# WINGS LANDING TIDAL HABITAT RESTORATION PROJECT

*CEQA ADDENDUM*

# APPENDIX B

## Adaptive Management and Monitoring Plan

# WINGS LANDING TIDAL HABITAT RESTORATION PROJECT

## ADAPTIVE MANAGEMENT AND MONITORING PLAN

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## *ACRONYMS & ABBREVIATIONS*

| | |
|---|---|
| AMAT | Adaptive Management Advisory Team |
| AMMP | Adaptive Management and Monitoring Plan |
| Baseline | Pre-Construction Conditions |
| BCDC | San Francisco Bay Conservation and Development Commission |
| BiOps | Biological Opinions |
| CEQA | California Environmental Quality Act |
| CDFW | California Department of Fish and Wildlife |
| CPUE | Catch Per Unit Effort |
| CRAM | California Rapid Assessment Method |
| Cross Berm | A 2,473-foot interior levee that will be converted to an exterior levee |
| DO | Dissolved Oxygen |
| DOM | Dissolved Organic Matter |
| DPS | Distinct Population Segment |
| DSC | Delta Stewardship Council |
| DWR | California Department of Water Resources |
| EAV | Emergent Aquatic Vegetation |
| ESA | Endangered Species Act |
| FAST | Fishery Agency Strategy Team |
| Fish Study | UC Davis Suisun Marsh Fish Study |
| FMWT | Fall Midwater Trawl Survey |
| FRP | Fish Restoration Program |
| FRPA | Fish Restoration Program Agreement |
| IEP | Interagency Ecological Program |
| ITP | Incidental Take Permit |
| Landowner | Wings Landing, LLC. |
| Methods | Sampling Techniques |
| Metrics | Measuring indicators of ecological status and function |
| NRG | Natural Resources Group, Inc. |
| NMFS | National Marine Fisheries Service |
| POD | Pelagic Organism Decline |

## *ACRONYMS & ABBREVIATIONS*

| | |
|---|---|
| POM | Particulate Organic Matter |
| Project | Wings Landing Tidal Habitat Restoration Project |
| Reference Site | Rush Ranch, an existing wetland to be monitored concurrently |
| SAV | Submerged Aquatic Vegetation |
| SFBRWQCB | San Francisco Bay Regional Water Quality Control Board |
| SFCWA | State and Federal Contractors Water Agency |
| SKT | Spring Kodiak Trawl Survey |
| SMHM | Salt Marsh Harvest Mouse |
| SMP | Suisun Marsh Habitat Management, Preservation, and Restoration Plan |
| SOP | Standard Operating Procedures |
| STN | Summer Townet Survey |
| SWP | State Water Project |
| TWM PWT | Tidal Wetland Monitoring Project Work Team |
| Reclamation | U.S. Bureau of Reclamation |
| USACE | United States Army Corps of Engineers |
| USFWS | United States Fish and Wildlife Service |
| WCGC | Walnut Creek Gun Club |
| 20 mm | Delta Smelt 20 mm Survey |

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# 1. PROJECT PURPOSE

The Wings Landing Tidal Habitat Restoration Project (Project or Proposed Project) will restore approximately 243.70 acres of tidal habitat in Solano County, California. All 267.02 acres of the Project Site will be permanently protected, and approximately 17.17 acres of tidal marsh will be enhanced. The Proposed Project is a Fish Restoration Project with DWR and NRG as the Project Proponents. The Proposed Project was originally designed in partial fulfillment of DWR's 8,000-acre tidal habitat restoration obligations contained within Reasonable and Prudent Alternative (RPA) 4 of the 2008 USFWS Biological Opinion (BiOp) on the Coordinated Operations of the Central Valley Project and State Water Project (2008 USFWS BiOp) (USFWS, 2008). The Proposed Project is also expected to benefit migrating and rearing juvenile salmonids, so it is consistent with RPA I.6.1 of the 2009 National Marine Fisheries Service (NMFS) Biological Opinion and Conference Opinion on the Long-Term Operations of the Central Valley Project and State Water Project (2009 NMFS BiOp) (NMFS, 2009). The 2008 USFWS BiOp RPA 4 and 2009 NMFS BiOp RPA I.6.1 were carried forward as baseline conditions in the USFWS Biological Opinion for the Reinitiation of Consultation on the Coordinated Operations of the Central Valley Project and the State Water Project (2019 USFWS BiOp) and the NMFS Biological Opinion on Long Term Operation of the Central Valley Project and the State Water Project (2019 NMFS BiOp), both of which were issued on October 21, 2019. In addition, Section 9.1.1 of the Incidental Take Permit for Long-Term Operation of the State Water Project in the Sacramento-San Joaquin Delta (2081-2019-066-00) (2020 LTO ITP), issued by the California Department of Fish and Wildlife (CDFW) on March 31, 2020, carries forward the 8,000-acre tidal habitat restoration requirement as compensatory mitigation for activities under the 2020 LTO ITP.

Upon construction, the Proposed Project will partially fulfill the Department of Water Resources (DWR) requirement to restore 8,000 acres of intertidal and associated subtidal habitat for Delta Smelt and salmonids and 800 acres of intertidal and associated subtidal wetland habitat in a mesohaline part of the estuary for Longfin Smelt. In September 2001, a Memorandum of Agreement Regarding the Early Implementation of Habitat Projects for the Central Valley Project and State Water Projects Coordinated Operations and Bay Delta Conservation Plan was signed by the USFWS, NMFS, CDFW, DWR, Bureau of Reclamation (Reclamation), and State and Federal Contractors Water Agency (SFCWA) that sets forth a process of identifying and evaluating habitat projects. The Fishery Agency Strategy Team (FAST), comprised of a technical representative from each fishery agency (USFWS, NMFS, Reclamation, and CDFW), was created to review and assist in the planning of the habitat projects and provides guidance to DWR, Reclamation, and SFCWA on the expected benefits of the habitat projects in meeting restoration objectives.

The Proposed Project is consistent with the Suisun Marsh Habitat Management, Preservation, and Restoration Plan (SMP), which provides a comprehensive 30-year plan for management of activities within Suisun Marsh, including tidal restoration activities. The SMP EIS/EIR programmatically evaluated the conversion of 5,000 to 7,000 acres of managed wetlands to tidal marsh over the next 30 years.

The Proposed Project will reconnect the high order marsh-adjacent subtidal channels in Boynton, Peytonia, and Suisun Sloughs to the newly restored tidal and subtidal marsh habitat onsite. It will convert previously inaccessible managed marsh into rearing and food production marsh to benefit Delta Smelt (*Hypomesus transpacificus*), Longfin Smelt (*Spirinchus thaleichthys*), North American Green Sturgeon (*Acipenser medirostris*), and salmonids including Central Valley Distinct Population Segment (DPS) steelhead (*Oncorhynchus mykiss*), Central California coast DPS steelhead (*Oncorhynchus mykiss*), and multiple evolutionarily significant units (ESUs) of Chinook Salmon (*Oncorhynchus tshawytscha*): Sacramento River winter-run, Central Valley spring-run Chinook Salmon, and Central Valley fall-/ late fall-run Chinook Salmon. The restored vegetated marsh will generate substantial detrital production from decaying plant matter and organisms to support a variety of microbes, which provide food for zooplankton as well as macroinvertebrates (Howe and Simenstad, 2011; Schroeter et al., 2015). These invertebrates provide a diverse and plentiful food base for fish such as Delta Smelt, Longfin Smelt, and salmonids. Particle-tracking modeling conducted for the Proposed Project indicates that the food particles generated on the Project Site will have far reaching effects well beyond the Proposed Project's footprint. This expansive impact will improve food availability for fish throughout Suisun Marsh and into Suisun Bay.

## 1.1 Project Goals and Objectives

The Proposed Project goal is to restore unrestricted tidal connectivity to the interior of the Project Site. Tidal connectivity will restore tidal channels and tidal marsh onsite to benefit native fish species.

### *Project Objectives*

1) Create appropriate habitat for salmonids, Delta Smelt, Longfin Smelt, and other native fish species.

2) Enhance available food web productivity for Delta Smelt, Longfin Smelt, and other native fish species within, adjacent to, and in the vicinity of the Project Site.

3) Enhance the quality of habitats to support more special-status and native wildlife that have the potential to occur on and in the vicinity of the Project Site.

4) Avoid promoting conditions, such as invasive species infestations, that are in conflict with the above project objectives.

## 1.2 Project Description

### *Regional Setting*

The Proposed Project is located in the north-central Suisun Marsh one mile south of Suisun City, within Suisun Marsh Plan (SMP) Region 1. The Project Site is surrounded on three sides by water; Peytonia Slough to the north, Suisun Slough to the east, and Boynton Slough to the south. The Project Site is within the ecologically diverse Great Valley Ecological Section (Miles and Goudey, 1997). Regional natural plant communities include annual grasslands, freshwater marshes, and salt marshes. The climate is temperate with mean annual precipitation of 22.68 inches and mean annual

temperatures ranging from a high of 73.4 to a low of 47.4 degrees Fahrenheit (Western Regional Climate Center, 2016).

Delta Smelt, Winter-run Chinook Salmon, and other native fish that inhabit the Suisun Marsh are currently enduring their lowest population numbers in recorded history (Moyle et al., 2014; DWR et al. 2016). Both Delta Smelt and Longfin Smelt have been found in nearby locations within each of the surrounding sloughs, although Delta Smelt have not been detected by the UC Davis Suisun Marsh Fish Study (Fish Study) since December 2015, reflective of their overall rapid decline. Since 1979 the Fish Study has identified 59 Chinook Salmon at monitoring stations near the Proposed Project in Suisun and Boynton Sloughs, and one steelhead was detected in Peytonia Slough in 2002. The Project Site isn't currently accessible to fish, but the sloughs and tidal marsh habitats surrounding the Project Site support the life-history of these fish, and the Proposed Project will increase the amount of, and access to, tidal marsh onsite to greatly benefit the long-term resilience of these species.

The Project Site is within a priority area in the 2008 USFWS BiOp Delta Smelt Crediting Decision Model and is located in Delta Smelt critical habitat as well as Green Sturgeon critical habitat. The Proposed Project is located in an important connective corridor where it will contribute to over 4,000 acres of contiguous protected land, including CDFW's Peytonia Ecological Reserve, CDFW's Hill Slough Wildlife Area, and the Solano Land Trust's Rush Ranch.

Please see the Biological Assessment for more details on regional conditions and Project Site use by special status species.

### *Restoration Actions*

The Project Site is currently owned by Wings Landing, LLC. (Landowner) and is managed as a successful, fully operational duck club with annual memberships. Public access is currently not allowed. Intensive management activities are focused exclusively on improving habitat conditions for resident and migratory waterfowl. Vegetation and water management activities such as mowing, disking, flooding, draining, and contouring are regularly performed to enhance foraging, resting, and breeding opportunities for waterfowl. The north end of the Project Site contains an approximately 19-acre brood pond managed for waterfowl nesting independently from the main marsh. The diked managed wetlands at the Project Site are enclosed by over three miles of levees maintained for water management and contain managed marsh, managed channels, and uplands. The Project Site contains ten water control structures including nine that connect adjacent sloughs to the Project Site, and one that connects the brood pond to the main marsh. These water control structures are used to manage inundation onsite, and are passive, gravity driven structures with no pumps, lifts, or siphons.

Vegetation in the managed marsh is dominated by a community of herbaceous, annual, wetland plants of exotic origin. The marsh is managed to promote waterfowl forage plants such as fat-hen and swamp timothy and to provide waterfowl cover and structural complexity by maintaining small stands of cattail and tules. These are some of the dominant plants in the managed marsh. Rough cocklebur, a target weed is also prevalent in the marsh. The outboard side of the levee experiences conditions most similar to the expected habitat post-restoration. The area between the levee road

and the open water of the surrounding sloughs is densely vegetated with tules, cattails, and common reed. Vegetation at the water's edge consists almost entirely of tules while further up the slope, toward the road, mid-marsh and high-marsh associates are more prevalent. These associates include California rose, cattail, Himalayan blackberry, large leather root, common reed, and Suisun Marsh aster.

