

Improving California's Riverine and Wetland Management Efforts

Final Report to the Resources Legacy Fund
Grant #12521

Central Coast Wetland Group at Moss Landing Marine Labs

and

Southern California Coastal Water Research Project



February, 2019

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Project Outcomes

The outcomes of this work include condition and vulnerability assessment maps for the Gabilan watershed, along with initial numeric and geographic resource protection and management objectives that can be used to guide protection, management and restoration, and building regional support for and expansion of the project through EPA funding in 2018.

In addition to helping prioritize efforts to protect "healthy" areas, the outputs developed in this project will help multiple stakeholders and agencies in the lower Salinas Valley coordinate management actions such as erosion stabilization, invasive pest control, and targeted habitat rehabilitation. These coordinated management efforts will improve the ecological function of focal watershed and the estuarine resources at their terminus.

A revised work plan was drafted for submission to EPA in spring, 2019. The work plan considers input from stakeholders in the Gabilan Watershed as well as developments in watershed modelling/mapping from Southern California.

Financial

Financial Report for February 2019

Improving California's Riverine & Wetland Mgmt Efforts

College:	College of Science	Account Holder:	Ross Clark
Department:	Moss Landing Marine Laboratory	Additional Signers:	Kathleen Donahue, Kevin O'Conner
Start Date:	01/01/18	End Date:	02/28/19
Admin Rate:	10%	Deliver To:	Kevin O'Conner 0144
Sponsor:	Resource Legacy Fund		

Revenue	Received To Date
49521 - Gifts-(TR)	40,000.00
Total Received	\$40,000.00

Expenses	Budgeted	February Expenditures	Purchase Orders	Unposted	Combined To Date	Over/Under Budget
<u>Direct Costs</u>						
<u>Personnel</u>						
51000 - Salaries & Wages	30,582.20	0.00	0.00	0.00	30,582.20	0.00
55600 - Fringe Benefits - Mandatory Benefits	4,281.49	0.00	0.00	0.00	4,281.49	0.00
<u>Other Direct Costs</u>						
63930 - Other Services	1,500.00	0.00	0.00	0.00	1,500.00	0.00
Total Direct Costs	\$36,363.64	\$0.00	\$0.00	\$0.00	\$36,363.69	\$0.00
<u>Admin Fee</u>						
99999 - Tower Foundation-Administration Fee	3,636.36	0.00	0.00	0.00	3,636.31	0.00
	\$40,000.00	\$0.00	\$0.00	\$0.00	\$40,000.00	\$0.00

Balance Available (Direct Costs Only): \$0.00

Narrative

Introduction

California's Wetland and Riparian Area Monitoring Plan (WRAMP) is a framework of monitoring and assessment tools for wetlands and streams in California developed by the California Wetland Monitoring Workgroup (CWMW). WRAMP is intended to be used by state regulatory and grant management agencies to aid interdepartmental coordination and document the cumulative benefits of state aquatic resource management actions. This request for bridge funding helped CCWG and SCCWRP identify how the tools can help local groups improve wetland and riverine management within the Gabilan (Monterey County) watershed. Demonstrating the use of WRAMP tools to describe the current condition of these watersheds and working with local stakeholders to get buy-in to use the compiled information to direct future restoration, management and conservation efforts provides the proof of concept necessary to obtain future EPA funding and will provide an example of the benefits associated with integration of standard tools for local decision making.

The Watershed

The Gabilan Watershed drains the Gabilan Range above the City of Salinas through the rich agriculture "Salad Bowl" of the Salinas Valley, through the urban area of the Cities of Salinas and Castroville, and discharges through the Tembladero Slough into Moss Landing Harbor, the Elkhorn Slough, and ultimately the Monterey Bay National Marine Sanctuary (Figure 1). The wetlands within the Gabilan Watershed perform an array of important functions such as flood attenuation, water filtration, and provision of wildlife habitat. However, due in part to this surrounding agricultural land use, the water that flows through this watershed is some of the most polluted water in the State (Tembladero Slough, Espinosa Slough, etc.). Fourteen TMDLs are scheduled for development in the Tembladero Slough. Erosion and sedimentation have increased flood risk, and serve to transport toxic chemicals through the watershed, leading to contamination and hypoxia within the Moss Landing Harbor and Elkhorn Slough.

Previous planning efforts which informed this project

- **Reclamation Ditch Watershed Assessment and Management Strategy (2006):** From 2003-2005, the Watershed Institute at California State University Monterey Bay completed an Assessment and Management Strategy for the Monterey County Water Resources Agency. Part A of this report contains the Assessment, comprising five elements that collectively assess the function of the watershed, including: Historical Conditions Assessment, Hydrology and Channel Conditions Assessment, Water Quality Assessment, Biological Assessment and a Botanical Assessment. Part B of this report contains the Management Strategy, comprising five main elements: Existing Plans, Public Process, Watershed Management Goals, Management Actions, and Management Strategies.
- **Gabilan Watershed Blueprint (2014):** The Gabilan Watershed Blueprint was drafted by the Greater Monterey County Regional Water Management Group and aimed at addressing and resolving water-related conflicts in the region, while promoting stakeholder collaboration and project integration. This process, called "Water Resource Project Coordination", was initiated in early 2011 and involved numerous stakeholders representing agricultural interests, environmental groups, government agencies, academic institutions, and interested citizens. The Gabilan Watershed Blueprint is comprised of four main sections: 1) The Landscape Strategy, 2) On-Farm Solutions, 3) Corporate Social Responsibility, and 4) Agency Coordination.

- **Castroville Community Outreach (2017):** This report describes community outreach efforts of the “Water Quality Enhancement for the Tembladero Slough and Public Access for the Community of Castroville Project.” This is a multi-phase watershed coordination and wetland restoration project targeted the lower Gabilan watershed and was funded through Integrated Regional Water Management Plan (IRWMP) implementation funds. These efforts have helped identify project sites for the creation or enhancement of wetlands for habitat, water quality improvements, and when feasible supporting public access values, while meeting the needs of the regional stakeholders.
- **Stormwater Resource Plan for Greater Monterey County (2019):** This plan promotes stormwater management implementation projects that provide regionally optimized benefits of increased water supply, improved water quality, better flood protection, enhanced environmental quality, and greater community opportunity. The SWRP achieves that purpose by: characterizing current stormwater dynamics in terms of sources, volume, flow, timing, quality, and rights; and identifying geographically and temporally specific opportunities to divert, capture, store, treat, recharge, and reuse this resource to guide the development of implementation projects that optimize regionally integrated benefits.

Successes and challenges

The intent of the RLF bridge funding was to continue to develop riparian assessment and modeling tools for use by state and regional agencies and municipal districts to set policy and prioritize resource management. The Central Coast Wetlands Group (CCWG) and Southern California Coastal Water Research Project (SCCWRP) submitted a grant proposal in Spring 2017 to integrate the Riverine and Estuarine wetland monitoring and assessment tools into south and central coast resource management efforts. The grant was not selected for funding, but EPA staff provided recommendations on how to improve the project to increase the likelihood of funding during the 2019 solicitation.

This one-year project has supported CCWG efforts to identify how the tools can help local groups improve wetland and riverine management within the Gabilan (Monterey County) watershed. Demonstrating the use of WRAMP tools to describe the current condition of this watershed and working with local stakeholders to get buy-in to use the compiled information to direct future restoration, management and conservation efforts will provide the proof of concept necessary to obtain future EPA funding and will provide an example of the benefits associated with integration of standard tools for local decision making.

Specifically, this work has 1) generated a condition and vulnerability assessment for the Gabilan watershed portion of the Salinas Valley, 2) established numeric (assessment scores) and geographic resource protection objectives (watershed maps) that can be used to guide protection, management and restoration efforts, 3) build regional support for systematic resource management planning at a watershed scale through the integration of data and model outputs into local plans and programs, and 4) prepare for the expansion of the project through EPA funding in 2019.

Successful completion of this project did not come without numerous challenges and setbacks that required the technical team to reevaluate data interpretation methodology and data extrapolation procedures. Modeling tools were found to be less useful in highly altered agricultural watersheds and previous restoration efforts confounded automated land-use model outputs. These challenges however helped to enhance the techniques used to estimate the current condition of riparian resources, document previous restoration success and prescribe future restoration priorities.

Key lessons learned

- Previous water quality models failed to correlate with riparian habitat condition due to dis-synergy between upstream sources of water quality degradation and immediate locality of riparian impacts.
- Probabilistic extrapolation of RipRAM or CRAM scores was found to be inappropriate procedure for estimating adjacent riparian condition. Correlations between local Condition score and adjacent land use and riparian width were found to be superior methods.
- Blue line maps (wasters of the state) were poor base layers for use in prioritizing riparian habitat restoration and management goals.
- When completing a condition of watershed health, it is critical to properly categorize condition assessments completed in areas that have been previously restored.

