

Elk Slough Fish Passage and Flood Improvement Plan Phase 1 Feasibility Study

Scope of Work

Project Description

The Elk Slough Fish Passage and Flood Improvement Plan Feasibility Study (Feasibility Study) is being proposed to evaluate the feasibility of restoring fish passage to a critical anadromous fish migration route within the Sacramento-San Joaquin Delta. Elk Slough historically provided a natural migration corridor for anadromous fish through the Delta (A Delta Transformed, SFEI). Restoration would provide an alternative migration route that bypasses the deeply channelized and riprap-lined routes of the Sacramento River and other Delta channels that are available today. However, Elk Slough's historic connection to the Sacramento River near Clarksburg was nearly severed over 60 years ago with the construction of the Sacramento River Flood Control Project, which constructed an embankment with a culvert across the inlet to Elk Slough. Following construction of this project, Elk Slough became a dead-end channel with no ability for salmonids and other anadromous species in the Sacramento River to migrate through the slough.

Elk Slough is one of the few channels in the Delta that avoided the extensive riparian vegetation removal that occurred throughout the Delta in the 1960s in response to U.S. Army Corps of Engineers flood control mandates. As such, it embodies the densely-vegetated and sinuous character of Delta channels that were widely represented prior to the agricultural transformation of the Delta. Consistent with its historic character, more than 97 percent of the 9.5 miles of levees along both sides of the slough contain mature riparian vegetation. However, due to recent large storm events and the associated damage done to the slough's levees due to high flows entering the slough from the south, the California Department of Water Resources has been selectively installing riprap to fortify the levees. These repairs are anticipated to continue and accelerate along Elk Slough, with the progressive loss of habitat values, unless alternative flood improvements are identified.

The Feasibility Study proposes to evaluate the benefits of reconnecting Elk Slough to the Sacramento River by removing the levee segment that separates the two water bodies. Removing this levee segment would provide unrestricted water flow into Elk Slough from the river. Because this unrestricted flow would increase the potential for a levee breach along Elk Slough, the Feasibility Study would evaluate the installation of a flood gate that would replace the function of the Sacramento River levee during periods of elevated flood risk. Based on initial evaluations, the flood gate would be expected to remain fully open year round and to be closed only during large storm events that generate high flood water stages in the river. In addition, the Feasibility Study would evaluate the installation of a flood gate at the downstream

end of Elk Slough. The purpose of the downstream flood gate would be to prevent high stages from Sutter Slough from backing up into Elk Slough putting severe pressure on the levees. As with the flood gate at the upstream end, the downstream flood gate would be expected to remain fully open year round and to be closed only during large storm events that generate high flood water stages in Sutter Slough. Levee improvements that directly integrate riparian habitat restoration would also be evaluated in the Feasibility Study.

The project is expected to benefit anadromous fish by opening a relatively pristine distributary channel for fish to use as they migrate through the Delta. Based on the natural sinuosity of the channel and density of riparian vegetation, the conditions along Elk Slough likely provide enhanced migration and rearing opportunities for fish compared to most other available migration routes through the Delta. In addition, by construction of the project, flood flows into Elk Slough would be reduced, thereby reducing stress to the levees and allowing preservation of the existing habitat within Elk Slough. The project also includes the evaluation of bioengineered bank protection improvements. These bioengineered improvements would be implemented on an as needed basis when erosion and/or slope stability sloughing occurs and would have the goal of minimizing environmental impacts while enhancing habitat along Elk Slough.

Funding Request

To conduct the planning necessary to position the Elk Slough Restoration Plan for implementation, Reclamation District 999 is requesting that the Delta Conservancy fully fund the grant application submitted on December 18, 2018. However, in response to project feasibility questions raised during the application's review, Reclamation District 999 is proposing to conduct the planning effort in two phases. Phase 1 would include preparing a Feasibility Study to determine the project's potential to benefit listed fish species. Phase 2 would include conducting additional public outreach, developing project design plans, conducting necessary CEQA compliance, and preparing an implementation grant application.

During Phase 1 Feasibility Study development, the project applicant team would work closely with key regulatory agency fish scientists to assess whether project implementation would benefit listed fish species. Following completion of the Feasibility Study, the project applicant team would brief Delta Conservancy staff on the results of the Feasibility Study and the outcome of the regulatory agency outreach efforts. If staff is comfortable with the Feasibility Study's findings and the results of the regulatory agency consultation efforts, then the project applicant team would initiate Phase 2 of the grant agreement.