The Proposed Project will restore an approximately 267.02-acre managed duck club to a tidally influenced marsh system. Restoration of the Project Site will benefit listed species and the native California tidal marsh ecosystem through habitat protection, creation, and enhancement, and supporting food web productivity. The Proposed Project will create an approximately 243.70-acre net increase in tidal habitat to meet Project objectives and promote natural ecological processes.

The design approach is to capitalize on the Project Site's existing and historic features. As much as possible, the design replicates conditions that were present prior to the Project Site's conversion from historic tidal marsh to managed wetlands for waterfowl management. The constructed dendritic channel system will be representative of natural marsh within the northern Suisun Marsh. The selected channel layout was based on data from historic aerials of the Project Site, reference sites, and relevant literature. This approach is expected to result in a self-sustaining system, as similar to the pre-existing conditions as possible. The Proposed Project was designed to replicate natural conditions by returning full tidal influence to the marsh plain. The existing exterior levees will be breached at five water control structures distributed around the Project Site. These levee breaches will restore natural tidal influence to the interior of the Project Site to meet Objective 1. Five additional water control structures will be removed and the levees backfilled in their place. The Proposed Project was designed to facilitate the natural formation of tidal marsh by directing the newly introduced tidal flows on and off the Project Site as well as increasing bathymetric diversity. The Proposed Project elements, described below, include cross berm improvement, borrow-ditch restoration, channel enhancement, channel creation, channel plugging, tidal depression creation, structure removal, and levee breaching (**Figure 1**).

***Cross Berm Enhancement***

- *Cross Berm Improvement* **–** The interior levee ("cross berm") will be improved and raised in elevation to maintain existing protections for the Walnut Creek Gun Club (WCGC).
- *Borrow-ditch Restoration* – The managed perimeter channel adjacent to the cross berm will be restored to vegetated tidal marsh to reduce tidal pressure including wind and wave action and maintain levee functionality.

***Tidal Channel Restoration***

- *Channel Enhancement* – Certain existing channels will be enhanced to improve water transport to the interior of the Project Site. This will include contouring channels from straight to meandering to increase overall channel length, as well as increase channel complexity to mimic natural tidal channels.
- *Channel Creation* – Channels will be created to maximize tidal action and distribute water to and from the interior of the Project Site.

***Channel Plugs –*** Strategic locations within existing channels will be plugged to direct water into the Project Site's interior and to facilitate flow of water on and offsite.

***Tidal Depressions –*** Seven tidal depressions will be created to increase topographic and bathymetric diversity.

***Structure Removal –*** Five water control structures along the existing exterior levee will be removed and the levee will be backfilled to prevent the need for disturbance from future maintenance.

***Levee Breaches –*** Exterior levees will be breached in five locations by removing water control structures to reintroduce full tidal exchange.

### 1.3 Restoration Potential

Reintroducing natural conditions will create suitable tidal marsh habitat for native fish, wildlife, and plants. Following construction, the 267-acre Project Site will contain approximately: 6.72 acres of restored tidal channel; 0.50 acres of enhanced tidal channel; 236.98 acres of restored tidal marsh; 17.17 acres of enhanced tidal marsh; and 5.65 acres of upland habitat (**Figure 2**). This ecosystem will benefit special status species and will increase food production for export throughout the Suisun Marsh.

Following construction the restored Project Site will undergo a natural conversion to tidal marsh species. Re-introducing tidal influence and eliminating duck club management, which promotes various non-native species, will facilitate the establishment of native tidal marsh vegetation. As vegetation colonizes, the Project Site elevations will likely remain stable and potentially increase through sediment accretion and accumulation of organic matter. These processes will buffer against sea level rise and maintain intertidal elevations for the foreseeable future. Additionally, the anticipated establishment of emergent wetland vegetation throughout the marsh plain will reduce wind and wave action to retain levee functionality of the cross berm.

The final design was selected following an iterative modeling effort. Hydraulic modeling evaluated channel and breach size and geometry to ensure full tidal exchange of the restored marsh with appropriate velocities that will minimize unfavorable conditions (RMA 2018). The Project Site will be allowed to evolve naturally with minimal maintenance. Breached levees will not be maintained and will be allowed to erode, providing that conditions do not affect the Proposed Project's success in meeting the Proposed Project objectives.

## 2. Adaptive Management

### 2.1 Purpose

Adaptive management is a structured approach to environmental management and decision-making in the face of uncertainty. It involves taking risks, assuming that plans may not always turn

out as intended, having a backup plan, and continuing to evaluate progress toward goals. It provides a pathway for undertaking actions when knowledge about a system is incomplete and then modifying the approach as knowledge is gained and uncertainty is reduced. Adaptive management makes learning more efficient and improves management practices.

Adaptive management fosters flexibility in management actions through an explicit process. It entails having clearly stated goals, identifying alternative management practices or objectives, framing hypotheses about ecological causes and effects, systematically monitoring outcomes, learning from the outcomes, sharing information with key players and decision-makers, and being flexible enough to adjust management practices and decisions (see Delta Independent Science Board 2016). Conceptual models often are used in adaptive management programs to integrate available knowledge and to provide synthesis and a means of developing and exploring promising management actions before they are attempted as field experiments or pilot projects.

Adaptive management may reduce uncertainty when management actions are thought of as experiments. By using a structured design that includes appropriate controls (or references), monitoring, and replication, observed outcomes can be disentangled from a welter of potentially confounding factors (Zedler 2005). As a result, one can have a good idea of why a management action did or did not work as expected.

A state or local agency that proposes to undertake a covered action, prior to initiating the implementation of that covered action, is required to submit a written certification to the Delta Stewardship Council, with detailed findings demonstrating that the covered action is consistent with the Delta Plan (Water Code Section 85225).

## 2.2 Use of Best Available Science

This plan is consistent with the *Tidal Wetland Monitoring Framework for the Upper San Francisco Estuary* (hereafter "Framework"; IEP TWM PWT 2017a), which was developed by the Interagency Ecological Program (IEP) Tidal Wetland Monitoring Project Work Team (TWM PWT). As such, this plan is structured around hypotheses that were derived from conceptual models of tidal wetland function with respect to smelt and salmon (Sherman et al. 2017). The theoretical underpinnings of the conceptual models derive from peer-reviewed literature and government reports describing studies throughout the estuary and relevant ecosystems elsewhere. The methods and sampling strategy described are designed to provide data that are comparable across restoration projects and with ongoing regional monitoring surveys. Comparable data from the channels adjacent to the Project Site and a reference site will facilitate Proposed Project monitoring as well as the eventual assessment of restoration program effectiveness. Proposed Project monitoring and adaptive management strategies are subject to adjustment as new information arises. Data comparability and transparency will be maintained throughout the evolution of the Proposed Project and its monitoring period.

Through Proposed Project planning and implementation, DWR commits to utilizing the best available science to design, manage, and monitor the Project Site. Adaptive management of the Proposed Project will be based on the utilization of input from monitoring data in conjunction with adaptive review of whether restoration goals and objectives are being achieved.

The final design was subject to many surveys and models, including hydraulics, sea level rise, species surveys and data investigation, a wetland delineation, geotechnical report, cultural resources report, vegetation surveys, and more. Additional analysis looked at historic aerials of the Project Site, reference sites, and relevant literature to replicate historic conditions onsite to result in a self-sustaining system, as similar to the pre-existing conditions as possible.

Hydraulic investigations included regional and Project-specific modeling to better understand the Proposed Project's influence on velocity, tidal prism, salinity, tidal range, particle tracking, residence time, and water-surface elevation. These initial hydraulic modeling results indicate significant food web benefits, appropriate velocities, minor changes to salinity, and improved tidal prism in surrounding sloughs with minor changes to tidal range.

DWR conducts vegetation monitoring encompassing the Project Site. These data are valuable for informing conditions and potential species presence prior to construction and can track the Project Site's evolution following restoration.

Sea level rise modeling of the Project Site was conducted using the Point Blue Conservation Science Sea Level Rise model (Veloz et al., 2014) analyzing various rates of sea level rise, sedimentation, and organic accretion through 2100. Based on observations of the Project Site's existing tidal marsh and its location within Suisun Marsh, moderate sedimentation and high organic accretion will help the Project Site keep up with rising sea levels in the foreseeable future.

The SMP Adaptive Management Plan called for the formation of an Adaptive Management Advisory Team (AMAT) to help achieve objectives and implement adaptive management, including use of best available science. The AMAT is staffed with technical experts who provide guidance to project proponents and the SMP Principals. The Wings Landing Project design has been presented to the AMAT to hear advice and implement changes as recommended. Through this process, experts from a variety of fields were able to provide feedback and input to improve the Proposed Project prior to permit consultation, ensuring the Proposed Project's success.

## 2.3 Restoration Design and Uncertainties

The Project Site currently endures heavy management to support waterfowl for hunting. The Proposed Project will restore 267 acres of managed marsh, managed perennial and seasonal channels, and uplands to a tidal marsh ecosystem, and will enhance existing tidal marsh surrounding the Project Site. The restoration design strategy is a "less is more" approach, with a focus on returning unfettered tidal action to the Project Site and letting nature take its course. The benefits to this approach include reducing disturbance to animals and plants already inhabiting the site, and minimizing further compaction of soils. Uncertainties include certain aspects of site evolution, including breaches filling in or becoming obstructed, sea level rise, and potential colonization by invasive plants. Monitoring related to these potential issues will be conducted to

inform adaptive management, which will address changes that impact the achievement of Proposed Project objectives. Adaptive management thresholds and potential responses are discussed in Section 5, *Restoration Objectives: Intervention Thresholds and Responses*, and shown in **Table 5** below.

Once the exterior levees onsite are breached, the remaining material between breaches will no longer serve its purpose of water control. Breaches and remnant portions of the exterior levee are expected to remain stable following construction, and may erode and change over time. All remnant levees, with the exception of the cross berm which separates the Project Site from WCGC (**Figure 1**), will no longer require maintenance and will be allowed to naturally erode. Remnant levees will become vegetated with primarily native vegetation due to eliminated duck club management, and will provide upland refugia for terrestrial marsh species. Newly established upland and marsh vegetation will also act to reduce erosion.

Modeling shows that the planned breaches and channels will be sufficient for delivering water throughout the marsh plain on high tides. Existing and constructed channels will change over time through natural hydrologic processes. Vegetation communities will take time to fully stabilize, and the majority of the marsh plain will become tidal marsh vegetated with tules and other native tidal marsh species, similar to the current communities present outboard of the existing exterior levees.

# 3. MONITORING

The Suisun Marsh ecosystem is extremely dynamic on multiple temporal and spatial scales. In the absence of rigorous monitoring, fluctuations in natural populations of native and non-native flora and fauna, as well as variations in the physical environment related to climate and anthropogenic influences, are likely to complicate the assessment of tidal wetland restoration actions. This document outlines a scientifically defensible approach to ascribing changes in habitat and food web characteristics in the vicinity of Wings Landing to restoration actions. Monitoring is an integral component of adaptive management as well. The plan incorporates elements of the Framework (IEP TWM PWT 2017a) and comprises three major components:

- Compliance monitoring – determining whether restoration actions have been completed as planned, including compliance with construction-related permitting requirements.
- Routine effectiveness monitoring – evaluating hypotheses related to the premise that tidal wetland restoration will benefit listed fish species in accordance with Proposed Project objectives.
- Potential special studies – Effectiveness monitoring that is too intensive in terms of time, expertise, and resources for regular implementation, but that would provide detailed information on the mechanisms responsible for wetland physical and ecological processes.

## 3.1 COMPLIANCE MONITORING

The Proposed Project's goal is to partially fulfill the 8,000-acre tidal restoration obligations of the Fish Restoration Program Agreement (FRPA), as credited by the FAST through the Prospectus. The Proposed Project will verify implementation by post-construction monitoring of constructed outputs (acres restored, as-built topography and elevations, and hydrology).

In addition, regulatory permits obtained for constructing the Proposed Project have associated conservation and mitigation measures that require specific monitoring actions to satisfy compliance. These monitoring elements focus on permitting requirements and mitigation measures under the Suisun Marsh Plan and as required by permitting agencies. Permit applications are in the process of being prepared and agency consultation is in progress.