Results by Task

Task 2: Mapping and Assessment of the Gabilan Watershed

Modeled Watershed Condition Assessment

From 2006 to 2017, approximately 49 riparian sites were evaluated within the Gabilan watershed using the California Rapid Assessment Method (CRAM). The sites were given an “index score” based on a number of factors visible at the sampling site, including landscape context, hydrology, physical structure, and biotic structure. In an attempt to extrapolate the results to other non-sampled reaches of the watershed, we employed a suite of GIS tools and models developed by a collaboration of researchers at NOAA and the Commonwealth Scientific and Industrial Organization (CSIRO) in Australia. The ArcGIS toolset, Spatial Tools for the Analysis of River Systems (STARS), was used to generate a landscape network of stream reaches, observed sample sites, and predictive sites.

Using R, we used a spatial statistical network model (SSN), developed by Ver Hoef et al. (2016), to assess autocorrelation of sites in upstream (“tail-up”), downstream (“tail-down”), and overland (“Euclidean”) directions. The SSN model operates on the principle that samples close together tend to be similar and therefore the condition of unsampled sites nearby may be estimated. The locations of unsampled sites, referred to as “predicted” sites, were chosen using the midpoint and endpoints of each stream segment. The SSN package was used to create generalized linear models for predicted CRAM scores using five different functions for tail-up and tail-down components, and four functions for Euclidean components. The performance of each of the functions was then analyzed using the InfoCritCompare function in the SSN package and the function with the lowest Aikake Information Criterion (AIC) value was selected as the best autocorrelation model to use. The final output included 425 predicted CRAM sites with a mean index score of 49, compare with a mean of 51 for the observed CRAM sites (Figure 2). Additionally, the results include an assessment of standard error (SE) for each of the predicted sites; not surprisingly lower SE values are clustered near the observed CRAM sites while higher values are in the upper reaches of the watershed where no CRAM sites exist.

It was determined by the project team the outputs from the modeling effort of watershed condition were not useful for the development of watershed prioritization and regional protection objectives. The standard error of the scores was too high and the modeled output did not reflect on-the-ground conditions that were observed in the field. The project team decided to work with partners at SCCWRP to utilize a state-wide modelling effort of stream condition based on stream CSCI condition score (CA Stream Condition Index) and adjacent land use. To evaluate potential constraints on biological integrity, SCCWRP developed a statewide landscape model for California that estimates

ranges of likely scores for a macroinvertebrate-based index that are typical at a site for the observed level of landscape alteration. This context can support prioritization decisions for stream management, like identifying reaches for restoration or enhanced protection based on how observed scores relate to the model expectations. For their model, constrained is defined as a biological community that is impacted by large-scale, historic alteration of the landscape. This model output, combined with on-site rapid assessments of condition (CRAM) provided the project team with the most accurate assessment of watershed condition (Figure 3).

The maps of habitat condition, and associated data, provide the necessary information to identify stream reaches in need of habitat restoration, conservation, and protection. Specifically, relationships between adjacent land use and habitat condition scores (CRAM) were evaluated to identify land use types that may have the highest impact on stream health (Figure 4).

Relationships between the percent cover of trees and habitat condition scores (CRAM) were evaluated to test the relationship between visible indicators of riparian health from aerial imagery interpretation and field-collected data to automate the projection of known scores upstream from an assessment location (Figure 5).

Watershed Vulnerability Assessment

Data sets related to watershed vulnerability, including current and future land use, flood maps and sea level rise, were utilized to generate watershed vulnerability maps (Figure 6). The maps identified areas of the watershed where management actions, as well as habitat restoration and conservation will be most needed in the near future. Specifically, the project team identified the City of Salinas urban expansion zone (to the north and east of the existing city boundaries), and farmland expansion areas along Gabilan Creek as highly vulnerable areas of future land use. The 2060 sea level rise projection map along with the 100-year flood zone map identified areas of future inundation, especially at the bottom of the watershed, where riparian and wetland restoration actions would benefit the surrounding landscape by buffering these potential future impacts.

Task 3: Development of watershed prioritization and regional protection objectives

Initial watershed priorities and restoration/management goals were established for the Gabilan watershed (Figure 7, Table 1). We developed quantifiable and spatially-explicit habitat goals for the priority watershed that support attainment of restoration and conservation objectives that address watershed stressors of greatest impact on the Gabilan estuary, which includes the Moro Cojo and Elkhorn Sloughs and multiple State Marine Reserves. This was done through the combination of watershed condition maps (to identify areas in need of restoration), vulnerability maps (to identify areas of future stress and change), and GIS base layers assembled by the Stormwater Resources Planning effort which identify areas of historical wetlands and infiltration based on soil type. This led to a map of riparian habitat restoration, conservation and management goals, which each area calling for specific actions.

Task 4: Develop the Process for WRAMP Tool Implementation

Results of this work have already been shared with local partners and integrated into parallel planning efforts occurring on the central coast including the Greater Monterey County Stormwater Resources Plan, the Integrated Salinas Valley Groundwater Plan, and the development of the Central Coast Agriculture Order 4.0. We have discussed continuing to develop our partnership with the Regional Board 3 and the Southern California Wetlands Recovery Project in preparation for submittal of an EPA grant proposal later this spring (2019).

CCWG is coordinating a workshop with Regional Board Staff to present the results of this project and discuss next phase development throughout the Central Coast. The meeting is scheduled for February 25th. Results have also been presented to the IRWMP and Stormwater Planning TACs as well as staff at the Groundwater Sustainability Agency. CCWG is scheduled to meet with Groundwater agency consultants tasked with developing their integrated regional plan in late March to discuss riparian assessment findings and integrate management recommendations into their planning process. Table 2 identifies key partners and their potential roles in implementing identified riparian conservation and restoration activities in the Gabilan watershed.

Southern Californian Collaboration

Numerous IRWM programs exist in southern California and are used to fund specific projects aimed at providing safe drinking water, flood control, and ecosystem benefits. Few, if any, of these programs take advantage of existing regional tools and programs such as the Stormwater Monitoring Coalition's regional stream survey, and there is little coordination across different IRWM plans. SCCWRP is working with local partners to increase awareness of the existing tools and discuss how these tools can help improve efforts to establish healthy watersheds.

Recently, Regional Water Quality Control Boards have changed the NPDES permits that regulate stormwater discharges to encourage watershed-scale management. The San Diego Regional Water Board, working with municipalities in Orange and San Diego counties, has begun to focus on stream and floodplain restoration as a water quality management strategy and is benefiting from these available riparian assessment tools. *See Appendix 1 for full description of Southern California efforts.*

Next Steps:

Partnerships engaged in on this project

We have partnered successfully with numerous programs to expand the capacity and success of this work. We partnered with the California Conservation Corps-Watershed Stewards Program to help collect the data used for this project and have demonstrated the value of Watershed Steward members as qualified field staff to collect data cost effectively.

Sharing the results of our work

We continue to develop our partnership with the Regional Board to investigate how data collection and reporting can help set policy and prioritize management actions of state agencies. We continued to investigate how these riparian tools can be used by our local groundwater sustainability agency to increase groundwater infiltration success through riparian enhancement.

The next phase of this effort

We are prepared to submit an EPA 104b3 Wetland Development grant in partnership with Regional Board 3, SCCWRP, and the Southern California Wetlands Recovery Program to further develop the Riparian tool kit and establish watershed restoration and management goals for Regional Water Boards 3, 4 and 9. *See Appendix 2 for EPA workplan.*

In Southern California, partners are working to integrate RipRAM and other riparian condition and management tools into the California Stormwater Monitoring Coalition's probabilistic survey of stream condition. The program is currently expanding their decade of work into new habitats, such as non-perennial and ephemeral streams, developing new indicators (e.g. molecular based tools), and addressing new questions, such as the effect of watershed best management practices on instream condition.

