

Final Report

Completing the Core Objectives of the Moro Cojo Slough Management and Enhancement Plan



Proposition 1:
The Water Quality, Supply, and Infrastructure Improvement Fund Bond Act of 2014

GRANT AGREEMENT BETWEEN:
OCEAN PROTECTION COUNCIL & COASTAL CONSERVATION AND RESEARCH, INC.
AGREEMENT NUMBER: P0-1-05

MARCH 2023

Report Written by Central Coast Wetlands Group at Moss Landing Marine Labs



Project Summary

In December 2014, an emergency situation occurred when the tide gate structure at Moss Landing Harbor that manages saltwater mixing within the Moro Cojo State Marine Reserve failed, threatening twenty years of restoration efforts. This catastrophic failure allowed saltwater to flood brackish and fresh water portions of the system, and threatened many special status species, including the tidewater goby (*Eucyclogobius newberryi*), California brackish water snail (*Tryonia imitator*), the Santa Cruz long-toed salamanders (*Ambystoma macrodactylum croceum*), California tiger salamanders (*Ambystoma californiense*), and California red-legged frogs (*Rana aurora draytonii*). All of these species are threatened with extirpation from the estuary if the tide gates are not repaired and operated properly. Reestablishing proper mixing however is technically problematic because data depicting tidal mixing supported by the old, malfunctioning gates are limited. The County requested technical guidance by researchers at CCWG/Moss Landing Marine Labs and its partners to prescribe the proper tidal regime necessary to reestablish tidal mixing characteristics and protect special status species.

This project drafted a long term tide gate management strategy, designed and constructed the upstream tidal management weir to protect freshwater habitat from inundation, transferred ownership of the last private parcel within the estuarine portion of the Moro Cojo Slough to Elkhorn Slough Foundation, restored that property to a functioning marsh, coordinated management of the numerous estuarine restoration and conservation projects and establish a transitional ecotone surrounding the estuary to accommodate adaptation to sea level rise.

Introduction to the Watershed

The Moro Cojo Slough Watershed is a region located in central California, USA, encompassing over 40 square miles of land and water resources. The watershed is home to diverse habitats and wildlife, including several endangered species (Figure 1).

The area has a rich history, with indigenous peoples residing in the area for thousands of years prior to European settlement. The indigenous people utilized the natural resources of the watershed for food, medicine, and materials for their daily lives.

In the late 19th and early 20th centuries, the Moro Cojo Slough Watershed underwent significant changes as a result of European settlement and land use practices. The area was converted into agricultural land, with many wetlands and streams drained for crops and livestock. The construction of roads and other infrastructure disrupted the natural hydrology of the region, leading to further degradation of the watershed.

More recently, the Moro Cojo Slough Watershed has become the focus of conservation efforts, with multiple organizations and agencies working to preserve and protect the natural resources of the region. These efforts include ongoing habitat restoration projects, as well as efforts to educate the public about the importance of preserving the watershed for future generations.

The *Moro Cojo Slough Management and Enhancement Plan* was drafted in 1996 to drive restoration efforts within the estuary and watershed, protect threatened species and manage the resource in concert with adjacent land uses. The Moro Cojo Plan was adopted as a portion of the Monterey County Local Coastal Plan and Central Coast Wetlands Group (CCWG) staff at Moss Landing Marine Labs, in collaboration with Coastal Conservation and Research (CCR), have led efforts to implement the Moro Cojo Plan since its drafting.

CCWG and CCR have restored more than 100 acres of estuarine and freshwater wetlands, documented improvements to water quality from these restoration projects and acted as a technical resource to Monterey County. Now, twenty years after its original drafting, CCWG and its partners including CCR, Monterey County, RCD of Monterey County, the Greater Monterey IRWMP, Elkhorn Slough Foundation, farmers, and various resource agency staff are partnering to finalize implementation of the Moro Cojo Plan and ensure long-term management of the system is preserved.

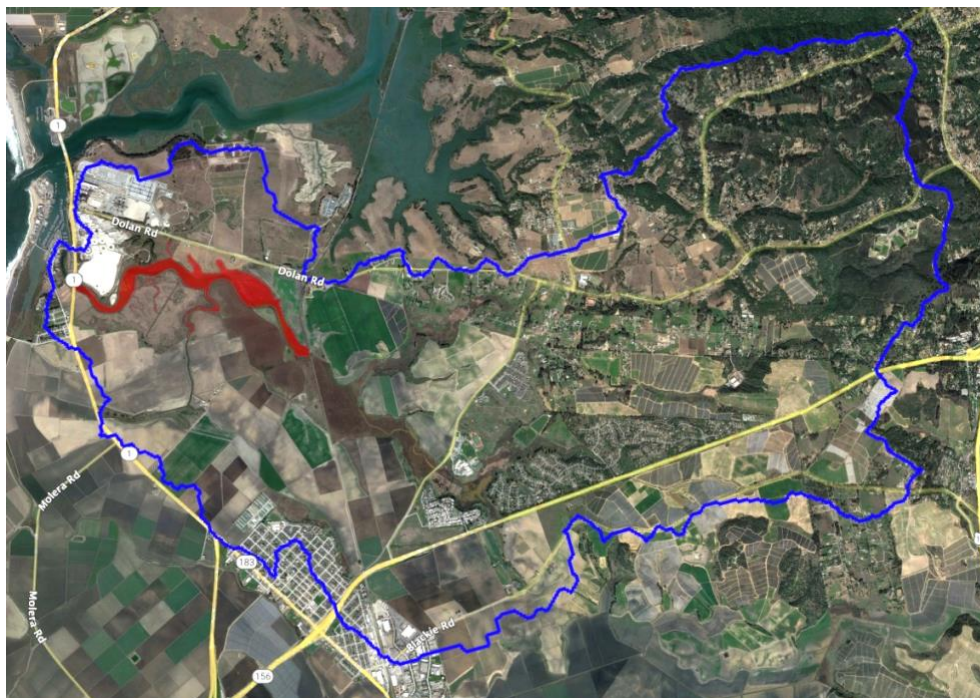


Figure 1. Moro Cojo Slough watershed (blue outline), located at the center of the Monterey Bay shoreline, with the Moro Cojo Slough State Marine Reserve shown in red.

Project Task Descriptions, Results, and Deliverables

Task 1. Project Administration and Reporting

Description: Regularly monitor progress and success of each project task, manage grant funds, subcontracts and deliverables, provide quarterly written updates to the State Project Manager, and submit a final report upon project completion.

Results: Over the course of six years the project team submitted 25 quarterly reports, an ArcGIS StoryMap, and this final report to the State Project Managers, of which this project had several. In addition, two grant amendments were completed, in both cases extending the completion date.

