

Monitoring Enterprise Review Workshop: Summary Report

Date: April 30, 2019

Location: Embassy Suites by Hilton Sacramento Riverfront Promenade
Sacramento, California

Facilitated by: ESSA Technologies Ltd., CBEC eco engineering, and
PAX Environmental Inc.

Hosted by: Delta Independent Science Board

1.0 Project and workshop background

The Delta Independent Science Board (ISB) is undertaking a broad review of the monitoring enterprise in the Sacramento-San Joaquin Delta (see [prospectus](#)¹). The objective of the Monitoring Enterprise Review (MER) is to develop recommendations that may improve how current and future monitoring programs meet decision-making needs of management agencies, how monitoring programs can be better coordinated, and how monitoring data can support implementation of adaptive management and assessments of performance measures.

A major component of this review involves undertaking a comprehensive inventory of the physical, chemical, biological and socio-economic monitoring activities in the Delta, and summarizing how these programs are being used to address important management and policy objectives, including adaptive management. The comprehensive inventory is being developed by ESSA Technologies Ltd., working with project partners CBEC eco engineering and PAX Environmental Inc. (see [workplan](#)²). ESSA and partners have delivered their first [interim report](#)³ with [appendices](#)⁴ to the Delta ISB.

On behalf of the Delta ISB, ESSA and its partners hosted a 1-day workshop on April 30, 2019, to gather input from others for this review. Participants were invited to provide their input as a monitoring practitioner, program manager, key decision maker, and/or information scientist who is broadly and deeply knowledgeable about monitoring activities in the Delta.

This workshop used an interactive format to gather feedback and input from participants. The meeting objectives were to:

- (1) Gather feedback on the review questions for the MER, their relative importance, and the metadata being collected about monitoring activities to provide answers to these questions;
- (2) Gather feedback on the scope of the monitoring enterprise and priority needs for information that the monitoring enterprise should serve; and
- (3) Identify key contacts who can provide more detailed information about existing monitoring activities for further follow-up after the workshop.

A more detailed program for the workshop is provided in Appendix A. The workshop was attended by 60 individuals. The list of participants is provided in Appendix B.

¹ <http://deltacouncil.ca.gov/docs/delta-isb-delta-monitoring-enterprise-prospectus-dated-4617>

² <http://deltacouncil.ca.gov/docs/delta-isb-review/work-plan-component-1-delta-isb-s-delta-monitoring-enterprise-review>

³ <http://deltacouncil.ca.gov/docs/monitoring-enterprise-review-lessons-and-methodology-interim-report-essa-et-al-dated-32919>

⁴ <https://deltacouncil.app.box.com/s/ngbnasiq358tv6ohy9k5p6qhwp3f24b2>

2.0 Participants' views about the monitoring enterprise

After a welcome, introductions, and presentation about the project, the program included time in the morning to hear participants' views about the monitoring enterprise (see 10:00 time slot in Appendix A). These views were gathered through plenary discussion and an online polling tool ([Mentimeter](https://www.mentimeter.com/): <https://www.mentimeter.com/>). This tool allows for the collection of real-time and anonymous opinions of a large group of people. Results from this polling exercise are provided in Figure 1 through Figure 5. Over the course of the workshop, a wall of hopes and concerns was also provided to participants to allow them to anonymously share post-it notes with a more detailed description of their hopes and/or concerns about the MER. A summary of these notes is provided in Table 1. Total responses are in the bottom right hand corner of each graph.

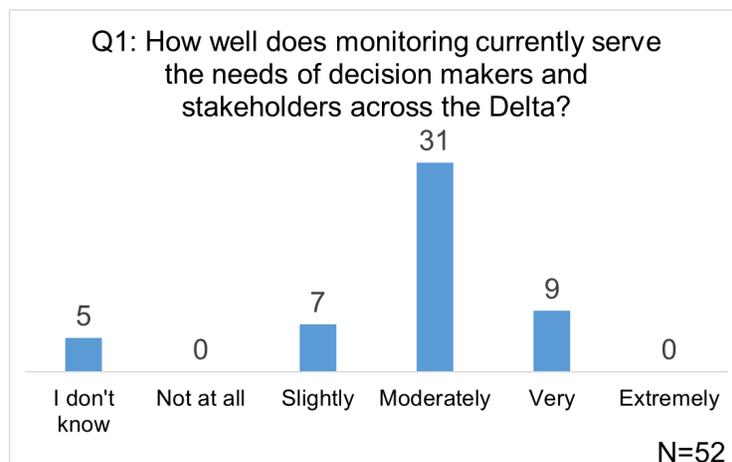


Figure 1: Anonymous real-time responses from workshop participants regarding their views about how well monitoring currently serves the needs of decision makers and stakeholders across the Delta.

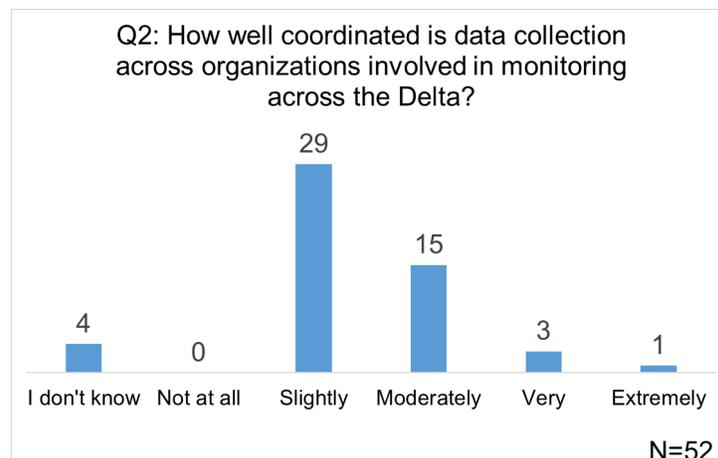


Figure 2: Anonymous real-time responses from workshop participants regarding their views about how well coordinated data collection is across organizations involved in monitoring across the Delta.

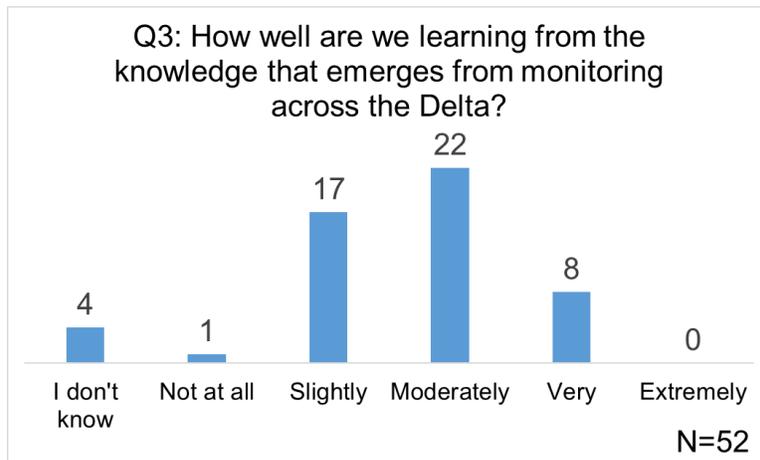


Figure 3: Anonymous real-time responses from workshop participants regarding their views about how well learning occurs as a result of knowledge that emerges from monitoring across the Delta.

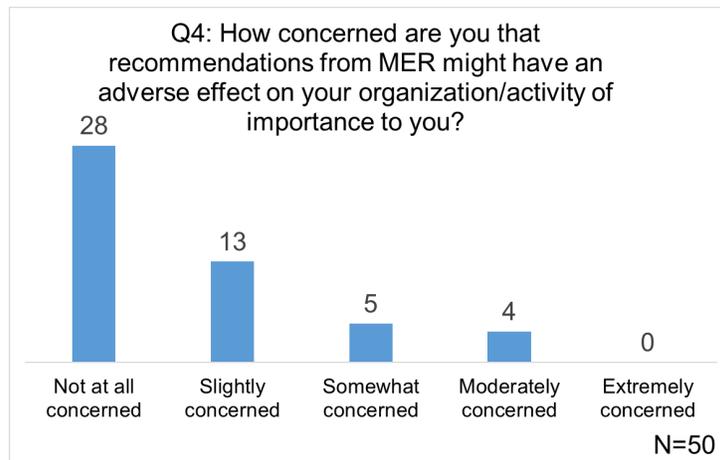


Figure 4: Anonymous real-time responses from workshop participants regarding their concern that recommendations from the MER might have an adverse effect on an organization or monitoring activity of importance to them.

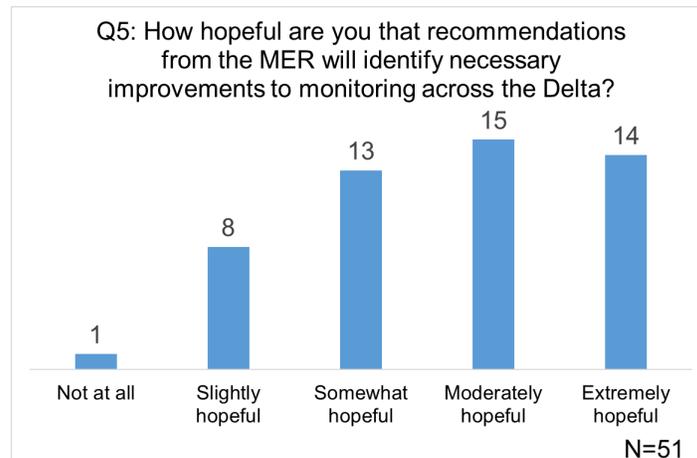


Figure 5: Anonymous real-time responses from workshop participants regarding their hopes that recommendations from the MER might identify necessary improvements to monitoring across the Delta.

Table 1: Summary of anonymous comments provided by workshop participants on a wall of hopes and/or concerns regarding their views about the MER.

