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DELTA SCIENCE PLAN – ANNOTATED OUTLINE

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VISION

All Bay Delta water and environmental policy is founded on the highest caliber science. The Delta Science Plan aims to achieve the vision of '*One Delta, One Science'* – a framework for an open Delta science community that works together to build a shared state of knowledge with the capacity to adapt and inform future water and environmental decisions.

1. OVERVIEW

Problem

There are many science efforts in the Delta, but most address a single objective or pragmatic question. Despite the close working relationships of many individual scientists and the collaborative efforts of focused programs such as IEP, it is very difficult to track all activities on a given topic including data, models and results. This lack of coordination makes it very difficult to conduct synthesis that can provide the broadly integrated knowledge base needed to provide the system-wide perspective essential to implement the Delta Plan and support adaptive management to achieve the coequal goals. In addition, there is no generally accepted and adequately supported organizational structure and process for ongoing scientific synthesis. Not surprisingly, there are few examples of broad synthesis efforts in the Delta. These synthesis activities are essential to establishing the "best available" science to support policy and management decisions. This Science Plan recognizes the mandates and sovereignty of individual agencies while enabling scientists to be more productive through interagency collaboration and common tools. Where possible, this plan builds on existing organizational structures to provide this coordination, communications and collaborative synthesis.

Themes to Support Delta Water and Environmental Decision making

- Synthesis of scientific information to summarize the state of knowledge
- Enhanced communication among policy, science and management communities
- Science to support adaptive management decision making
- Build the community of science in an open, transparent, sustainable and collaborative manner with the necessary infrastructure

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DELTA SCIENCE PLAN – ANNOTATED OUTLINE

Objectives

- Coordinate and facilitate science synthesis activities that contribute to holistic understanding of the Bay-Delta in a manner that complements and supports the integrated view provided by the Delta Stewardship Council.
- Create effective policy, science and management interfaces to create shared understanding of problems and science-based solutions to achieve the coequal goals.
- Create a vision for *One Delta, One Science* – the framework to develop an open Delta science community that works together to build a shared body of knowledge with the capacity to adapt and inform future water and environmental decisions.
- Demonstrate how science is a critical part of adaptive management and essential for major planning, policy and management actions related to achieving the coequal goals.
- Reduce meeting and planning time across many programs due to the shared body of knowledge (particularly synthesis documents that describe the current state of knowledge and provide easy access to information).

Example Actions

- Develop and implement a Delta Science Plan as a framework for conducting science which is subject to periodic updates in step with Delta Plan updates.
- Develop a Triennial Science Agenda to achieve the objectives of the science plan including setting research priorities and coordinating adaptive management programs.
- Initiate a Triennial State of Bay-Delta Science report, starting in 2014.
- Create a web-tracking system that captures all funded research activities and provides summaries and contact details of the project including abstract, start and end dates, contact details, significant findings and publications.
- Convene Policy-Science Leadership Forums and Science Synthesis Steering Group.

Expected Outcomes

- Clear communication of synthesized science to decision makers.
- Use of a shared body of knowledge as best available science to explore uncertainties, competing hypotheses, and inform and select policy and management decisions.
- A strategy for collaborative adaptive management tailored to identifying and filling key knowledge gaps.
- Increased rate of learning as a result of coordinated research, use of common models and guidelines for research and adaptive management.

Efforts to Build On:

- Collaborative science planning efforts by the Interagency Ecological Program, Bay Delta Conservation Plan, State Water Resources Control Board , Biological Opinions Remand Process

- All Bay-Delta water and environmental policy and management is founded on the highest caliber science.
- Sustainable funding for Delta science and supporting infrastructure.

Delta Plan Relevance

- Develop, coordinate and provide the best possible unbiased scientific information to inform water and environmental decision making.
- Implement the Delta Plan using adaptive management principles in a coordinated and collaborative way.
- Develop an interagency structure for decision making that fosters communication among scientist, decision makers and stakeholders.
- Provide a strategy for leveraging reliable funding to sustain needed science advancements and infrastructure.
- Address the science and information needs in the Delta Plan.

