management opportunities and issues
Action Area 2. Develop tools to understand the impacts of climate change on natural resources and identify opportunities to reduce greenhouse gas emissions
Action Area 3. Understand the factors affecting entrainment of native fishes and the importance of entrainment on native fish populations
Protect, Restore, and Enhance the Delta Ecosystem
Action Area 4. Understand the conservation needs of native species.
Action Area 5. Understand the effects of habitat restoration and other management actions to address environmental stressors
Action Area 6. Improve understanding of lower aquatic food web dynamics and productivity and its effect on native species
Action Area 7. Investigate methods to control and minimize the impacts of non-native species (aquatic and terrestrial)
Action Area 8. Understand the abundance and distribution of predators and their importance to native fish
Protect and Enhance the Unique Cultural, Recreational, Natural Resource, and Agricultural Values of the California Delta as an Evolving Place
Action Area 9. Improve understanding of factors that affect the Delta economy (i.e., agriculture, recreation, tourism)
Improve Water Quality to Protect Human Health and the Environment
Action Area 10. Improve understanding of the sources and drivers of contaminants (e.g., selenium, pesticides, and mercury) in the Bay-Delta system and their effects on people and the ecosystem
Action Area 11. Understand the role of nutrients in the Bay-Delta system
Reduce Risk to People, Property, and State Interests in the Delta
Action Area 12. Improve the characterization of risks associated with natural disasters
Science Actions that Build the Science Infrastructure and Capacity to Achieve *One Delta, One Science*
Adaptive Management for a Complex System
Action Area 13. Build tools and resources (i.e., project tracking and coordinated monitoring) for adaptive management in the Delta
Building the Infrastructure for Science
Action Area 14. Improve data and information accessibility and exchange (biological and physical data)
Action Area 15. Improve and promote coordinated monitoring and assessment through, 1) incorporating modern science tools and methods while maintaining long-term data sets; and 2) establishing standard/common methodologies for collecting data (biological and physical)
Action Area 16. Establish collaborative modeling approaches for the Bay-Delta system
Resources to Implement the Delta Science Plan
Action Area 17. Build the science capacity, infrastructure and institutional support needed for the science community to be nimble and responsive to new demands, including non-routine and opportunistic science needs (i.e., special monitoring, studies, and synthesis)

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Action Area 3. Understand the factors affecting entrainment of native fishes and the importance of entrainment on native fish populations 6

Protect, Restore, and Enhance the Delta Ecosystem 6

Action Area 4. Understand the conservation needs of native species. 6

Action Area 5. Understand the effects of habitat restoration and other management actions to address environmental stressors 7

Action Area 6. Improve understanding of lower food web dynamics and productivity and its effect on native species 7

Action Area 7. Investigate methods to control and minimize non-native species (aquatic and terrestrial) 8

Action Area 8. Understand the abundance and distribution of predators and their importance to native fish 9

Protect and Enhance the Unique Cultural, Recreational, Natural Resource, and Agricultural Values of the California Delta as an Evolving Place 10

Action Area 9. Improve understanding of factors that affect the Delta economy (i.e., agriculture, recreation, tourism) 10

Improve Water Quality to Protect Human Health and the Environment 11

Action Area 10. Improve understanding of the sources and drivers of contaminants (i.e., selenium, pesticides, and mercury) in the Bay-Delta system and their effects on people and the ecosystem 11

Action Area 11. Understand the role of nutrients in the Bay-Delta system 12

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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 investigations in the Delta, this science is not always well organized and coordinated. The Interim Science Action Agenda will improve the 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 315 science actions identified by multiple organizations that contribute to or use scientific information in the Delta into a list of 17 science action areas. These actions and action areas reach beyond mission-specific science and further 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 Plan[2] , a framework called for by the Delta Plan 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 (See the Delta Science Plan, Appendix C). Because this is an "Interim" Science Action Agenda, it does not include formal direction from a Policy-Science Forum (Delta Science Plan, Appendix B), but it is guided by advice from the Science Steering Committee, a multi-disciplinary advisory committee formed by the Delta Lead Scientist to guide and advise science in the Delta (Delta Science Plan, Appendix D).