Other Items:
Figures and Tables

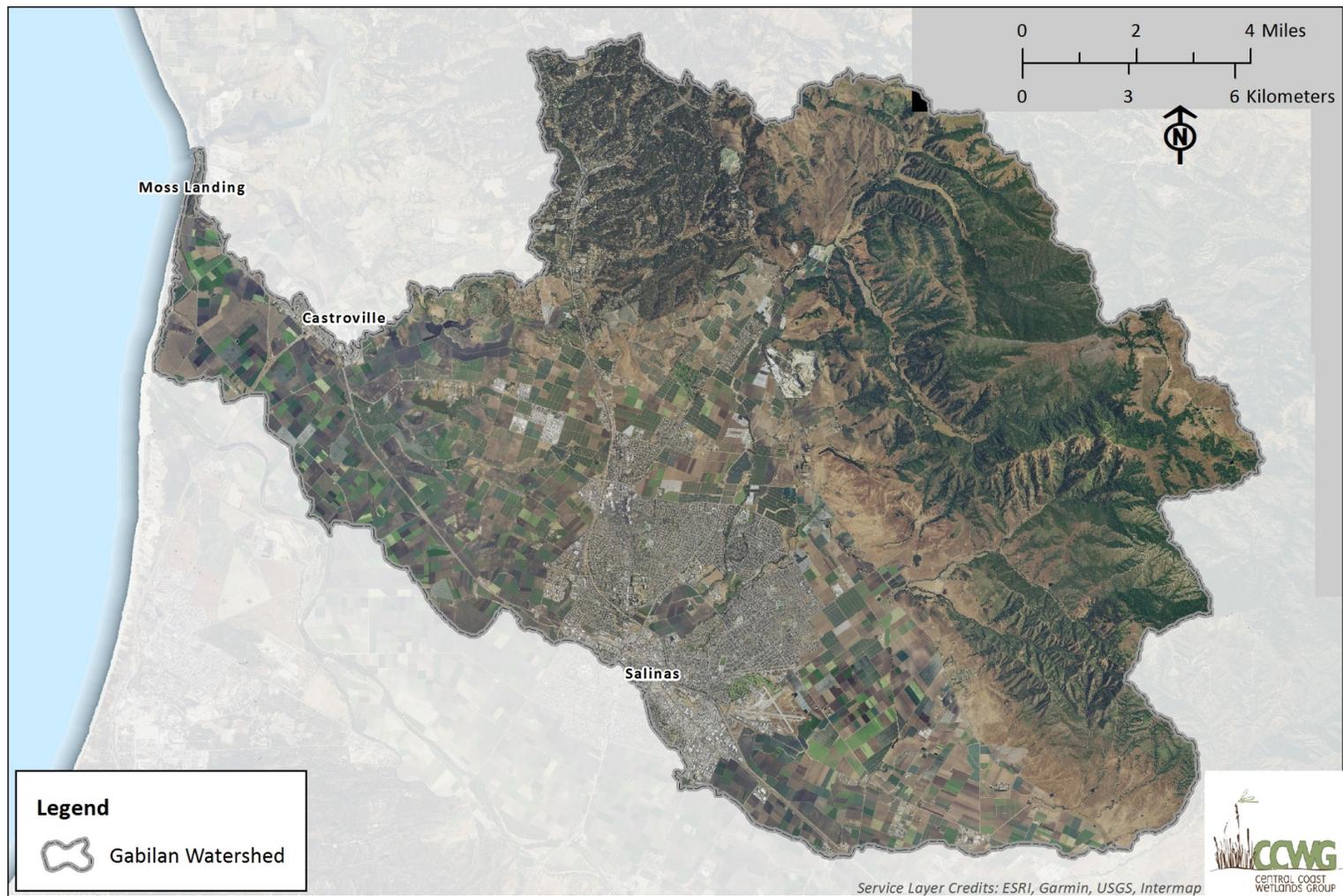


Figure 1. The Gabilan watershed

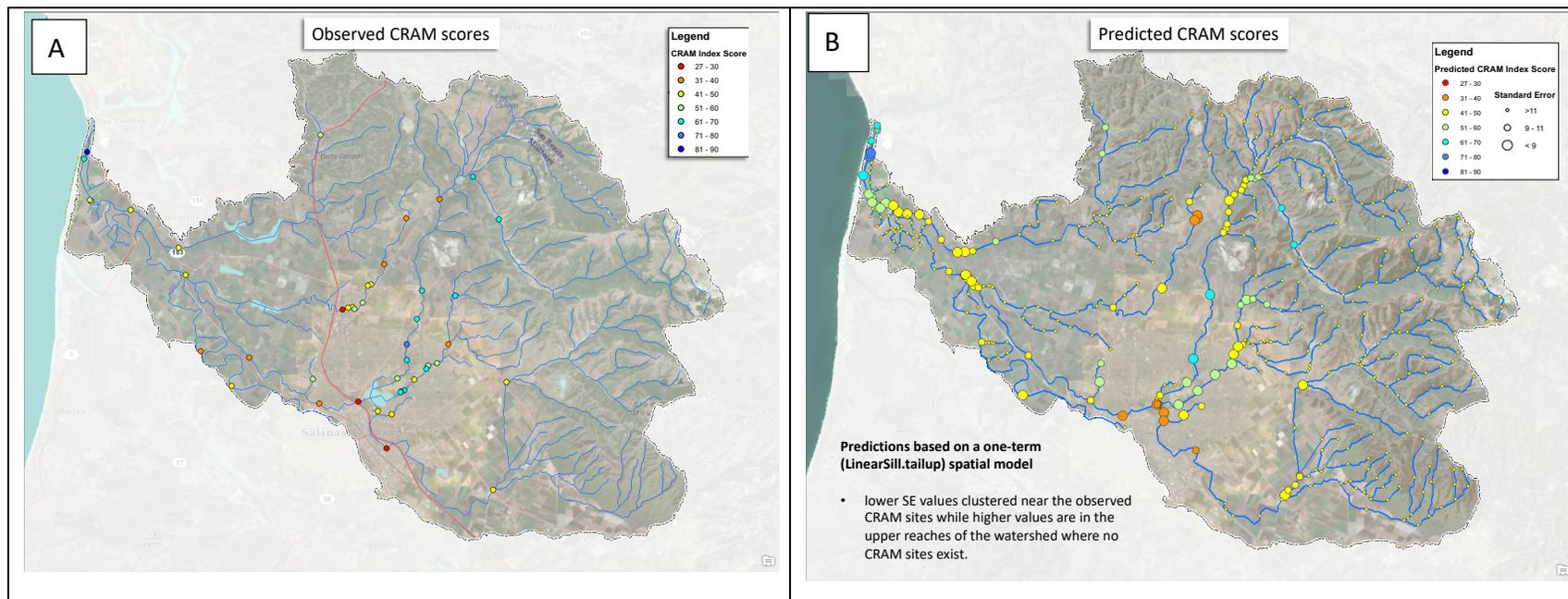


Figure 2. Observed (A) and predicted (B) CRAM scores in the Gabilan Watershed using the STARS toolset.

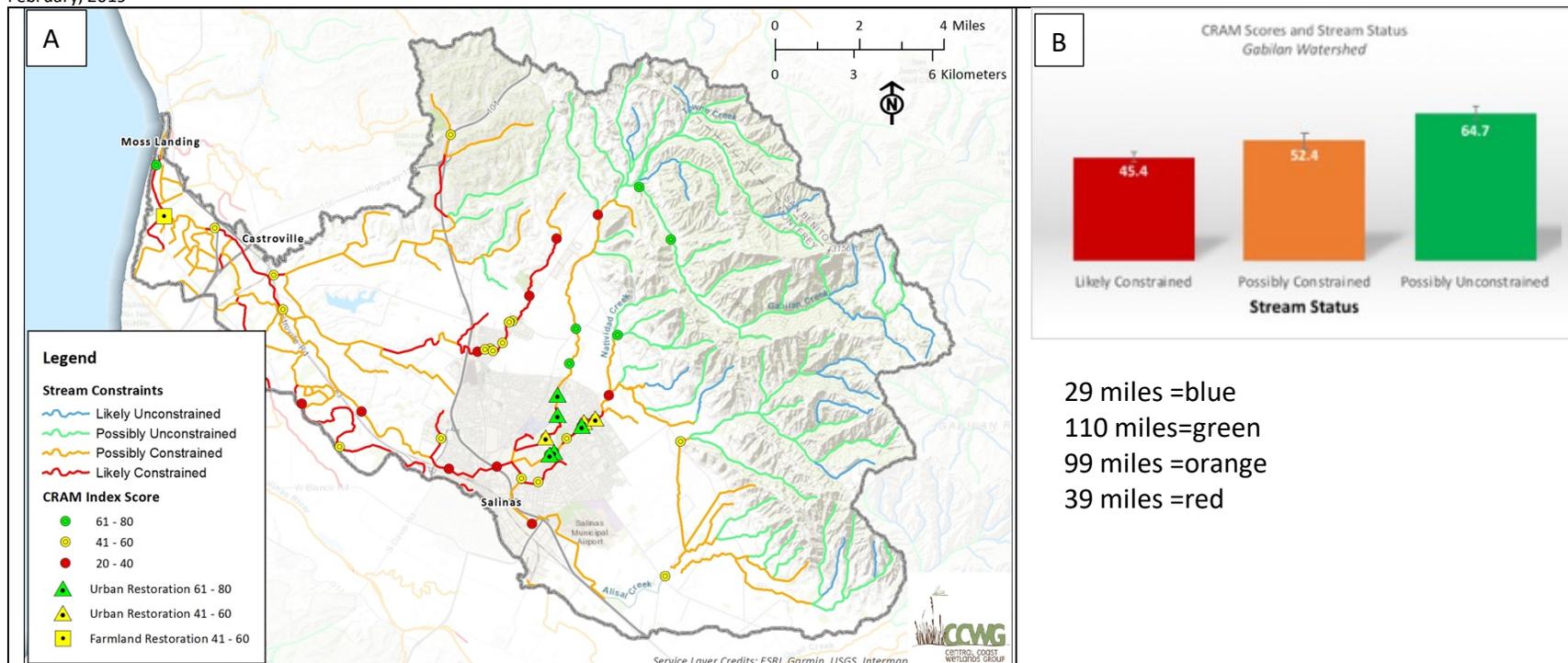


Figure 3. Watershed condition map showing modeled output of level of constraint of biological integrity along stream reaches and CRAM index score at point locations (A). Average CRAM score decreases by level of constraint (B).