Proposed Project-specific performance standards were developed to track habitat development over time and establish measurable restoration outcomes. By meeting the following performance standards, the Wings Landing Tidal Habitat Restoration Project will be considered successful in terms of creating tidal habitats per requirements of the BiOps.

### *3.1.1 COMPLIANCE MONITORING AND CHECKPOINT SCHEDULE*

DWR and CDFW will monitor the restoration site under this plan for up to 10 years. The monitoring summary and schedule is outlined in **Table 1.** The monitoring schedule is approximate and could be adjusted every year to account for changing environmental conditions (e.g., floods, drought), listed species take authorization, and current status of performance standards.

If remedial activities are required to meet the performance standards, annual monitoring of any remediated habitat will occur for two out of the next five growing seasons or until the performance standards have been met.

*TABLE 1, WINGS LANDING PERFORMANCE STANDARDS MONITORING SCHEDULE*

| Performance Standards Component | | |
|---|---|---|
| | Years Post Breach | Season |
| **Hydrologic Connections** | 1, 3, 5, & 10, Discretionary | Summer, Tidal Regime Year-Round |
| **Invasive Plants** | 1 through 5, every 3 years | Summer or during land management visits |
| **Food Web Productivity** | 1 through 5, Discretionary | Spring, Summer, Fall, Up to Year-Round |
| **Fish** | N/A | N/A |
| **Other Wildlife** | Rails: 2 and 4, every 5 years<br>SMHM: Years 5 & 10 | Nesting season<br>Following vegetation mapping |

### 3.1.2 HYDROLOGIC CONNECTIONS PERFORMANCE STANDARDS

The following performance standards for hydrologic connections will be verified through a combination of photo-point pictures and water stage and flow monitoring (metrics "tidal regime" and "general habitat conditions" in Table 2).

- Pre- and post-breach, year 5, every 5 years: Levee breaches and channels are not blocked by debris, sediment, or by beaver dams in the first 5 years. Any blockage does not severely limit water exchange within the restoration site or the habitat adjacent to it.
- Post-breach, years 1, 3, and 5, then discretionary: Water level inside the restoration site fluctuates in response to the daily tidal regime as shown by a gauge or water level logger inside the restoration site.

### 3.1.3 INVASIVE PLANTS PERFORMANCE STANDARDS

The following performance standards will be used to document establishment of invasive nonnative aquatic plants in the restoration site by using a combination, as appropriate, of photo-point pictures, aerial pictures, GIS mapping, and/or transect surveys across the tidal wetland (metrics "general habitat conditions," "vegetation composition and cover," and "invasive plants" in Table 2).

- Pre- and post-breach, annually, then every 3 years: Highly-invasive, nuisance vegetation is not established in first 5 years to an extent that it poses an ecological threat to the success of restoration goals.
- Pre- and post-breach, annually, then every 3 years: *P. australis* does not invade additional areas in the site. Invasive weed coverage does not increase.

### 3.1.4 *Food Web Productivity Performance Standards*

CDFW will use a combination of sampling methods to collect primary and secondary production data within and adjacent to the restoration site (see Effectiveness Monitoring section for methods; all metrics under the "Food Web" monitoring group in Table 2).

- Pre- and post-breach, years 1-5, then discretionary: Some combination of primary and secondary production is exported from the restoration site or made available during certain times in the tidal cycle in at least 3 of the 6 years. If Delta Smelt take restrictions prohibit monitoring of secondary production in two or more years, this performance standard will be based solely on primary production.

### 3.1.5 *Fish Performance Standards*

Delta Smelt performance standards were not developed for the Proposed Project in order to reduce take of this imperiled species. Delta Smelt are known to occur year-round in the waters surrounding Wings Landing and at the time of writing, their relative abundance was at a historic low (data available http://www.dfg.ca.gov/Delta/data/). Because most fish sampling gear that catches juvenile salmonids can also catch Delta Smelt, performance standards were not developed for juvenile Chinook Salmon, steelhead, or other native fishes.

### 3.1.6 *Other Wildlife Performance Standards*

CDFW and DWR will conduct surveys for native species of concern that may benefit from the Proposed Project as highlighted in the SMP. These species include SMHM and secretive marsh birds (e.g., rails), which are expected to benefit from habitat enhancement resulting from restoration.

- Pre- and post-breach, years 2 and 4, then every 5 years: There is no reduction in detection of rails and other secretive marsh birds.
- Pre- and post-breach, years 5, 10: There is no reduction in habitat for SMHM.

## 3.2 Effectiveness Monitoring

Effectiveness monitoring will track progress towards objectives by measuring indicators of ecological status and function ("metrics") and comparing the measurements to expected or hypothesized outcomes. Sampling techniques ("methods") will include terrestrial surveys of vegetation, hydrologic and water quality monitoring via instrumentation, sampling of aquatic food web components, and sampling of fish presence, where permitted. Measurements of physical and biological components will be used to evaluate the evolution of habitat on the Project Site including tidal channel and marsh morphology, vegetation response (including non-native invasive plants) to

the reconnected tidal influence, habitat component contributions to the food web, and identification of occupied fish habitat.

The effects of restoration on local and regional biological resources will be evaluated relative to pre-construction conditions ("baseline"), concurrent monitoring of an existing wetland (reference site), and conditions in the channels adjacent to the Project Site. To test for differences between areas within Wings Landing, sampling will target multiple habitat types, as shown in **Figure 3**.

Hypotheses applicable to Proposed Project objectives were selected from the Framework and modified to reflect site-specific considerations. Some hypotheses can be addressed within the scope of Proposed Project monitoring or programmatic monitoring, while others require detailed mechanistic studies that would require special studies. Framework hypothesis are sorted by Proposed Project objective and identification codes from the Framework are noted in parentheses.

***Create appropriate habitat for salmonids, Delta Smelt, Longfin Smelt, and other native fish species:***

- The area of substrate and structure suitable for rearing, refuge, and/or adult residence of at-risk fish species on the Project Site will increase after restoration. (P1)
- At risk fish species including Delta Smelt, Longfin Smelt, Chinook Salmon, Green Sturgeon, and steelhead will be present in and adjacent to the restored and enhanced tidal marsh habitat for some portion of their life history, with a frequency similar to, or higher than the existing tidal marsh and adjacent sloughs, and reflecting current population trends. (P4)
- Establishment and growth of aquatic vegetation will influence fish community structure and abundance on the Project Site. (P14)

***Enhance available food web productivity for Delta Smelt, Longfin Smelt, and other native fish species within, adjacent to, and in the vicinity of the restoration site:***

- Pelagic invertebrate (zooplankton) community composition and size structure will change seasonally and affect fish diet. (F4)
- Increased area of tidal marsh will increase the contribution of epiphytic, epibenthic, and drift invertebrates to fish diets relative to appropriate temporal and spatial comparison data. (F5)
- Increased emergent vegetation will increase the contribution of periphyton, detritus, and other marsh-derived carbon to fish diets. (F6)
- Fish on or adjacent to Wings Landing will have higher food consumption, resulting in higher condition and/or growth rate relative to current conditions and similar to appropriate spatial comparison data. (F7)
- Restoration will result in a net increase of primary production (phytoplankton and detritus) and secondary production (zooplankton and other invertebrates) exported from Wings Landing, or at a minimum increase access to productivity by making it available at certain times in the tidal cycle. (F9 and F10)

***Enhance the quality of habitats to support more special status and native wildlife that have the potential to occur on and in the vicinity of Wings Landing:***

- Establishment and growth of aquatic vegetation will result in localized decreases in water velocity, promoting sediment accretion, which in turn will promote more emergent aquatic vegetation (EAV) establishment. (P12)

***Avoid promoting conditions, such as invasive species infestations, that are in conflict with the above Project objectives:***

- Restored tidal marsh will be passively colonized by emergent aquatic vegetation species that are proximate and connected to Wings Landing. (P7)
- Planting, plant propagation method and propagule size, and initial colonizer species will influence vegetation community composition. (P8)

### *3.2.1 Routine Monitoring*

The following sections describe the metrics and methods that may be used in routine monitoring of the Wings Landing Tidal Habitat Restoration Project, subject to the constraints of sampling sites, gear availability, staff availability, and budget. Multiple metrics will be necessary to evaluate each Proposed Project hypothesis, and a given metric may be pertinent to multiple hypotheses. Routine monitoring of the Proposed Project will extend up to ten years after construction under the Fish Restoration Program.

*TABLE 2, WINGS LANDING TIDAL HABITAT RESTORATION PROJECT METRICS AND MONITORING METHODS*

| | | | Sampling Intervals | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Pre-Breach | Post Breach | Years | | | | After | Breach | |
| **Metric** | **Method** | **Time of Year, Frequency** | | | **1** | **2** | **3** | **4** | **5** | **5-10** | **Sites and samples** |
| **Hydrologic Connections, Physical Processes and Hydrology** | | | | | | | | | | | |
| Topography and bathymetry (e.g., channel morphology, pond depths) | Ground-based GPS survey, or LiDAR if available, aerial photos | During summer | X | X | | | | | X | Once Every 5 years | Project area, up to 6 cross-sections including breaches, major channels, marsh plain |
| Tidal Regime | Gauges or water level loggers | All year, automatic measurements (may focus on spring-fall or tidal extremes) | | X | X | | X | | X | D | 1-3 sites (breaches, main channel, marsh plain) |
| **Water Quality** | | | | | | | | | | | |
| Water quality (temperature, EC, turbidity, pH, DO) | Continuous data | Automatic measurements (may focus on spring-fall period) | X | X | X | X | X | X | X | D | Up to 1-3 sites (Permanent, telemetered sonde at Rush Ranch, temporary sondes at various locations within project site) |
| | Discrete seasonal samples | Up to monthly Mar-Nov, winter sampling discretionary (up to 12 sampling events) | X | X | X | X | X | X | X | D | At sonde locations and concurrently with invertebrate sampling. |

| | | | Sampling Intervals | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Pre-Breach | Post Breach | Years | | | | After | Breach | |
| **Metric** | **Method** | **Time of Year, Frequency** | | | **1** | **2** | **3** | **4** | **5** | **5-10** | **Sites and samples** |
| Nutrients ($NH_4$-$PO_4$) | Grab samples, standard methods | Up to monthly Mar-Nov, winter sampling discretionary (up to 12 sampling events) | X | X | X | X | X | X | X | D | Up to 27 sites (12 sites within Wings Landing, 9 sites in Peytonia, Boynton, and Suisun Sloughs, 6 sites in Rush Ranch |
| Particulate organic matter (POM), dissolved organic matter (DOM) | Grab samples, standard methods or FDOM on sonde. | Up to monthly Mar-Nov, winter sampling discretionary (up to 12 sampling events) | X | X | X | X | X | X | X | D | Up to 27 sites (12 sites within Wings Landing, 9 sites in Peytonia, Boynton, and Suisun Sloughs, 6 sites in Rush Ranch |
| **Food Web Productivity** | | | | | | | | | | | |
| Chlorophyll a | Optical sensor (if available); Grab samples | X | X | X | X | X | X | X | Reduced frequency | X | |
| Phytoplankton | Plankton grab samples lab sorting | X | X | X | X | X | X | X | Reduced frequency | X | Up to 27 sites (12 sites within Wings Landing, 9 sites in Peytonia, Boynton, and Suisun Sloughs, 6 sites in Rush Ranch |
| Zooplankton | Mesozooplankton and mysid net trawls, lab sorting | X | X | X | X | X | X | X | Reduced frequency | X | |

| | | | Sampling Intervals | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Pre-Breach | Post Breach | Years | | | | After | Breach | |
| **Metric** | **Method** | **Time of Year, Frequency** | | | **1** | **2** | **3** | **4** | **5** | **5-10** | **Sites and samples** |
| Benthic macroinvertebrates | Benthic grab samples or sediment cores, lab sorting | X | X | X | | X | X | X | Reduced frequency | X | |
| Surface invertebrates | Neuston tow | X | X | X | | X | X | X | Reduced frequency | X | Up to 27 sites (12 sites within Wings Landing, 9 sites in Peytonia, Boynton, and Suisun Sloughs, 6 sites in Rush Ranch |
| Epibenthic/epiphytic macroinvertebrates | Sweep nets | X | X | X | | X | X | X | Reduced frequency | X | |
| **Wetlands and Vegetation** | | | | | | | | | | | |
| General habitat conditions | Photo points (qualitative record) | Annual during growing season (summer) | X | | X | X | X | X | X | Every 5 years | Up to 10 points across site |
| EPA recommended level II assessment (optional) | California Rapid Assessment Method (CRAM) | Once during growing season (summer) | X | | X | | | | X | D | Vegetated marsh plain |
| Vegetation composition and cover | Aerial imagery and other methods consistent with regional monitoring requirements | Monitoring will be coordinated with the triennial marsh-wide vegetation survey effort and include full surveys consistent with SMPA requirements* | X | X | X | | | X | | Year 7 and 10, D | Entire site. |

| | | | Sampling Intervals | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Pre-Breach | Post Breach | Years | | | | After | Breach | |
| **Metric** | **Method** | **Time of Year, Frequency** | | | **1** | **2** | **3** | **4** | **5** | **5-10** | **Sites and samples** |
| Invasive plants | Visual assessment, ground surveys with aerial imagery during triennial marsh-wide surveys | Annual during early growing season or coincident with land-management visits | X | X | X | X | X | X | X | Every 3 years | Assess entire site. Annual checks to continue during qualitative site surveys. |
| **Other Monitoring** | | | | | | | | | | | |
| Salt Marsh Harvest Mouse | Aerial Vegetation surveys | Every 3-5 years | X | X | | | | | X | Every 5 years | Entire site |
| Secretive marsh birds | Currently accepted sampling methods | 3x during survey season, every other year, or as methods specify | X | X | X | | X | | X | Every 5 years | Several points around Wings Landing |