What hopes do you have for the MER?	What concerns do you have about the MER?
<ul style="list-style-type: none"> • Information about who is doing what, where, when, and how • Contact information to people, along with “family tree” of who’s who • Improve data evaluation and synthesis to glean more information from our monitoring and improved communication of this information to decision makers / stakeholders / public 	<ul style="list-style-type: none"> • Being asked to do more monitoring with the same resources • Whether this effort will be specific enough (by parameter, location, timing, method) to be useful • I recognize the need for a defined geographic scope, but I am somewhat concerned that some of the relevant upstream and downstream monitoring activities may not be well captured. A potential drawback to this would be a de-emphasis in the importance of those monitoring activities (e.g., rotary screw traps monitoring salmon leaving tributaries and entering Delta, Chinook harvest, Bay Study, etc.) • No support / funding for people doing the monitoring to provide needed information for this effort (i.e., metadata collection) • Long-term funding to support monitoring enterprise is sparse • Most data collection may not be considered “monitoring” because of the short duration

3.0 Framing of the MER

After an exploration of participants' views of the MER and prior to lunch, the morning discussions included time to gather feedback on (1) the broad "review questions" around which the MER would focus, (2) the metadata attributes that have been identified as providing more detailed information about monitoring activities to help provide answers to these questions, as well as (3) the data sources and data contacts that could be used to inform the inventory phase of this project (see 10:50 time slot in Appendix A).

During the morning's introductory presentation about the project, a broad set of review questions were presented to participants to communicate the intended focus of the MER. These questions were initially proposed by the Delta ISB in its prospectus for the MER with some slight modifications by ESSA and its project partners in its first interim report for the project. The six originally identified review questions included:

- (A) Are there potential gaps in serving the relevant needs of decision makers?
- (B) Are there potential redundancies in monitoring?
- (C) Are there other opportunities to increase efficiencies in monitoring?
- (D) What is the level of coordination of data collection across different organizations?
- (E) Are data accessible to the public, decision makers, and other scientists?
- (F) What resources are being dedicated to monitoring?
- (G) What is the level of scientific rigor of monitoring to address purposes and needs for data?

Plenary discussions with participants led to revisions of questions (A) and (D) with some other questions being added to this initial list (see questions (H) through (N) below). A revised list of review questions based on participant input included the following:

- (A) Are there potential gaps in serving the relevant needs of decision makers (including gaps in relevant areas beyond the Delta and priority topics, such as birds, critical incidents)?
- (B) Are there potential redundancies in monitoring?
- (C) Are there other opportunities to increase efficiencies in monitoring?
- (D) What is the level of coordination of data collection across different organizations and disciplines?
- (E) Are data accessible to the public, decision makers, and other scientists?
- (F) What resources are being dedicated to monitoring?
- (G) What is the level of scientific rigor of monitoring to address purposes and needs for data?
- (H) What is the level of compatibility of monitoring activities across the Delta?
- (I) What resources are being dedicated to the evaluation and synthesis of data from monitoring?
- (J) What are the gaps in resources for activities that support monitoring (e.g., QA/QC, evaluation, synthesis, reporting)?
- (K) How vested are organizations involved in monitoring across the Delta?
- (L) Are there other opportunities for improvements (beyond efficiencies)?
- (M) What is the level of coordination in selecting topics upon which to focus monitoring?
- (N) What is the resiliency of the monitoring enterprise?

This revised list of questions was then used as the basis for a prioritization exercise in which participants were asked to indicate the **two most important** and **two least important questions** around which the MER should focus. Results from that prioritization exercise are presented in Figure 6 and Figure 7.

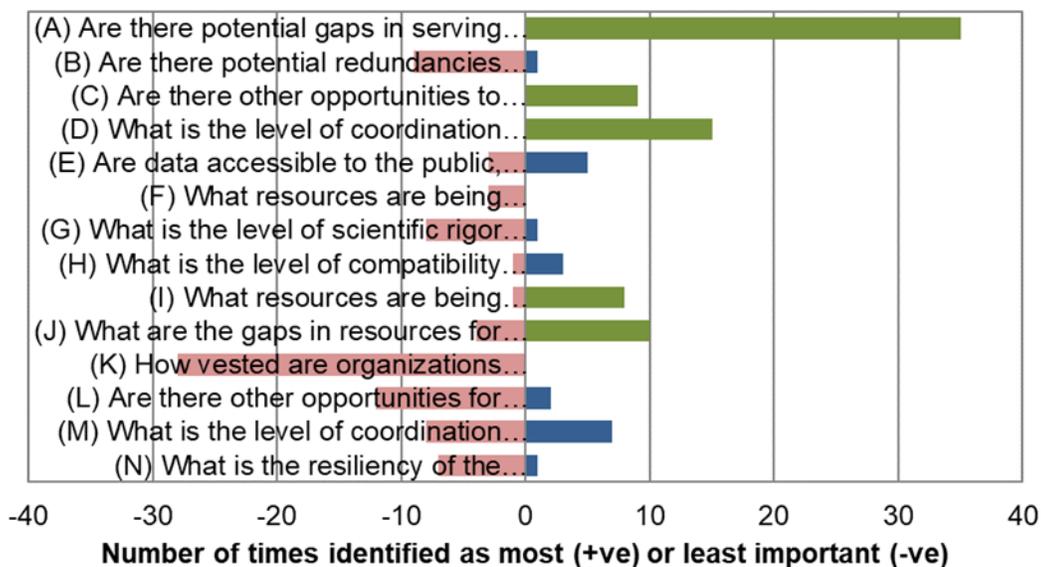


Figure 6: Most (+ve) and least (-ve) important review questions around which workshop participants thought MER should focus. Figure represents responses from 48 individuals. Top 5 most important review questions are in green (A, C, D, I, and J).

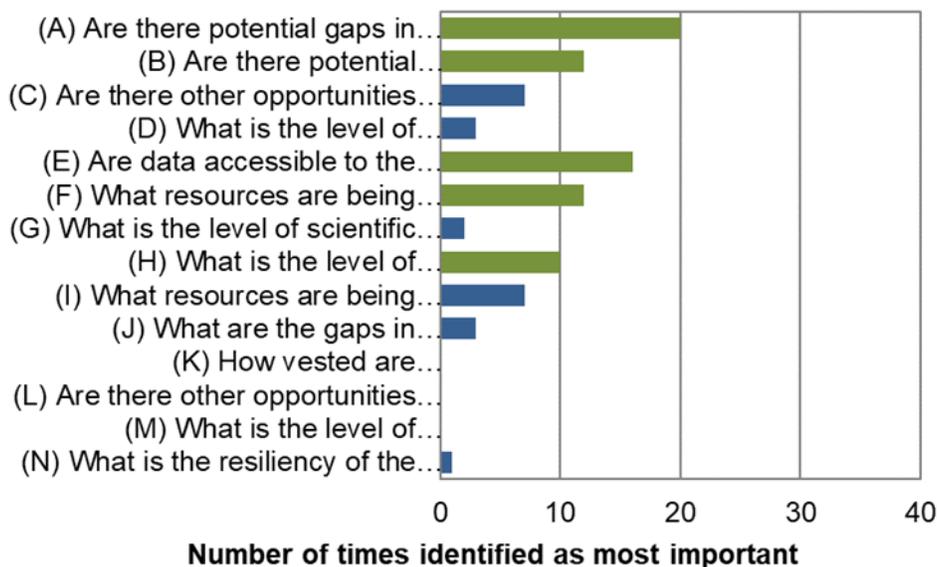


Figure 7: Most important review questions people indicated they would like to explore on their own if provided a tool. Figure represents responses from 48 individuals. Top 5 most important review questions are in green (A, B, E, F, and H).

At the workshop participants indicated a desire to revisit the prioritization of review questions independently based on some potential anchoring of responses in the group workshop exercise. As such, the exercise was re-deployed to participants after the workshop using an online survey tool ([Survey Monkey](https://www.surveymonkey.ca/): <https://www.surveymonkey.ca/>). Results from the second deployment of the prioritization exercise are presented in Figure 8 and Figure 9.

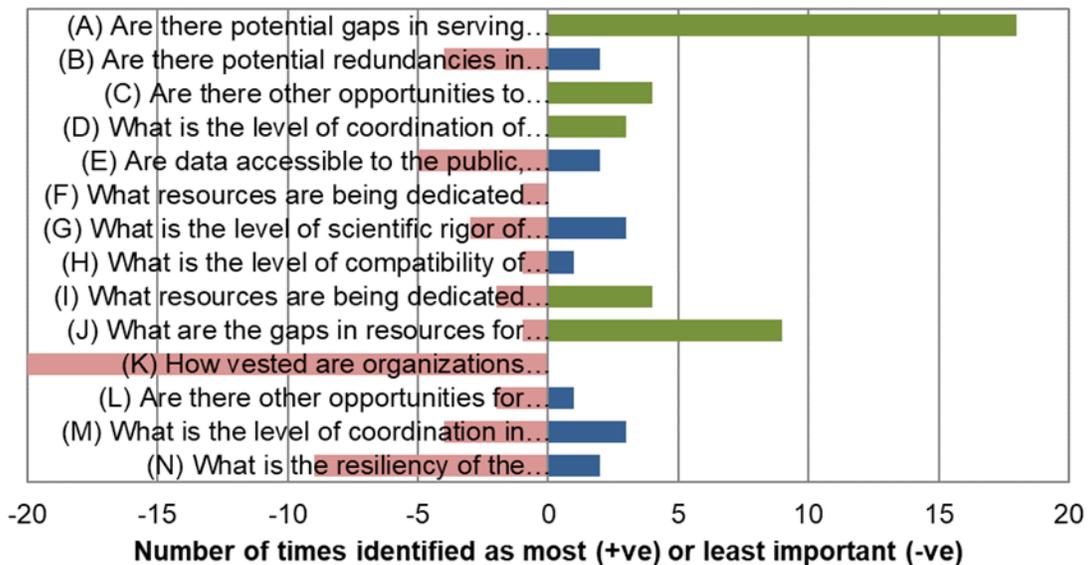


Figure 8: Most (+ve) and least (-ve) important review questions around which workshop participants thought MER should focus. Figure represents responses from 26 individuals. Top 5 most important review questions are in green (A, C, D, I, and J).