Grant funds were managed in an effective manner allowing for completion of all tasks and deliverables described in the work plan. All task deliverables have been made available to the State Project Manager via a shared google drive. The google drive folder is organized by tasks, allowing for easy access to task-specific deliverables.

Deliverables submitted to OPC: Twenty-five quarterly progress reports, an ArcGIS StoryMap reviewing the Moro Cojo Slough Management and Enhancement, and a final report.

Task 2. Moro Cojo Technical Advisory Committee

Description: Reestablished the Moro Cojo technical advisory committee (TAC) and host a minimum of three meetings with stakeholders, landowners, resource managers and Monterey County staff.

Results: The Moro Cojo Technical Advisory (Table 1) was reconvened in June 2017 when the first meeting occurred as part of this project. During the meeting the following was covered:

- Define TAC goals and objectives
- Outline TAC procedures with regard to prioritization of issues, and the process for evaluation of data and making recommendations
- Provide background on previous projects and success of existing implementation of the Moro Cojo Management and Enhancement Plan goals and objectives
- Provide a status update on salinity/freshwater in the Moro Cojo following the initial failure and subsequent repair of the tide gates that restrict saltwater flow into the Moro Cojo watershed.
- Provide a status update on current and future monitoring of water quality parameters and salinity.

The first meeting set the stage for the following 5 meetings and 2 subcommittee meetings that took place over the course of the project. The TAC served as a reliable and objective group for input on decisions and review of materials for this project.

The TAC will continue to operate as staff at CCWG finalize the Long-term Management Plan over the course of the next few months and work through adoption by Monterey County.

Table 1. Moro Cojo Slough Technical Advisory Committee Members

FIRST	LAST	ORGANIZATION	EMAIL
James	Oakden	CC&R	joakden@gmail.com
Ross	Cark	CCWG-MLML	ross.clark@sjsu.edu
Kevin	O'Connor	CCWG-MLML	kevin.oconnor@sjsu.edu
Dave	Feliz	CDFW	dave.feliz@wildlife.ca.gov
Sara	Worden	CDFW	sara.worden@wildlife.ca.gov
John	Olson	CSUMB	joolson@csumb.edu
Doug	Smith	CSUMB	douglas_smith@csumb.edu
Suzanne	Worcester	CSUMB	sworcester@csumb.edu
Dash	Dunkell	ESF	dash@elkhornslough.org
Mark	Silberstein	ESF	marksilberstein@elkhornslough.org
Monique	Fountain	ESNERR	monique@elkhornslough.org
Kerstin	Wasson	ESNERR	kerstin.wasson@gmail.com
Robert	Burton	Independent	rburton@csumb.edu
Tom	Connolly	MLML	thomas.p.connolly@sjsu.edu
Melanie	Beretti	Monterey County	berettim@co.monterey.ca.us
Mark	Foxworthy	Monterey County WRA	foxworthyme1@co.monterey.ca.us
Alex	Henson	Monterey County WRA	hensona@co.monterey.ca.us
Maria	Rodriguez	OPC	maria.rodriguez@resources.ca.gov
Kelli	Camera	Santa Cruz County RCD	kcamara@rcdsantacruz.org
Gage	Dayton	UCSC	ghdayton@ucsc.edu
Amanda	Canepa	USFWS	amanda.canepa@wildlife.ca.gov
Lilian	Carswell	USFWS	lilian_carswell@fws.gov
Chad	Mitcham	USFWS	chad_mitcham@fws.gov
Mark	Ogonowski	USFWS	mark_ogonowski@fws.gov

Deliverables submitted to OPC: Agendas, meeting notes, and presentations from six TAC meetings and two focused TAC subcommittee meetings.

Task 3. Hydrological and Salinity Data Collection and Flow and Nutrient Modeling

Task 3.1. Watershed Flow and Water Quality Modeling

Description: Deploy salinity/water quality and flow gauging stations within the Moro Cojo Slough system. Sites include one location upstream of the harbor adjacent to the tide gates and one on each of the three primary sub-drainages within the watershed. Flow monitoring will continue throughout the project period and continue periodically after the end of this project (with support from MLML researchers and students) to ensure that the tidal exchange parameters are met and sustained.

Results: CCWG deployed and maintained a multi-parameter sampling array (Moro Cojo Slough Quality Under Intense Real Time Sampling-MCSQUIRTS) within the Moro Cojo Slough near HWY 1 (Figure 2)¹. The sampling array collects temperature, salinity, nitrate concentration, oxygen saturation, and water discharge. It also calculates nutrient loading into or out of the Moro Cojo slough in kilograms per hour (Figure 3).

In addition, CCWG staff conducted monthly salinity transects along the length of the main channel of the Moro Cojo Slough, from HWY 1 in the west to Castroville Blvd. in the east. Measurements were taken at the surface and bottom. Constituents include temperature, conductivity, total dissolved solids, salinity, dissolved oxygen and pH. Additional water quality samples were collected throughout the watershed to assist in modelling nutrient flow.

CCWG worked with a MLML student to model water quality, salinity and water elevation in the slough using the data collected over the course of the project. The student deployed additional dissolved oxygen sensors at several locations up the slough to assist in modeling efforts.