Effectiveness monitoring activities are subject to adaptation. Considerable uncertainty about the response of the ecosystem to tidal wetland restoration is identified in the suite of Tidal Wetland Conceptual Models (chapters in Sherman et al. 2017). Sampling methods, frequency, and/or location may be adjusted. We will not increase the intensity of sampling using any method that could incur take of listed species and that is included in Project Biological Opinions without prior discussion with the appropriate agency (USFWS, NMFS, and/or CDFW).

Where possible, existing data will be leveraged from long-term fish and zooplankton monitoring conducted by various IEP and academic programs (**Table 3, Figure 5**).

***TABLE 3, SUMMARY OF LONG-TERM MONITORING PROGRAMS IN THE DELTA AND SUISUN MARSH THAT FRP MAY USE FOR REGIONAL STATUS AND TRENDS.***

Adapted from the Bay-Delta Conservation Plan public draft**.**

| Monitoring Program | Agency | Primary Purpose and Timeframe |
|---|---|---|
| Environmental Monitoring Program | DWR, CDFW | Monitors water quality, phytoplankton, benthos, microzooplankton, and macrozooplankton. |
| Spring Kodiak Trawl Survey (SKT) | CDFW | Monitors spawning adult Delta Smelt distribution, relative abundance, and reproductive status, January–May, 2002–present. |
| Delta Smelt 20 mm Survey (20 mm) | CDFW | Monitors postlarval-juvenile Delta Smelt distribution and relative abundance, March–June, 1995–present. |
| Summer Townet Survey (STN) | CDFW | Monitors Striped Bass and Delta Smelt abundance indices, June–August, 1959–present. |
| Fall Midwater Trawl Survey (FMWT) | CDFW | Monitors Striped Bass and Delta Smelt abundance indices, September–December, 1967–present. |
| Smelt Larval Study | CDFW | Monitors smelt larval distribution and relative abundance, January–March, 2009–present. |
| San Francisco Bay Study Survey | CDFW | Monitors abundance indices for a variety of species in South San Francisco and Suisun Bays, year-round, 1980–present. |
| Suisun Marsh Fish Community Survey | UC Davis | Monitors abundance of all fish species in Suisun Marsh, year-round, 1979–present. |
| Chipps, Mossdale, and Sacramento Trawl Survey | USFWS | Monitors fish abundance and distribution in mid-channel at surface at Chips Island, Mossdale (RM 54), and Sacramento (RM 55), and survival through the Delta, targets Chinook Salmon, year-round, 1976–present. |

| Monitoring Program | Agency | Primary Purpose and Timeframe |
|---|---|---|
| Delta Juvenile Fish Monitoring Program Beach Seine | USFWS | Monitors fish abundance and distribution throughout the Delta, upstream Sacramento River, northern San Francisco and San Pablo Bays, targets Chinook Salmon, year-round, 1976–present. |
| Chinook Salmon escapement estimates | CDFW, DWR | Collects all life history variants of Chinook Salmon escapement. |

### Hydrologic Connections and Physical Processes

Fish Restoration Program (FRP) wetland restoration projects are being constructed to develop physical habitats suited to native fishes and their food webs. With the return of tidal action via levee breaching and tidal channel restoration, natural processes such as sedimentation, erosion, and vegetation establishment will continually change the wetland complex. These changes may affect wetland productivity (e.g., via changing water residence times; Sommer et al. 2004) and accessibility of fish habitat. Thus it is important to track changes as a site evolves, not only to assess performance of the Proposed Project, but also to inform adaptive management and design of future restoration projects. The following metrics are particularly important in addressing the hypotheses associated with the four Proposed Project objectives, described above under *Project Goals and Objectives*.

### Topography and Bathymetry

Topography and bathymetry of the Project Site will control hydrology within the site, as well as area of available habitat and rates of sediment action. The evolution of bathymetry after restoration is particularly important in understanding fish opportunity to access the Project Site. The baseline topography and bathymetry of the Project Site were described and evaluated in the planning process, and will be re-assessed periodically. If feasible, LIDAR and SONAR surveys will be conducted. Otherwise more traditional elevational survey transects may be used (as described in Roegner et al. 2008).

### Internal Hydrology and Connections

After construction, tidal range within the Project Site will be compared to outside the Project Site to verify restoration of full tidal action. Inundation extent, duration, timing, and frequency are the metrics most directly related to provisioning of wetland habitat for fish (Robinson et al. 2014). The inundation regime is expected to change over time as the bathymetry, hydrology, and sedimentation rate changes during the process of wetland evolution. Water levels will be measured concurrently with water quality at the sites of semi-permanent sondes. Photo points will also aid in documenting tidal range.

### Water Quality

Water quality parameters are as important as the physical structure of the habitat in determining where fish will thrive. Important water quality parameters can change very quickly, requiring precise and targeted monitoring. A combination of temporarily deployed sondes or discrete continuous sondes, water quality transects, and point measurements taken concurrently with other sampling will be used to characterize water quality parameters, including temperature, electrical conductivity, pH, turbidity, and dissolved oxygen. Contaminant monitoring is not planned, but may be conducted as a special study or if other monitoring results indicate need.

### Nutrients and Organic Carbon

Nutrient concentration and form will influence the abundance and community composition of primary producers. Dissolved and particulate organic carbon (DOC and POC) are indicators of the detrital loop. Ten paired water grab samples from breaches and multiple replicates inside and outside the Project Site will be collected up to once per month from March to November. Winter sampling could take place discretionarily, but no more than 12 total sampling events will take place annually. Samples will be used for analysis of all relevant nutrients and carbon species. The methods of DWR's discrete water quality monitoring program will be used (drawn from EPA 600/4-79/020, "Methods for Chemical Analysis of Water and Wastes" (Campisano et al. 2017), and Standard Methods for the Examination of Water and Wastewater (APHA 2017)).

For total nutrients, a 250 mL bottle may be filled with unfiltered water, transported on ice, and frozen as soon as possible. For nitrate, nitrite, ammonia, and orthophosphate, a 250 mL sample may be aspirated through a 0.45 micron nitrocellulose filter and the filtrate would be frozen. An additional 500 mL of filtrate may be collected in a separate bottle for analysis of inorganic anions, chloride, dissolved organic nitrogen, and total dissolved solids and frozen for transport to the laboratory. All nutrients samples would be analyzed by DWR's Bryte Laboratory.

## Food Web Sampling

Tidal wetlands are hypothesized to produce and export phytoplankton and zooplankton resources for the pelagic food web, but it is unclear whether they will provide these benefits in all circumstances (Herbold et al. 2014; Lehman et al. 2010). For example, presence of invasive bivalve grazers (*Potamocorbula amurensis* and *Corbicula fluminea*) may cause tidal restoration areas to become net sinks for zooplankton (Lucas and Thompson 2012). Therefore, benthic and planktonic invertebrates, nutrients, primary productivity, and food web processes will be monitored to determine when and whether tidal wetlands increase resources for fishes. The following metrics most directly relate to the hypotheses under Proposed Project objective 2) "Enhance available food web productivity for Delta Smelt, Longfin Smelt, and other native fish species within, adjacent to, and in the vicinity of the restoration site," though aquatic vegetation mapping also pertains to habitat hypotheses.

### *Phytoplankton*

Phytoplankton productivity in the estuary has experienced declines in quantity and quality over the past 30 years, possibly due to a combination of changing nutrient concentrations and grazing by introduced clams (*Corbicula fluminea* and *Potamocorbula amurensis*) (Baxter et al. 2010 POD

report). Zooplankton that contribute most to fish food resources (large calanoid copepods, mysids) depend on phytoplankton production (Mueller-Solger et al. 2006). However, not all plankton are equally important to the diet of consumers such as the macro and mesozooplankton smelt rely on. Large, nutritionally valuable diatoms are significantly more important to some zooplankton than microflagellates (Mueller-Solger et al. 2006). Cyanobacteria such as *Microcystis* may cause harmful algal blooms that may reduce dissolved oxygen (DO)and release toxins that can kill invertebrates (Lehman et al. 2013) and harm fishes (Baxter et al. 2010). Therefore, phytoplankton will be collected and preserved during fall and spring sampling bouts, and when triggered by potential bloom conditions. Community composition will be identified using the Utermöhl microscopic method by a contracting lab (Utermöhl 1958).

During ecologically relevant time periods, sondes will be deployed to collect continuous chlorophyll-a fluorescence. In addition, at each zooplankton trawling station, field crews will use hand-held sondes to measure chlorophyll fluorescence or take grab samples for laboratory analysis. At a subset of sampling stations, samples will be taken to calibrate fluorescence readings in the lab. Field crews will fill a 1 to 3 L bottle with water, withdraw a 100-500 mL sub-sample and aspirate it through a 47 mm diameter glass fiber filter of 0.3 µm pore size. For phytoplankton community composition, 110 mL of water would be collected, preserved, and dyed with Lugol's iodine solution for storage. All nutrients and chlorophyll samples would be analyzed by DWR's Bryte Laboratory. All phytoplankton community samples would be analyzed by an outside contractor.

### *Zooplankton Sampling*

Planktivorous fishes such as Delta Smelt, Longfin Smelt, and juvenile Striped Bass rely on zooplankton for a large percentage of their diet (Feyrer et al. 2003). However, they preferentially consume large meso- and macro-zooplankton such as calanoid copepods and mysid shrimp. Introduction of several non-native zooplankton to the region such as *Limnoithona tetraspina* (a small cyclopoid copepod with low nutritional value that now dominates the low salinity zone of the estuary) may be competing with larger zooplankters (Gould and Kimmerer 2010). Other introduced species, including the Asian calanoid copepod *Pseudodiaptomus forbesi,* now constitute the most important food source for adult smelt (Slater and Baxter, 2014). Because declines in zooplankton were implicated in the Pelagic Organism Decline (POD) (Baxter et al. 2010), it is important to quantify both the quantity and quality of zooplankton both in the wetland and exported to the surrounding sloughs. The following gears are used to sample pelagic invertebrates; catch per unit effort (CPUE) will be calculated as organisms per volume of water filtered, as measured by a flow meter. (Similar to CDFW IEP zooplankton methods, (Hennessy 2009)). Mesozooplankton, such as Copepoda and Cladocera, will be sampled with a 150 µm mesh net with 15 cm mouth diameter and a 5.9 cm diameter cod end. The net will be towed obliquely or near the surface for five minutes. The net will be rinsed from the outside, and organisms preserved in ethanol or formalin for later identification in the lab.