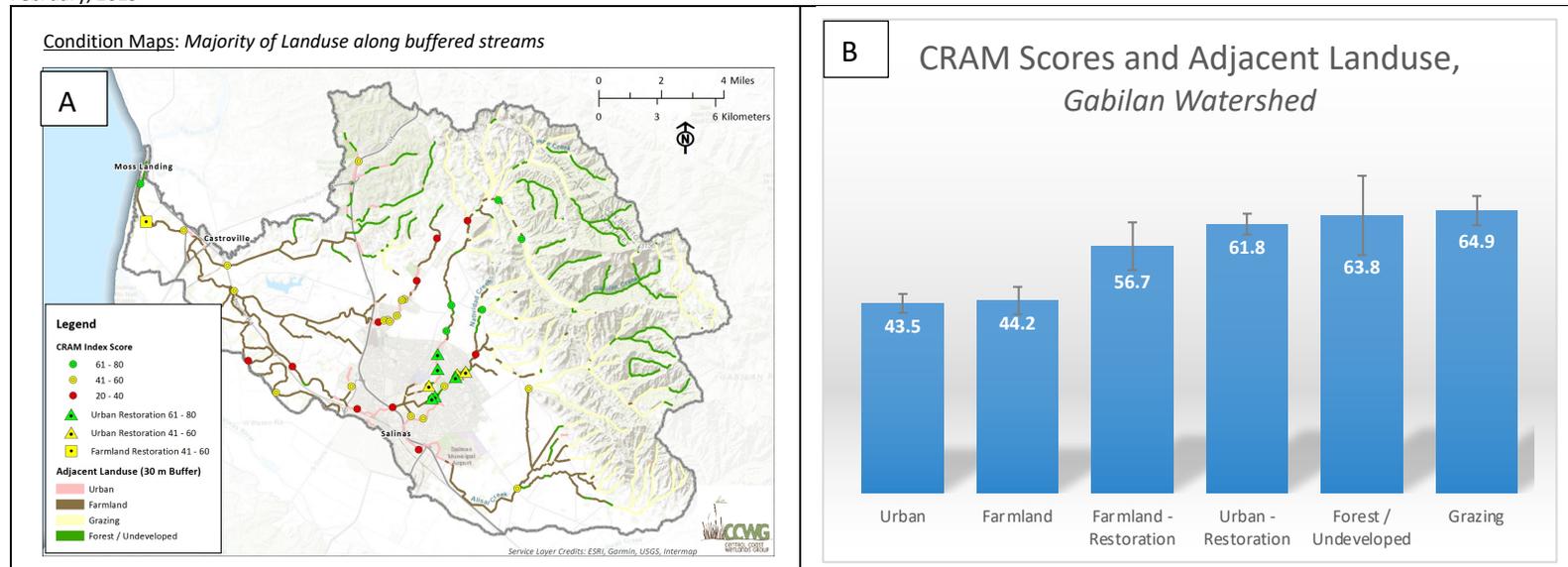


Figure 4. Watershed condition map showing stream reaches color coded by adjacent land use and CRAM index score at point locations (A). Average CRAM score differs by adjacent land use and level of restoration that has taken place (B)

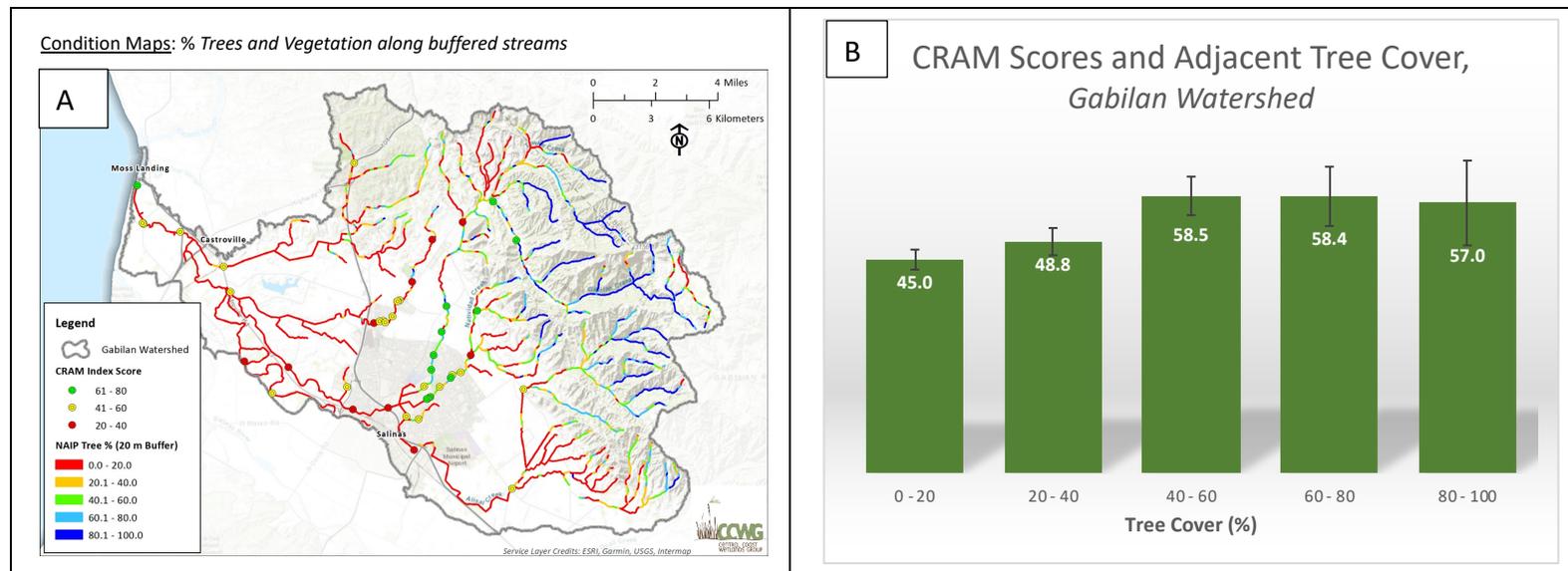


Figure 5. Watershed condition map showing stream reaches color coded by percent cover of trees within a 20m buffer of the stream and CRAM index score at point locations. Average CRAM score differs by percent cover of trees (B)

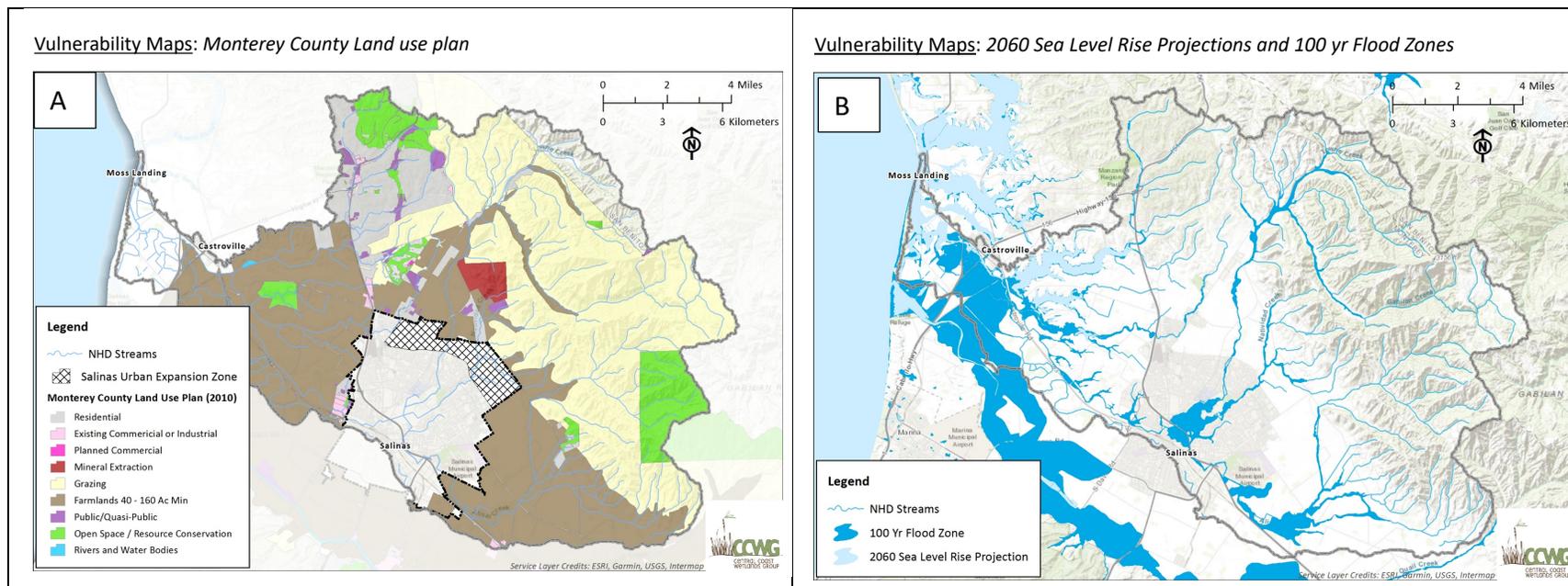


Figure 6. Watershed vulnerability maps of future Monterey County land use plan (A) and the 2060 sea level rise projects combined with the 100 year flood map (B)

