

Activity Number	Activity Type	Report Section	Recommended Science Activity	Management Relevance
1	Modeling	Egg to Fry Emergence – Keswick Dam to RBDD	Support the collaborative model improvement work of the Temperature Modeling Technical Committee	Improved predictions - Extension of the CE-QUAL-W2 modeling of Shasta Lake and Keswick Reservoir to include appropriate river models, creating a linked modeling framework to improve model predictions that assist resource managers.
2	Targeted Data Collection	Egg to Fry Emergence – Keswick Dam to RBDD	Pilot monitoring of input stream and local meteorology in the Shasta, McCloud, and Pit River arms of Shasta Lake	Increased detection – Greater resolution of water temperature data above Shasta Dam. Improved predictions - Data to validate or refine model inputs and the better incorporate the role of meteorological conditions on thermal regime of Shasta Lake and tributary inflows.
3	Targeted Data Collection	Egg to Fry Emergence – Keswick Dam to RBDD	Increase vertical resolution for temperature profiling in Lake Shasta especially in mid-to-late summer during drier years	Increased detection - Greater resolution of water temperature and density data within Lake Shasta. Improved predictions - Improved characterization of density gradients that could influence the ways in which water moves through the various gated structures.
4	Targeted Data Collection	Egg to Fry Emergence – Keswick Dam to RBDD	Conduct velocity surveys to assess dynamics around TCD gates operating individually and for blending, and surveys throughout the TCD operating season to assess how the dynamics change as the TCD is operated over time.	Increased detection - Greater resolution of water velocity dynamics around the TCD gates. Improved predictions - Improved characterization of local dynamics of withdrawal zones for TCD gates operating individually or for blending, under varying seasonal conditions.
5	Targeted Data Collection	Egg to Fry Emergence – Keswick Dam to RBDD	Supplement existing carcass and redd surveys with enhanced boat and in-water surveys, potentially focused on specific areas or environmental conditions	Increased detection – Additional data to support escapement and fecundity estimates. Improved understanding - Evaluation of critical assumptions that may bias routine field surveys and thus impact management actions reliant on the survey data.
6	Integrated Study	Egg to Fry Emergence – Keswick Dam to RBDD	Collaboratively plan and conduct a multi-year Integrated Study to understand how river-scale management actions translate down to the scale of the redd, e.g., detailed field measurement and model simulations of physical conditions, surveys, and field and laboratory experiments to assess biotic response.	Improved understanding - Evaluation of how river-scale management actions, individually and in combination, that alter flow, temperature, DO, and substrate translate down to the scale of the redd and influence redd-specific egg-to-fry survival.
7	Modeling	Rearing-Out Migrating Juveniles – Keswick Dam to RBDD	Identify, refine, and test suitable bioenergetics models for use in conjunction with flow models of in-channel and off-channel habitats.	Improved prediction – Promote models that support planning and evaluation of habitat restoration projects by accounting for how changes in thermal regime, flow conditions, and food availability affect fish growth. Information on the potential effects of different flow management decisions on rearing habitat.