Mysid nets have been used extensively to characterize water column macrozooplankton that are large components of fish diets (Feyrer et al. 2003; Slater and Baxter 2014). Mysid nets may be mounted to a sled and sampled by trawling across the bottom of the substrate (benthic trawl),

pulled obliquely through the water column, or sampled at the surface of the water, each for five minutes. FRP uses sleds with mysid nets that have a 40 cm by 40 cm mouth and 500 µm mesh that tapers to a 1000 mL, 8.9 cm diameter cod end. When pulling a surface trawl, FRP uses a 50 cm diameter conical net that is 2 m long and tapers to a 1000 mL, 11.5 cm diameter cod end. After retrieval, the net is rinsed from the outside to wash the sample to the cod end. All organisms in the cod end are preserved in ethanol or formalin for later identification in the lab. The mesozooplankton and mysid nets may be attached to the same frame and deployed simultaneously to sample multiple size classes of plankton.

### *Benthic Invertebrates*

Benthic infauna may provide a large proportion of the diet of juvenile fish in shallow water. For example, one study found chironomids (which can spend their larval stage in benthic sediments) make up over 50% of the food biomass for Chinook Salmon in a recently restored tidal wetland (Simenstad et al. 2000), and are an important component of the diet of many other pelagic and littoral fishes in the Delta (Grimaldo et al. 2009). However, invasive bivalves which also reside in the benthos may deplete phytoplankton and cut off subsidy of wetland productivity to the surrounding environment (Baxter et al. 2010 POD report). Decreases in mysid shrimp have been linked to increases in invasive bivalves, and subsequent cascading effects have caused dietary shifts and contributed to population declines of several native fish (Feyrer et al. 2003).

Benthic grab samples will be collected with methods similar to Wetlands Regional Monitoring Program Plan (Lowe 2002) and DWR Environmental Monitoring Program sampling (Wells 2015). In brief, a 0.05 $m^2$ surface area of the benthos will be sampled to a depth of 20 cm at each sampling location. A Ponar grab will be used where a vessel can access the larger channels. The grab is equipped with hinged stainless steel mesh lids with rubber flaps to allow flow through of water during descent and retrieval to minimize disturbance of surface sediments and to trap organisms on the sediment surface. In small channels or vegetated areas, a 10 cm PVC corer will be used to obtain the same surface area and volume of sediment.

At the field wash station, crews will gently wash the sample through the nested 1 mm and 500 µm sieves. Organisms may be identified on board or the cleaned material may be transferred to labeled sample jars and fixed in 70% ethanol.

### *Epifaunal Invertebrates*

Macroinvertebrates associated with vegetation and the bottom of the water column, such as amphipods and insect larvae, are important to salmonid diets (Maier and Simenstad 2009; Sommer et al. 2001), and are a component of Delta Smelt diets when smelt occur in areas of high macrophyte production (Whitley and Bollens 2014). In heavily vegetated areas, trawling and benthic grab samples may be unable to accurately sample the invertebrate community. Therefore, additional samples will be taken to quantify the invertebrate community associated with vegetation.

Sweep nets are used to collect invertebrates that associate closely with a substrate in shallow water; they include a handle attached to a metal ring that supports a tapered net. Sweep nets are

typically pulled by hand through the water just above mud, sand, cobble, or riprap. They can be used to scrape invertebrates off vegetation in emergent vegetation and are used as a method of harvesting submerged aquatic vegetation. Sweep nets can also be used to collect organisms associated with floating aquatic vegetation by placing the net beneath the vegetation and lifting the net from below while severing the connection to surrounding plant material with shears. These nets are d-frame nets, with a 30 cm by 25 cm mouth and 500 µm mesh, tapering to a blind tightly-woven cod-end. The net is inverted and rinsed down to retrieve the sample, which is preserved in 70% ethanol.

### *Terrestrial and Drift Invertebrates*

Emerging insects and Collembola found at the surface of the water are an important feature in salmonid diets, and are commonly sampled using neuston tows and drift nets (Howe et al. 2014; Sommer et al. 2001). The neuston net is a 45 cm x 30 cm rectangular net, 1 m long with 500 µm mesh towed half-way out of the water to sample invertebrates on the surface of the water. The neuston net will be towed at the surface of the water from the side of the boat via a davit or boat-hook. Tows are three to five minutes, depending on fouling. In narrow channels, the net may be pulled along the edge of emergent vegetation by hand (as in Howe et al. 2014). Effort is calculated by surface area sampled. After retrieval, all content collected in a cod end will be preserved in 70% ethanol for later ID.

## Bed/Soil/Substrate Composition

Substrate type is important in determining suitability for benthic communities, fish habitat, and vegetation establishment. It also plays a role in the efficiency of certain sampling gear types. Substrate composition will be estimated from samples collected for other purposes (e.g., benthic samples), and therefore is not included as a separate monitoring activity.

## Channel Length, Width, and Complexity

If feasible, LIDAR and/or aerial photography will be used to map locations of tidal channels with line features in a GIS. The total length of these lines will then be measured and tracked over time to see if the length and width of the tidal channels evolve. Maps of channels, combined with vegetation maps, can be analyzed to determine habitat heterogeneity, length of edge, channel complexity, area of different habitat types, ratio of marsh to open water area, and Shannon-Weiner index of habitat diversity as recommended by the San Francisco Estuary Institute's Delta Landscapes Project (Robinson et al. 2014).

## Vegetation Mapping

The major classes of terrestrial and aquatic vegetation will be mapped across the Project Site before construction, and periodically after construction. Terrestrial vegetation will be characterized using ground surveys, available aerial imagery, and if aerial imagery is inadequate, drones may be flown to capture new data.

If present, submerged aquatic vegetation (SAV), which is poorly characterized by aerial imagery, will be characterized using sonar or rake transects. When possible, a Lowrance sonar will record a

track over beds of aquatic vegetation, and tracks will be processed with BioBase's EcoSound software to convert the sonar tracks to biovolume of SAV (CMAP Inc., https://www.cibiobase.com/). This software converts sonar data to estimates of water column filled with submerged aquatic vegetation. To supplement sonar, or if sonar is infeasible, SAV will be characterized by random samples using a thatch rake. Methods will be consistent with standard procedures developed by the IEP Aquatic Vegetation Project Work Team.

## California Rapid Assessment Method (CRAM) (www.cramwetlands.org)

CRAM is a standard wetland monitoring and assessment tool that is used throughout the state as a validated "level 2" evaluation in the EPA three-tier wetland monitoring framework. This rapid assessment combines considerations of site ecocline position with measures of hydrology, physical structure, and biotic structure and facilitates placing the development, or lack thereof, of a restoring wetland into a landscape context. CRAM results may also be used as factors in statistical models to characterize aquatic community composition. Multiple assessment areas (each ~ 1 hectare) will generally be assessed every 2 to 5 years post-restoration to track restoration trajectory. Comparison with pre-restoration CRAM scores is not appropriate, as wetland type will change with restoration.

## Other Wildlife Surveys

Native species of concern highlighted in the SMP that may benefit from the Proposed Project will be monitored for continued habitat availability and/or presence onsite. Surveys include monitoring for secretive marsh birds and SMHM.

### *Salt Marsh Harvest Mouse*

Salt marsh harvest mouse (*Reithrodontomys raviventris halicoetes*) habitat quality and availability will be assessed at Wings Landing through analysis of vegetation maps. Aerial vegetation surveys will be conducted across the Project Site every three to five years by CDFW and DWR (see Vegetation Composition and Cover). Mapping of vegetation types can inform habitat suitability for SMHM by determining the availability of preferred plant species and habitat types. The onsite area of vegetation types considered high-quality habitat for SMHM will be quantified as percent cover of the Project Site.

### *Secretive Marsh Birds*

CDFW and DWR will sample for secretive marsh birds on the perimeter of Wings Landing, following the accepted sampling methods at the time. Sampling will take place at several points around Wings Landing or as accepted methods dictate. Any secretive marsh bird calls or detections (rails, bitterns, etc.) will be recorded with the estimated distance from the survey point and direction. Surveys will be conducted three times every other year during the survey season.

## Fish Sampling

Though draining and channelization of previously complex Suisun Marsh habitat pre-dates precipitous declines in native species abundances, large-scale loss of suitable habitat may have reduced population resilience to other stressors (Moyle et al. 2010). Restoration of a heterogeneous

wetland complex on Wings Landing may support rearing and/or adult habitat for Delta Smelt, Longfin Smelt, Chinook Salmon, and other native fish.

The UC Davis Suisun Marsh Fish Study ("Fish Study") has been conducting monthly samples since 1979 (O'Rear et al. Unpub.). Both Delta Smelt and Longfin Smelt have been found in nearby locations within each of the surrounding sloughs, although Delta Smelt have not been detected by the Fish Study since December 2015, reflective of their overall rapid decline. Tidal marshes in the Suisun Marsh have recently been recognized as habitats that augment nursery habitat for Delta Smelt by the UC Davis Suisun Marsh Team, indicating that restoration of the Project Site could greatly benefit the species. The Suisun Marsh, including the Project Site, is within designated critical habitat for Delta Smelt. Since the Fish Study began in 1979, 153 Delta Smelt have been detected at the five monitoring stations nearest Wings Landing, with 109 of those observations being immediately adjacent to the Project Site (O'Rear et al. Unpub.). The same survey years and stations detected 522 Longfin Smelt, 216 of which were immediately adjacent to the Project Site. Almost 60 Chinook Salmon have been detected in the sloughs surrounding the Project Site since the beginning of the Fish Study (O'Rear et al. Unpub.). Their presence in the area indicates that they will benefit from restoration, either through increased habitat availability or food production.

Only one steelhead has been detected in the immediate vicinity by the Fish Study, which occurred in Peytonia Slough in 2002 (O'Rear et al. Unpub.). IEP surveys have detected steelhead in lower Montezuma Slough, at sampling locations approximately 3-4 miles south of the Project Site (the IEP does not have sampling locations in closer proximity) (Table 4). Particle tracking models conducted on the Project Site indicate the food resources produced onsite will be transmitted offsite, through the adjacent sloughs, and into areas important for steelhead such as the lower Montezuma Slough region.

*TABLE 4, TOTAL ANNUAL CATCH OF DELTA SMELT AT IEP SURVEY STATIONS PROXIMATE TO WINGS LANDING AND REFERENCE WETLANDS FROM 2011-2016/2018.*

Data downloaded from ftp://ftp.dfg.ca.gov/Delta%20Smelt/ in September 2019.

| | Station | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|---|---|
| **Smelt** | **602** | 0 | 1 | 2 | 0 | 0 | 0 | 1 | 2 |
| **Larval** | **606** | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| **Survey** | **609** | 1 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| **20mm** | **602** | 136 | 6 | 0 | 0 | 0 | 4 | | |
| **Survey** | **606** | 143 | 45 | 19 | 0 | 0 | 1 | | |
| | **609** | 120 | 38 | 79 | 0 | 1 | 4 | | |

Although metrics of fish presence, abundance, diet, growth, and health are central to all of the Proposed Project objectives and hypotheses, the current population estimates of special-status species warrants caution in fish collection. Detailed fish sampling plans for each calendar year will be submitted, by June of the prior year, to the IEP Science Management Team for consideration of inclusion in the IEP Work Plan. Current indicators of population distribution and abundance of

Endangered Species Act (ESA)-listed fish species, geographic and temporal coverage of existing sampling programs, and the significance of the results of additional sampling will be weighed in the development of fish sampling plans and estimates of any resulting take of listed species. Any fish sampling would follow the methods described in IEP TWM PWT (2017b).