2. CREATE EFFECTIVE POLICY-SCIENCE-MANAGEMENT INTERFACES

Problem

Communication channels between natural resources decision makers and scientists are weak and not clearly established. Challenges to communicate and develop a shared understanding of needs and opportunities at these interfaces have led to considerable frustration and decision inertia. Also, current fragmentation or science institutions without an overarching plan to coordinate synthesis of knowledge discovery and to implement shared science priorities hinder efficient use of a common and trusted body of science for Delta decision making.

Objectives

- Develop a shared approach to identifying decision makers' grand challenges and needs, research priorities, science that addresses agency needs, and updates of progress towards addressing grand challenges and needs.
- Build trust and forums for identifying and communicating the key scientific uncertainties that are likely to limit restoration and water management effectiveness and potentially low return on investment.
- Create an infrastructure for policy-science-management early engagement, continuous dialogue, and innovative approaches for effective use of best available science to inform Delta decision making

Build a collaborative process for conducting science and develop shared scientific understanding.

Example Actions

- Establish Policy-Science Leadership Forums (i.e., special sessions at the Bay-Delta Science Conference, Interagency Implementation

Efforts to Build On:

- Town Hall Meeting with policy makers and the science community at the 2012 Delta Science Conference
- Coordinated invited Science Expert Panels to synthesize the state of knowledge for State Water Resources Control Board members

Committee Meetings) for convening Agency Directors and science leaders on high-priority issues to identify grand challenges, and direct committees to collaboratively analyze policy alternatives and advise adaptive management of policies and programs.

- Hold legislative briefings with Agency Directors and science leaders.
- Link interagency and coordinated science strategies through a Triennial Science Implementation Plan.

Expected Outcomes

- Common use and clear direction for using best available science in decision making (i.e., common use of a best available science protocol or checklist).
- Synthesized and current applicable science is provided to decision makers to inform policy and management decisions for joint exploration of "what if" questions and evaluating alternative futures.
- Science work plans (including targeted studies and synthesis activities).
- Processes for efficient scientific input in determining consistency with the Delta Plan.

Delta Plan Relevance

- The Council shall make use of the best available science.
- Develop and use best possible unbiased scientific information to inform water and environmental decision making in the Delta.

3. ADAPTIVE MANAGEMENT FOR A COMPLEX SYSTEM

Problem

Current adaptive management implementation for Delta water management and habitat restoration is fragmented and not covering the full adaptive management cycle. There is a risk that it will be impossible to quantify the benefits at the system level if multiple adaptive management 'experiments' are incomplete, uncoordinated, or fail to capture system-wide and local effects.

Objectives

- Use of valid scientific designs, common metrics, and dedication to sharing results
- Implementer buy-in for using an integrated, collaborative approach to water management and habitat restoration that is consistent with the Delta Plan adaptive management approach.

Example Actions

- Link adaptive management decision making to relevant science programs

Efforts to Build On:

- Delta Plan adaptive management framework
- Suisun Marsh Plan Adaptive Management Advisory Team
- Yolo Ranch Restoration Plan Adjustments
- Water Operations Management Team and technical team recommendations process under the Operations Criteria and Plan Biological Opinions
- Real-time management of the State and Federal water projects

equipped to evaluate the implementation of adaptive management actions.

- Track adaptive management cycle and cumulative effects of individual programs.
- Establish a system-wide adaptive advisory and consultative DSP staff available to assist project implementers.

Expected Outcomes

- Efficient use of resources to achieve faster and more effective implementation of water management and habitat restoration.
- Greater consistency among individual adaptive management programs and projects so results may provide cumulative and system-wide benefits.
- Improved consistency between adaptive management projects will result in improved cumulative and system-wide benefit.

Delta Plan Relevance

- Develop, coordinate, and promote the use of science through the Delta Science Program, including promoting science-based adaptive management.
- Provide guidance for proponents of covered actions certifying consistency with the adaptive management elements of GP 1 (Delta Plan).
- Periodically update the Delta Plan as an adaptive management plan.