¹ <http://pubdata.mlml.calstate.edu/mcsquirts/index.php>

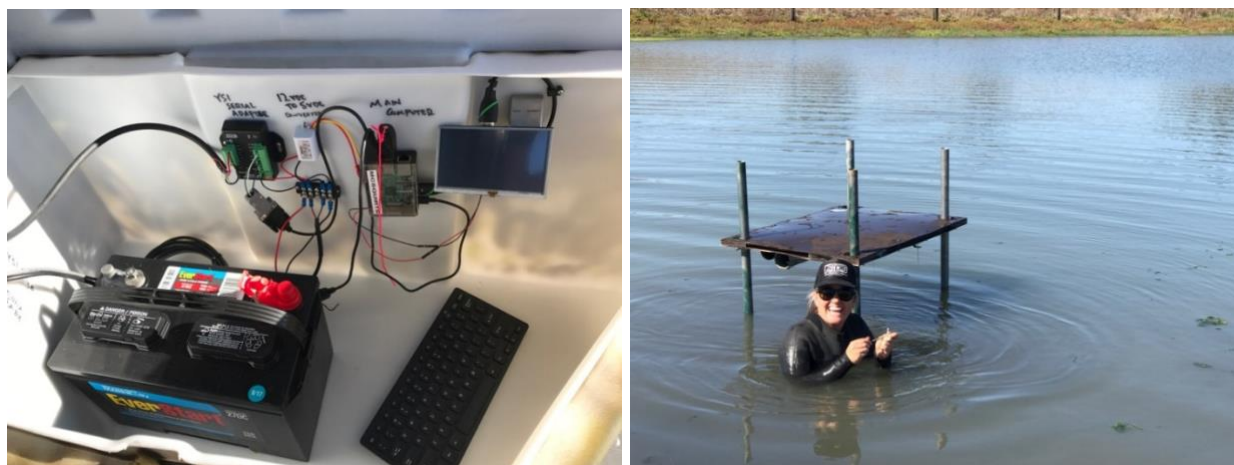


Figure 2. MCSQURTS monitoring array in the Moro Cojo Slough

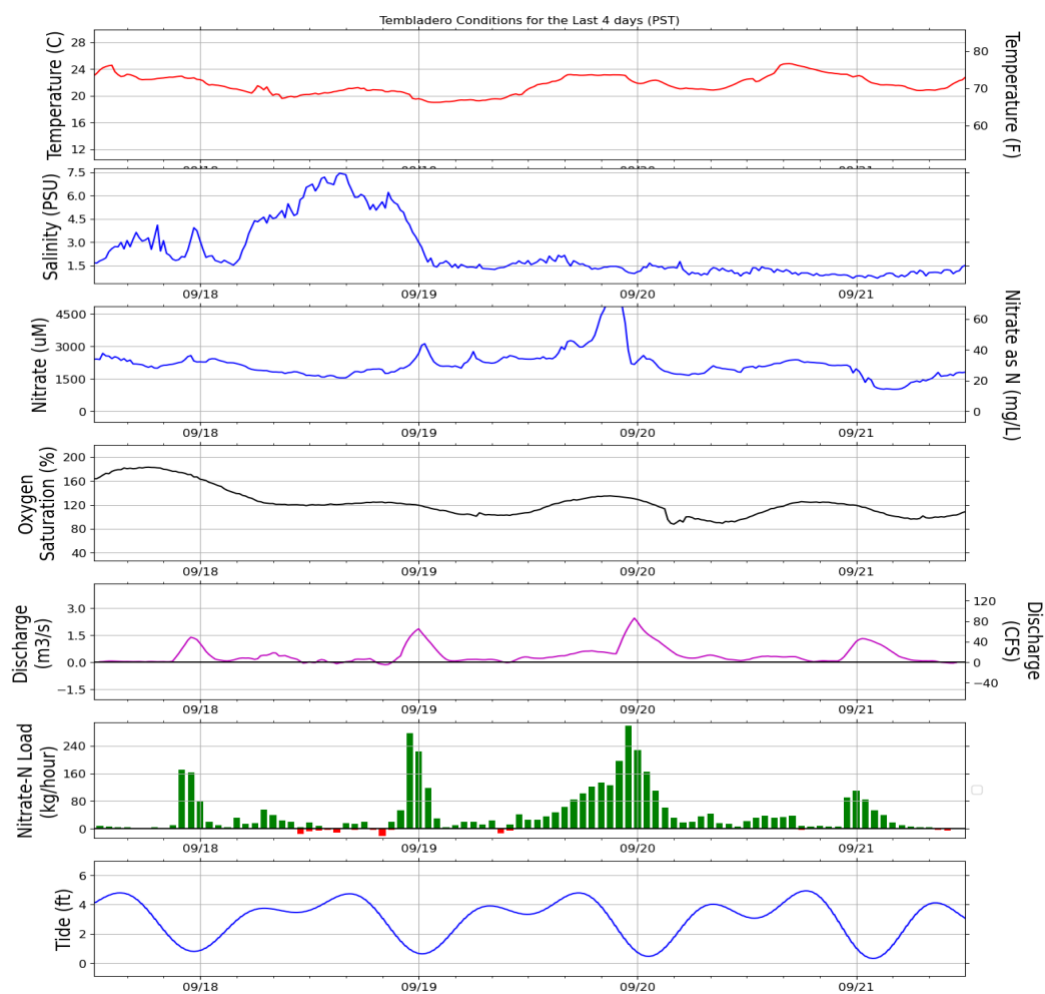


Figure 3. Example output of the MCSQURTS monitoring array in the Moro Cojo Slough

Deliverables submitted to OPC: MLML Student presentations on watershed flow and water quality modeling, Water Quality Monitoring data submitted to CEDEN

Task 3.2. Hydraulic Exchange and Salinity Gradient Determination

Description: Establish new tide gate hydraulic settings using historical data, current tidal exchange conditions, water quality, freshwater flows and freshwater wetland storage to define a preferred seasonal salinity gradient and tidal exchange condition and ensure that this condition is reestablished by the County. Considerations of watershed processes (fluvial inputs), tidal action, distribution and abundance of special status species will all be integrated to establish a set of agreed upon tide gate hydraulic exchange parameters that the County will adhere to.

Results: Data collected as part of Task 3.1 and the associated analysis resulted in several tech memos that were drafted by MLML faculty member Tom Connolly describing the watershed model results and confirming the validity of the model that was developed (Figure 4).

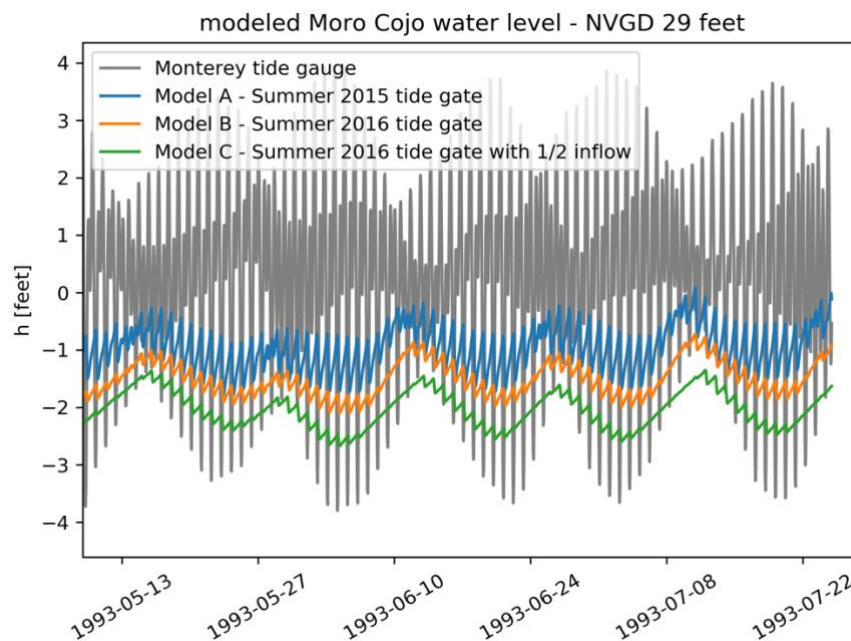


Figure 4. Example Moro Cojo Slough watershed flow model output comparing the (A) broken tide gate condition to (B) the repaired condition to (C) a hypothetical $\frac{1}{2}$ water inflow condition

Deliverables submitted to OPC: Report on the Effects of Tidal Management on Salinity and Nutrient Concentrations in a Low-Flow Estuary, Moro Cojo Water Level Model Results and Analysis (January 2019 and April 2019), Moro Cojo Salinity Monitoring Summary (2005-2017, CSUMB Class ENVS660 Fall 2015-observations of seawater intrusion in surface waters of the Moro Cojo Watershed, Moro Cojo Salinity Survey summary presentation.