### *3.2.2 SPECIAL STUDIES*

Opportunities exist for special studies that require more in-depth investigation than basic monitoring can provide. DWR is open to discussions for studies proposed by prospective researchers that can be incorporated into the monitoring efforts proposed by FRP. Design and implementation of special studies, however, are outside the scope of this monitoring plan and would depend on availability of funding and partners. These studies would ideally be developed with guidance from the Fish Agency Strategy Team and be designed to address unique opportunities provided by the Project Site or identified knowledge gaps related to restoration assumptions, questions, hypotheses, or outcomes. For example, the Project Site has unique opportunities to inform restoration design and habitat quality due to existing straight channels that could be compared with the sinuous, meandering channels that will be created and enhanced onsite. This presents opportunities for studies focused on habitat quality and function within the wetland and its effect on species presence. Another opportunity would be to compare created channels in historic locations to created channels in new locations to investigate differences in their functions. Results of these studies could be used to inform future restoration designs. Examples of potential special studies are below.

#### Flux

A major objective of the Fish Restoration Program is to increase primary and secondary productivity, not only on the Project Site, but also in the surrounding areas. Even if a site is not a net exporter, it may increase access to food by making it available to consumers in the adjacent channels during certain points of the tidal cycle (Lehman et al. 2010). Estimates of the contribution of primary and secondary production from a wetland to the surrounding channels will be made by sampling inside the Project Site in various channel types (enhanced, existing, newly created, and re-created historic), in the channel immediately outside the site, and further down the channel beyond the tidal excursion. Tidal excursion may be estimated via hydrodynamic model results or short-term drifter studies. The difference in concentration of the constituent of interest inside and outside the tidal excursion provides an estimate of wetland contribution.

For a more accurate estimate of nutrients and productivity flux on the site, a load study may be conducted over a relatively short term. This will be similar to DWR's Methylmercury study (DWR 2013) and will only occur if time and resources allow.

#### Fish Diet

Food production that will benefit target fish species is a primary objective of the Fish Restoration Program. Analysis of target species diets will allow us to determine whether fish are able to benefit from any increase in food resources that occur on the site, while analysis of predatory fish diets may allow us to determine whether predators are consuming target species.

Diet analysis may take the form of microscopic identification or genetic analysis of gut contents (currently experimental, most commonly used for searching for particular taxa rather than characterizing diet). If a high proportion of the diet is composed of wetland specialists or life stages particular to wetland habitats (e.g., emergent insects in shallow water vegetated habitat), the fish has likely recently fed on a wetland. Current diet studies on collections from IEP's long-term monitoring may be leveraged for data (Slater and Baxter 2014). Unfortunately, gut contents are digested relatively quickly and cannot be tied to a particular restoration site. Individuals of selected species/life stages should be randomly subsampled for diet analysis from samples collected during routine fish monitoring. Fish should be placed in an individual perforated plastic bag with a unique serial number and preserved in 10% buffered formalin (the head may be preserved separately in ethanol for otolith and genetic analysis). Using a dissecting microscope, laboratory personnel will remove the entire digestive tract for examination of the esophagus and stomach, weigh it, place it on a petri dish, and cut it open. Stomach fullness will be assessed through a ranking system (Volume II, SOP 2.6). All contents will be identified to the lowest possible taxon and measured to the nearest 0.1mm.

Fish utilization of restored wetlands of the Project Site could also be tracked using acoustic tags or PIT tags. This tracking would help reveal the value of the wetland restoration by indicating the extent of use by sensitive species the Proposed Project is targeting. This monitoring would also require analysis of reference sites to compare fish preferences.

### *3.2.3 AVOIDING MONITORING IMPACTS*

Throughout all field activities, monitoring personnel will be trained and take steps to avoid or minimize take (including harassment) of any state or federally ESA listed species. For a list of minimization measures, see *Appendix* A to the Wings Landing CEQA Addendum (ESA and NRG 2019).

Estimated mortality of ESA listed fish species incidental to food web sampling will be calculated using 2016-2017 catch data from Smelt Larval Survey (SLS) station 606, 20mm station 606 (**Table 3**), and 2015-2016 catch data from University of California Davis' Suisun Marsh Study Otter Trawl. Both years' summed monthly catch at each station was divided by the total number of tows to provide an average catch per trawl. The average volume sampled from the SLS, 20mm, and otter trawl were each divided separately within their sampling time frames for the following gear types' average volumes: mesozooplankton, mysid net, neuston net, and sweep net, providing a scaling ratio for each gear type. The scaling ratio was multiplied by the average catch per trawl and then by number of proposed sampling stations, providing an estimate of ESA catch for the mesozooplankton, mysid net, neuston net, and sweep net. All monthly estimated Delta Smelt and Longfin Smelt catches greater than zero were rounded up to the nearest whole number and added together to project ESA take for the year. No other ESA fish were caught by any survey in the specified years and stations, so one winter-run, one spring-run Chinook Salmon, one steelhead, and one Green Sturgeon were conservatively estimated to avoid sampling shutdown due to one fish. Final take estimates will be included in the Project Biological Opinions.

Harassment of Delta Smelt or alteration of their habitat through the placement of equipment (e.g., sondes) or use of sampling gear (e.g., ponar grabs) will be brief and not likely to cause lasting damage. When sampling for invertebrates, any fish that are identifiable in the field will be measured and released alive, if possible.

To minimize the risk of exceeding take estimates, Delta Smelt catches at IEP stations near Wings Landing (606) will be monitored near real-time. If exceptional catches (>30 individuals in a single tow) are recorded at the stations surrounding Wings Landing in the survey prior to a planned sampling event, the event will be postponed until after the next survey. Monitoring personnel will notify the USFWS when take reaches 50% and 90% of annual maximum to discuss options for adaptive management of sampling. Potential actions include cessation of sampling until IEP monitoring shows Delta Smelt have moved out of the area, reduction of monitoring frequency, and modification of gear to result in less harm, injury, or mortality.

# 4 Data and Communication

## 4.1 Data Quality, Management, and Dissemination

Quality assurance / quality control will be implemented as laid out in the Framework. We support adopting the IEP Data Utilization Work Group's recommendations whenever possible to facilitate data sharing and compatibility between agencies, which become particularly important during data federation and synthesis. Standard operating procedures (SOPs) documented in the Framework for all field sampling, laboratory processing, and data entry activities will be used (IEP TWM PWT 2017b). When possible, the SOPs used will be comparable to those of long-term regional monitoring programs to maximize data comparability. Metadata will be documented at all stages of data collection and processing, and stored in standard formats along with the data. A relational database will organize all Proposed Project-related data and metadata. All data manually entered into the database will be cross-checked for transcription errors. Spurious data points will be identified using raw data scatter and box-and-whisker plots, and outliers identified by this method will be dealt with on a case-by-case basis, with full records of any changes. Proposed Project monitoring annual reports will include summaries of all monitoring data, along with any analyses completed to-date. Data, their summaries, and/or reports may also be shared with other researchers and the public via the CDFW FTP site, and one or more wetland inventories or hubs (e.g. BIOS, EcoAtlas, and Estuarine Portal). Data will be shared as soon as reasonably possible after collection, not more than one year after collection. Data, analyses, and interpretation will be presented periodically to the IEP Tidal Wetland Monitoring Project Work Team.

## 4.2 Data Analysis and Project Evaluation

Monitoring metrics will be related to each hypothesis using a variety of established statistical techniques as recommended in the Tidal Wetland Restoration Monitoring Framework. Data will be integrated and compared with IEP long-term monitoring data and any special studies, where applicable. In the annual reports for the Proposed Project, the data will be graphed, summarized,

and any preliminary statistics presented. Many hypotheses and analysis methods will be more appropriate for the Programmatic Monitoring Report, which will synthesize data from all FRP projects.

*Hypothesis:* The area of substrate and structure suitable for rearing, refuge, and/or adult residence of at-risk fish species on the Project Site will increase after restoration. (P1)

> *Analysis:* Maps of pre- and post-restoration topography and bathymetry will be presented, with a table comparing area of different habitat types before and after restoration. The tidal stage inside and outside the restoration site will be graphed over a representative tidal cycle, with calculation of residuals and lag time between the two stages, if applicable.

*Hypothesis:* At risk fish species including Delta Smelt, Longfin Smelt, Chinook Salmon, Green Sturgeon, and steelhead will be present in and adjacent to the restored and enhanced tidal marsh habitat for some portion of their life history, with a frequency similar to, or higher than the existing tidal marsh and adjacent sloughs, and reflecting current population trends. (P4)

> *Analysis:* Without targeted fish sampling, this hypothesis can only be tested through special studies. If there has been fish sampling on the site, fish CPUE will be summarized before and after restoration, and in comparison with reference wetlands and IEP long-term monitoring trends. A more rigorous testing of this hypothesis will be included in the Programmatic Report.

*Hypothesis:* Establishment and growth of aquatic vegetation will influence fish community structure and abundance on the Project Site. (P14)

> *Analysis:* The aquatic vegetation communities onsite will be mapped, and percent invasive vegetation will be graphed in comparison to the reference site. The influence of the vegetation on fish communities will only be testable with special studies.

*Hypothesis:* Pelagic invertebrate (zooplankton) community composition and size structure will change seasonally and affect fish diet. (F4)

> *Analysis:* Zooplankton catch per unit effort, community composition, and size structure will be summarized and compared over time on the site and in comparison to existing studies of zooplankton in surrounding channels. While fish diet analysis requires a special study, the analysis will use existing diet studies to estimate what percentage of the pelagic invertebrate community is commonly found in salmon and Smelt diets. A more rigorous testing of this hypothesis will be included in the Programmatic Report.

*Hypothesis:* Increased area of tidal marsh will increase the contribution of epiphytic, epibenthic, and drift invertebrates to fish diets relative to pre-project conditions, and these levels will be similar to nearby tidal marshes. (F5)

> *Analysis:* Summary statistics and box-plots will be produced for wetland-associated invertebrates (insects, gammarid amphipods, isopods, and other epiphytic and epibenthic invertebrates), comparing abundances before and after restoration, inside and outside the

site, and in comparison to the reference wetland. Detecting changes in fish diets from restoration will require special studies.

*Hypothesis:* Increased emergent vegetation will increase the contribution of periphyton, detritus, and other marsh-derived carbon to fish diets. (F6)

*Analysis:* While fish diet analysis requires a special study, existing diet studies can be used to estimate what percentage of emergent vegetation-derived productivity is commonly found in salmon and Smelt diets. A more rigorous testing of this hypothesis will be included in the Programmatic Report.

*Hypothesis:* Fish on, or adjacent to, Wings Landing will have higher food consumption, resulting in higher condition and/or growth rate relative to current conditions and similar to appropriate spatial comparison data. (F7)

*Analysis:* Without targeted fish sampling, this hypothesis can only be tested through special studies. If there has been fish sampling on the site, fish condition and/or growth rate will be summarized before and after restoration, and in comparison with reference wetlands and IEP long-term monitoring trends. If there have been diet studies on the Project Site or in the region, fish stomach fullness can also be compared before and after restoration. A more rigorous testing of this hypothesis may be included in the Programmatic Report.

*Hypothesis:* Restoration will result in a net increase of primary production (phytoplankton and detritus) and secondary production (zooplankton and other invertebrates) exported from Wings Landing, or at a minimum increase access to productivity by making it available at certain times in the tidal cycle. (F9 and F10)

*Analysis:* Data on catch and concentration of organic carbon, nutrients, phytoplankton, zooplankton, and other invertebrates will be summarized. Comparisons will be made between standing stock inside the site, immediately outside the site, and in channels greater than one tidal excursion from the site to estimate whether the wetland has increased available production in the surrounding area.

*Hypothesis:* Establishment and growth of aquatic vegetation will result in localized decreases in water velocity, promoting sediment accretion, which in turn will promote more EAV establishment. (P12)

*Analysis:* The vegetation communities onsite will be mapped through regional monitoring triennially. Areas with established aquatic vegetation will be monitored over time, tracking vegetation density and growth, and plotting it against velocity and sediment accretion. Over time these data will be analyzed to determine if the areas which saw these conditions demonstrated increased recruitment of aquatic vegetation compared with areas that did not have measurable changes in velocity or sediment accretion.

*Hypothesis:* Restored tidal marsh will be passively colonized by emergent aquatic vegetation species that are proximate and connected to Wings Landing. (P7)

*Analysis:* The vegetation communities onsite and at reference sites will be mapped. The correlation between proximity to vegetation types and community structure can be compared by analyzing nearby and connected vegetation types and monitoring their frequency on the Project Site over time.