Figure 9: Most important review questions people indicated they would like to explore on their own if provided a tool. Figure represents responses from 26 individuals. Top 5 most important review questions are in green (A, B, F, H, and L/M – indicated as a tie).

Separately from the discussion about the above review questions, the list of metadata attributes below was presented to participants as representing the items around which the more detailed inventory and research about monitoring activities would focus to help provide answers to these review questions. The metadata attributes presented were from Interim Report #1 (see footnote 3), which included the following:

(1) Overview

- Monitoring activity
- Monitoring program
- Description of monitoring activity
- Monitoring purpose
- Information sources

(2) Organization

- Contact person/details
- Organization (funding, primary, supporting)

(3) Cost

- Cost \$\$ / labor start-up
- Cost \$\$ / labor O&M

(4) Relevance

- Monitoring theme(s)
- Monitoring metrics(s)
- Type of monitoring
- Monitoring driver(s)
- Link to monitoring driver(s)
- Management issue(s)

(5) Data

- QA/QC
- Data management
- Reporting
- Access

(6) Sampling Design

- Sampling years
- Sampling frequency
- Sampling timing
- Sampling location(s)
- Sampling region(s)
- Monitoring design
- Permitting requirements
- Sampling equipment
- Sampling protocol
- Known challenges

The following feedback was provided by workshop participants regarding additional items to consider in this list of metadata attributes:

- Reporting lag
- Machine readable / accessible
- Estimate of precision (standard error) or C.V. (coefficient of variation)
- Data uncertainty
- Study plans
- QA project plans
- Data quality objectives

Lastly, participants were asked to independently review and provide feedback on a preliminary list of data sources and data portals that were compiled to-date as an indication of the monitoring activities being conducted across the Delta. A summary of this feedback from participants is provided in Appendix C.

4.0 Scope of the MER and needs for information

In the afternoon, participants were divided into smaller sub-groups of 6-8 people, with discussions organized around one of seven management themes (see 1:00 time slot in Appendix A): (1) flow management, (2) flood management, (3) water quality, (4) land use management, (5) invasive species management, (6) species management, and (7) aquatic habitat management. Roundtable discussions were convened around each of these topics in two rounds. Participants rotated to a different group and different topic of discussion for the second round. Each management theme and round of discussion involved discussion around three questions:

- (1) What are the priority needs for monitoring information that relate to this management theme?
- (2) What are the big questions that scientists, decision makers, stakeholders, and/or the public have about understanding the Delta and understanding the effectiveness of management actions / decisions within this management theme?
- (3) What are the most important / influential legislative, policy, management, and/or operational drivers that dictate the need for the monitoring information identified above for this management theme?

Feedback from participants in responses to these questions is summarized in Table 2, Table 3, and Table 4 below.

Table 2: Summary of feedback from workshop participants in response to the question “What are the most important / influential legislative, policy, management, and/or operational drivers that dictate the need for the monitoring information identified above for this management theme?”

Theme 1. Flow Management

Monitoring parameter	Monitoring metric
<ul style="list-style-type: none"> • Flow 	<ul style="list-style-type: none"> • Freshwater outflow • Timing • Routing • Delta cross channel • Supporting model needs (calibration and validation) • Relationship with other parameters / tradeoffs
<ul style="list-style-type: none"> • Water quality 	<ul style="list-style-type: none"> • None provided
<ul style="list-style-type: none"> • Biogeochemistry 	<ul style="list-style-type: none"> • None provided
<ul style="list-style-type: none"> • Nutrients (N/P) 	<ul style="list-style-type: none"> • Ammonium, nitrate, N/P ratio • Relationship with flow
<ul style="list-style-type: none"> • Hydrodynamics 	<ul style="list-style-type: none"> • Modeling
<ul style="list-style-type: none"> • Primary productivity 	<ul style="list-style-type: none"> • None provided
<ul style="list-style-type: none"> • Wastewater 	<ul style="list-style-type: none"> • Treatment
<ul style="list-style-type: none"> • Salinity 	<ul style="list-style-type: none"> • Low salinity • Surface area • Location of X2
<ul style="list-style-type: none"> • Pelagic food-web 	<ul style="list-style-type: none"> • None provided

Monitoring parameter	Monitoring metric
<ul style="list-style-type: none"> • Phytoplankton 	<ul style="list-style-type: none"> • None provided
<ul style="list-style-type: none"> • Zooplankton 	<ul style="list-style-type: none"> • None provided
<ul style="list-style-type: none"> • Fish • Delta smelt • Salmon 	<ul style="list-style-type: none"> • Abundance • Distribution • Take • Survival relationships, mechanisms and pathways
<ul style="list-style-type: none"> • Fish community 	<ul style="list-style-type: none"> • Response to flow • More than single species focus
<ul style="list-style-type: none"> • Habitat • Tidal estuaries 	<ul style="list-style-type: none"> • Response to flow • Habitat requirements for species (seasonal / annual)
<ul style="list-style-type: none"> • Harmful algal blooms 	<ul style="list-style-type: none"> • None provided
<ul style="list-style-type: none"> • Sediment 	<ul style="list-style-type: none"> • Turbidity
<ul style="list-style-type: none"> • Organic carbon 	<ul style="list-style-type: none"> • None provided
<ul style="list-style-type: none"> • Water storage 	<ul style="list-style-type: none"> • None provided
<ul style="list-style-type: none"> • Contaminants 	<ul style="list-style-type: none"> • List of contaminants • Loads • Residence time / movement
<ul style="list-style-type: none"> • Climate change 	<ul style="list-style-type: none"> • Effects on flows
<ul style="list-style-type: none"> • Levees 	<ul style="list-style-type: none"> • Failures / emergency • Relationship to flow / non-flow measures

Additional considerations of monitoring needs for flow management:

- Synthesize existing knowledge
- Understand functional relationships between flow and other parameters (i.e., to inform predictions of effects and evaluate flow tradeoffs)
- Support development of flow models (e.g., validate and calibrate)
- Understand flow relationships with greater complexity (e.g., move beyond single species management and simple flow rules)
- Improve evaluation of decisions at the appropriate resolution (e.g., some response variables insensitive to small changes in flow)
- Address gaps in spatial network (recognizing relatively good coverage exists)
- Integrate flow monitoring with other biological and water quality parameters

Theme 2. Flood Management

Monitoring parameter	Monitoring metric
<ul style="list-style-type: none"> • Habitat 	<ul style="list-style-type: none"> • Restoration • Benefits to salmonids (food production) • Effects on invasive fish
<ul style="list-style-type: none"> • Floodplain 	<ul style="list-style-type: none"> • Management • Drainage
<ul style="list-style-type: none"> • Levees 	<ul style="list-style-type: none"> • Structural / geotechnical integrity
<ul style="list-style-type: none"> • Water storage 	<ul style="list-style-type: none"> • Reservoir storage and release upstream

Monitoring parameter	Monitoring metric
<ul style="list-style-type: none"> • Groundwater (upstream and downstream) 	<ul style="list-style-type: none"> • Banking
<ul style="list-style-type: none"> • Water conveyance 	<ul style="list-style-type: none"> • Capacity • Effect of tunnel
<ul style="list-style-type: none"> • Flow / Flood 	<ul style="list-style-type: none"> • Forecasting • Flood-Managed Aquifer Recharge (Flood-MAR) • Water supply reliability • Stage-discharge
<ul style="list-style-type: none"> • Weather and climate 	<ul style="list-style-type: none"> • Data and forecasting
<ul style="list-style-type: none"> • Land 	<ul style="list-style-type: none"> • Areas and priorities for flooding • Elevation • Rate of change (e.g., accretion) • Subsidence
<ul style="list-style-type: none"> • Climate change 	<ul style="list-style-type: none"> • Modelling
<ul style="list-style-type: none"> • Seismicity 	<ul style="list-style-type: none"> • Modelling
<ul style="list-style-type: none"> • Invasive species 	<ul style="list-style-type: none"> • None provided
<ul style="list-style-type: none"> • Water quality 	<ul style="list-style-type: none"> • Changes and connectivity to flooding
<ul style="list-style-type: none"> • Hydrodynamics 	<ul style="list-style-type: none"> • Modelling
<ul style="list-style-type: none"> • Sea level rise 	<ul style="list-style-type: none"> • None provided
<ul style="list-style-type: none"> • Socioeconomics 	<ul style="list-style-type: none"> • None provided

Additional considerations of monitoring needs for flood management:

- Improve prediction of when, where and how much flooding is expected
- Improve future forecasting / projections (under climate change with subsidence and sea level rise)
- Understand linkages to other actions / decisions (e.g., reservoirs, conveyance, aquifers, water reliability)
- Understand priority locations (for protection / flooding)
- Understand integrity of flood management system
- Understand linkages to other ecosystem components (e.g., salmonid benefits, water quality)

Theme 3. Water Quality

Monitoring parameter	Monitoring metric
<ul style="list-style-type: none"> • Water quality 	<ul style="list-style-type: none"> • Link to biological responses • Status and trends • Relationship with flow • Residence time • Effects on wildlife
<ul style="list-style-type: none"> • Nutrients 	<ul style="list-style-type: none"> • Management actions • Nitrogen loss and impacts
<ul style="list-style-type: none"> • Water temperature 	<ul style="list-style-type: none"> • None provided
<ul style="list-style-type: none"> • Sediment 	<ul style="list-style-type: none"> • Turbidity • Runoff
<ul style="list-style-type: none"> • Salinity 	<ul style="list-style-type: none"> • Salt runoff