Task 3.3. Data Analysis and summary

Description: Draft a synthesis document that recommends management parameters of the tide gates. Flow rate and tidal range monitored and reported to the TAC and County to support enhanced tide gate operations.

Results: Data and results from Tasks 3.1 and 3.2 resulted in a report which includes the assumptions, results, and discussion for an adapted water level model created to estimate water level in Moro Cojo Slough (MCS) in response to the tide gate's orifice sizing. Two sets of 6-month periods (May-October) for the years 2018 and 2019 were used for the construction of the model. This model used a piecewise linear regression approach to relate water level difference (between Moss Landing Harbor and MCS) and discharge rates (Q) to water level response in MCS. These model outputs were transferred to Monterey County to inform repairs to the Moro Cojo Slough culverts and tide gate (Figure 5).

2018 Dry Season Orifices (Summary)			
	Minimum (cm)	Maximum (cm)	Mean difference (cm)
6"x12"	0	6.5	3.6
9"x12"	0	19.5	12.1
12"x12"	0	28.9	18.6

2019 Dry Season Orifices (Summary)			
	Minimum (cm)	Maximum (cm)	Mean difference (cm)
6"x12"	0	7.5	3.6
9"x12"	0	18.9	12.2
12"x12"	0	25.9	18.8

Figure 5. Modeled output of tide gate size parameters (first column) and the effect on minimum, maximum and mean water elevation in the Moro Cojo Slough.

Deliverables submitted to OPC: Moro Cojo Water Level Model Results and Analysis (May 2021 and March 2022)

Task 4. Planning for the restoration and conservation of the last remaining parcel within the Moro Cojo Slough

Task 4.1 Tottino II Agreement and Acquisition

Description: Complete purchase negotiations and acquire 35-acre parcel.

Results: During the first year of the project the main patriarch of the family who the project team was working with on property acquisition died. This resulted in a large set back as the property passed to all of his descendants and the project team had to approach all of them with the project, its benefits, and the timeline. At the beginning of year two the family drafted a letter committing to working with the project team to complete the transfer. Over the course

of the second year the project team held many meetings with representatives of the family and the trusts that own the land. An agreement to sell was eventually obtained by the end of year two. During year three the project team moved forward with title reports and an appraisal and hired a lawyer in coordination with Elkhorn Slough Foundation to draft the Transfer Agreement (CCR to ESF), Escrow Instructions, Deed Restrictions and an Access and Indemnification Agreement (in re post-closing restoration work). The Lot line adjustment permit went before the County planning commission at the end of year three and was approved. At this point the COVID-19 pandemic hit which ground everything to a halt. The project team moved forward with Monterey County in drafting legal descriptions of the new parcels, a permit approval notice and a floodplain notice for Monterey County. The permit approval notice and a floodplain notice needed to be signed and notarized by all of the family members that are partial owners of the parcel along with Elkhorn Slough Foundation. There multiple delays in the County drafting the permit approval notice (wrong names, then misspelled names, etc.). In addition, the Escrow Company we were working with has staff turnover resulting in more delays. This led to multiple rounds of revisions needing to take place. Several months later we were informed by Monterey County that a second grant deed is required to complete the LLA which will need to be drafted by ORTC and sent out to the owners to be signed. One grant deed transfers a portion of the parcel to ESF (signed and completed back in May), the second grant deed grants the remaining portion of the parcel back to the existing landowners. These deeds needed to be signed/notarized by all of the family members that are partial owners of the parcel along with Elkhorn Slough Foundation. This led to more delays. Once all the documents were finalized and signed/notarized by all of the family members that are partial owners of the parcel along with Elkhorn Slough Foundation the documents were filed with Monterey County at the end of year four. At this point the County had to issue the certificates of compliance which took place in at the beginning of year five. Once that document was recorded, and additional fees were paid, the transfer was complete and escrow closed during the second quarter of year 5.

Deliverables submitted to OPC: land acquisition documents (buyer and seller statements, land survey, agreements to sell), permits, environmental assessment, appraisal.

Task 4.2. Construction Project Permitting

Description: Work with federal, state, and Monterey County agencies to finalize and submit all necessary permits for restoration activities and weir construction.

Results:

Weir: CCWG staff worked with Kelli Camara at the Santa Cruz RCD to help obtain all necessary permits for the weir in the main channel of the Moro Cojo Slough (SWRCB, ACOE)

Wetland Restoration Site: CCWG worked with California Ecological Analytics to complete a biotic resources assessment and Albion Environmental to complete an archaeological assessment of the restoration site. A Notice of Determination was filed by OPC and Monterey County indicating that a Negative Declaration was prepared for the project (Moro Cojo Slough Management and Enhancement Plan) which covers activities in this grant. The project team obtained a CDP and a grading permit from Monterey County for the restoration actions utilizing the design plans drafted by Water Ways Consulting.

Deliverables submitted to OPC:

Weir: SWRCB 401 Cert., Nationwide Permit

Wetland Restoration Site: Coastal Development Permit, grading permit, surveys, Notice of Determination

Task 4.3 Weir Engineering Designs, Freshwater Retention, and Water Quality Enhancement

Description: Complete a hydraulic and topographic study to determine the most effective means for restricting salt water from migrating upstream of the railroad bridge, allowing the County greater flexibility in managing tide gate functions near the harbor.

Results: CCWG staff worked with Water Ways Consulting to analyze water elevation data near the weir location which supported the necessary elevation of the weir to be effective at reducing the flow of salt water to the upper portions of the watershed (Figure 6). A project description was then drafted along with final project designs. CCWG presented the designs and project description to the Moro Cojo TAC. Approval was given by the TAC and the project team moved forward.