*Hypothesis:* Plnt propagation method and propagule size, along with initial colonizer species, will influence vegetation community composition. (P8)

*Analysis:* The vegetation communities onsite will be mapped, and percent invasive vegetation will be graphed in comparison to reference sites. Plant communities that will naturally shift in species composition (areas outside of the direct construction footprint) will be compared with those areas of similar conditions that have been seeded or planted with salvaged marsh vegetation.

## 4.3 Stakeholder Communication and Reporting

Stakeholder involvement, public outreach, and communication of novel information are important components of restoration and adaptive management. The FRP holds planning meetings throughout the planning and design phases of each project with landowners, stakeholders, local agencies, and other restoration teams to exchange information, discuss concerns, and provide input. Monitoring and adaptive management results will be communicated to regulatory agencies through routine meetings and annual reports. Novel information will be disseminated through conferences like the Bay-Delta Science Conference and State of the Estuary Conference as well as through scientific teams such as the Interagency Ecological Program Tidal Wetland Monitoring Project Work Team.

DWR will submit annual project-specific monitoring reports to the resources agencies for the duration of the monitoring program. The monitoring reports shall include:

a. General project information including: project name; applicant name, address, and phone number, consultant name (if applicable), address, and phone number; acres of impact and types of habitat affected; date project construction commenced; indication of monitoring year;
b. Goals and objectives of the project;
c. Monitoring and maintenance dates with information about activities completed and personnel;
d. Summary of all quantitative and qualitative monitoring data;
e. Color copies of a subset of monitoring photographs;
f. Maps identifying monitoring areas, transects, planting zones, etc. as appropriate;
g. A list of success criteria and progress towards meeting them; and
h. Planned remedial action for the coming monitoring period, which must address failures to meet performance.

A final report to cover the entire Wings Landing Tidal Habitat Restoration Project will be prepared at the end of the 10-year monitoring term. More thorough analyses of the effectiveness of the

overall restoration program in meeting the objectives of the 2019 NMFS and USFWS Biological Opinions and the 2020 LTO ITP will be provided in the FRP annual reports.

# 5 RESTORATION OBJECTIVES: INTERVENTION THRESHOLDS AND RESPONSES

While it is not anticipated that major modification to the Project Site will be needed, an objective of this plan is to guide monitoring to identify any thresholds that may compromise the Proposed Project objectives, and to propose potential management responses or further focused monitoring efforts. **Table 5** summarizes the Proposed Project objectives, the expected outcomes related to those objectives, the metrics by which progress towards meeting the objectives is measured, as well as thresholds for undertaking a management response if goals are not being met or problems occur which require intervention. DWR shall consult with the resource agencies before taking any major corrective measures.

***TABLE 5,*** *POTENTIAL WINGS LANDING MANAGEMENT RESPONSES TO DEFICIENCIES IN ACHIEVING OBJECTIVES*

| Objective | Expected Outcome | Monitoring Group | Metric | Target | Intervention Threshold |
|---|---|---|---|---|---|
| **Objective 1** | | | | | |
| Create appropriate rearing habitat for salmonids, Delta Smelt, Longfin Smelt and other native fish species. | Levee breaches and channels would restore tidal exchange within the restoration site. | Physical & Hydrological | Topography, Tidal gauges, Photo-point pictures, | Slough stage and tidal stage in the restoration site shall be reciprocal. Connectivity to the breaches shall evolve with channel formation over time creating more habitat. | Levee breach becomes blocked by debris, sediment, or by beaver dams in first 5 years. Blockage severely limits water exchange within the restoration site or the habitat adjacent to it. |
| | Enhanced tidal exchange would increase primary and secondary productivity at the site and/or adjacent to it. | Food web | Phytoplankton, Zooplankton, Surface invertebrates, Benthic macroinvertebrates. | Increase in abundance of prey beneficial to Delta Smelt, Longfin Smelt, and salmonids shall be made available during certain times in the tidal cycle. | Highly-invasive, nuisance vegetation becomes established in first 5 years such that it poses an ecological threat to the success of restoration goals. |
| **Objective 2** | | | | | |
| Enhance available productivity for salmonids, Delta Smelt, Longfin Smelt, and other native fish species within, adjacent to, and in the vicinity of the restoration site. | Levee breaches would increase intertidal habitat and the exchange of food resources within and adjacent to the site for Delta Smelt, Longfin Smelt, and salmonids. | Food web | Phytoplankton, Zooplankton, Surface invertebrates, Benthic macroinvertebrates. | Increase in abundance of prey beneficial to Delta Smelt, Longfin Smelt, and salmonids shall be made available during certain times in the tidal cycle. | Levee breach becomes blocked by debris, sediment, or by beaver dams in first 5 years. Blockage severely limits water exchange within the restoration site or with the habitat adjacent to it. |
| | | | | | Highly-invasive, nuisance vegetation becomes established in first 5 years such that it poses an ecological threat to the success of restoration goals. |

| Objective | Expected Outcome | Monitoring Group | Metric | Target | Intervention Threshold |
|---|---|---|---|---|---|
| **Objective 3** | | | | | |
| Enhance the quality of habitats to support more special-status wildlife and plants that have the potential to occur on the restoration site. | Tidal restoration would create suitable habitat for secretive marsh birds. | Other monitoring | Secretive Marsh Birds | Shall try to maintain secretive marsh bird detections. | N/A |
| | Tidal restoration would not cause the SMHM population to decline. | Other monitoring | Aerial Vegetation surveys | Shall try to maintain long-term availability in SMHM habitat. | N/A |
| | Tidal restoration would create suitable habitat for special-status plants | Other monitoring | Aerial Vegetation surveys | Shall try to maintain habitat for special-status plants | N/A |
| **Objective 4** | | | | | |
| Avoid promoting conditions, such as invasive species infestations, that are in conflict with the above project objectives. | Invasive species composition and spread is reduced as much as possible. | Vegetation | Aerial imagery, site visit | Shall try to limit Invasive weeds coverage to less than 5% of the site. | *P. australis* invades previously *P. australis* free areas in the site. Invasive weed coverage increases. |

# 6 RESPONSIBLE PARTIES

The Project Site is currently owned by Wings Landing LLC, an affiliate of Natural Resources Group, Inc. (NRG). Ownership will be transferred to DWR prior to construction, and DWR will be the party responsible for ensuring execution of the management and certain monitoring of the site. Management activities are outlined in the Long Term Management Plan, and specific monitoring activities are described below in **Table 6**. DWR is responsible for ensuring management and monitoring activities are completed, maintaining records, reporting, and coordinating and approving any research activities proposed on the Project Site. DWR will plan, permit if necessary, and execute any potential management actions deemed necessary in consultation with the FAST, as described above.

Various groups within CDFW and DWR, as well as qualified consultants are responsible for specialized monitoring as described in this plan. The monitoring biologists shall be familiar with wetland biology and have knowledge relative to monitoring protocols, management techniques, endangered species needs, and fisheries ecology. Significant personnel changes will be noted in annual reports to the FAST.

## 6.1 RESOURCES TO IMPLEMENT MONITORING AND ADAPTIVE MANAGEMENT

The FRP is funded in whole by DWR through State Water Project (SWP) funding to meet permit compliance for SWP operations. The Proposed Project is a DWR FRPA Project, therefore, funding for full implementation of the action, maintenance activities, and monitoring is guaranteed in perpetuity. The FRP has both an annual program budget and individual project budget. Plans for individual projects include DWR funding sufficient to accomplish full implementation of the action.

The long-term costs for implementation of individual actions would be directly funded by DWR in lieu of endowment funding since DWR is able to provide adequate funding assurances into the future based on DWR's long-term SWP water supply contracts. Pursuant to the Burns-Porter Act, DWR is authorized to use SWP revenue without annual approval by the State Legislature to pay the operations and maintenance of the SWP (Water Code Section 12937(b)). This revenue is not appropriated under the annual State budget process. Costs incurred to pay for the long-term operations and maintenance of fish and wildlife mitigation areas for SWP activities are considered SWP maintenance and operations obligations, included within the first priority before payment of other SWP obligations.

In addition, DWR has a strong AA bond rating and is in a good financial position to make any on-going payments for mitigation purposes. DWR's SWP contractors also have strong credit ratings, which provide additional assurances of DWR's ability to make on-going payments for fish and wildlife mitigation purposes required by FRPA. DWR has notified the SWP contractors of the mitigation costs estimated by FRPA for compliance with the Biological Opinions and ITP, which is now being included in annual charges to the SWP contractors.

*TABLE 6, PARTIES RESPONSIBLE FOR SPECIFIC MONITORING AND ADAPTIVE MANAGEMENT TASKS*

| Task | Method | Responsible Party |
|---|---|---|
| **Physical Processes Monitoring** | | |
| Topography and Bathymetry | Ground-based GPS survey, or LIDAR if available, aerial photos | DWR |
| Tidal Regime | Gauges or water level loggers | DWR |
| **Water Quality Monitoring** | | |
| Water quality (temperature, EC, turbidity, pH, DO) | Sonde and/or discrete measurements | CDFW – FRP Monitoring |
| Nutrients | Grab samples, standard lab methods | CDFW – FRP Monitoring and contracting lab |
| Particulate and Dissolved Organic Matter | Grab samples, standard lab methods | CDFW – FRP Monitoring and contracting lab |
| Contaminants | TBD- Would occur if other monitoring indicates need | DWR and consultants |
| **Food Web Productivity Monitoring** | | |
| Chlorophyll a | Optical sensor, grab samples | CDFW – FRP Monitoring and contracting lab |
| Phytoplankton | Grab samples | CDFW – FRP Monitoring and contracting lab |
| Zooplankton | Zooplankton net trawls | CDFW – FRP Monitoring |
| Benthic macroinvertebrates | Benthic grabs or cores | CDFW – FRP Monitoring |
| Surface invertebrates | Neuston tows | CDFW – FRP Monitoring |
| Epibenthic/epiphytic macroinvertebrates | Sweep nets | CDFW – FRP Monitoring |
| **Wetlands and vegetation** | | |
| General habitat conditions | Photo-points | CDFW – FRP Monitoring |

| Task | Method | Responsible Party |
|---|---|---|
| EPA recommended level II assessment | CRAM | CDFW – FRP Monitoring |
| Vegetation composition and Cover | CDFW protocols, rake for SAV | DWR and CDFW – FRP Implementation |
| Invasive plants | Visual surveys (aerial and ground) | CDFW – FRP Implementation and Monitoring |
| **ESA-listed wildlife** | | |
| Salt Marsh Harvest Mouse | Aerial vegetation survey analysis | DWR and CDFW Suisun Marsh Group |
| Ridgway's Rail | Acoustic Surveys or accepted marsh-wide protocols | DWR and CDFW Suisun Marsh Group |
| **Adaptive Management** | | |
| Planning and Permitting | | DWR |
| Construction | | DWR |
| Monitoring | | CDFW – FRP Monitoring |
| Annual Report | | DWR, with assistance from CDFW |
| Maintenance and General Inspections | | DWR, CDFW FRP Implementation |