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, Interagency Ecological Program and several others. The 17 science action areas in this action agenda address the need for increased understanding and science capacity to provide best possible science 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 determining regulations to manage multiple stressors.

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 Delta decision makers. In its early development, a preliminary synthesis of science needs and actions from existing documents was developed by the Delta Science Program. This served as the basis for a public workshop attended by federal, State, and local agencies and programs,

[2] 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.

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 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.

The Interim Science Action Agenda does not contain an exhaustive catalog of science actions, underway or proposed, that could be taken to improve understanding about the Delta and California's water supply system. The action areas and actions identified in this document also do not represent a prioritization of science actions, nor will they result in the science necessary to inform every possible management or policy decision that could be taken in the Delta.

The Interim Science Action Agenda does represent the science actions, that when taken, will fill many of the most critical gaps in scientific understanding of the Delta and build the science communities' capacity to provide credible, relevant and legitimate decision-support 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.

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

Success of the Interim Science Action Agenda relies on the ability of programs and agencies to work together. The Interim Science Action Agenda presents an opportunity for achieving integrated, collaborative, and transparent science to inform decision making. Success of the Interim Science Action Agenda means that there is a single roadmap guiding science to inform decision making in the Delta. This would be fulfilled through coordinated work plans (e.g., State of California Five Year Coordinated Work Plan for Wetlands Conservation Program Development[3]) and joint funding of priority science (e.g., multi-agency funding of Delta Science Fellow[4]s). Success also means that decision makers have access to credible, relevant, and legitimate science and the Delta science community has 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:

[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

1) Better science is available to support agency decisions;
2) Multiple science agencies and organizations endorse the Interim Science Action Agenda as a collaborative road map for addressing decision maker's science needs in the Delta;
3) Agency or program science efforts and work plans are informed by the Interim Science Action Agenda;
4) Resources are leveraged to accelerate learning and make progress in the 17 shared science action areas;
5) Strategies to fill funding gaps are guided by the Interim Science Action Agenda;
6) Collaborative and individual funding of Proposal Solicitation Packages, directed actions, and science fellowships reference the 17 shared science action areas;
7) An increased transparency of proposed and ongoing science actions exists in the Delta; and
8) 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 institutions engaged in Delta science.

In addition, the Interim Science Action will serve as the starting point for developing a full Science Action Agenda as described in the Delta Science Plan, Appendix C. The information learned from implementing the Interim Science Action Agenda will be captured in updates to *The State of Bay-Delta Science*.

Science Action Areas

The following 17 science action areas are an inclusive summary of the 315 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 Actions Designed to Address Knowledge Gaps (organized by the policy areas/chapters in the Delta Plan), and 2) Science Actions that Build the Infrastructure and Capacity to Achieve *One Delta, One Science* (organized by the chapters in the Delta Science Plan). They 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. The order of the action areas and science actions does not indicate any order of priority.

Please note: For each action area a brief description is provided along with example individual science actions. These examples are drawn from the 315 individual actions that were organized into the 17 science action areas. For each example, the source (either the reference document name or interviewed organization) and a unique number ID is provided so that additional information about the individual action can be found in the Excel workbook containing all 315 individual science actions. Summary tables and figures of the science actions included in the synthesis are provided in Appendix C.

1 **Table 2. The number of individual actions from interview responses and documents that were**
2 **summarized into one of 17 action areas for the Interim Science Action Agenda**