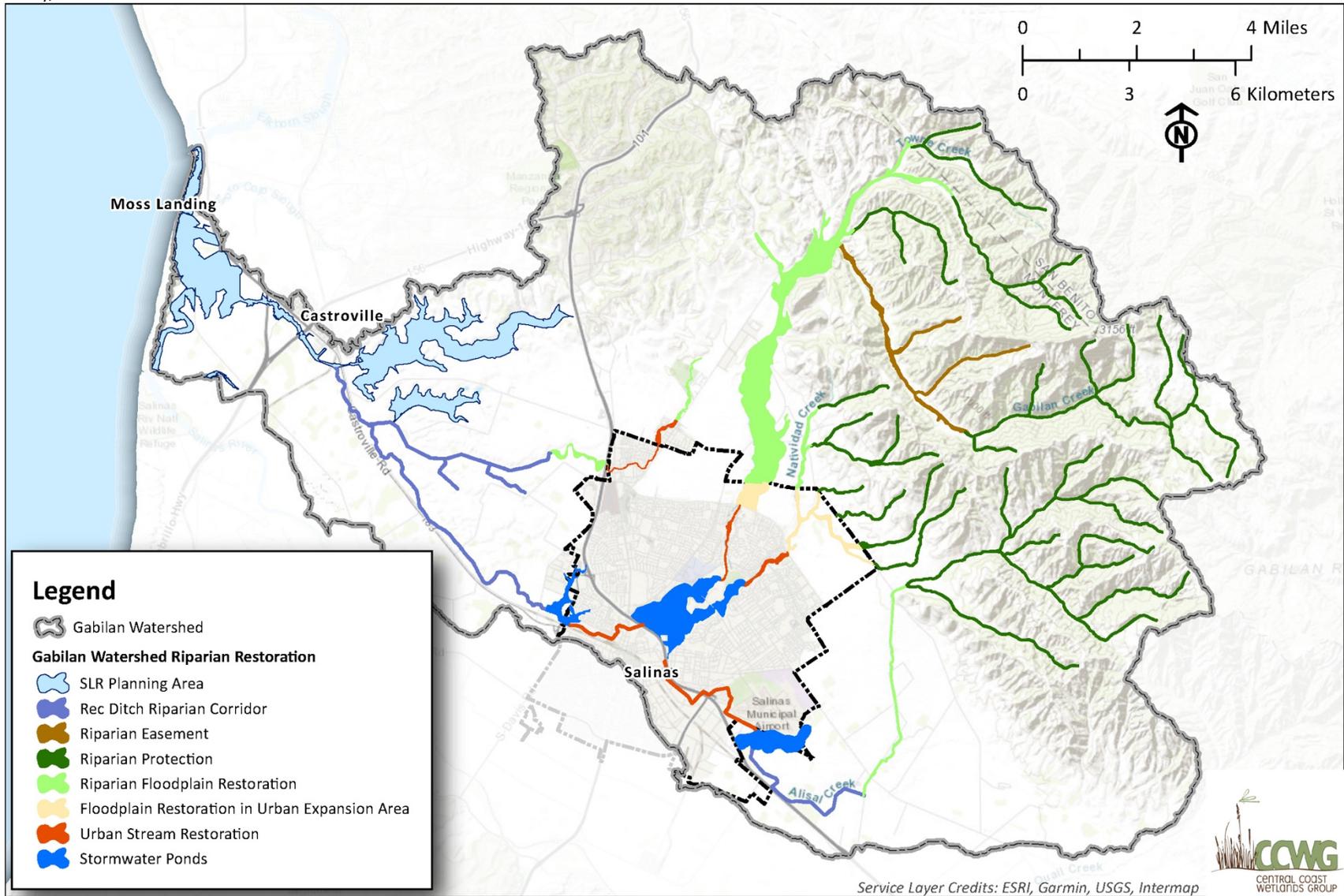


Figure 7. Map of Gabilan watershed priority restoration and management goals. Actions listed in the legend and depicted on the map are described in Table 1.

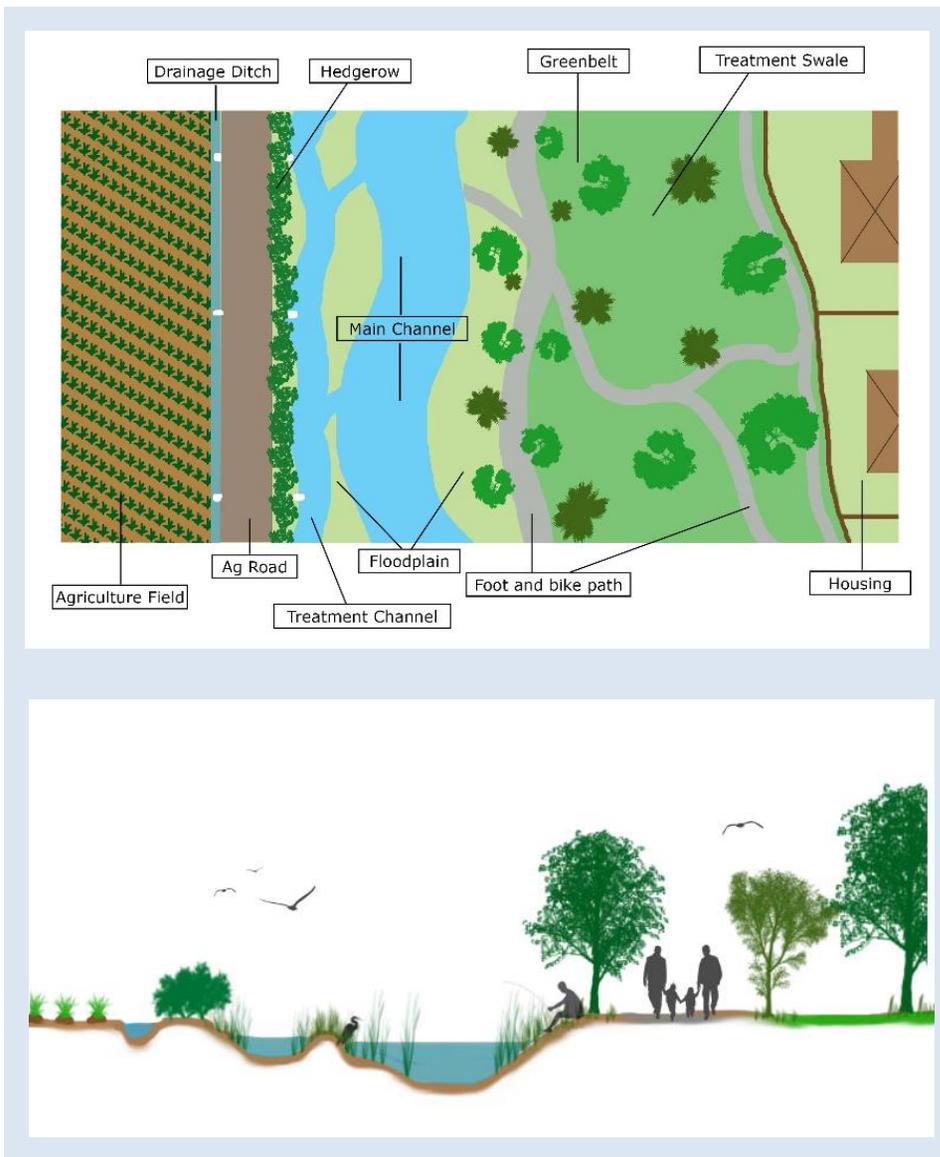


Figure 8. Concept drawing of a typical cross section of the Reclamation Ditch Riparian Corridor