Most of the tasks necessary to conduct the Feasibility Study are included in the first four tasks of the original grant application. However, some additional work not included within these

tasks will be necessary to complete the Feasibility Study. This additional work is proposed to be conducted by the Sacramento Area Flood Control Agency (SAFCA), a project teaming partner. SAFCA has committed to leveraging Delta Conservancy funding to assist in completing the Feasibility Study. As part of this commitment, SAFCA has funded significant pre-planning efforts, including the preparation of a detailed Reconnaissance Study. In addition, SAFCA will provide bridge funding during grant agreement development and will fund the efforts outside of the grant agreement that are necessary to answer outstanding project feasibility questions. The following table breaks down the Phase 1 funding request and SAFCA’s role in funding the development of the Feasibility Study.

Grant Application Tasks	Delta Conservancy Phase 1 Feasibility Study Funding	SAFCA’s Pre-feasibility and Feasibility Study Funding
Elk Slough Pre-Planning, Reconnaissance Study, and Geotechnical Evaluation	N/A	Approx. \$300,000 (spent to date)
Task 1: Grant Management	\$9,500	N/A
Task 2: Define Existing Environmental Conditions	\$116,600	\$90,000*
Task 3: Conduct Detailed Hydrodynamic Modeling	\$116,000	\$20,000
Task 4: Conduct Community Engagement	\$9,500	\$10,000
Phase 1 Funding Request	\$251,600	\$420,000

**Approximately \$10,000 of the Task 2 funds will be used to collect available predatory density data from existing studies and to estimate comparative travel times.*

The detailed scope of work identifying the tasks to be completed for the Phase 1 Feasibility Study and the parties responsible for completing each task are described below.

Feasibility Study Scope Development

On December 18, 2018, Reclamation District 999 submitted an application to the Delta Conservancy to fund the preparation of a planning study to evaluate reconnecting Elk Slough to the Sacramento River. During the Conservancy’s evaluation process, several questions were raised by reviewers regarding the project’s feasibility. On July 31st, 2019, the Delta Conservancy convened a group of fisheries biologists representing state and federal regulatory agencies to discuss these questions. A summary of the key questions raised during this meeting are provided below followed by preliminary response by the project applicant team.

Following this meeting, the project applicant team worked with the Delta Conservancy to identify how these questions could be more fully addressed through the preparation of a Feasibility Study. Therefore, embedded in each response are the tasks that would be implemented by the project applicant team to more fully address the key questions raised by the fisheries biologists.

Outstanding Questions and Scope Tasks

1. What are the existing habitat conditions within Elk Slough?

Scope Task: As originally proposed in the grant application, existing habitat conditions in Elk Slough will be characterized to further evaluate the potential fish passage and rearing benefits of reconnecting Elk Slough to the Sacramento River. Environmental data will be collected seasonally both in Elk Slough and the adjacent Sacramento River to characterize the range of environmental conditions that currently exist in Elk Slough relative to conditions in the Sacramento River. Key indicators of habitat quality (e.g., water temperature, dissolved oxygen, turbidity) for the target species will be measured and used to further evaluate the potential benefits of reconnecting Elk Slough to the Sacramento River.

This task will include identifying the project area boundary and preparing a baseline assessment of the overall environmental conditions including the conditions of the slough levees. Existing topography, bathymetry, substrate composition, mean flow velocity, and tidal flux data will be collected and summarized from past studies, including the Sacramento River Delta 3D Mapping Project Technical Report (Freshwater Map 2014). Existing hydrology will be characterized using existing historical flow and stage data from the Sacramento River. Within Elk Slough, up to 4 remote continuous monitoring stations will be installed to measure water level, temperature, and dissolved oxygen. Available geotechnical data will be used to characterize the stability/suitability of the soils at the slough entrance and along the levees to pass the flow range necessary to support fish passage and to protect the area from flood and scour impacts, seismic events, and hydraulic changes due to climate change.

Relationship to Grant Application Task: This task is consistent with Task 2: Define Existing Environmental Conditions included in the grant application with the exception of collecting data from the Sacramento River. Funding allocated to Task 2 in the grant is proposed to be used to generate the following deliverables included in the grant application. Any data collection efforts in the Sacramento River will be funded by SAFCA.

Grant Deliverable: Existing Environmental Conditions Report
Monitoring Station Installation

2. Does Elk Slough provide habitat for salmonids that is better than would be experienced in the Sacramento River?

A major benefit of the project is the restoration of fish migration and rearing opportunities in a historical Delta channel that has retained a number of the key attributes that once supported large numbers of native fishes, including high channel sinuosity, abundant riparian vegetation, and natural substrates. These attributes are associated with high prey densities (e.g., aquatic/terrestrial invertebrates), cover, and velocity refugia, and therefore are expected to enhance rearing and foraging opportunities for juvenile salmonids and other anadromous species that depend on the Delta for additional rearing and growth prior to their seaward migration (e.g., Chinook salmon fry, juvenile sturgeon). Restoring a direct connection with the Sacramento River is also expected to enhance habitat conditions in Elk Slough by improving water quality through beneficial effects on water temperature, dissolved oxygen, and contaminants; creating more dynamic physical habitat through increased sediment inputs; and increasing productivity and food web support through increased inputs of organic matter and nutrients.