Monitoring parameter	Monitoring metric
<ul style="list-style-type: none"> • Contaminants • Contaminants of emerging concern • Herbicides (gap) • Pesticides 	<ul style="list-style-type: none"> • Relationships between contaminants, human stressors and ecosystem change (species) • Thresholds • Priorities • Toxicity testing • Bioavailability • Bioaccumulation • Responses to extreme / episodic events
<ul style="list-style-type: none"> • Flow / discharge 	<ul style="list-style-type: none"> • Relationship with water quality
<ul style="list-style-type: none"> • Hydrodynamics 	<ul style="list-style-type: none"> • Aligned with water quality
<ul style="list-style-type: none"> • Water conveyance 	<ul style="list-style-type: none"> • Influence on water quality
<ul style="list-style-type: none"> • Tidal wetlands • Sloughs • Side channels 	<ul style="list-style-type: none"> • Restoration and effects on nitrogen • Relationship with water quality constituents
<ul style="list-style-type: none"> • Weather and climate • Wind speed • Solar radiation 	<ul style="list-style-type: none"> • None provided
<ul style="list-style-type: none"> • Sea level rise 	<ul style="list-style-type: none"> • None provided
<ul style="list-style-type: none"> • Drought 	<ul style="list-style-type: none"> • None provided
<ul style="list-style-type: none"> • Flooding 	<ul style="list-style-type: none"> • None provided
<ul style="list-style-type: none"> • Land use 	<ul style="list-style-type: none"> • Land use / land cover as a surrogate for contamination • Relationship to water quality / contaminants
<ul style="list-style-type: none"> • Food web 	<ul style="list-style-type: none"> • Impacts due to contaminants

Additional considerations of monitoring needs for water quality:

- Improve consistency in measurement protocols / data collection processes and comparability of data
- Clarify management needs and focus on priority water quality constituents
- Improve understanding of relationship between water quality, human stressors, and management actions
- Improve real-time monitoring of water quality using new technologies instrumentation and better spatial / temporal coverage (i.e., current emphasis is on monitoring in open water)
- Improve data analysis synthesis using machine learning to better communicate observations to decision makers
- Improve QA/QC requirements
- Improve coordination in planning of monitoring activities
- Improve understanding of biological endpoints / thresholds to inform water quality monitoring and management

Theme 4. Land use management

Monitoring parameter	Monitoring metric
<ul style="list-style-type: none"> • Terrestrial habitats 	<ul style="list-style-type: none"> • Requirements for species • Best management practices • Vegetation cover

Monitoring parameter	Monitoring metric
<ul style="list-style-type: none"> • Species 	<ul style="list-style-type: none"> • Regulated, threatened and endangered species • Focal species • Birds / Waterfowl • Population dynamics • Abundance • Status and trends • Relationship to land use
<ul style="list-style-type: none"> • Land use / land cover 	<ul style="list-style-type: none"> • Ownership • Infrastructure • Dynamics / changes • Farming • Urbanization • Conversion from wetlands • Resource extraction
<ul style="list-style-type: none"> • Nutrients 	<ul style="list-style-type: none"> • Sources • Export • Cycling • Upstream / downstream impacts • Relationship to land use
<ul style="list-style-type: none"> • Contamination 	<ul style="list-style-type: none"> • Trends • Locations
<ul style="list-style-type: none"> • Socio-economic 	<ul style="list-style-type: none"> • Economic drivers of land use change • Ecotourism

Additional considerations of monitoring needs for land use management:

- Document change / dynamics in land use and land cover
- Understand relationships between best management practices, habitat requirements, and important species
- Understand relationship between land use and other stresses on ecosystem (e.g., nutrients, contamination)
- Understand relationships between land use and socio-economic drivers of change / outcomes

Theme 5. Invasive Species Management

Monitoring parameter	Monitoring metric
<ul style="list-style-type: none"> • Invasive species 	<ul style="list-style-type: none"> • Plants (state, biomass, species mix) • Fauna • Locations / mapping of all taxa • Possible benefits • Priorities for management • Links to climate change • Links to restoration actions (herbicide) • Links to native species • Links to (bio)control efforts (positive and negative)

Monitoring parameter	Monitoring metric
<ul style="list-style-type: none"> • Invasive species (continued) 	<ul style="list-style-type: none"> • Agency jurisdiction (who is responsible for what taxa, where)
<ul style="list-style-type: none"> • Terrestrial habitat 	<ul style="list-style-type: none"> • Signs of early detection
<ul style="list-style-type: none"> • Aquatic habitats • Tidal wetlands 	<ul style="list-style-type: none"> • Aquatic vegetation

Additional considerations of monitoring needs for invasive species management:

- Understand what, where, what's coming (with influence of climate change)
- Communicate early detection and rapid response
- Identify funds to execute monitoring and mapping
- Understand effectiveness of restoration efforts
- Understand thresholds of invasion
- Improve citizen involvement / engagement / teaching

Theme 6. Species Management

Monitoring parameter	Monitoring metric
<ul style="list-style-type: none"> • Habitats • Riparian habitat 	<ul style="list-style-type: none"> • Suitability / use by all life stages / species (aquatic – spawning, migration, rearing – and terrestrial – breeding, migration and wintering season) • Restoration • Habitat conditions • Changes / denudation
<ul style="list-style-type: none"> • Species • Smelt • Salmon • Sturgeon • Birds 	<ul style="list-style-type: none"> • Distribution, movement, and abundance (by runs) • Growth and survival • Status and trends (towards recovery) • Spawning timing • Functional relationship between biological responses and habitat variables (e.g., flow), other influences • Health metrics • Genetics, DNA • Physiological markers • Reproductive condition • Fecundity rates • Gear efficiency
<ul style="list-style-type: none"> • Fish communities 	<ul style="list-style-type: none"> • Predators • Pelagic fish • Structure • Diversity
<ul style="list-style-type: none"> • Food web 	<ul style="list-style-type: none"> • Arthropods • Insects • Lower trophic levels • Prey / diet • Zooplankton

Monitoring parameter	Monitoring metric
<ul style="list-style-type: none"> • Human stressors 	<ul style="list-style-type: none"> • None provided
<ul style="list-style-type: none"> • Contaminants 	<ul style="list-style-type: none"> • Insecticides • Pesticides • Pyrethroids • Herbicides • CECs • Microplastics
<ul style="list-style-type: none"> • Flow / hydrology 	<ul style="list-style-type: none"> • Exports and inflow
<ul style="list-style-type: none"> • Hatcheries / aquaculture 	<ul style="list-style-type: none"> • None provided
<ul style="list-style-type: none"> • Water storage 	<ul style="list-style-type: none"> • Reservoir release
<ul style="list-style-type: none"> • Invasive species 	<ul style="list-style-type: none"> • None provided
<ul style="list-style-type: none"> • Water temperature 	<ul style="list-style-type: none"> • Species / life history temperature thresholds • Distribution across Delta
<ul style="list-style-type: none"> • Sediment 	<ul style="list-style-type: none"> • Turbidity
<ul style="list-style-type: none"> • Fishing 	<ul style="list-style-type: none"> • None provided
<ul style="list-style-type: none"> • Recreation 	<ul style="list-style-type: none"> • None provided
<ul style="list-style-type: none"> • Climate change 	<ul style="list-style-type: none"> • Vulnerability of species
<ul style="list-style-type: none"> • Levees 	<ul style="list-style-type: none"> • None provided
<ul style="list-style-type: none"> • Wildfire 	<ul style="list-style-type: none"> • None provided
<ul style="list-style-type: none"> • Entrainment 	<ul style="list-style-type: none"> • None provided

Additional considerations of monitoring needs for species management:

- Improve spatial and temporal coverage of species information
- Improve understanding of species associations with habitat types / conditions
- Improve understanding of aquatic food web (lower trophic levels and predators)
- Improve understanding of species responses to flow
- Improve understanding of restoration actions and their effectiveness to support species recovery
- Improve information about species vital rates to support species modelling (e.g., growth, survival, health, fecundity)
- Understand species vulnerability to climate change
- Understand key threats to species (e.g., contamination, habitat alterations, invasive species)

Theme 7. Aquatic Habitat Management

Monitoring parameter	Monitoring metric
<ul style="list-style-type: none"> • Land use / land cover 	<ul style="list-style-type: none"> • Land ownership • Land management • Landscape changes • Restoration actions
<ul style="list-style-type: none"> • Water quality 	<ul style="list-style-type: none"> • None provided
<ul style="list-style-type: none"> • Invasive species 	<ul style="list-style-type: none"> • Control / treatments
<ul style="list-style-type: none"> • Water temperature 	<ul style="list-style-type: none"> • None provided
<ul style="list-style-type: none"> • Levees 	<ul style="list-style-type: none"> • None provided

Monitoring parameter	Monitoring metric
<ul style="list-style-type: none"> Water conveyance 	<ul style="list-style-type: none"> Gates and weirs Operations
<ul style="list-style-type: none"> Hydrodynamics 	<ul style="list-style-type: none"> None provided
<ul style="list-style-type: none"> Tides 	<ul style="list-style-type: none"> None provided
<ul style="list-style-type: none"> Carbon 	<ul style="list-style-type: none"> Dissolved organic Sequestered
<ul style="list-style-type: none"> Methylmercury 	<ul style="list-style-type: none"> Production
<ul style="list-style-type: none"> Food web 	<ul style="list-style-type: none"> Production
<ul style="list-style-type: none"> Salinity 	<ul style="list-style-type: none"> Area
<ul style="list-style-type: none"> Socio-economics 	<ul style="list-style-type: none"> Economic trends for biofuels
<ul style="list-style-type: none"> Ecosystem services 	<ul style="list-style-type: none"> Links to human communities Links to human actions (land management / restoration)

Additional considerations of monitoring needs for aquatic habitat management:

- Understand links between habitat management and invasive species introductions
- Understand effectiveness of habitat restoration
- Understand role of habitats to support ecosystem (food web, carbon, methylmercury)

*Table 3: Summary of feedback from workshop participants in response to the question: “What are the **big questions** that scientists, decision makers, stakeholders, and/or the public have about understanding the Delta and understanding the effectiveness of management actions / decisions within this management theme?”*

Big questions
Flow management
<ul style="list-style-type: none"> What are the most effective actions for increasing native fish populations? How important is flow? What are the feedback loops between flow and habitat, and how do other stressors relate to those feedbacks (e.g., contaminants, other water quality changes, climate change problems)? Do we need to restore tidal marsh habitat or lower X2 value? How do we restore and rebuild aquatic species, while providing water supply reliability? What’s the frequency of “good” flow years (to support ecosystem needs)? How do we design monitoring to detect lag effects vs. instantaneous responses?
Flood management
<ul style="list-style-type: none"> Are we changing flooding patterns through management actions? How? How do management actions affect flood risk (when, where, how much)? Can / should we invest in subsidence reversal? Can we do it rapidly enough? Where do we prioritize restoration to encourage tidal wetland habitat (with implications to flooding)? How do we balance flood management with operational and functional flows (overall health of Delta, salinity management)? What are the impacts of climate change on flooding in the Delta?