8	Targeted Data Collection	Rearing-Out Migrating Juveniles – Keswick Dam to RBDD	Document the consequences of flow management, i.e., the magnitude of minimum flows or the rate of flow decrease, on utilization of in-stream rearing habitat (potentially expanding on stranding surveys and restoration site surveys) including sampling as flows decline.	Increased detection - Refined information on habitat use by juveniles. Improved understanding - Potential identification of thresholds in environment-use relationships to improve planning and design of habitat restoration projects.
9	Targeted Data Collection	Rearing-Out Migrating Juveniles – Keswick Dam to RBDD	Document the relative abundance and distribution of potential predators in the river above RBDD and the types of in-channel habitats with which they are associated with varying flows and environmental conditions.	Increased detection - Improved identification of the response of juvenile passage to flow management, i.e., predation as a potential source of non-temperature mortality. Improved understanding - Support planning and implementation of projects that seek to improve in-channel rearing habitats.
10	Targeted Data Collection	Rearing-Out Migrating Juveniles – Keswick Dam to RBDD	Assess the role of pathogens and disease through targeted sampling of intestinal tract samples from carcasses, and evaluation of how changes in flow conditions could disrupt polychaete habitat.	Increased detection - Increased appreciation of the conditions under which pathogens and disease may influence the effectiveness of management actions.
11	Analysis	Rearing-Out Migrating Juveniles – Keswick Dam to RBDD	Plan, support, and implement a structured approach for efficiency tests at RBDD RST across run/size, flow conditions, etc.	Increased detection - Increased confidence in egg-to-fry survival estimates. Improved understanding - Evaluation of critical assumptions that may bias routine field surveys and thus impact management actions reliant on the survey data.
12	Analysis	Rearing-Out Migrating Juveniles – Keswick Dam to RBDD	Analyze existing RBDD juvenile monitoring data to assess the relationship between flow and environmental conditions and fish passage.	Improved understanding - Validate current approaches to imputing data when conditions prevent RST operation.
13	Analysis	Rearing-Out Migrating Juveniles – Keswick Dam to RBDD	Continue exploration of parentage-based tag methods (PBT) to provide information on the reproductive success of individual spawners.	Improved understanding - Evaluation of how management actions that influence spawn timing, location, and origin (hatchery or wild) affect reproductive success. Improved predictions - Potential refinement of egg-to-fry survival estimates.
14	Focused Study	Rearing-Out Migrating Juveniles – Keswick Dam to RBDD	Plan and conduct a focused study to understand predator distribution and predation in different environments of the river under varying flows and seasonal temperature condition potentially including gut analysis of predators, predation activity, and tracking predator movements with changing environmental conditions, including those associated with management actions.	Improved understanding - Evaluation of when and where predation mortality of salmonids can impact the success of management actions.

15	Integrated Study	Rearing-Out Migrating Juveniles – Keswick Dam to RBDD	Collaboratively plan and conduct a multi-year Integrated Study to understand how managed flows interact with existing and newly restored habitat features to benefit rearing fry, including detailed field measurement and model simulations of physical conditions, and surveys of habitat utilization by fry and potential predators, growth rates (non-listed species), and prevalence and potential infection rates for <i>C. shasta</i> .	Improved understanding – Assessment of factors influencing fry growth and predation, and the role of physical stream conditions including those influenced by flow management. Improved prediction – Incorporate understanding of factors into the planning and design of habitat restoration management actions.
16	Modeling	Rearing-Out Migrating Juveniles - RBDD to Verona	Identify, refine, and test suitable bioenergetics models for use in conjunction with flow models of in-channel and floodplain habitats.	Improved prediction - Improved planning and evaluation of habitat restoration and flow management actions by allowing planning and design to better account for how changes in thermal regime, flow conditions, and food availability affect fish growth.
17	Modeling	Rearing-Out Migrating Juveniles - RBDD to Verona	Foster communication and information sharing to support the ongoing development of the Spring-run LCM. Identify additional data or research needed to appropriately reflect the role of the mainstem Sacramento River conditions and management actions in the model, such that it could eventually be used to assess tradeoffs and support SDM.	Improved prediction - Ensure that the Spring-run LCM appropriately reflects the role of management actions that change conditions in the mainstem Sacramento and thus support future management decision making.
18	Analysis	Rearing-Out Migrating Juveniles - RBDD to Verona	Convene an expert group to evaluate the need for additional juvenile passage monitoring locations on the mainstem Sacramento River in relation to other potential approaches, e.g., additional measurement of survival, modeling.	Increased detection - Data to provide an overall assessment of how ambient conditions and management actions in the Sacramento influence outmigration (including passage through Sutter Bypass). Improved prediction - Support for refined JPE estimates.
19	Targeted Data Collection	Rearing-Out Migrating Juveniles - RBDD to Verona	Strategically plan and conduct boat-based surveys of predators to identify how predator abundance and distribution changes through different reaches of the river.	Increased detection – Provide greater resolution of river reach-specific predator densities. Improved understanding - Support for planning and implementation of projects that seek to improve in-channel rearing habitats
20	Targeted Data Collection	Rearing-Out Migrating Juveniles - RBDD to Verona	Strategically plan and conduct data collection campaigns to identify patterns of abundance of drift insects and zooplankton in association with habitat features such as side channels, bars, bank slopes, etc. Consider extending data collection to floodplains during periods of inundation.	Increased detection - Improved background data for planning restoration projects. Specifically, baseline data for future examination of the effects of management actions that seek to increase food resources for salmonids.
21	Targeted Data Collection	Rearing-Out Migrating Juveniles - RBDD to Verona	Conduct a series of paired releases of tagged hatchery fish into the Sutter Bypass during flooding and the adjacent Sacramento River, to detect whether passage through the Sutter Bypass increases survival for outmigrating juvenile salmonids	Increased detection - Documentation of the potential benefits of floodplain passage on survival or outmitgrating fish.