Table 1. Gabilan watershed priority restoration and management goal descriptions

Action descriptions for Figure 7	Goal: Stream miles	Goal: Acres of habitat
SLR Planning Area: Agricultural land owners have committed to working with our team to develop a farm adaptation and resiliency program that will transition vulnerable agriculture lands to creek and wetland habitat and provide critical connectivity among isolated areas of habitat refugia, increasing coastal habitat complexity and resilience to SLR.	N/A	2482
Rec. Ditch Riparian Corridor: increase flow capacity while enhancing wetland habitat and water quality by creating a linear restoration project along the Reclamation Ditch between the City of Salinas and Moss Landing. This enhanced drainage system will support flood control and environmental goals while also providing a recreational opportunity to north Monterey County residents (Figure 8).	15	444
Riparian Easement: establish riparian zone protection easements in areas of the upper Gabilan watershed that have been identified in future land use maps as agricultural zones.	8	246
Riparian Protection: in areas of current grazing land use, implement riparian zone cattle exclusion fencing in the upper Gabilan watershed. In other areas, investigate necessary management actions to establish proper riparian zone protection.	68	1612
Riparian Flood Plain Restoration: Storm runoff from the Gabilan Mountains presents one of the greatest flood risks to Salinas. As runoff passes through agricultural fields it picks up sediment, nutrients, pesticides and other pollutants that are further concentrated as flow continues downstream to Carr lake and onward to Moss Landing Harbor and Monterey Bay. This action proposes to negotiate the seasonal lease or land sale of up to 247 acres of floodplain lands around the City of Salinas and restore proper riparian floodplain functions.	21	1617
Floodplain Restoration in Urban Expansion Area: Floodplain infiltration and natural corridor enhancement will be integrated into future development plans for the City of Salinas eastern expansion zone.	5	247
Urban Stream Restoration: Work with the City of Salinas and existing urban stream restoration programs including CSUMB's Return of the Natives to implement riparian zone restoration actions within the urban core of the City of Salinas.	9	216
Stormwater Ponds: Changes in rainfall patterns, rising coastal ocean levels and upstream land uses are leading to increased flooding of the Lower Gabilan/Salinas Valley watershed. Summer water resources are overburdened and Salinas Valley water purveyors are looking to identify	N/A	994

other summer water sources. This action offers an opportunity for water supply, flood management, water quality, environmental and community benefits. The project consists of a three pronged approach to upgrade stormwater impoundment capacity, create freshwater impoundments, and to treat lake water quality for reuse of water through a sinuous treatment wetland drainage system. Areas identified for the action are located in historical lakes in the areas around the City of Salinas.

Table 2. Key partners and their potential roles in implementing identified riparian conservation and restoration activities in the Gabilan watershed

Team Members	Land Acquisition	Design and permitting	Construction	Operations	Monitoring
City of Salinas		X		X	X
Monterey County Water Resources		X		X	
CCWG	X	X	X	X	X
Big Sur Land Trust	X	X	X	X	
Monterey County RCD	X	X	X	X	
Monterey County Parks Department	X		X	X	
Local Land owners	X		X		
Monterey County Grower Shippers				X	
Central Coast Regional Water Board					
Preservation Inc.					X

Appendix 1: Promoting Restoration and Management of Healthy Watersheds in Southern California

This project will help the State of California develop objective riparian assessment tools needed to support large-scale, long-term protection and management of healthy watersheds on the central and south coast. The 2013 EPA "Integrated Assessment of Watershed Health" report (Cadmus, 2013) documents the relatively high degradation of central and southern California watersheds and recommended the use of standard assessment tools to generate watershed specific objectives, direct restoration efforts and prioritize the protection of high quality riverine resources. The State currently lacks an integrated set of tools to aid in prioritization of actions within more defined drainages to ensure that resources are allocated effectively to enhance riparian condition, improve watershed functions and restore downstream beneficial uses. Recent bond programs and agency policies are providing the necessary funding and incentives to improve watershed management, riparian restoration, and protection of healthy riparian areas.

The WRAMP framework provides a roadmap for prioritizing restoration actions to maximize the likelihood of providing healthy and resilient watersheds. Several nascent actions in southern California provide an excellent foundation for assessing the extent and condition of riverine riparian areas to promote restoration and management of healthy watersheds. Each of these foundational efforts should be expanded to help local policy makers and managers ultimately achieve their healthy watershed goals:

1. Mapping of extent and distribution of riparian areas

Between 2013 and 2015, USEPA funded development of the California's wetland status and trends program (Figure 1). This probability-based mapping program builds on the national wetland status and trends program by intensifying the number of plots and the type of resources mapped within each plot to provide statistically robust, statewide estimates of extent and distribution of all aquatic resource types. Unlike the national program, the California status and trends program includes freshwater and tidal wetlands and streams (regardless of whether or not the streams include wetland areas) and is not limited by the seasonality of the resources (i.e., perennial, intermittent, and highly ephemeral resources are included). Program documents and mapping protocols have been completed and reviewed by a suite of technical and agency advisors (Lackey and Stein. 2015). The program was pilot tested in 2015 by mapping 110 probabilistically selected 4km² plots, approximately 1/3 of which were in southern California. Mapping the same plots over time provide estimates of extent, distribution, and change of all aquatic resources (Stein et al. 2015). The pilot study demonstrated that the status and trends program could be successfully implemented and provided initial statewide estimates of wetland and stream density (Stein et al. 2016). Stream density in southern California ranged from 0.04 km/km² for high order streams to 0.38 km/km² for low order streams, with an average stream density in the region of 0.20 km/km². Unfortunately, resources have never been available for full program implementation.

Application of the status and trends program at sufficient spatial intensity can provide watershed or regional scale estimates of riparian extent and distribution and can provide a sample frame for (Level 2 or 3) condition assessments. This probability-based assessment could be coupled with GIS and model-based mapping, such as the RipZET tool, to provide spatially explicit maps of the expected distribution of riparian habitats. Applying these tools retrospectively (i.e. using older aerial photographs) can be used to help prioritize watersheds or catchments with the largest historical losses and most opportunities for future restoration. Over time, these tools and approaches can also help track gains and losses associated with land use change, restoration, and management actions.

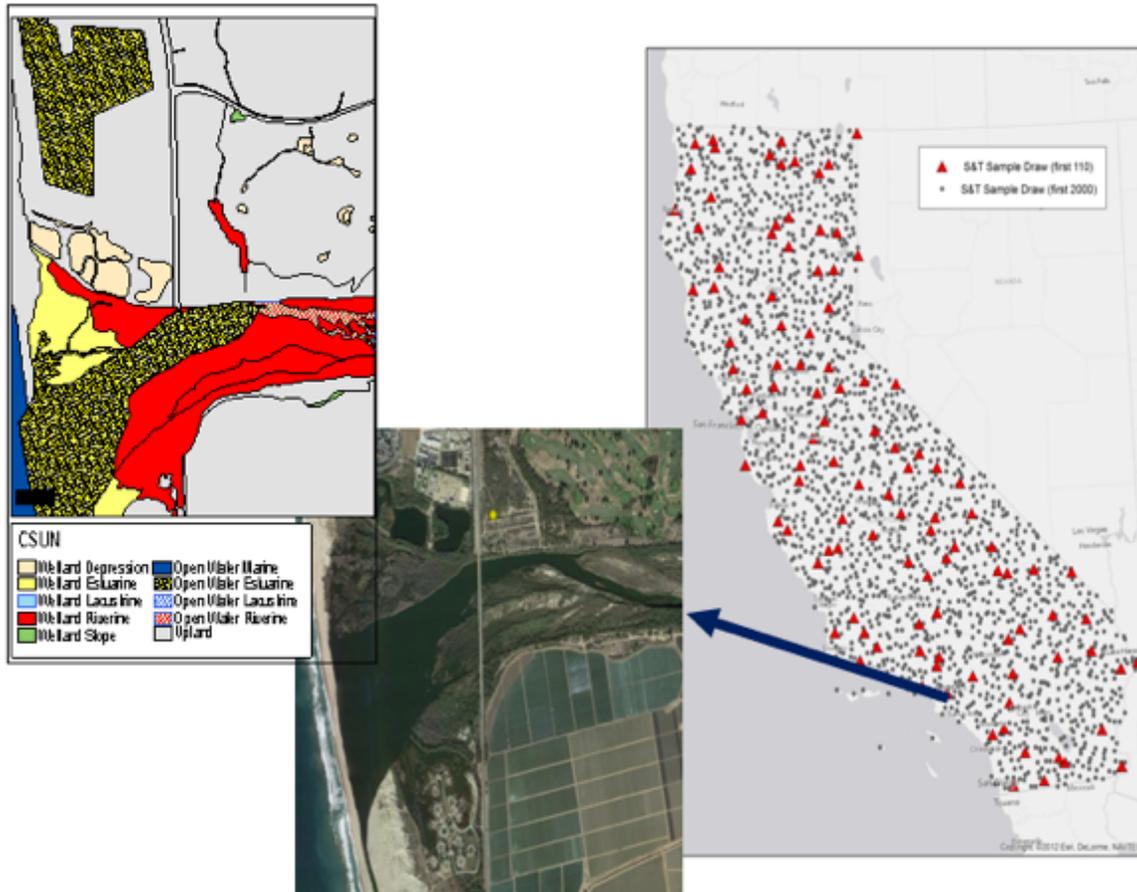


Figure 1: Example application of the California status and trends program. Grey dots on the map show completed statewide sample draw; red triangles show 100 plots mapped in the pilot study. Aerial photograph and map demonstrate photointerpretation of a sample 4 km² plot.