Big questions

Water quality

- Do water quality conditions support beneficial uses?
- How do we best protect and maintain beneficial uses?
- Can I go kayaking and swimming here?
- Is my water safe to drink?
- How is the Delta functioning? How is it impaired?
- What are the effects of flow on nutrients?
- How is salinity influencing habitat?
- How will WaterFix affect the Delta's water quality?
- What contaminants are going to be a big deal in the future (CECs)? What should we focus on?
- How do we prioritize contaminants for monitoring, including emerging contaminants of concern?
- How does land use affect what is running off into receiving waters?
- What is the temporal and spatial variability in water quality and its relationships with habitat?
- What changes to the landscape drive changes in water quality across space and time?
- How, when, where and well are best management practices working?
- Could more constituents be managed more effectively instead of managing constituents individually?
- What are the effects of water quality on specific species and food webs?
- Do habitat restoration benefit or adversely affect water quality?
- How do we protect in Delta use versus Delta exports (i.e., balancing needs for water)?
- What are the impacts of water quality on food production?
- Is water quality a serious stressor in the Delta?
- What are the links between water quality and beneficial uses (water supply, drinking water quality, fish, and recreation)?
- What is an optimum water quality? Does it change across regions (spatial) or temporally (time of year)?
- Are Delta species being impacted by water quality? If so, how?
- What level of nutrient control is appropriate? Do we actually want to denitrify? Is the cost worth the benefit?
- What are the next generation of treatment control technologies (best management practices) for urban development and agriculture?
- What pollutants occupy the Delta beyond the 124 priority pollutants that are typically monitored?
- What are the impacts that water quality has on water supply and ecosystems?
- Are species of concern positively or negatively impact by changes in various water quality parameters and why?
- Do we have adequate spatial and temporal coverage of water quality conditions to understand the effects of water / flow management?

Big questions

Water quality (continued)

- How will climate change and drought affect water quality?
- What are the cumulative impacts of water quality contamination?
- Has there been an observed decline in species due to water quality contamination?
- How does water quality respond to different conditions and management actions?
- Are water quality management actions working?
- Are there too many drivers for water quality monitoring?
- How is sediment linked to being a source / sink for nutrients and impact on ecological conditions? Where does sediment (and its bound contaminants) go to rest?
- Are certain processes / drivers altering sediment inputs?
- How do extreme / episodic events affect water quality conditions?

Land use management

- What ecosystem services can we expect from the Delta? What is the new normal for ecosystem services to expect under future climate conditions?
- What are the effects of sedimentation on how land is used?
- What are the goals for land management? Do we have targets?
- Are there objectives and thresholds for management action?
- What are the drivers of land use change?
- What are the appropriate metrics for land use change? How do they influence land use processes?
- Are species declining? How do we prevent species decline from occurring? What land management practices can affect species decline? What are the trends in land cover and land management that affect species abundance in the Delta?

Invasive species management

- What is the existing state of invasive species in Delta habitats?
- What is the effect of climate change on the future state of estuary habitats?
- Are there design criteria that could exclude or limit invasive species?
- When and what actions do we take to manage invasive species, especially with climate change (e.g., eradicate / control / give up)?
- Do we want to spend money on the long term-control of invasive species?
- What are the effects of climate change on invasive species?
- What are the costs and benefits of invasive species control measures?
- Are invasive species control measures working?
- What role do invasive species have on our habitat (positive and negative)?
- Are invasive species control measures cost-effective?
- How do invasive species interact with native species and at what point do invasive species negatively affect native species?

Species management

- How accurate are we counting what we are counting? What does that mean?
- When do we call species extinct?
- What is the government doing with my tax dollars?

Big questions

Species Management (continued)

- How does delta smelt survival affect the public (need to do a better job of communicating what is happening)?
- Why should I care about a species?
- What is the status and trends of contaminants? What is the effectiveness of Delta management?
- How do we understand the role of the Delta in salmon resiliency?
- Is the Delta a limiting factor in salmon recovery?
- What are the tradeoffs between management actions targeting different life stages of salmon?
- What are the trends in the species?
- What management actions are of interest?
- Are the implemented management actions effective?
- Are management actions benefiting species at the appropriate scales?
- How are decision makers addressing impact on the species?
- What are the trends / trajectories of the species?
- Who is responsible for causing declines in populations?
- What is happening and how is it affecting me?
- How can we help recover the species?
- How does water withdrawal affect fish behavior and survival?
- What is really wrong with the Delta for fish (beyond flow)?
- Is species composition changing over time? Are changes an evolutionary process or human caused?
- Can we manage predators with habitat and flow actions?
- What management actions can be changed and what management actions can't be changed?
- What management actions can increase sustainability and abundance in the system?
- How do we evaluate the success of restoration actions? How do we do monitor and evaluate effectiveness for species that are imperiled?
- Is there a target population size for recovery (difficult with changing/variable environment)?
- Are there adaptive strategies to help manage species (e.g., if this happens, then this happens)?
- What is the abundance of these species that we are managing?
- What are the factors that may affect catch in the fish surveys?
- How to deal with the information from monitoring when doing statistical analysis?
- What are the stressors affecting the fish health?
- What is the effect of management actions affecting species?
- What is the effect of predation?
- Can the species be recovered?
- Do we actually think we are going to recover the species?

Big questions

Species Management (continued)

- Do we know how changes in abundance of one fish species affects another?
- How are change in species abundance going to affect my land use (land and water use)?
- How can species diversity and human well-being be balanced?
- What management practices lead to which change in species diversity and trends?
- What happens when we do what we do?
- How can habitat conditions be maximized? How do habitat conditions relate to climate change?
- How can the public remain engaged?
- How does natural flow and flow alteration affect native fish? What mechanisms are behind relationship?

Aquatic habitat management

- How does the landscape and tides affect things outside of flow to provide aquatic habitat?
- What is the best management strategy (e.g., natural management) and how much do we intervene (e.g., adding pumps to improve dissolved oxygen)?
- Are restored tidal marshes producing food for smelt and salmonids?
- Is there enough information to introduce hatchery delta smelt into the wild? Is there enough habitat?
- What extent of floodplain inundation in terms of acres, days inundated, is needed to ensure the survival of salmonids and other species?
- What are the cumulative landscape-level benefits of habitat restoration from individual projects?
- Is there potential for ecotourism?
- Can aquatic habitats serve as flood buffers?
- Is habitat restoration a good strategy for recovering species given logistical constraints?
- What are the benefits of habitat restoration (e.g., more habitat, more food)?
- How does climate change affect the relationships/tradeoffs?
- Should we be managing for specific species or for the ecosystem?
- What are the tradeoffs (and win-win situations) of different land management actions for wildlife, humans, and ecosystem services?
- How will climate change effect aquatic habitats and water supply?
- Have past management actions (e.g., flow augmentation, restoration) succeeded? What can we learn from them?
- Where are the areas of refugia for fish in light of climate change?
- Will habitat restoration provide the intended benefits for listed species?
- Will habitat restoration projects be overtaken by invasive species? How do you prevent this?
- Are there unintended consequences to habitat restoration?
- Do restoration projects improve productivity for fish?
- What are the most cost-effective restoration strategies?

Big questions

Aquatic habitat management (continued)

- How do floodplains improve survival for fish? Do the benefits occur on the floodplain and are there carryover effects?
- In the tidal prism, how does restoring one area affect another area?
- Does habitat restoration improve conditions for non-native species that hurt native species?
- What management choices are we trying to evaluate?
- What learning experiences and management scenarios will be usefully documented?
- Are we characterizing alternative actions to help achieve biological goals and objectives, or are we actually vetting them to see if they meet goals/objectives?
- How do flow management and land use decisions impact aquatic habitat?
- How do invasive species effect habitat function?
- Where is the Delta nutrient-limited in terms of primary production?
- How does aquatic vegetation effect water quality?
- How effective are aquatic vegetation control management strategies and the impacts?
- How does aquatic vegetation effect the physical environment in light of climate change, Regional San plant upgrades, tunnels?
- What and where are the monitoring priorities?
- What parameters are important in what locations (e.g., temperature, flow, aquatic vegetation)?
- How can we measure success from actions (e.g., Regional San plant upgrade)?
- Does aquatic habitat restoration make a difference? Is it worth the cost?
- What threshold or level of non-native species establishment are we willing to tolerate?
- How much does tidal restoration contribute to the pelagic food web?
- How do we address tradeoffs between habitat restoration and flow?
- How to optimize floodplain inundation vs. other goals (ag production, flood control, recreation, etc.)?
- How best to design waterside habitat to support salmon rearing?
- What is the nexus between habitat restoration and species survival?
- How do we balance tides and levee breaches for salinity and tidal energy budget?
- What portion of successful aquatic habitat management is a result of flow modification such as environmental flow requirements and limits to exports vs. structural changes that create stationary habitat such as tidal marsh, channel marsh, wetland?