4. GROWING THE KNOWLEDGE BASE

4.1. Prioritizing Research

Problem

Research priorities are narrowly focused on agency mission and research needs with insufficient cooperation and communication between research programs. This reduces the efficient use of finite resources to meet needs common to multiple agencies and conduct research jointly.

Objectives

- Develop a coordinated interagency process for choosing and prioritizing research that balances short-term management-relevant science needs with science that anticipates emerging issues and enhances a comprehensive understanding of the Delta system over the long term.
- Establish a common process for targeted and competitive research solicitations that contribute to both pragmatic research priorities and contribute to holistic understanding of the Bay-Delta system.

Example Actions

- Develop and periodically update a list of research priorities for funding by agencies, institutions, and organizations.

Efforts to Build On:

- Multi-agency sponsorship of Delta Science Fellows solicitations
- Delta Science Program Proposal Solicitation Package process
- Delta Science Plan Science Needs sections

- Synthesize research findings to inform reassessment of policy and research priorities.
- Maintain conceptual models to identify the current state of knowledge and identify gaps in understanding to prioritize research to fill gaps.

Expected Outcomes

- Research priorities will be set in part, to build upon ongoing research and anticipated priority needs.
- Limited funding will be used more effectively.
- Knowledge gaps will be identified, and the gaps will be used to re-evaluate priorities.

Delta Plan Relevance

- Address the science and information needs in the Delta Plan.
- Prioritize research to reduce uncertainties in Delta decision making.

4.2. **Shared Modeling**

Problem

Currently modeling needed to support management of the Delta takes place at a number of different agencies, academic institutions, and private entities. While a variety of models are necessary and multiple models applied to the same problem can contribute to understanding, modeling needs to be done in a more organized way to accelerate knowledge discovery and avoid duplication of efforts.

Objectives

- Accelerate the discovery of knowledge about the functioning of the Delta system through development of a mechanism to support the models used for management actions today, while researching and testing the models of the future.
- Establish community models that are accessible, transparent, sustained by multiple sources and encapsulate the current knowledge of the Delta system.

Example Actions

- Work with the California Water Environment Modeling Forum (CWEMF) to develop a framework for community Delta modeling. This will include the mechanisms for agency, academic, NGO, consultant, PWAs, and local government staff to contribute to the development and generate model projections of future outcomes.
- Continue to support high priority model development and refinement through research grants, fellowships,

Efforts to Build On:

- Work with the California Water Environment Modeling Forum (CWEMF) to develop a framework for community Delta modeling
- Strong Linkage to California WQ Monitoring Workgroups
- Delta Independent Science Board periodic reviews of monitoring programs to support adaptive management of the Delta

workshops, seminars, and conferences.

Expected Outcomes

- Enhanced collaborative activities between modelers, shared input data, shared scenarios and results, data streaming between different models, and a modeling community that is at the forefront for informing water and environmental management.
- Accelerate the transfer of best available science to inform the management actions in support of water supply reliability and Delta ecology.
- A broad shared modeling framework will reduce resources required for model development and set-up and increase the time for analyses, synthesis and interpretation.

Delta Plan Relevance

- Identification of existing and future needs for refining and developing numerical and simulation models along with enhancing existing Delta conceptual models (G R1).
- Address Delta Plan Science Needs – new or improved models (Ch. 3, 4, and 6).

4.3. **Monitoring**

Problem

A shared strategy for integrated monitoring in the Delta does not exist. Specific problems include: inadequate conceptual foundation (purpose), the lack of a comprehensive experimental design of monitoring to establish a framework for future term-studies, inconsistent and inefficient spatial, temporal, and metric coverage, inconsistent data quality, and other challenges. Despite several new initiatives to coordinate data clustered around specific topics, a monitoring framework designed to accommodate new issues that might arise or facilitate broad synthesis analyses is currently lacking.

Objectives

- Development of a Delta monitoring framework based on clear conceptual models.
- Identification of key monitoring gaps and opportunities for improved efficiencies.
- Data compatibility among Delta monitoring programs.

Example Actions

- Fund an assessment of monitoring in the Delta system building on existing models (i.e., the Central Valley Monitoring Directory).
- Build a collaborative and comprehensive Delta monitoring program to support achievement of the coequal goals and support implementation of the Delta Plan, based on existing and emerging efforts.
- Data compatibility among Delta monitoring programs.