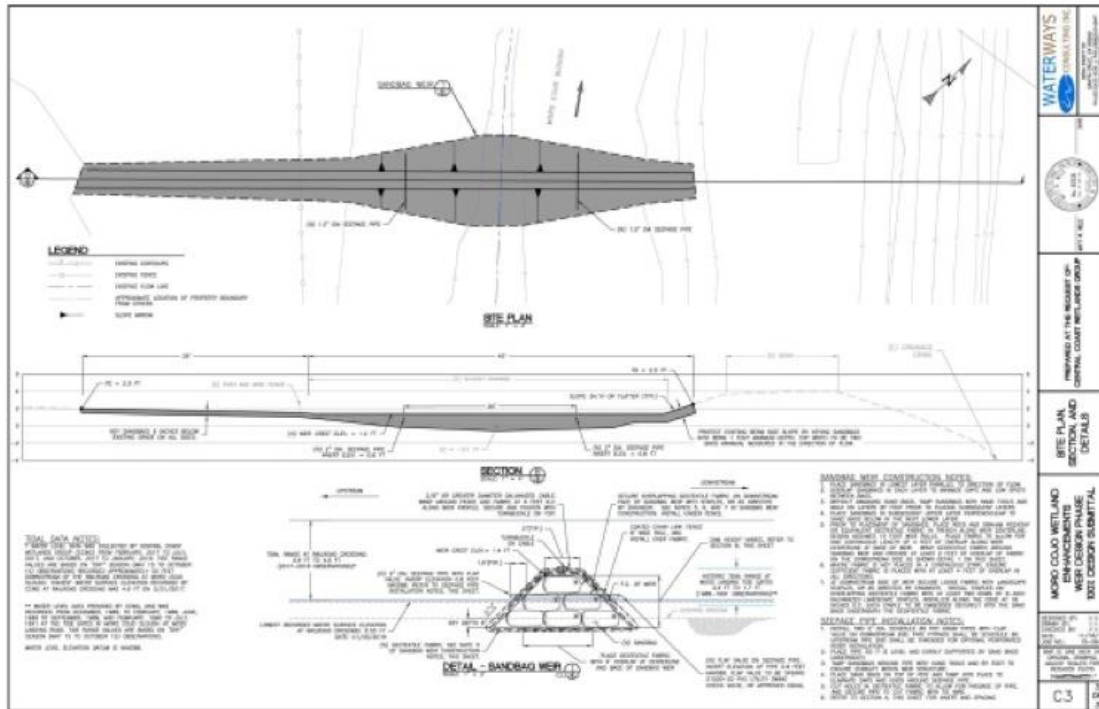


Figure 6. Design plan for the Moro Cojo Slough weir, located just upstream of the Southern Pacific Rail Road bridge.

Deliverables submitted to OPC: Project description, Water surface elevation data analysis, Weir engineering and design plans

Task 4.4 Engineering and Environmental Designs for Restoration Actions

Description: Draft a restoration plan for the 35-acre parcel that supports a brackish water mixing zone between fresh and saltwater portions of the estuary. The Restoration Design Plan will specify the location of channels and ponds to be constructed and will include detailed native plant designs for wetland and upland species.

Results: CCWG staff drafted a concept design plan for the Tottino II restoration site in preparation for the grant application. The project team then worked with Water Ways Consulting to analyze water elevation data near the restoration location which supported the final design considerations of the restoration site. A Restoration, Construction and Maintenance Plan was then drafted along with final project designs (Figure 7). CCWG presented the designs and project description to the Moro Cojo TAC for approval.

Results:

Weir: In November 2019 CCWG staff with support from Water Ways Consulting and the Santa Cruz RCD worked with the California Conservation Corps to construct the weir in the main channel of the Moro Cojo slough (Figure 8).



Figure 8. California Conservation Corps crew working with CCWG on the construction of the Moro Cojo Slough weir.

Water quality monitoring in the slough before and after construction of the weir show that it is meeting its intended function of reducing the salinity of waters upstream of the weir, in the region of the slough watershed where T&E species that require fresh water are located (salamanders and frogs). In the figure below (Figure 9), each box plot represents data collected at a monitoring station in the slough. MC-1 is located at HWY 1 near the mouth of the slough while MC-13 is located near Castroville Blvd, in the upper portions of the slough. The weir is located between MC-8 and MC-9 monitoring locations in the slough. Note the strong decrease in the average salinity in monitoring stations MC-9 through MC-13 after the weir was installed in November 2019.

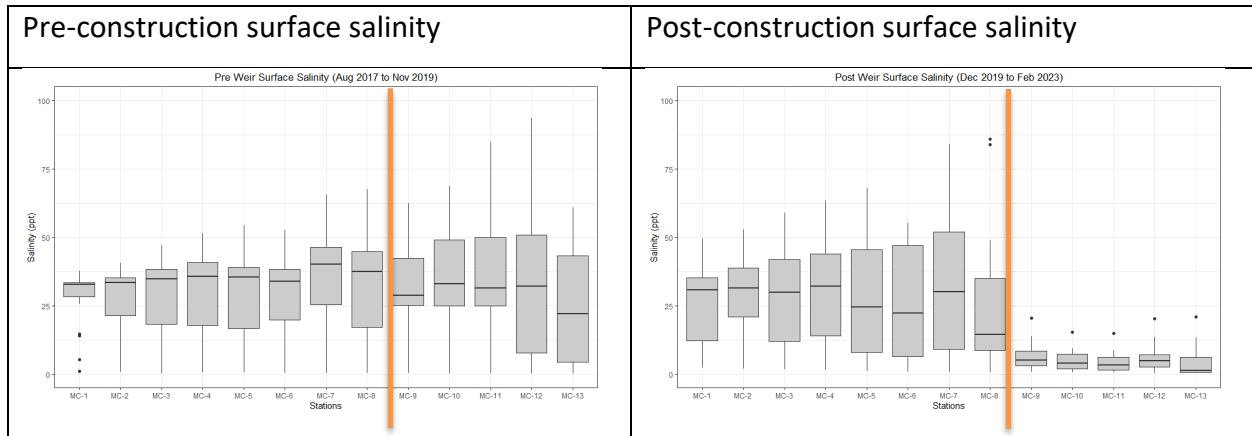


Figure 9. Moro Cojo Slough surface salinity monitoring results comparing average salinity at locations along the entire slough before and after installation of the weir (represented by the orange line between stations MC-8 and MC-9)

Wetland restoration site: Sea Mist Farms enacted Phase 1 (fall 2019) by building a berm that separates the wetland area from the farm to the south. Spoils used to build the berm were strategically taken from the areas of Ponds 3 and Pond 4. Phase 2 was completed two years later (fall 2021), when contractor Durden Construction dug the remaining ponds and built raised areas for driving access. Phases 1 and 2 were followed by seeding and planting (fall 2021 through spring 2023). Each phase involved grading the site with tractors to create the ponds, followed by invasive plant management via herbicide application and mowing, and native seeding and planting (Figure 10 and 11).