17 Science Actions Areas in the Interim Science Action Agenda	Count of Individual Science Actions
Action Area 1. Investigate and characterize watershed and water management opportunities and issues	26
Action Area 2. Develop tools to understand the impacts of climate change on natural resources and identify opportunities to reduce greenhouse gas emissions	8
Action Area 3. Understand the factors affecting entrainment of native fishes and the importance of entrainment on native fish populations	10
Action Area 4. Understand the conservation needs of native species.	56
Action Area 5. Understand the effects of habitat restoration and other management actions to address environmental stressors	11
Action Area 6. Improve understanding of lower aquatic food web dynamics and productivity and its effect on native species	14
Action Area 7. Investigate methods to control and minimize the impacts of non-native species (aquatic and terrestrial)	13
Action Area 8. Understand the abundance and distribution of predators and their importance to native fish	16
Action Area 9. Improve understanding of factors that affect the Delta economy (i.e., agriculture, recreation, tourism)	11
Action Area 10. Improve understanding of the sources and drivers of contaminants (e.g., selenium, pesticides, and mercury) in the Bay-Delta system and their effects on people and the ecosystem	23
Action Area 11. Understand the role of nutrients in the Bay-Delta system	7
Action Area 12. Improve the characterization of risks associated with natural disasters	9
Action Area 13. Build tools and resources (i.e., project tracking and coordinated monitoring) for adaptive management in the Delta	31
Action Area 14. Improve data and information accessibility and exchange (biological and physical data)	16
Action Area 15. Improve and promote coordinated monitoring and assessment through, 1) incorporating modern science tools and methods while maintaining long-term data sets; and 2) establishing standard/common methodologies for collecting data (biological and physical)	29
Action Area 16. Establish collaborative modeling approaches for the Bay-Delta system	21
Action Area 17. Build the science capacity, infrastructure and institutional support needed for the science community to be nimble and responsive to new demands, including non-routine and opportunistic science needs (i.e., special monitoring, studies, and synthesis)	14
Total	**315**

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Science Actions Designed to Address Knowledge Gaps

A More Reliable Water Supply for California

Action Area1. Investigate and characterize watershed and water management opportunities and issues

Investigations to better understand how to sustainably manage water from the Sierra to the sea is needed. Watershed and water management includes the development of shared models, monitoring and associated research to understand the effects of lower or minimum 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.

Example science actions	*Source*	*Unique number ID*
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. Develop tools to understand the impacts of climate change on natural resources and identify opportunities to reduce greenhouse gas emissions

Research and modeling that lead 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.

Example science actions	*Source*	*Unique number ID*
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 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. Understand the factors affecting entrainment of native fishes and the importance of entrainment on native fish populations

While several ongoing studies are underway to improve our understanding of factors affecting entrainment of native fish, several knowledge gaps exist. Science to better understand the population-level effects of entrainment includes research, monitoring, modeling and synthesis. This action builds understanding about the causes and effects of entrainment as well as the effects of water management actions (i.e., 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 making changes to existing biological opinions for operating the Central Valley Project and State Water Project, operational decisions about the proposed Bay Delta Conservation Plan and changes to the State Water Resources Control Board's Bay-Delta Plan.

Example science actions	*Source*	*Unique number ID*
1. Understand entrainment effects on fish populations.	Delta Plan	154
2. 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
4. Develop a Delta smelt life cycle model to help manage operations to avoid entrainment of smelt at the water project's intakes.	California Water Action Plan	189

Protect, Restore, and Enhance the Delta Ecosystem

Action Area 4. Understand the conservation needs of native species.

Investigate the conservation needs of native species though investments in research and monitoring activities to fill knowledge gaps necessary to improve native species management. This action area includes targeted research and monitoring to understand factors that influence survival of native species at the population level. These factors include identifying important habitat attributes (e.g., understanding the importance of seasonal outflows, understanding the physical attributes of key migratory corridors, and temperature requirements). 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.

Example science actions	*Source*	*Unique number ID*
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. Understand the effects of habitat restoration and other management actions to address environmental stressors

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 associated with the Draft Bay Delta Conservation Plan.

Example science actions	*Source*	*Unique number ID*
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 - *Effects of fish predation on salmonids in the Sacramento River – San Joaquin Delta and associated ecosystems*	291

Action Area 6. Improve understanding of lower food web dynamics and productivity and its effect on native species

Studies and targeted monitoring are needed to understand lower food web dynamics and productivity of the Delta ecosystem. This information will help reduce uncertainties about factors 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 Board water quality control plans.

Example science actions	*Source*	*Unique number ID*
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 Agencies	96

Action Area 7. Investigate methods to control and minimize non-native species (aquatic and terrestrial)

Science support of invasive species control methods is needed to protect, restore, and enhance the Delta ecosystem. This includes research to understand the timeframe for future invasions as well as investigations of 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 control 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.

Example science actions	*Source*	*Unique number ID*
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. Understand the abundance and distribution of predators and their importance to native fish

Information is needed to understand the abundance and distribution of native and non-native predators, one of several stressors to 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 salmonid 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 that prey on native fish.