Table 4: Summary of feedback from workshop participants in response to the question “What are the most important / influential legislative, policy, management, and/or operational **drivers that dictate the need for the monitoring** information identified above for this management theme?”

Summary of feedback around monitoring drivers	
Flow management	<ul style="list-style-type: none"> • The Salmon/Smelt Resiliency Strategies are key drivers as these represent a suite of management actions. • One participant felt there was an opportunity to integrate big drivers, such as the Water Rights Decision 1641 and NMFS Biological Opinions (BiOps), into monitoring, and allow for greater flexibility in monitoring such that the process is more collaborative and involves an adaptive management (AM) component. • There is a heavy focus on status and trend monitoring, and not enough focus on effectiveness monitoring and validation monitoring. • Participants broadly felt that there is a severe lack of flexibility in contracting which hinders the inclusion of AM or more opportunistic experiments and monitoring. • Other identified drivers include the Sustainable Groundwater Act, the Yuba Accord, and CAMT/CSAMP.
Flood management	<ul style="list-style-type: none"> • Participants felt that prioritizing levee maintenance (through the Delta Levees Maintenance Subventions Program and its Investment Strategy (DLIS)) was critical. • The Central Valley Flood Protection Plan (CVFPP) was also noted to be a critical driver and should be the focus of funding. • Other drivers include the Salmon Resiliency Strategy, FloodMAR, invasive species, the Collaborative Adaptive Management Program, the Porter Cologne Water Quality Act, Basin Plans (such as the Delta Nutrient Research Plan and Regional Monitoring Plan), WaterFix, the Delta Reform Act, the Clean Water Act, and ECHO-waters (NPDES permit).
Water quality	<ul style="list-style-type: none"> • Participants flagged the Clean Water Act (section 303), ESA, EcoRestore, the Delta Plan, the Water Right Decision 1641, the Porter Cologne Water Quality Act, BiOps (such as the Delta Smelt BiOp), and Basin Plans as important drivers. • It was mentioned that implementing infrastructure (like WaterFix) creates a driver. • Federal and state contracts are seen as too rigid and prevent rapid response to urgent situations. • There is a lack of water quality data, which can have implications on determining the source of ecological decline. For instance, in some cases, people may attribute an ecological decline in health to water quality issues simply because there hasn't been any meaningful progress in identifying other sources of the decline, and there isn't enough water quality data to support or dispute such claims. • It was suggested that there is significant focus on data collection related to water quality, and not enough focus on analysis.

Summary of feedback around monitoring drivers

Water quality (continued)

- One participant noted that climate change acts as a huge driver, as it will necessitate operational changes.

Land use management

- The Delta Plan and Delta Conservation Framework were highlighted as drivers along with CWA, ESA, CESA, and HCPs which drive mitigation and subsequently land use.
- The Farm Bill was also identified as a legislative driver of agricultural land use. It was mentioned that changes in farm policy can have enormous impacts on land use.

Invasive species management

- Drivers include the State lands ballast water control program, 2008/9 BiOps (which focuses on fish management), the North America Waterfowl Management Plan, the Central Valley Joint Venture (CVJV), the ESA (Endangered Species Act), Smelt/Salmon Resiliency Strategies, HCP, EcoRestore, the Delta Conservation Framework (by CDFW, summarizes management actions), and the Delta Plan.
- Cost/benefit analysis of invasive species control is important.
- A community monitoring program might be useful to permit enhanced information gathering about invasive species which could then create the foundational knowledge that determines if monitoring is mandated in legislation.
- ESA is intended to protect the habitat of a species, not just the endangered species.
- General consensus that better communication with the community would be essential.

Species management

- Managing individual species is difficult, a broader-ecosystem mind frame should be adopted.
- Participants felt that key drivers included the Clean Water Act (especially sections 401/402), the Porter Cologne Water Quality Act, the ESA, CESA, BiOps, and the Delta Plan.
- Drivers include the Smelt/Salmon Resiliency Strategies, EcoRestore, incidental take estimates, requirements of the Delta Water Control Plan, Yolo Recovery Plans, the WINN Act, San Joaquin Decision, WaterFix, plans to reorganize the IEP, the Farm Bill, NOAA ecosystem policy, Sustainable Groundwater Management Act, FERC, and the Magnuson-Stevens Fishery Conservation and Management Act.
- The focus should be on sturgeon, salmon, and smelts.
- Gaps related to decision modelling should be filled and that monitoring should be integrated with existing models.
- Questions about whether any of the mentioned legislation would drive future research beyond monitoring.

Aquatic habitat management

- General consensus among participants regarding top priority drivers: EcoRestore, the Yolo Bypass Salmon Habitat Restoration and Fish Passage, the Delta Smelt/Salmon Resiliency Strategy, ESA (food web monitoring and spawning habitat conditions are key drivers), RPA's from SWP/CVP BiOps, and the Delta Plan.

Summary of feedback around monitoring drivers

Aquatic habitat management (continued)

- Other drivers include the Central Valley Joint Venture (CVJV), the North America Waterfowl Management Plan, the Fish Restoration Program, Yolo Habitat Conservation Plan, the Porter Cologne Water Quality Act, NOAA Ecosystem-based Fishery Management Policy / NOAA Species Recovery Plan, the Magnuson-Stevens Fishery Conservation and Management Act, the Delta Plan (chapter 4), the Water Rights Decision 1641, SGMA, Net Waters of the State requirement, the Governor's executive order of 4/29/19 (Statewide portfolio of actions - similar to California water action plan), NMFS BiOps, the Clean Water Act, and future bond funds.
- Participants felt that the monitoring drivers list should be more specific and ensure that all drivers are captured.

5.0 Summary of next steps

To close the workshop, participants were provided with a summary of the immediate next steps and tasks for the project. These next steps included:

- Summarizing and distributing a short summary of workshop feedback to participants which will be used to inform next steps for the MER;
- Revising the lessons and methodology report (Report #1) which compiles monitoring insights from the Delta and elsewhere, as well as proposes a research methodology for the MER;
- Developing a monitoring inventory tool to store and query metadata about monitoring activities (not to store raw data from monitoring);
- Completing the inventory of monitoring activities, including follow-up with key data contacts to provide additional metadata about monitoring activities;
- Summarizing metadata for physical, chemical, biological, and socio-economic monitoring across the Delta into an inventory report (Report #2); and
- Assessing the monitoring enterprise in the inventory against the broad review questions to develop insights that can be used to inform Component 2 of the MER being completed by the Delta ISB (Report #3).

The anticipated timeline for project completion is early 2020.

Appendix A: Workshop program

Monitoring Enterprise Review Workshop



Delta Independent Science Board

When:

Tuesday, April 30
9:00-5:00

Where:

Embassy Suites by Hilton Sacramento Riverfront Promenade
Steamboat/Central Pacific Room
100 Capitol Mall
Sacramento, CA 95814

[Workshop Directions](https://goo.gl/maps/WWbNyvHp5bN2): <https://goo.gl/maps/WWbNyvHp5bN2>

Project Background:

The Delta Independent Science Board is undertaking a broad review of the monitoring enterprise in the Sacramento-San Joaquin Delta (see [prospectus](#)). The objective of the Monitoring Enterprise Review (MER) is to develop recommendations that may improve how current and future monitoring programs meet decision-making needs of management agencies, how monitoring programs can be better coordinated, and how monitoring data can support implementation of adaptive management and assessments of performance measures.

A major component of this review involves undertaking a comprehensive inventory of the physical, chemical, biological and socio-economic monitoring activities in the Delta, and summarizing how these programs are being used to address important management and policy objectives, including adaptive management. The comprehensive inventory is being developed by ESSA Technologies Ltd., working with project partners CBEC eco engineering and PAX Environmental Inc (see [workplan](#)). ESSA and partners have delivered their first [interim report](#) with [appendices](#) to the Delta ISB (it is not necessary that you review these materials before the workshop).

On behalf of the Delta Independent Science Board, ESSA and its partners are hosting a 1-day workshop to gather input from others for this review. You have been invited to provide your input as a monitoring practitioner, program manager, key decision maker, and/or information scientist who is broadly and deeply knowledgeable about monitoring activities in the Delta.

This will be an interactive workshop to gather feedback and input from participants. Workshop facilitation will be led by Clint Alexander (calexander@essa.com) and Marc Nelitz of ESSA (mnelitz@essa.com). ***It will be important that you come prepared by: (1) reviewing the accompanying 13-page workshop backgrounder about this component of the MER; and (2) providing your top 3 preferences for topics to discuss during sub-group exercises.*** To select your preferences, please complete this [1-minute survey](#) no later than April 26: <https://www.surveymonkey.com/r/ZSRHV2Q>.

Elements of the workshop will involve collecting real-time input from you. In addition to work at small subgroup tables, we will be asking you to enter responses using an anonymous polling

tool (Mentimeter) when in plenary. To provide responses using this tool, ***you will also need to bring a smart phone or laptop.***

If you have any questions about this workshop or the review, please contact Edmund Yu (Edmund.Yu@deltacouncil.ca.gov) and/or Marc Nelitz (mnelitz@essa.com).

Workshop Objectives:

- (1) To gather feedback on the review questions⁵ for the MER, their relative importance, and the metadata being collected about monitoring activities to provide answers to these questions [*related to Focal Topic 1 below*];
- (2) To gather feedback on the scope of the monitoring enterprise and priority needs for information that the monitoring enterprise should serve [*related to Focal Topic 2 below*];
- (3) To identify key contacts who can provide more detailed information about existing monitoring activities for further follow-up after the workshop [*related to Focal Topic 1 below*].