(A) 2018-prior to construction



(B) 2020-initial earthmoving complete



(C) 2022-final earthmoving complete and wetland flooded

Figure 10. Photo monitoring at photo point #2 showing (A) the condition of the restoration site prior to construction, (B) following Phase 1 and (C) following phase 2 of construction with the site flooded.



Figure 11. California Conservation Corps crew working with CC&R on the planting of the Tottino II restoration site.

Deliverables submitted to OPC:

Weir: May 2020 Weir monitoring report

Wetland restoration site: Wetland construction contract with Durden, Tottino II Construction Biological Monitoring Report

Task 5.2 Habitat Assessments and Project Success Monitoring

Description: Utilize the California Rapid Assessment Method (CRAM) to monitor habitat condition prior to, during, and following restoration activities. Establish photo monitoring locations and document conditions prior to, during, and following restoration activities.

Results: In 2018 before restoration implementation, CCWG established 7 CRAM assessment areas (AAs) within the restoration project area. Tottino II was created through two phases of construction in 2019 and 2021. CCWG performed post-restoration CRAM assessments of the ponds in 2022. Increases were seen in the average scores for the Index score, along with the Buffer and landscape Context, Physical Structure and Biotic Structure attributes. A decrease was seen in the score for the Hydrology attribute due to installation of culverts and increasing source water from ag pumps (Figure 12).

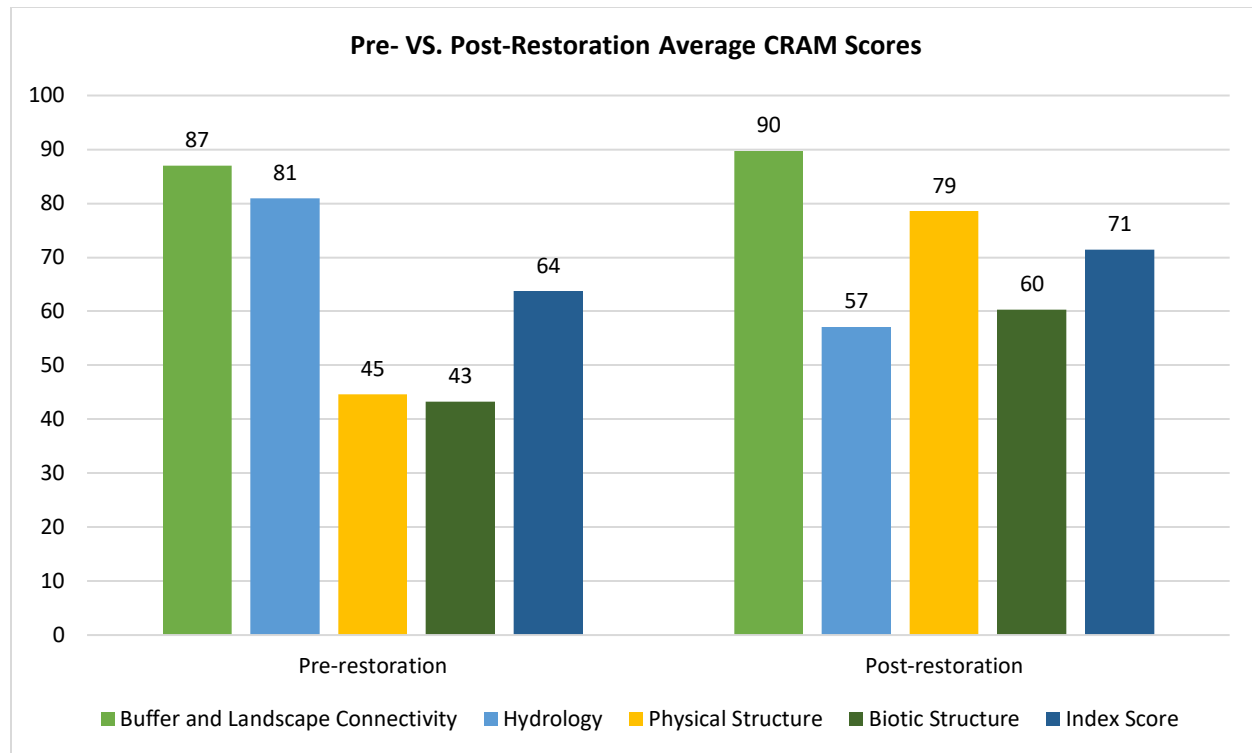


Figure 12. Results of pre- vs. post-restoration assessments of habitat condition at the Tottino II restoration site using the California Rapid Assessment Method (CRAM). Results are shown for the four CRAM attributes (buffer and landscape, hydrology, physical structure and biotic structure) and the Index Score.

CCWG worked with a local bird surveyor, Rick Fournier, to conduct one (1) pre and four (4) post implementation bird surveys of the Tottino 2 restoration site. Results, shown below, indicate and increase in all metrics (diversity, evenness, species richness, and abundance) (Figure 13).