2. Assessing regional stream and riparian condition/health

Since 2009, the southern California Stormwater Monitoring Coalition (SMC) has been conducting a regional, probabilistic survey of stream condition (SMC 2007). The SMC is a coalition of multiple state, federal, and local agencies working collaboratively to improve the management of stormwater in southern California. SMC members include regulatory agencies, flood control districts, and research agencies. The SMC regional stream survey is a component of the State's Perennial Stream Assessment (PSA) program and partially fulfills NPDES permit monitoring requirements for local stormwater

agencies. Approximately 1,000 sites have been sampled since 2009 using a combination of Level 2 (California Rapid Assessment Method (CRAM)) and Level 3 indicators (assessment of benthic invertebrates, instream algae, and physical habitat) using tools and protocols developed by the California Wetland Monitoring Workgroup and the Surface Water Ambient Monitoring Program (SWAMP; Ode et al. 2016). In addition, information on chemical and physical stressors are collected to support emerging causal assessment programs (discussed below). Under the current program design, 1/3 of the sites sampled annually are revisits of past sites to contribute to region trends assessment. The most recent results suggest that approximately 25% of wadable streams are considered in healthy condition, but conditions vary by watershed across the region (Mazor 2015, Figure 2). The program is currently expanding into new habitats, such as non-perennial and ephemeral streams, developing new indicators (e.g. molecular based tools), and addressing new questions, such as the effect of watershed best management practices on instream condition.

In addition to assessing stream condition, the SMC program partners have been collaborating on development of a series of causal assessment tools aimed at determining which stressors are most likely responsible for affecting streams with biological condition below threshold values. Initial causal assessment tools are focusing on impacts due to flow alteration and to nutrient enrichment and subsequent biostimulatory response. These tools are currently being pilot tested in several southern California watersheds.

Prioritization of restoration and management actions could be supported through future efforts to expand the breadth of indicators to include presence of species of interest and additional measures of stress (e.g. improved flow monitoring). Spatial modeling could also be used to extrapolate condition to unsampled reaches and to better predict biological response to stress to assess watershed vulnerability at the reach or catchment scale and help prioritize areas for restoration or management.

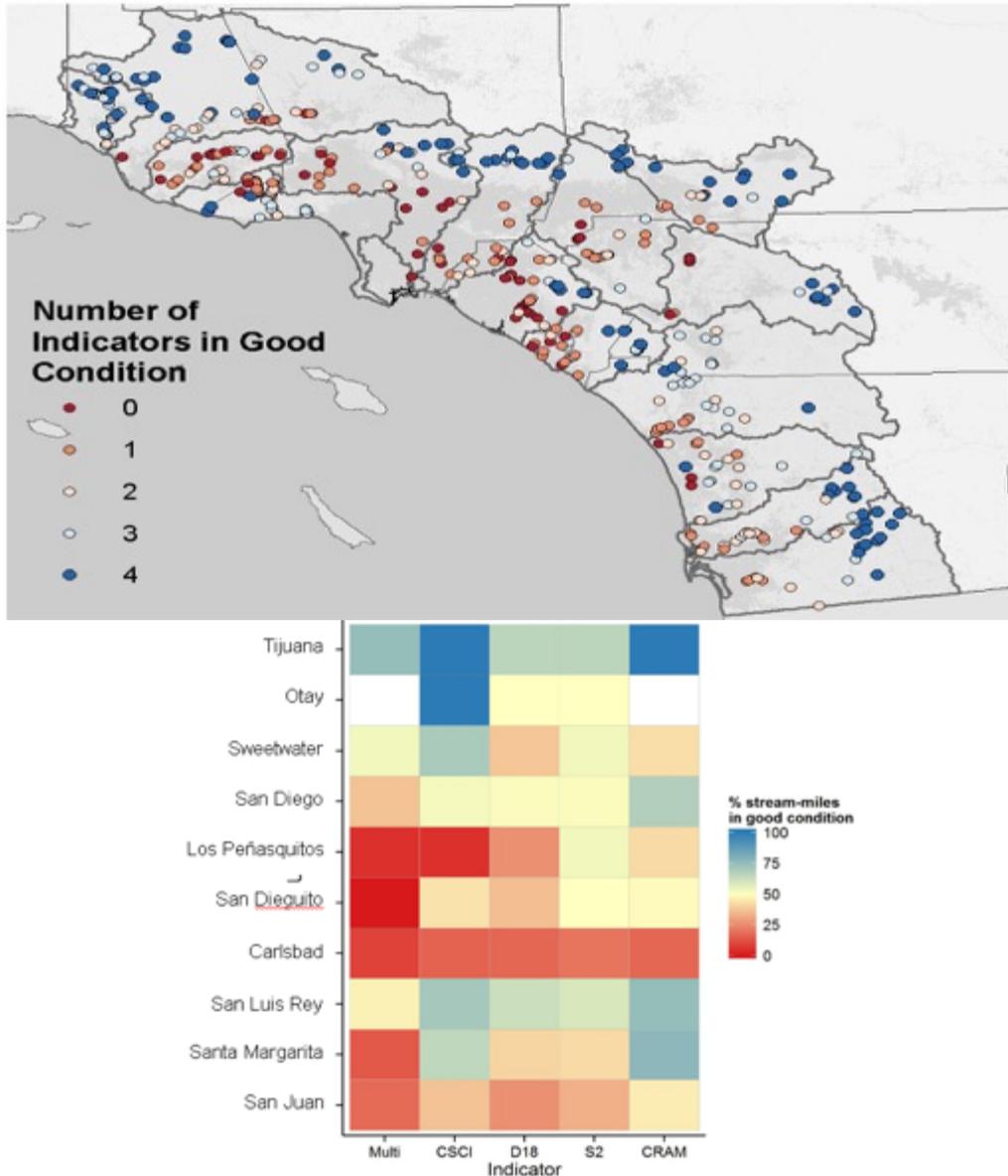


Figure 2: Results of the SMC regional stream monitoring program. Top panel shows the number of indicators indicating healthy conditions for each probabilistically sampled site. Indicators include benthic invertebrates (CSCI), diatoms (D18), soft bodied algae (S2) and CRAM. Bottom panel shows an extrapolation of the percent stream miles considered healthy by indicator and major watershed.

3. Watershed-scale restoration case studies

There are two principle mechanisms for restoration of healthy watersheds in southern California; grant funded watershed management through the Prop 84 funded Integrated Regional Water Management (IRWM) program and watershed planning through the NPDES permit program. The IRWM Grant Program is designed to encourage integrated regional strategies for management of water resources and to provide funding for implementation projects that support integrated water management, including protection and restoration of rivers, lakes and streams. Numerous IRWM programs exist in

southern California and are used to fund specific projects aimed at providing safe drinking water, flood control, and ecosystem benefits. Few, if any, of these programs take advantage of existing regional tools and programs such as the SMC regional stream survey, and there is little coordination across different IRWM plans. Increasing awareness of the existing tools could help improve efforts to establish healthy watersheds.

More recently, several Regional Water Quality Control Boards have changed the NPDES permits that regulate stormwater discharges to encourage watershed-scale management. Most of the watershed-based permits focus on application of traditional Best Management Practices (BMPs) and Low Impact Development or Green Infrastructure to address water quality problems. However, the San Diego Regional Water Board, working with municipalities in Orange and San Diego counties, has begun to focus on stream and floodplain restoration as a water quality management strategy. Perhaps the best example of this is the San Juan and Aliso Creek Water Quality Improvement Plan (WQIP), developed by the County of Orange (in coordination with the cities of the watershed) as a condition of their stormwater (MS4) permit. The WQIP establishes several "water quality" priorities including restoring incised channels and re-establishing natural flow regimes. These priorities reflect a desire to restore riparian health in the watershed. The WQIP proposes to use data and methods from the SMC regional stream survey and existing causal assessment tools to prioritize stream reaches for restoration with a goal of promoting overall watershed health. The proposed WQIP monitoring program would establish performance targets for flow, physical condition, and ecological health using the same tools and methods. Assessing progress toward achieving these targets could be incorporated into the existing regional program.

The San Juan and Aliso Creek WQIP could serve as a model for broader application of the integration of watershed restoration and management with existing regional monitoring and assessment programs. Use of this approach across numerous watersheds would ultimately provide a mechanism for promoting healthy watersheds region-wide.