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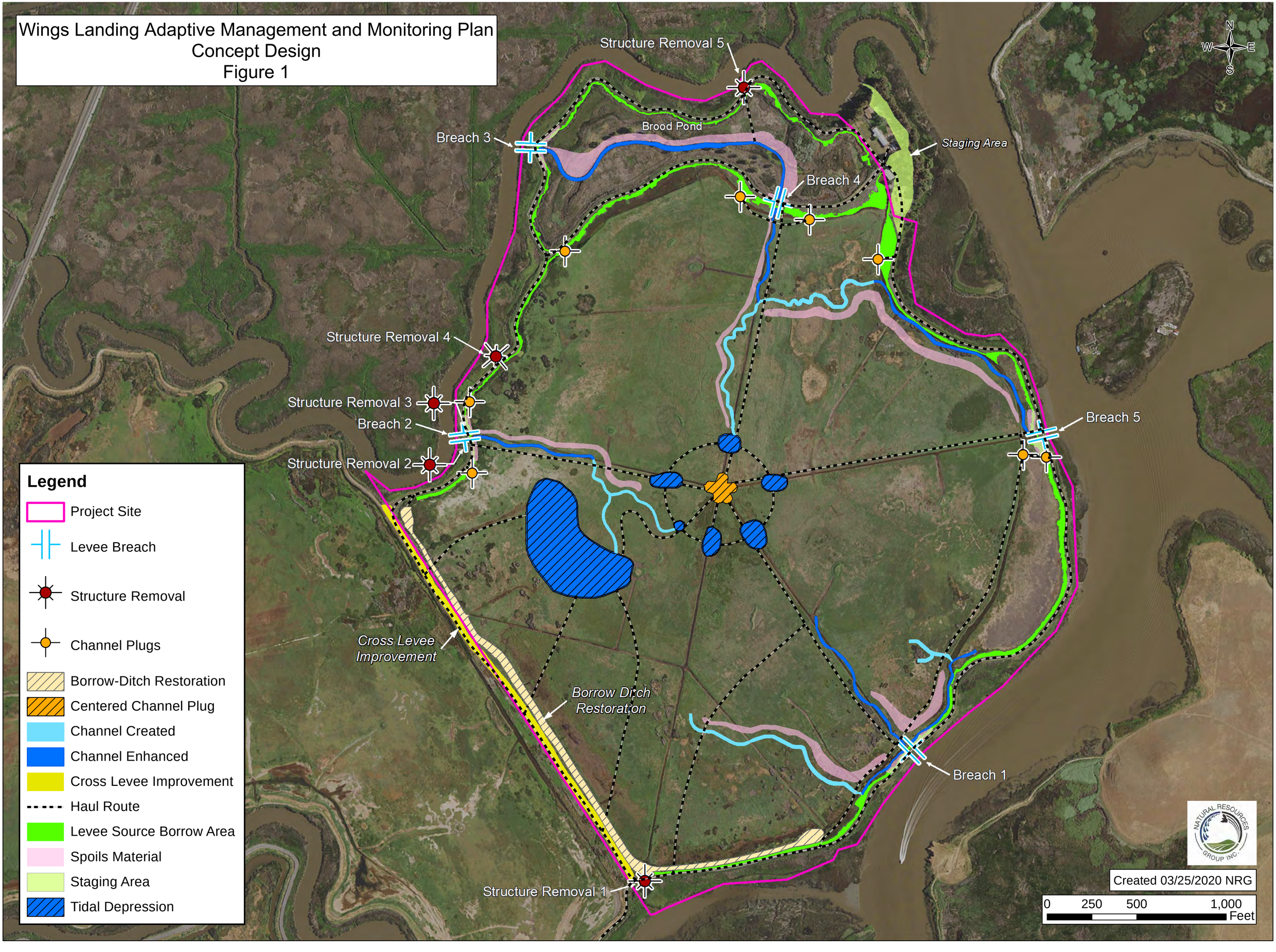
# Wings Landing Adaptive Management and Monitoring Plan
# Concept Design
# Figure 1



# Wings Landing Adaptive Management and Monitoring Plan
## Restored Habitats
## Figure 2

| Habitat Classification | Existing | Change | Future |
|---|---|---|---|
| Managed Marsh | 229.42 | -229.42 | 0.00 |
| Managed Perennial Channel | 3.11 | -3.11 | 0.00 |
| Managed Seasonal Channel | 2.33 | -2.33 | 0.00 |
| Restored Tidal Channel | 0.00 | 6.72 | 6.72 |
| Enhanced Tidal Channel | 0.42 | 0.08 | 0.50 |
| Restored Tidal Marsh (interior of levees) | 0.00 | 236.98 | 236.98 |
| Enhanced Tidal Marsh (exterior of levees) | 17.25 | -0.08 | 17.17 |
| Upland | 14.49 | -8.84 | 5.65 |
| Total | 267.02 | 0.00 | 267.02 |

**Legend**

- Project Site
- Restored Tidal Channel - 6.72 acres
- Enhanced Tidal Channel - 0.50 acres
- Tidal Marsh (Restored) - 236.98 acres
- Tidal Marsh (Enhanced) - 17.17 acres
- Upland - 5.65 acres

N
W E
S

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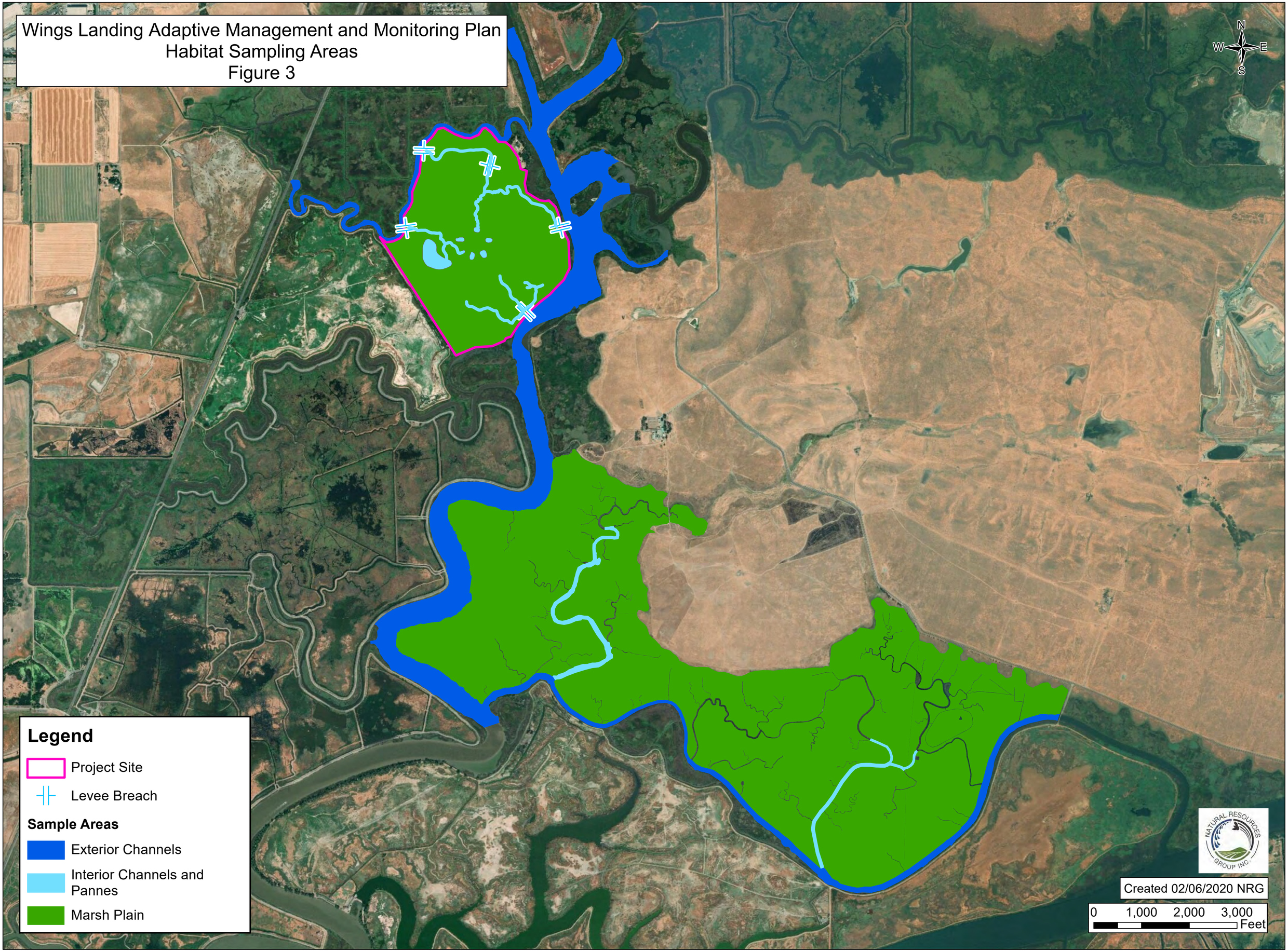
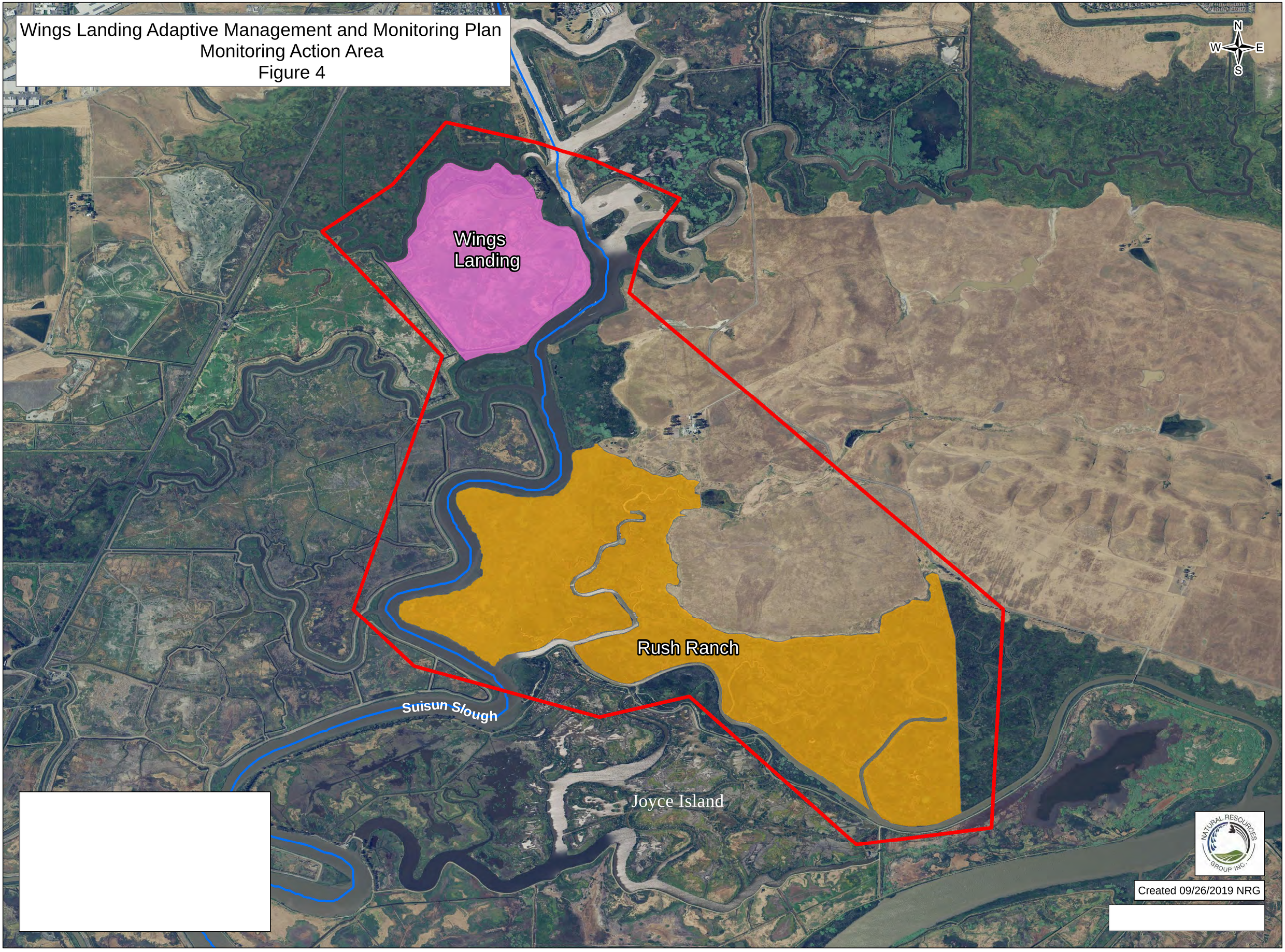
0 250 500 1,000
Feet

# Wings Landing Adaptive Management and Monitoring Plan
## Habitat Sampling Areas
## Figure 3



Wings Landing Adaptive Management and Monitoring Plan
Monitoring Action Area
Figure 4

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# Wings Landing Adaptive Management and Monitoring Plan
## Fish Study Locations
## Figure 5