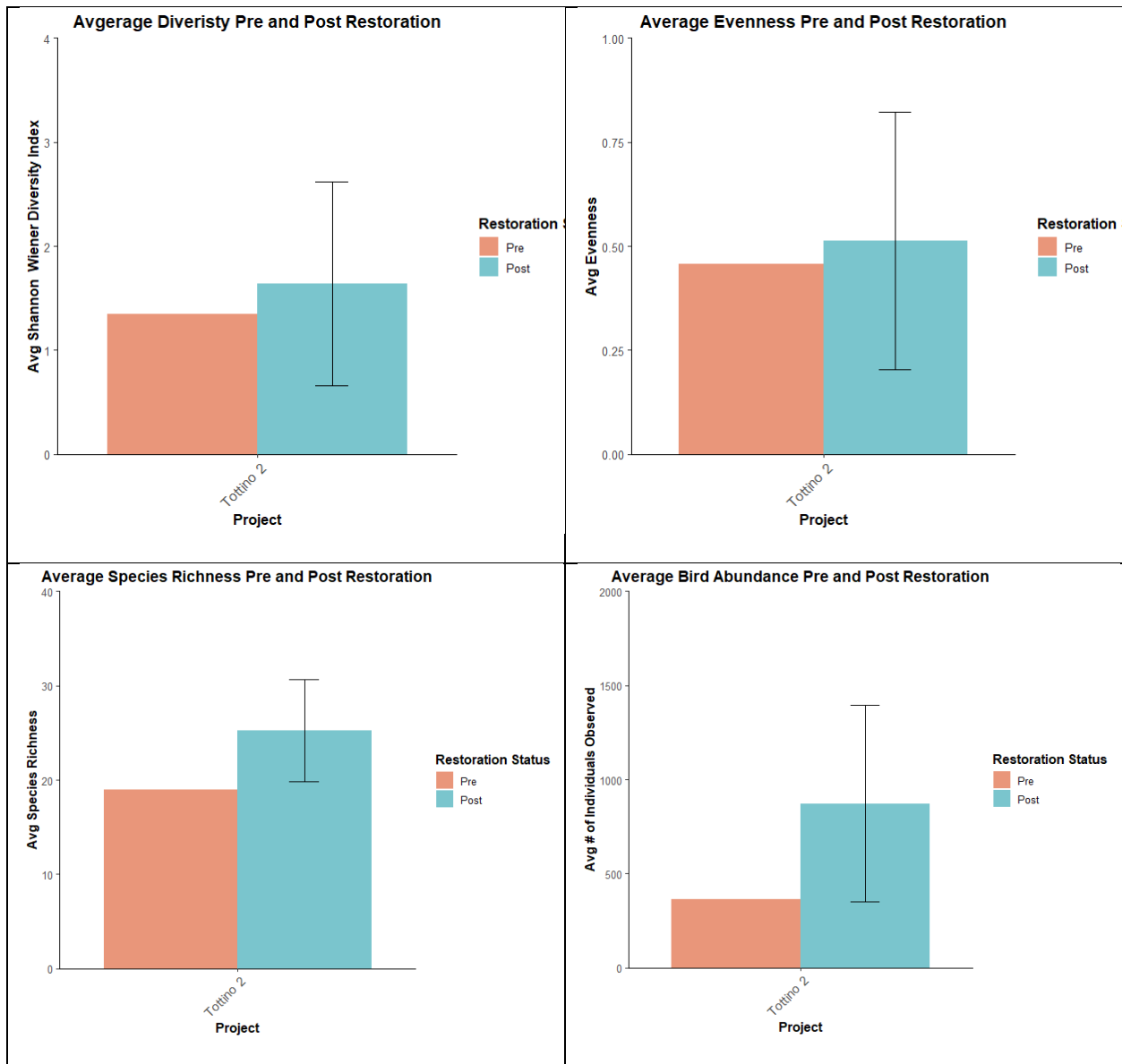


Figure 13. Bar charts comparing the pre-construction (orange) with the post-construction (turquoise) bird metrics at the Tottino II restoration site.

CCWG and CC&R conducted post-construction surface salinity monitoring of the Tottino II restoration site to confirm the design specifications that the wetland would be brackish. The monitoring event confirmed the design criteria of constructing a brackish water wetland, with salinity ranging from 1.86 to 25.2 ppt. (Figure 14).

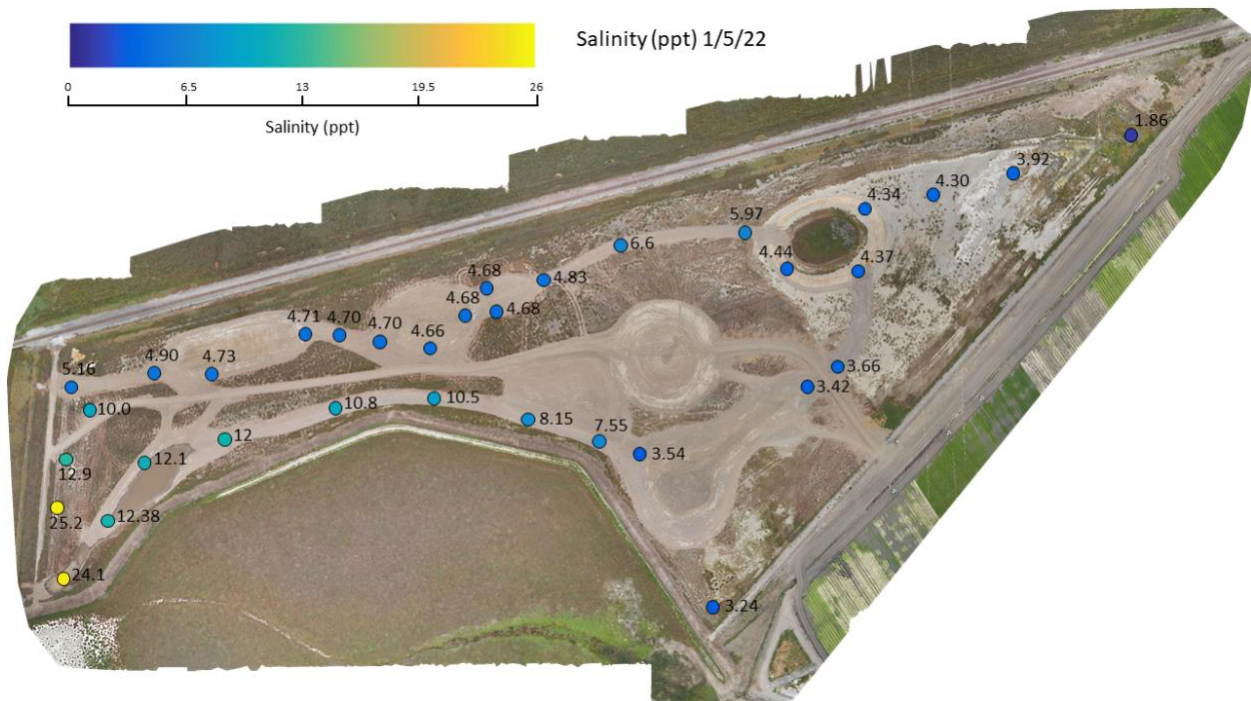


Figure 14. Results of surface salinity monitoring at the Tottino II restoration site on January 5th, 2022.

Other forms of project success monitoring included photo monitoring, drone images, post implementation surface salinity monitoring, and a comprehensive condition assessment looking at water quality, vegetation, invertebrates, and wetland morphology/hydrology completed by the CSUMB Geology 460 class in Spring 2022.

Deliverables submitted to OPC:

Weir: May 2020 monitoring report, and photo documentation from during and post construction.