Efforts to Build On:

- Efforts underway by the Delta Regional Monitoring Program, Interagency Ecological Program and others
- Delta Independent Science Board periodic reviews of monitoring programs that support adaptive management of the Delta

Expected Outcomes

- Development of a collaborative and comprehensive monitoring framework based on clear conceptual models.
- A commitment by the appropriate agencies to implement the monitoring framework.
- Create the ability to leverage and share data among individual monitoring programs, resulting in lower costs for individual projects.

Delta Plan Relevance

- Recommendations on an integrated approach for monitoring that incorporate existing and future monitoring efforts (Delta Plan GR1).
- Adaptive Management - Monitoring Progress toward Achieving the Coequal Goals (Ch. 2).
- Monitoring for performance measurement evaluation of the Delta Plan.

4.4. **Data Management and Accessibility**

Problem

Individual research groups collect data that is best suited to their requirements and mandates leading to fragmented data sets that are not conducive for data sharing, collaboration and synthesis. Research groups may also find related data not accessible as they are collected and maintained with different standards and protocols or may be withheld for proprietary or legal reasons. Collaborative science and data synthesis will face challenges unless data can be generated with interoperability and documentation standards, the resources and commitment to build an open community of science.

Objectives

- Enable data related to the Bay-Delta to be easily accessed, visualized and processed from diverse data management systems.

Example Actions

- Host a summit on environmental data with data management leaders from state agencies, federal agencies, and national and international experts to explore interoperability standards, web services, and resources needed for building a sustainable open-source science community accessing the same data, visualization and data mining tools.

Efforts to Build On:

- California Technology Agency (http://www.cio.ca.gov/)
- Water Quality Monitoring Council, My Water Quality (http://www.waterboards.ca.gov/mywaterquality/)

Expected Outcomes

- Enhanced collaborative activities between modelers, shared input data, shared scenarios and results, data streaming between different models, and a modeling community that is at the forefront for informing water and environmental management.

- Infrastructure for collaboration among the Delta community.
- Real-time connectivity to Delta community research and data streams.

Delta Plan Relevance

- Where appropriate, utilize monitoring, data collection, and analysis of actions sufficient to determine progress toward meeting the quantified targets (Delta Reform Section 85308 (c)).
- Organize and integrate ongoing scientific research, monitoring, and learning about the Delta as it changes over time (Delta Plan Ch. 2, p.44.1).

4.5. **Synthesis to Accelerate Knowledge Discovery**

Problem

Currently, there is no integrated description of the components of the system and how they relate to each other; a synthesis of the best available science; and a representation of the dynamic response of the system to change. [Adapted from NRC, 2012. p220]

Objectives

- Analyze and synthesize existing data to develop new insights and a better understanding of the system.
- Explore cutting-edge science research concepts that might have high payoff, including a mechanism for exploring these concepts before a more significant investment.
- Bring together Delta community researchers, foster relationships, integrate research data.
- Communicate synthesis results at all levels (between scientists-managers, community and agency leaders). Promote new knowledge discoveries that help progress toward achieving the coequal goals.

Efforts to Build On:

- *State of Bay Delta Science 2008*
- Synthesis products in *San Francisco Estuary Watershed Science*
- National Center for Ecological Analysis and Synthesis model
  - IEP Pelagic Organism Decline
- Delta Science Program Workshops
- IEP Management Analysis and Synthesis Team
- Estuary Monitoring Portal

Actions

- Establish protocols for routine synthesis through shared processes (e.g., among DSP and BDCP, SWRCB, and/or OCAP). Four mechanisms are:
  1. Invited white papers/journal articles by small groups of authors
  2. Expert workshop panels (per Effects Analysis)
  3. Delta Collaborative Analysis and Synthesis [DCAS] (NCEAS model)
  4. Delta ISB reviews

Expected Outcomes

- Accelerated knowledge discovery - state of the Delta ecosystem.
- A prominent role of synthesis activities in Delta Science Conference and other scientific meetings.
- A series of products in *The State of Bay Delta Science* (e.g., SFEWS, DSP White Papers, Journal articles).
- A culture of interdisciplinary scientific exploration that enhances the understanding of a dynamic system.
- A better understanding about how the Delta responds to change induced by management actions, climate change, natural disasters, and chronic stressors such as invasive species etc.