Scope Task: In conjunction with the evaluation of existing habitat conditions (see Task 2 discussion above), the potential rearing and foraging benefits of Elk Slough will be evaluated by comparing prey densities in Elk Slough, Sutter or Steamboat Slough, and the Sacramento River. This evaluation will be conducted during the primary migration and rearing periods of juvenile Chinook salmon (January through April) and will include bi-weekly plankton and benthic sampling to characterize taxonomic composition and densities (abundance and biomass) of invertebrates in the water column and bottom substrates. Water depth and velocities, water temperature, and dissolved oxygen will be measured concurrently with invertebrate sampling. This task will be conducted in coordination with ongoing zooplankton monitoring being conducted by DWR in the Sacramento River (Sherwood Harbor) as part of the IEP Monitoring Program. The results will also be compared to the results of other studies and data on prey abundance in habitats known to support high growth rates of juvenile salmonids (e.g., Knagg's Ranch floodplain habitat). In response to comments provided by Brian Ellrott with NOAA Fisheries, predatory density data available within existing studies will be collected and compared for Elk, Sutter and Steamboat Sloughs. Also, travel lengths will be quantified for juvenile salmon and available flow velocity information will be used to develop rough estimates of comparative travel times to better understand the benefits of Elk Slough as a migration route.

Relationship to Grant Application Tasks: This task includes components that are identified in Task 2: Define Existing Environmental Conditions, including specifically evaluating the baseline conditions and conducting water monitoring and sampling. Funding allocated to Task 2 in the

grant is proposed to be used to generate the following deliverables included in the grant application. The collection of predator and prey density information outside of Elk Slough will be funded by SAFCA.

Grant Deliverable: Existing Environmental Conditions Report
Monitoring Station Installation

3. Will the reconnection between Elk Slough and the Sacramento River result in salmonid predation that is greater than currently occurs in the Sacramento River?

Higher inflows resulting from the reconnection of Elk Slough to the Sacramento River are expected to improve habitat conditions in Elk Slough because of more positive flow rates (i.e., reducing tidal influence and creating more riverine conditions) and potentially higher turbidity, factors that have been linked to shorter travel times, improved survival, and lower predation risk of juvenile salmonids. Although few studies have been able to directly address the role of predation in outmigrant survival, recent studies using modern fish tracking methods (acoustical telemetry) have provided a means of evaluating differences in reach-specific survival that include the effects of predation as well as other factors that affect overall survival through the Delta. These efforts include recent studies designed to evaluate differences in survival of sub-yearling smolts (fall- and spring-run) that use alternative migration routes through the Delta, including Sutter, Steamboat, and Georgiana sloughs, and the mainstem Sacramento River (Eric Chapman, personal communication).

Scope Task: To further address this question, a white paper will be prepared to review relevant studies and ongoing investigations on route selection and survival of salmonids in the Delta, and synthesize this information with knowledge of predator life history, habitat requirements, and behavior to evaluate the relative risk of predation as it relates to the proposed reconnection of Elk Slough to the Sacramento River. The potential for the flood gate structures to act as predator hot spots for entering/exiting juveniles will be assessed. This task will include a review of the studies being conducted by DWR to evaluate Salmon Survival Engineering Solutions, as required by the 2009 Biological Opinion and Conference Opinion on the Long-Term Operations of the Central Valley Project and State Water Project Reasonable and Prudent Alternative Action IV.1.3. Potential engineering solutions being explored by DWR include installing barriers to keep salmon out of Georgiana Slough and Three-Mile Slough, both of which are downstream of Elk Slough on the Sacramento River. In addition, the information collected regarding predator densities and juvenile salmonid travel times in response to comments provided by Brian Ellrott with NOAA Fisheries and as described in response to question 2 above, will be integrated into this paper.

The regulatory agency stakeholder group formed by the Delta Conservancy will be closely consulted in developing this white paper. This engagement will occur through the formation of a Technical Advisory Committee (TAC) that will consist of the regulatory agency stakeholder group, Delta Conservancy staff, and the project applicant team. The regulatory agency stakeholder group is assumed to include the following agencies: NOAA Fisheries, US Fish and Wildlife Service, California Department of Water Resources, California Department of Fish and Wildlife, and the Delta Stewardship Council. The TAC will meet every six weeks through the completion of Phase 1.