Agenda/Program:

Approx time	Topic	Contributors
8:30	Arrival and check in	N/A
9:00 [10 minutes]	Welcome by Delta Independent Science Board	Vince Resh
9:10 [20 minutes]	Overview of agenda <ul style="list-style-type: none"> • Introductions, workshop objectives / outputs, and ground rules 	Clint Alexander
9:30 [30 minutes]	Overview of MER project <ul style="list-style-type: none"> • Project tasks and deliverables, review questions, metadata attributes, scope of monitoring enterprise, needs for information, role of monitoring in adaptive management 	Marc Nelitz
10:00 [30 minutes]	Participant views about monitoring enterprise, hopes and fears about MER <ul style="list-style-type: none"> • Anonymous feedback from participants to gauge thoughts around current situation, hopes and possible fears of MER, brief plenary discussion 	Clint Alexander
10:30	Break	N/A
10:50 [70 minutes]	<u>Focal Topic 1 [in plenary]:</u> MER questions and metadata attributes <ul style="list-style-type: none"> • Discussion and consideration of questions, such as “<i>What’s missing, what’s possible to answer, and what’s most important to understand?</i>” • Call for key contacts who can contribute to collection of metadata (after the workshop) 	Clint Alexander / Marc Nelitz
12:00	Lunch (provided)	N/A

⁵ Review questions seek to clarify and focus the data collection and synthesis of monitoring activities across the monitoring enterprise. The accompanying workshop backgrounder includes a summary of the review questions, proposed scope of the monitoring enterprise, and a summary of the broad needs for information from the monitoring enterprise.

Approx time	Topic	Contributors
1:00 [90 minutes]	<p><u>Focal Topic 2 [at sub-group tables]</u>: Scope of the monitoring enterprise and needs for information</p> <ul style="list-style-type: none"> • <i>Round 1</i> of small group discussions and exercise at small tables⁶ framed around 7 core management themes: (a) Flow management (e.g., water supply), (b) Flood management (e.g., levees), (c) Water quality (e.g., pollution control), (d) Aquatic habitat management (e.g., physical habitat restoration and protection), (e) Species management (e.g., hatcheries, harvest, direct mortality), (f) Invasive species management (e.g., control measures), and (g) Land use management (e.g., zoning, land use practices). • Sub-group tables will receive additional guidance at the workshop, but the exercise will include discussion and consideration of questions, such as <i>“What are the needs for information within each of these management themes and what is the related scope of monitoring that needs to occur to provide that information?”</i> 	A notetaker / reporter from the project team will be assigned to each table to support discussions
2:30	Break	N/A
2:50 [60 minutes]	<p><u>Focal Topic 2 [at sub-group tables]</u>: Scope of the monitoring enterprise and needs for information</p> <ul style="list-style-type: none"> • <i>Round 2</i> of small group discussions and exercise (i.e., switch to a new table for discussion about a second management theme) 	A notetaker / reporter from the project team will be assigned to each table to support discussions
3:50 [55 minutes]	<p><u>Focal Topic 2 [in plenary]</u>: Scope of the monitoring enterprise and needs for information</p> <ul style="list-style-type: none"> • Plenary reporting back around each management theme • Looking for common feedback on scope and needs for information 	Notetakers from each table to report back.
4:45 [15 minutes]	Next steps and closing remarks	Clint Alexander / Vince Resh
5:00	Adjourn	N/A

⁶ Participants are asked to provide preferences for sub-group assignments in advance of the workshop by responding to this [1-minute survey](https://www.surveymonkey.com/r/ZSRHV2Q) **no later than April 26**: <https://www.surveymonkey.com/r/ZSRHV2Q>.

Appendix B: List of workshop participants

Name	Organization
Ali Dunn	California State Water Resources Control Board
April Hennessy	California Department of Fish and Wildlife
Brittany Davis	California Department of Water Resources
Brian Thompson	U.S. EPA, Region 9
Caitlin Semmens	ESSA Technologies Ltd
Campbell Ingram	Delta Conservancy
Cathy Ruhl	United States Geological Survey
Chris Bowles	CBEC Eco-Engineering
Clint Alexander	ESSA Technologies Ltd
Darcy Austin	State Water Contractors
David Bubenheim	National Aeronautics and Space Administration
David Fries	San Joaquin Audubon
Dawit Tadesse	California State Water Resources Control Board
Edmund Yu	Delta Stewardship Council
Elizabeth Stumpner	United States Geological Survey
Erin Foresman	California State Water Resources Control Board
Erwin Van Nieuwenhuyse	United States Bureau of Reclamation
George Isaac	Delta Stewardship Council
Gina Darin	California Department of Water Resources
Heather Swinney	United States Fish and Wildlife Service
Jai Singh	CBEC Eco-Engineering
Janis Cooke	Central Valley Regional Water Quality Control Board
Jeff McLain	United States Fish and Wildlife Service
Jenna Rinde	DWR
Joe Fernando	Delta ISB
John Callaway	Delta Stewardship Council
John Franco Saraceno	California Department of Water Resources
John Wiens	Delta ISB
Jon Burau	United States Geological Survey
Josh Israel	United States Bureau of Reclamation
Kristy Dybala	Point Blue
Larry Brown	United States Geological Survey
Lauren Hastings	Delta Stewardship Council

Name	Organization
Lynda Smith	Metropolitan Water District of Southern California
Marc Nelitz	ESSA Technologies Ltd
Mark Schwartz	UC Davis
Mike Chotkowski	United States Geological Survey
Mike Dempsey	California Department of Water Resources
Natasha Nelson	Delta Protection Commission
Rachel Johnson	National Marine Fisheries Service
Rainer Hoenicke	Delta Stewardship Council (Retired)
Richard Looker	San Francisco Bay Regional Water Quality Control Board
Robert Amrime	Bethel Island Municipal Improvement District
Samsor Safi	Sacramento Regional County Sanitation District
Shaara Ainsley	Fishbio
Shruti Khanna	California Department of Fish and Wildlife
Stacy Sherman	California Department of Fish and Wildlife
Stephanie Fong	California Department of Fish and Wildlife
Steve Brandt	Delta ISB
Steve Culberson	Delta Stewardship Council
Steve Lindley	National Marine Fisheries Service
Steven Albert	The Institute for Bird Populations
Steven Slater	California Department of Fish and Wildlife
Sujoy Roy	Tetra Tech
Tamara Kraus	United States Geological Survey
Timothy Mussen	Sacramento Regional County Sanitation District
Tom Lagerquist	Pax Environmental
Tracy Collier	Delta ISB
Val Connor	California State Water Resources Control Board (Retired)
Vince Resh	Delta ISB

Appendix C: Data sources and data contacts

This table describes the list of data sources that were provided by workshop participants after their review of a [handout of existing data sources](#)⁷ that were compiled by the project team before the workshop. This table transcribes all of the information provided, as is, with the exception of the data contact and the person who provided the information. Therefore, there is some duplication in this table.

Monitoring Activity Name / Data Source	Organization	Additional Information
ewrims	State Water Boards	Electronic Water Rights Information
California Dept of Fish and Wildlife Delta studies (IEP)	CDFW	Update to existing description data includes Fish, Zooplankton and Environmental data.
IEP is inclusive of many agencies – split out DWR EMP (IEP)	DWR	Identify DWR EMP (IEP) and other monitoring
Add USFWS DJFMP (IEP)	USFW	Not filled out
UC Davis Suisun Marsh (IEP)	UC Davis	Long term monitoring by UC Davis by DWR for Suisun Marsh Salinity Control Gates
Organize CDFW & California Dept together in sorting table handout #2	Not filled out	Not filled out
BIOS is CDFW	Not filled out	Not filled out
CNDDDB is CDFW	Not filled out	Not filled out
Zoop	CDFW (IEP), (FRP)	Not filled out
Fish	CDFW (IEP), CDFW (FRP)	Not filled out
Zoop and Phyto	DWR (IEP)	Not filled out
Fish	USFWS (IEP)	Completely missing from table
SWAMP	SWRCB	Not filled out
CVTEMP/RAFT (Pike et al 2013) water resources research 49.9	NOAA	www.oceanview.pfeg.noaa.gov real-time and forecasted Sac river temps
SacPAS Central Valley prediction and assessment of salmon	USBR	www.cbr.washington.edu/sacramento Integrates salmon monitoring (real-time + archive)
Salmon survival monitoring (acoustic telemetry)	NOAA/IEP	www.calfishtrack.github.io/real-time/pageSLPRFR_2019.html
Delta Juvenile Fish Monitoring Program	USFWS	Not filled out

⁷ <https://deltacouncil.ca.gov/docs/monitoring-enterprise-workshop-43019-handout-2>

Monitoring Activity Name / Data Source	Organization	Additional Information
Green sturgeon abundance monitoring	NOAA/ UCSC	Estimate of abundance in river; green sturgeon migrate through Delta to csf to & from there
Delta Juvenile Fish Monitoring (IEP)	USFWS	This is a large complex program. Denise can provide more info
Environmental Data Initiative	Not filled out	http://environmentaldatainitiative.com
Economic Monitoring	Local cities or chambers of Commerce?	Socio economic data for delta communities? Data on tourism? Delta Recreation? Shipping data for Stockton & West Sac ports
Aquatic Invasive Weed Monitoring	Dept. of Boating and Waterways	Extent of invasive weed coverage and spatial /temporal data of treatment. Maybe this is already included? I can't tell.
Municipal Water Quality Investigations (MWQI, DWR)	DWR	Water quality monitoring in Delta, Calif Water Data Library
Dept Pesticide Regulation Surface Water Monitoring	DPR	Not filled out
Environmental Monitoring Program	DWR	Not filled out
Delta Regional Monitoring Program	Central Valley RWQCB	Not filled out
CDEC	USGS comment	Not filled out
IEP/EMP Zooplankton Study CDFW	CDFW/DWR/IEP	Add to CDFW Delta Studies and surveys and CA Estuaries Portal
Environmental Data Index/IEP Data	IEP	Creating DOIs for IEP datasets
Aquatic Map Mapping and Assessment on Regular Time Scale / SatBased	NASA	Weekly/ regular FAV assess
Sub. Aquatic Veg Biomass/Biovolume Assessment	Div. Boating & waterways	Not filled out
Delta Flows: Water Quality	USGS	Not filled out
Delta Flows	DWR	Not filled out
Delta Water Quality	DWR	Not filled out
EMP	Not filled out	Not filled out
Environmental Data Initiative (EDI)	NSF	IEP datasets are being published to EDI w/DOI's, metadata, and QC standards. This DOI is accessed via other platforms such as CNRA and CA Estuaries Portal.