Wetland restoration site: CRAM Assessment Report of the Tottino II Restoration Project (including raw CRAM data sheets), bird observations from one pre and four post implementation surveys, drone images from 2021 and 2022, post implementation surface salinity monitoring, CSUMB Geology 460 class report, and photo documentation from pre, during, and post construction. Habitat and photo monitoring data were submitted to EcoAtlas.org

Task 6. Development of a Long-Term Integrated Management Strategy

Description: Compile the numerous reports and data sets completed to date in the watershed and summarize those results within a comprehensive update to the Moro Cojo Management

Plan. Integrate the management of multiple restoration and conservation projects to streamline costs, and ensure the Moro Cojo Slough State Marine Reserve management objectives are met (improve water quality, maintain habitat areas for special status species and expand adaptive capacity to climate change).

Results: CCWG staff worked with a MLML student assistant and Rob Burton at CSUMB to draft the revised Long-term management plan for the watershed. Input from the TAC was gained via full meetings and subcommittee meetings. The document is in DRAFT form at this time. CCWG will work with the TAC over the next 3-6 months to finalize the Long-term Management Strategy (Figure 15). Once complete it will be submitted to Monterey County for adoption.

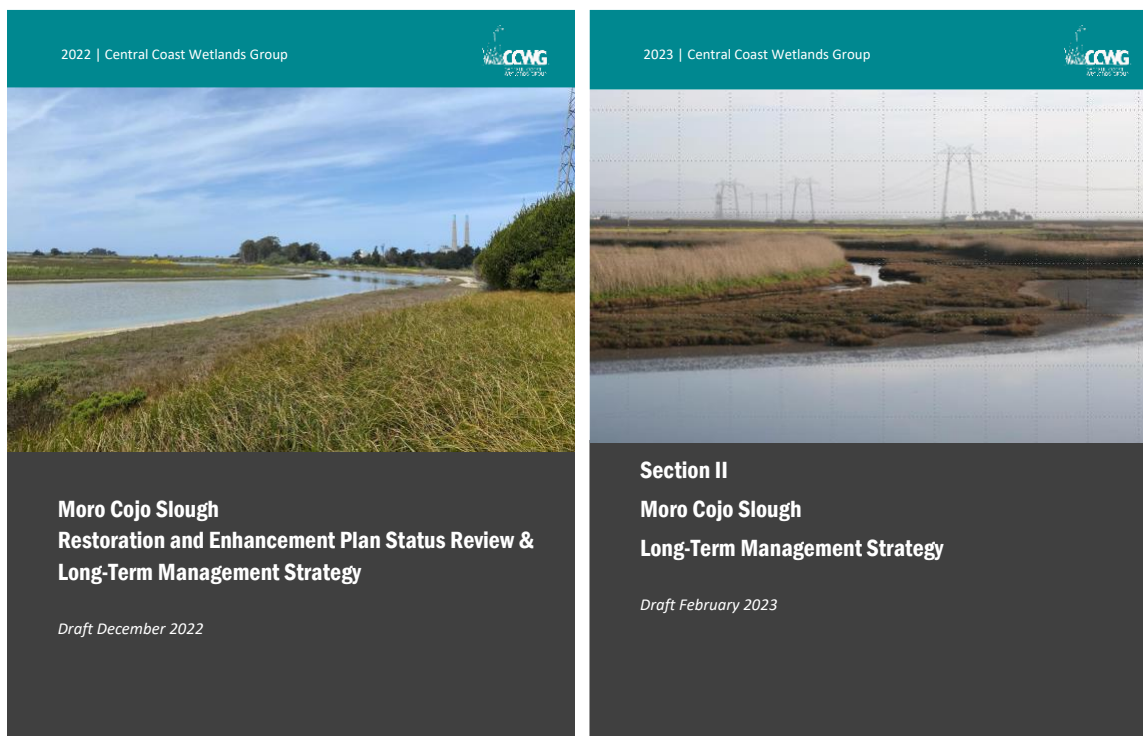


Figure 15. Cover pages of Sections 1 and 2 of the update to the Moro Cojo Slough Management and Enhancement Plan.

Deliverables submitted to OPC: Two documents representing the update to the Moro Cojo Management Plan. The first is Moro Cojo Slough Restoration and Enhancement Plan Status Review, which reviews all of the progress to date on implementing the Moro Cojo Slough Management and Enhancement Plan. The second is the Long-term Management Strategy which presents recent studies, their implications for management, and management recommendations going forward for the slough.

Task 7. Prop 1 Acknowledgement Sign

Description: Install a sign informing the public that the project received funds from the OPC and from the Water Quality, Supply, and Infrastructure Improvement Act of 2014. The sign will display the official Prop 1 logo (CWC §79707[g]) as well as the official OPC logo.

Results: Two signs were designed, printed, and installed at the restoration site (Figure 16). The first sign displayed the required information according to the agreement (project received funds from the OPC and from the Water Quality, Supply, and Infrastructure Improvement Act of 2014 and displayed the official Prop 1 logo (CWC §79707[g]) as well as the official OPC logo), while the second sign displays the layout of the restoration site, the water sources to the wetland, all of the partners involved in the implementation, and project benefits.

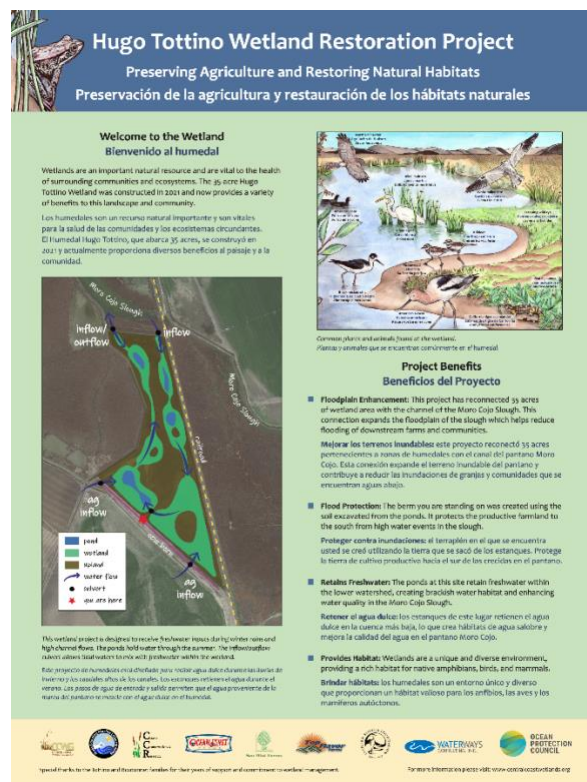


Figure 16. Descriptive and required signs installed at the Hugo Tottino Wetland Restoration Project (Tottino II).

Deliverables submitted to OPC: funding sign and restoration project signs, Spanish translation of sign text, and photos of two signs installed at wetland restoration site