Relationship to Grant Application Tasks: The development of a white paper was not included in the grant application and will be funded by SAFCA. However, this task includes components of Task 2: Define Existing Environmental Conditions, and Task 4: Conduct Community Outreach. Task 2 includes developing the Existing Environmental Conditions Report and the results of the white paper will be integrated into the Existing Environmental Conditions Report. In addition, the white paper will be developed in close consultation with the TAC and Task 4 includes engaging directly with resource and regulatory agency representatives to ensure the project meets state and federal objectives. SAFCA is also proposing to provide funding to support these tasks. Funding allocated to Tasks 2 and 4 in the grant is proposed to be used for these components to generate the following deliverables included in the grant application.

Grant Deliverable: Existing Environmental Conditions Report
Formation of a Technical Advisory Committee (TAC)
Outreach Meeting Agendas and Summaries

4. What is the expected timing and frequency of gate operations at the upstream and downstream ends of Elk Slough?

The proposed Project would include replacing the existing Sacramento River culvert connection with a new crossing for County Road E9, and new operable gates at the upstream and downstream ends of Elk Slough. The existing upstream culvert has an operable gate and is capable of providing flood risk reduction benefits. However, it is an obstruction to fish passage due to its small cross sectional area, deep submergence, and excessive length. The proposed gate structure and bridge replacement would facilitate fish passage by providing physical and hydraulic conditions consistent with the swimming capabilities and behavior of the target species. The proposed upstream and downstream gate structures would provide flood risk reduction benefits by providing the ability to limit the water surface in Elk Slough and limit the volume of water available should a levee breach occur.

The gates' priority operation during non-flood periods would be to remain fully open to allow anadromous fish passage. The gates would be closed briefly during Sacramento River floods. In

preparation of the grant application, gate operations were evaluated reflecting two potential Elk Slough threshold water surfaces. The threshold water surface elevations were 18.0 and 16.5 feet. These elevations were based on the height of the existing levees along Elk Slough.

Observed stage information was compiled and analyzed to estimate the number and duration of gate closure events that would have occurred from 2008 through 2018 if the gates were closed at a threshold water surface elevation of 18.0 feet and 16.5 feet. At a threshold water surface elevation of 18.0 feet there were five events of closure at the inlet of Elk Slough with durations ranging from 2 to 23 days. There were no closure events at the outlet of Elk Slough. At a threshold water surface 16.5 feet the number of closure events were 9 with durations ranging from 2 to 32 days at the inlet. The number of closure events at the outlet was 2 with durations from 4 to 7 days.

Scope Task: The analysis summarized above provides an understanding of the range of closure dates that would be expected with project implementation in relation to juvenile and adult salmonid presence. However, more detailed hydrodynamic modeling is proposed to more precisely define the anticipated operational windows for the two gates.

Hydrodynamic modeling will be undertaken using a model developed specifically for the project site. This modeling will be used to understand the hydrologic and hydraulic impacts associated with more directly connecting Elk Slough to the Sacramento River. It will also be used to better understand the project's potential to facilitate fish passage and modify potential predator habitat in Elk Slough (Task 3), and modify sediment transport, deposition, levee stability, channel erosion potential, and vegetative cover in Elk Slough and the Sacramento River. The modeling will also be used to identify how the project could be adapted to respond to larger flow events associated with climate change. Sufficient modeling runs will be conducted to support the development of the Salmon HQT analysis. The hydrodynamic modelers will work through an iterative process with the fisheries biologists conducting the Salmon HQT analysis to be able to identify the project design that would optimize salmon survival. The results of the Salmon HQT analysis will be summarized in a memorandum that will be used to inform the project design.

Relationship to Grant Application Tasks: This task is consistent with Task 3: Conduct Detailed Hydrodynamic Modeling. The modeling is expected to generate the necessary hydrodynamic information that would be necessary to more precisely define the operational parameters of the two gates. Funding allocated to Task 3 in the grant is proposed to be used to generate the following deliverables included in the grant application.

Grant Deliverable: Hydrodynamic Modeling Output Files and Graphics
Salmon HQT Memorandum

5. How will the diversion of water into Elk Slough affect downstream water users?

Elk Slough was historically connected to the Sacramento River as an open channel. Its connection to the Sacramento River was reduced to a small box culvert with the construction of County Road E9. Due to the location of the Slough within the Sacramento River Delta System, it is anticipated that simply returning the Slough's connection to an open channel will not significantly affect water supply deliveries to Central Valley Project (CVP) South of Delta water service contractors and wildlife refuges.