Monitoring Activity Name / Data Source	Organization	Additional Information
SacPAS: Central Valley Protection & Assessment at Salmon	Not filled out	Not filled out
Recent Waterbird Survey data, throughout Delta & Central valley	Point Blue Conservation Science	Not filled out
Riparian bird survey data throughout Central Valley	Point Blue Conservation Science	Mostly upstream of legal Delta
Central Valley Joint venture estimates of regional habitat availability & bird population sizes/densities	Point Blue Conservation Science	Recent data synthesis of current status to conservation objectives
Point Blue water tracker	Point Blue Conservation Science	Near-real-time maps of surface water availability in Central Valley, including Delta
Riparian bird & tidal marsh bird survey data in lower Delta & SF Bay	Point Blue Conservation Science	Not filled out
Pacific Flyway Shorebird Survey	Point Blue Conservation Science	Some of these bird survey data are discoverable through the California Avian Data Center, but there are far more info from these contact folks listed.
Recreational use data	CA Dept. of Parks and Rec / Local Parks Rec Depts, NGO's.	Not filled out
Litigation costs related to controversial decisions	Courts	Not filled out
RipZET visualization tool w pertinent data	SFEI	Not filled out
Value of data/information relative to cost of decision - implementation	EcoRestore, water contractors, Nat Resources Agency	Not filled out
Benthic & invert monitoring	WGS Western Ecol Research Center	Not filled out
Levees program (habitat enhancement)	CDFW, DWR	Not filled out
Nutria response – monitoring and eradication	CDFW	Not filled out
Environmental Data Initiative	Not filled out	IEP, Fish Restoration Program starting to use as data repository

Monitoring Activity Name / Data Source	Organization	Additional Information
Fish Restoration Program Monitoring Team	CDFW	Wetland Monitoring Framework & SOPs published online
Suisun Marsh Group	DWR CDFW	If including the Marsh (& salt marsh harvest monitoring)
Spatial/Datasets temporal science base-catalog	USGS can search community USGS California Water Science Center	I think other agencies can publish here too. Our group is making a big push to publish a lot of maps (water quality) soon
Pesticides	USGS	Contaminants!
Long-term monitoring elements (biology)	IEP	See IEP website & data portal
WOMT	USFWS	Water operations monitoring team notes
DOSS	NOAA	Delta operations for salmon & sturgeon notes
SWG	USFWS	Smelt working group notes
Remote Imagery Consortium	R.I.C.	New coordination team: R.I.C.
Delta Regional Monitoring Program	Delta RMP (multiple entities)	Pesticides, nutrients, pathogens, mercury
NPDES permittee data submitted to the water boards by POTWs & stormwater (MS4) permittees. Includes CIWQS & other databases	Not filled out	Not filled out
My Water Quality Portals	Not filled out	Note: Important for data accessibility. Data are in CED EN, but portals provide easier access to public.
Delta Invasive Aquatic Veg. spp mapping	UC Davis	2004 – 2008 2014 – 2019 Raster Data (1/yr)
Water Quality Data (WQX) STORET Water Quality Portal	USEPA	epa.gov/waterdata
MAPS – Monitoring Avian Productivity & Survivorship	The Institute for Bird Populations	<u>Rigorous</u> and standardized measures avian vital rates
Heron and Egret Colony Monitoring – Deltawide	The Institute for Bird Populations	Not filled out
Ebird – presence/absence	Cornell Lab of ornithology	Growing and widely use citizen site with bird presence/absence

Monitoring Activity Name / Data Source	Organization	Additional Information
Christmas Bird Count	National Audubon	<u>Not rigorous</u> but long-term and widespread. Gaps in the Delta
North American Breeding Bird Survey	USGS	Rigorous and widely used but appear to be few routes to the Delta
E-bird	Cornell Ornithological Institute (Laboratory)	Not filled out
Audubon State & National Christmas Bird Counts	Not filled out	Not filled out
Institute for Bird populations	Not filled out	Not filled out
Grand Tab	CDFW	Not filled out
Invasive plant monitoring	CA Invasive plant council Cal-IPC	Statewide management application CalWeed Mapper & WHIPPET (prioritization)
Botanical monitoring from rare to invasive populations	Calflora	Statewide botanical database with management applied apps.
Waterfowl Monitoring	CA DWR Suisun Marsh Branch	Research programs Cliff knows people working a monitoring waterfowl in Delta. Suisun Marsh
GHG Gas Flux	UC Berkeley UC Davis	Not filled out
Public USP of reserved land and recreation	UC Davis	Not filled out
Gas Flux Data	UC Berkeley UC Davis	Not filled out
San Francisco Bay National Estuarial research reserve	SF Bay NERR SFSU	Multiple types of monitoring at Rush Ranch
Sediment Elevation Tables and wetland accretion	NOAA is coordinating inventory	Mostly in Suisun & SF Bay
Wetland Regional Monitoring Program	SFEP and SFEI	Being developed for SF Bay & Suisun with Delta coordination
Delta surface elevations (LAND) routine monitoring - LIDAR	USGS	[not sure what the official title of this program is]
Continuous water quality data Bathymetry data Flow data	CA DWR	Paul is the branch manager for these various monitoring programs

Monitoring Activity Name / Data Source	Organization	Additional Information
Municipal Water Quality Program	CA DWR	Not filled out
Central Valley & Delta prediction + assessment of salmonids (SacPAS)	UW, USBR, IEP	See mission statement @ www.cbr.washington.edu/sacramento
Enhanced acoustic telemetry program/ NOAA-USGS Interagency Telemetry Advisory Group (ITAG)	USBR, USGS, NOAA, IEP	See website Calfishtrack.github.io
Directed Outflow Project	USGS, ICF	Not filled out
Enhanced Delta Smelt Monitoring Project	USFWS, IEP	Not filled out
Knight Landing Rotary Screw Trap	CDFW, IEP	Used for Delta Cross Channel operations Calfish.org/ProgramsData See "Middle Sacramento River Salmon & Steelhead Monitoring"
Bird sightings ebird	The Cornell Lab of Ornithology	Better capture avian data available
CDFW's salt marsh harvest mouse surveys (and DWR)	CDFW	Better reflect SWHM data available
California Clapper rail and black rail surveys	CDFW	Better reflect avian data available
Suisun Marsh vegetation surveys	CDFW	Better reflect vegetation data
Grizzly Island Wildlife Area	CDFW	Better reflect annual surveys for waterfowl & breeding surveys for tule elk pheasant, and waterfowl
Audubon Society Christmas Bird Count	Audubon Society	Long term health status of bird populations across North America
Tricolored blackbird surveys	CDFW	Better reflect avian data available
North Delta Arc UC Davis effort	UC Davis	Aquatic monitoring
California Waterfowl Association	Grizzly Island Wildlife Area	Better reflect avian data available
Aquatic Weed Control Program	DOW	Not filled out
Enhanced Delta Smelt Monitoring (EDSM)	LDFWO	Delta Smelt
Levee elevation data	DWR	Not filled out
Suisun Marsh Fish Study	UC Davis	Look for website
Land IQ – Delta ag info	Land IQ	website
Municipal Water Quality Investigations Program	DWR	website

Monitoring Activity Name / Data Source	Organization	Additional Information
Delta Plan performance measures	DSC	Not filled out
Restoration project monitoring (Tule Red)	ESA	Not filled out
Suisun Marsh monitoring (general knowledge)	Suisun Resource Conservation District	Not filled out
NERR activities	NERR	Not filled out
DWR – Bay-Delta Office activities	DWR – Bay-Delta Office	Delta Fish barriers
CA Water Plan (Planning & info exchange) Water PIE	DWR	Not filled out
Yolo Bypass Fisheries & Engineering Technical Team (FETT)	DWR	Not filled out
Uncertainty around Delta Consumptive use	Not filled out	Delta Consumptive use
Sciencebase.gov Science Base Catalogue	USGS + other	All kinds of datasets can be put here. Have to know what you are looking for.
Deep Water Shipping Channel	BOR/UC Davis	Long term data collection program
Yolo Bypass and Toe Drain	DWR	Long term efforts in this area
Wasterwater permits – monitoring, compliance infrastructure exchange	CWQIX CA water quality	Information about flow and amount + constituent concentrations
Modellers!	Many	They compile a lot of data and create output used by managers.

Additional notes about data sources and contacts:

- Not clear how “special studies” play into the effort. A lot of data collection by universities/consultants, even State, Federal that are not often placed online
- Listed plant species are missing from Handout #3 and a more robust list of avian species
- Clarify portals vs repositories – could have some info in multiple places
- Handout #2 needs agency and program columns – could have multiple monitoring activities per agency and program.
- Need consistency on Handout #2 for how groups are named and how constituents or programs within an agency are grouped. Should split Handout #2 into data repositories from portals that draw from them.
- A lot of important work is done in special 2 – 3 yrs studies not included in long-term monitoring.
- Some data sets are provided in different data sets. For example CDEC contains a broad spectrum of Real-Time data. But USGS posts the same data after it has been QA/QC’d. So perhaps a hierarchal structure – CDEC (top level, real time), DWR water data library – check to see you have this, USGS – NWIS
- Organize lists by agency, disciplines to make searches easier.