22	Focused Study	Rearing-Out Migrating Juveniles - RBDD to Verona	Support science to understand the effects of the spring pulse flow action including during drier conditions than those identified in the Biological Opinion.	Improved understanding - Evaluate the effects of the new management action under varying water year conditions, thus supporting evaluation of tradeoffs among water management benefits and impacts for different runs of salmon.
23	Focused Study	Rearing-Out Migrating Juveniles - RBDD to Verona	Plan and conduct coordinated field sampling to identify patterns of habitat use within the mainstem Sacramento, including the broader meandering reaches above Colusa and the leveed reaches above Knight's Landing, and assessment of predation potential and prey availability	Improved understanding - Support for bioenergetics modeling for planning and design of habitat restoration and flow management actions. Improved prediction - Provision of information to apply/refine decision support tools, e.g., use of IBMs, refinement of transitions in LCMs.
24	Focused Study	Rearing-Out Migrating Juveniles - RBDD to Verona	Plan and conduct experimental studies of the effects of actively-managed agricultural floodplain utilization on outmigrating salmonids including potential for avian predation, channelized and managed floodplain-mainstem egress on subsequent predation, and tradeoffs between enhanced growth and delays in outmigration associated with extended durations of floodplain access.	Increased detection – Focused monitoring of juvenile salmonid utilization of actively-managed agricultural floodplain. Improved understanding - Identification of the potential benefits and risks to salmonids of actively managed access to/use of agricultural floodplains.
25	Integrated Study	Rearing-Out Migrating Juveniles - RBDD to Verona	Collaboratively plan and conduct a multi-year Integrated Study to understand how variations in passive inundation of the Sutter Bypass influences the benefits gained, including model simulations of habitat quality, surveys of habitat utilization and potential for predation and disease, juvenile growth rates, and data to support improved modeling of habitat quality.	Increased detection – Focused monitoring of juvenile salmonid utilization of passively inundated floodplains. Increased understanding of the Increased understanding - Evaluation of the benefits and risks of passive access to floodplain habitats to juvenile salmon. Improved prediction - Information to support the refinement of predictive tools for supporting floodplain management decisions.
26	Targeted Data Collection	System-Level Assessment	Ensure routine collection of genetic markers for anadromy in Steelhead.	Increased detection – Identification and collection of genetic markers for anadromy in Steelhead. Improved understanding - Consideration of the effects of management actions on anadromous vs. resident Steelhead.
27	Targeted Data Collection	System-Level Assessment	Ensure routine collection of otoliths (or scales for Steelhead) for assessment of habitat utilization.	Increased detection – Collection of samples/data to support assessment of habitat utilization using otoliths (or scales for Steelhead). Improved understanding - Quantification of survival and relative contributions of different rearing strategies.
28	Targeted Data Collection	System-Level Assessment	Ensure routine collection of data needed to assess the effects of pathogens.	Increased detection – Collection of samples/data to support assessment of the effects of pathogens. Improved understanding - Establish the role of disease influencing salmonid populations.
29	Synthesis	System-Level Assessment	Routinely develop summary brood year assessments	Improved understanding - Ongoing transparent appraisal of species response to ambient conditions and management actions.

30	Synthesis	System-Level Assessment	Develop a synthesis report on the effectiveness of restoration projects in the Upper Sacramento based on monitoring and other available data, including any lessons learned in relation to project evaluation, monitoring or implementation.	Improved understanding – Provide accessible information on the field-verified benefits of habitat restoration approaches, to support planning and design of future projects.
31	Synthesis	System-Level Assessment	Identify, prioritize, and conduct additional synthesis efforts	Improved understanding - Periodic evaluation of scientific progress, effects of management actions, and change in the system providing context for management actions and enabling the development of new science questions.