To assess the potential south of Delta water supply impacts of the proposed Elk Slough Project, the results of the water supply impact assessment conducted for the Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project (YBSHRFPP) were reviewed. The YBSHRFPP was selected as a reference project for the Elk Slough Project due to its location within the Sacramento River and Delta (Figure 1).

The YBSHRFPP is being implemented to improve fish passage and increase floodplain rearing habitat in the Yolo Bypass and lower Sacramento River basin. The YBSHRFPP would divert up to approximately 6,000 cubic feet per second (cfs) of water from the Sacramento River, at stages below the current weir crest elevation, into the Yolo Bypass through a new gate structure within the Fremont Weir. The diverted flows would return to the Sacramento River in the vicinity of Rio Vista. The diversions would not occur during the spring and summer months.

Based upon the results of the YBSHRFPP water supply impact assessment, it was concluded that the changes to the State and CVP South of Delta deliveries for monthly and annual long-term and dry and critical year averages would be less than significant. The results are presented in the report titled "Yolo Bypass Salmonid Habitat Restoration & Fish Passage Environmental Impact Statement/Environmental Impact Report Final May 2019."

A hydraulic assessment of Elk Slough was conducted to estimate flows in the slough under varying stages in the Sacramento River. The results are presented in the report titled "DRAFT Reconnaissance Study Elk Slough Flood Control and Habitat Improvement Project Yolo County CA, May 24, 2019." Under Project conditions, flows in Elk Slough were estimated to generally range from approximately 1,000 cfs to 2,000 cfs during the winter. Because the diverted flows are relatively low and would return to the River in essentially the same location as the YBSHRFPP, the Project impacts on winter South of Delta water deliveries would be anticipated to be less than significant as well.

Unlike the YBSHRFPP, flows from the Sacramento River into Elk Slough would occur during the summer months. It's estimated that these flows would generally be on the order of 1,000 cfs. This diversion could affect flows from the Sacramento River into the Cross Canal.

Scope Task: The assessment included in the YBSHRFPP EIS/EIR provides some context for understanding the project’s potential effects on downstream water rights. However, to specifically address concerns raised by state and federal water contractors, an evaluation of the project’s effects on water rights will be conducted. This includes conducting the hydrodynamic modeling necessary to quantify the volume of water that would be diverted into Elk Slough during a variety of flow conditions. Direct engagement with state and federal water contractors will be conducted to ensure the assessment is directly addressing this question. This engagement will occur as part of the community outreach effort identified in the grant application.

Relationship to Grant Application Tasks: This task includes components of Task 2: Define Existing Environmental Conditions, Task 3: Conduct Detailed Hydrodynamic Modeling, and Task 4: Conduct Community Outreach. Task 2 includes evaluating the water rights associated with diverting water into Elk Slough. As part of this evaluation, the downstream effects will necessarily need to be described. Task 3 includes conducting the hydrodynamic modeling that will be necessary to determine how much water would be diverted into Elk Slough during multiple time periods and various seasonal conditions. The hydrodynamic model will also be used characterize changes in water velocities and hydraulic conditions at the head and interior of Elk Slough. Task 4 includes engaging directly with agency representatives to ensure the project meets state and federal objectives, including water supply objectives. Funding allocated to Tasks 2, 3 and 4 in the grant is proposed to be used for these components to generate the following deliverables included in the grant application.

- Grant Deliverable:** Water Rights Memorandum
- Hydrodynamic Modeling Output Files and Graphics
- Formation of a Technical Advisory Committee (TAC)
- Outreach Meeting Agendas and Summaries

Schedule

The schedule of tasks identified in the table below is based on SAFCA authorizing the consultant team to initiate tasks that are outside of the grant application immediately following the Delta Conservancy Board’s decision regarding entering into a grant agreement with Reclamation District 999 at the September 25th Board meeting. The SAFCA funded tasks would continue during the period when the grant agreement is being put into place and following its execution. This schedule assumes a grant agreement would be executed between the Delta Conservancy and RD 999 in January 2020.

Tasks	Date
Form a Technical Advisory Committee	October 2019
Initiate Preparation of Existing Environmental Conditions Report	October 2019
Initiate Hydrodynamic Modeling	November 2019
Complete Salmon Survival White Paper	January 2020
Install Water Quality Monitoring Stations	February 2020
Complete Water Rights Memorandum	March 2020
Complete Hydrodynamic Modeling	April 2020
Complete Salmon HQT Assessment	April 2020
Complete Existing Environmental Conditions Report	Early June, 2020
Present Report and Outreach Findings to Delta Conservancy Staff	July 2020