Delta Plan Relevance

- Be based on the best available scientific information and the independent science advice provided by the Delta Independent Science Board (Delta Reform Act 85308 (a)).
- Where appropriate, utilize monitoring, data collection, and analysis of actions sufficient to determine progress toward meeting the quantified targets (Delta Reform Act 85308 (c)).
- Where appropriate, recommend integration of scientific and monitoring results into ongoing Delta water management (Delta Reform Act 85308 (e)).

4.6. **Independent Scientific Peer Review and Advice**

Problem

Environmental research projects in the Bay-Delta are interdisciplinary and initiated by federal agencies, state agencies, academia, NGOs, water contractors, and consultants. Research results and policy proposals not subject to peer review may result in unchecked or biased scientific information. Decision makers and environmental managers require peer reviewed robust science for managing the Delta resources.

Objectives

- Develop a program that uses the best available science, information and data to assist management and policy decisions to further the coequal goals. Clearly documented and effectively communicated processes and information to foster improved understanding and decision making. The resulting scientific information from a peer review process will be valuable to making sound environmental decisions.

Efforts to Build On:

- Draft Policy and Procedures for Independent Scientific Review (February 2013)
- National Academies' review approach and role
- Delta Independent Science Board review of the Delta Science Plan

Actions

- Establish a well-defined process for conducting scientific peer review for research in the Delta.
- Seek direction and clarification from the Independent Science Board on its role and level of engagement.
- Refine existing processes and align with other agencies and groups to establish standards in conducting scientific peer review.

Expected Outcomes

- An established multi-tier collaborative peer review process that produces the best science, clearly outlining assumptions and limitations. The best science is also reputable as it goes through peer review conducted by active experts in the applicable field(s) of study.
- Where necessary, a 'fast-track' peer review/advice process to address urgent issues.

Delta Plan Relevance

- As relevant to the purpose and nature of the project, all covered actions must document use of best available science (as described in Appendix A) (GP 1).
- Best available science is developed through a process that meets the criteria of (1) relevance, (2) inclusiveness, (3) objectivity, (4) transparency and openness, (5) timeliness, and (6) peer review (NRC 2004).

4.7. **Communication**

Problem

Important scientific information is often under-utilized because it is not effectively communicated. Better science communication is needed to build the Delta science community and effective interfaces among policy makers, scientists and managers.

Objectives

- Improve communication of science within and outside of the science community through current communication mechanisms and the development and application of innovative communication tools.
- Provide regular exchange of new scientific information with policy and management communities.

Actions

- Investigate expanding science communication (e.g., outreach to the State Legislature).
- Develop collaboration with other large ecosystem management programs in the U.S. and internationally.

Efforts to Build On:

- IAHR – Rivers-list (http://riverslist.iahr.org/)
- Delta Science Program's *Science News*
- IEP's online calendar (http://www.water.ca.gov/iep/activities/calendar.cfm)
- *Pulse of the Delta*
- *Pulse of the Bay*
- *Estuary Portal*

- Investigate innovative means of communication including cyber-collaboratories and Virtual communities such as moderated community discussion sites.
- Establish and maintain the Delta Science Program website to include science summaries.

Expected Outcomes

- Existing Delta science communication that is working will be continued and enhanced. New forms of communication will accelerate scientific discovery and improve science-policy and science-management communication.
- Managers interested in developing scientific understanding and communicating science when describing their actions.
- Managers able to apply current scientific results to ongoing management issues relevant to achieving the coequal goals.

Delta Plan Relevance

- Support the Council's role to inform Delta decision making through use of best available science.
- Communication and the Delta Plan - "The Council is committed to open communication of current understanding gained through the evaluation of performance measures, monitoring, science, and adaptive management." (Delta Plan Ch. 2)