Example science actions	*Source*	*Unique number ID*
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 - Effects of fish predation on salmonids in the Sacramento River – San Joaquin Delta and associated ecosystems	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 - Effects of fish predation on salmonids in the Sacramento River – San Joaquin Delta and associated ecosystems	288

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

Action Area 9. Improve understanding of factors that affect the Delta economy (i.e., agriculture, recreation, tourism)

Scientific support to inform decisions that affect the Delta economy includes science to reduce knowledge gaps about impacts to agriculture (i.e., habitat restoration on neighboring lands and pesticide and fertilizer use) 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.

Example science actions	*Source*	*Unique number ID*
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. Improve understanding of the sources and drivers of contaminants (i.e., selenium, pesticides, and mercury) in the Bay-Delta system and their effects on people and the ecosystem

Improved understanding of the sources and drivers of contaminants and their effects consists of research and monitoring actions 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. 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 safe consumption of fish.

Example science actions	*Source*	*Unique number ID*
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. Understand the role of nutrients in the Bay-Delta system

Research, monitoring, modeling, and synthesis actions are needed to better understand the role of nutrients (e.g. nitrogen and phosphorus) in the Bay-Delta system, including their importance to the ecosystem and water supplies. This science action 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.

Example science actions	*Source*	*Unique number ID*
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. Identify the specific science questions and the types of studies needed to better understand the hypothesized mechanisms of the ammonium-inhibition conceptual model	Suisun Bay Ammonium Synthesis Report	240
3. 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. Improve the 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 to support decision such as determining emergency drought operations and updating emergency response plans for levee failures and earthquakes that impact the Delta.

Example science actions	*Source*	*Unique number ID*
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 Actions that Build the Science Infrastructure and Capacity to Achieve *One Delta, One Science*

Adaptive Management for a Complex System

Action Area 13. Build tools and resources (i.e., project tracking and coordinated monitoring) for adaptive management in the Delta

This action area includes the development of science tools and frameworks to inform habitat restoration, water, water quality, and watershed management. It includes coordinated and long-term monitoring actions that facilitate adaptive management of habitat restoration and the implementation of adaptive management of specific habitat restoration projects. Implementing these science actions will support decisions such as adjusting flows based on adaptive management of the State Water Resources Control Board's Bay-Delta Plan and deciding how and when restore wetlands within restoration opportunity areas.

Example science actions	*Source*	*Unique number ID*
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 Agencies	94

Building the Infrastructure for Science

Action Area 14. Improve data and information accessibility and exchange (biological and physical data)

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 improve their data sharing as well as 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.

Example science actions	*Source*	*Unique number ID*
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. Improve and promote coordinated monitoring and assessment through, 1) incorporating modern science tools and methods while maintaining long-term data sets; and 2) establishing standard/common methodologies for collecting data (biological and physical)

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

Example science actions	*Source*	*Unique number ID*
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. Evaluating 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. Establish collaborative modeling approaches for the Bay-Delta system

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.

Example science actions	*Source*	*Unique number ID*
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. Build the science capacity, infrastructure and institutional support needed for the science community to be nimble and responsive to new demands, including non-routine and opportunistic science needs (i.e., special monitoring, study needs, and synthesis)

Building the capacity, infrastructure and institutional support 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).

Example science actions	*Source*	*Unique number ID*
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 Agencies	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 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. The focus of the preliminary synthesis was on the 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 for each interview (Appendix B), and the responses were compiled into a spreadsheet. Shortly after each interview, the interviewee(s) were provided with an 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, 21 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 priority 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 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 science in the Delta (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. It is further recognized that interviews with additional organizations and the review of additional documents could lead to different synthesis outputs.

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 Agencies (SFCWA)
U.S. Bureau of Reclamation
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
U.S. Geological Survey

Appendix B: 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.

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

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 C: Summary Tables

This appendix includes 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 C-1) and 2) the agencies and organizations most frequently engaged in individual science actions (Table C-2).

Table C- 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	86
Bay Delta Conservation Plan	79
Federal Clean Water Act	41
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 C- 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
Department of Water Resources	29
Independent Review Panel	28
State Water Resources Control Board	25
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