4. Establishing regional watershed goals

The southern California Wetlands Recovery Project (WRP) recently released their updated regional strategy for wetland and stream restoration and management. *Wetlands on the Edge: The Future of Southern California's Wetlands* (Lowe et al. 2018) establishes quantitative targets for coastal wetland and stream acquisition and restoration with a goal of improving watershed health by enhancing riparian condition, stream connectivity and spatial integrity of watersheds. The objectives in the regional strategy will promote healthy watersheds by guiding the funding and implementation of stream and wetland restoration and management over the next several decades.

The WRP is a consortium created in 1997 consisting of directors and staff of 18 public agencies coordinating with each other regarding the protection, restoration, and enhancement of California's coastal wetlands and watersheds between Point Conception and the Mexican border.

Goal 2 of the Regional Strategy is "Preserve and restore stream corridors and other non-tidal wetland ecosystems to support healthy watersheds" (Table 1). Consideration of the Goal 2 objectives by

individual project and watershed restoration plans could help promote healthy watersheds regionwide. However, improved coordination is needed among agencies in sharing monitoring data, project evaluations, and ongoing assessment of project performance. Moreover, Goal 2 of the WRP Regional Strategy was based on a somewhat cursory analysis, given that the overall emphasis of the Regional Strategy was on tidal wetlands. An expanded analysis of watershed condition, historical losses, and future vulnerabilities would support development of a more robust set of regional watershed objectives to guide future restoration and management actions.

Table 1: Goal 2 objectives from the WRP Regional Strategy, focusing on restoration of healthy watersheds.

Objective	Description
1. Streams, adjacent habitats, and other non-tidal wetland area	Maintain 160,618 acres (65,000 hectares) and restore 49,421 acres (16,766 hectares) to achieve 210,039 acres (85,000 hectares) of non-tidal wetlands.
2. Habitat composition	A. Restore or maintain 189,036 acres (76,500 hectares) of streams and associated adjacent habitat. B. Restore or maintain 21,004 acres (8,500 hectares) other non-tidal wetlands (depressional, slope, etc.).
3. Connectivity	A. Ensure that there are no artificial physical barriers that obstruct water, sediment, and wildlife movement from watersheds to coastal wetlands. B. Remove 100% of the total and partial barriers to steelhead passage in the high priority watersheds identified in the Southern California Steelhead Recovery Plan (California Fish Passage Assessment Database (PAD)).

Summary and Recommendations

Numerous programs have been developed and implanted in southern California over the past 15 years that position the region well for establishing healthy watersheds. However, additional work is necessary to fully realize the goal of healthy watersheds regionwide. Existing tools and programs should be expanded to help advance restoration and management actions in both central and southern California, subject to the following recommendations:

1. Expand on the WRP effort to develop a more comprehensive set of watershed goals and objectives to guide management actions. Develop an associated monitoring program to track progress toward meeting the expanded set of objectives. Expand this watershed goals effort to the central coast.
2. Implement the status and trends program (statewide), coupled with model-based mapping to assess extent, distribution, areas of historical losses of watersheds, and areas of potential gain in riparian habitat.
3. Expand existing condition and causal assessment programs to better quantify stress and areas of highest vulnerability. On those south coast through the SMC, on the central coast through CCAMP.

4. Develop additional watershed management programs that integrate restoration prioritization, performance assessment, and regional monitoring and assessment using consistent tools and approaches (modeled after the San Juan and Aliso Creek WQIP).
 - a. Present the WQIP approach to RB3 NPDES staff
5. Improve coordination among agencies and programs to expand awareness of existing mapping and assessment tools, enhance data and information sharing and better coordinate monitoring and assessment.

All the above efforts should be coordinated through the State's Healthy Watersheds Partnership, which provides a forum for interagency coordination and joint development of tools and information management strategies.

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Appendix 2: EPA Grant Proposal Workplan

PROJECT TASKS

This grant will accomplish several tasks designed to provide the necessary scientific support to develop objective riparian assessment tools needed to support large-scale, long-term protection of healthy watersheds:

Task 1: Project Administration, Reporting and formation of TAC

Description: CCWG will manage each project task, oversee grant funds and deliverables, provide bi-annual written updates to EPA, and submit a final report. An update to the previous EPA approved quality assurance project plan (QAPP) will be completed to govern the collection of new data. CCWG will form and host a Riparian TAC to guide the development of the grant products, input from which will be used in the development of recommendations to the State Level 2 Committee and to the CWMW.

Deliverables: 1) Quarterly Reports, 2) Final report 3) Updates to the QAPP 4) TAC meeting minutes

Task 2: Complete Statewide development of Riparian rapid condition assessment tool

Description: The Riparian Rapid Assessment Method for California (RipRAM) was developed on the central coast as a parallel tool to CRAM focused on the evaluation of riparian health. Between 2013 and 2016, RipRAM was developed and verified by CCWG throughout the Central Coast, guided by a technical review team of wetland scientists from federal, state and local agencies, academia, consultants, and non-profits. The RipRAM results were compared with water quality and IBI data collected by the Central Coast Water Board's "Central Coast Ambient Monitoring Program" (CCAMP). A key value of the tool is the ability to derive condition scores in areas with restricted access (from road crossings and public right of ways). The method has been adopted by the Central Coast Water Board as their measure of riparian health for CCAMP. We have yet to document the state wide applicability of the tool. Thus, this grant proposal aims to complete development of the tool and integrate its use within three additional Regional Boards along the south coast.

RipRAM will be tested throughout California at 50 locations to ensure that the module is able to assess riparian zones across the full range of condition and ecoregions present in California. The RipRAM field book will be updated to capture riparian features not yet documented, provide additional guidance and examples, and update any metric narratives or scoring tables to reflect the range of riparian conditions throughout the State. RipRAM sample collection activities will include evaluating level of property access, preparation of field materials, travel to the site, field assessment, and data entry and QA. RipRAM assessments will be compared with available level 3 data including biological (e.g. IBI), water quality, soil condition, or faunal surveys (see Stein et al 2009). We will then work with our partners at the San Francisco Estuary Institute (SFEI) to create an online repository for RipRAM data. The field book will be revised, a validation report written and submitted for publication, scores will then be displayed on EcoAtlas.org and final results presented to the L2 committee and CWMW. We will then develop a training curriculum and hold several trainings on the methodology with Regional Board Staff involved in stream and riparian monitoring.

Deliverables: Finalized RipRAM field book, validation and QA report, eRipRAM module, training presentations

Task 3: Map and prioritize healthy watersheds

Description: This task will synthesize information from multiple tools and data sets to rank healthy watersheds for protection and management. Data sets related to both watershed condition and vulnerability (such as fire risk, past drought maps, future land use) will be compiled for 6 central and southern California watersheds to guide watershed management decisions. We will augment existing data layers compiled through the previously completed California Integrated Assessment of Watershed Health (Cadmus, 2013) with newly available data sets such as the USGS map of hydrologic condition, The Nature Conservancy's Atlas of Freshwater Biodiversity, CDFW's Fish Passage Assessment Database, the California Natural Diversity Database, and available regional data sets (e.g. Central Coast Ambient Monitoring Program, Southern California Stormwater Monitoring Coalition).

Working with the project advisory committee, we will use the Riparian Zone Estimator Tool (RipZET), the Spatial Tools for the Analysis of River Systems (STARS) ArcGIS custom toolset, the Functional Linkage of Water basins and Streams (FLoWS) toolbox, random forest models with the StreamCat dataset, and the "SSN package" for R Statistical software to fit spatial statistical models to available stream data and develop condition assessment maps of river and riparian condition and vulnerability for selected watersheds. These stream reach watershed condition estimates will then be verified using RipRAM. In effect, we will be integrating RipRAM data with other watershed condition and vulnerability indicators to establish an assessment framework for healthy watersheds.

In addition, we will use the task output to define and map the reference riparian widths for central and south coast watersheds. The initial exploration of this approach in reference areas in the Central Coast Region during our previous grant were encouraging, but also make it clear that it will be important to undertake this analysis with an understanding of reference relative to specific habitat types within a Region.

Deliverables: rectified GIS data layers and maps, a watershed health assessment and data output, defined reference riparian widths for 2 regions, freshwater biodiversity conservation data and flow alteration data from TNC and USGS integrated with watershed health assessment.

Task 4: Development of watershed prioritization and regional protection objectives

Description: We will demonstrate application of the tools developed in the prior tasks to establish watershed priorities and restoration/management goals for the southern California and Central Coast regions.

Building on a decade of new research data and tools, the Southern California Wetlands Recovery Project (WRP) began the process to update their Regional Strategy in 2012. The Regional Strategy Update (RSU) will include quantifiable and spatially-explicit goals for coastal wetlands that can ultimately be used by WRP member agencies and partners for reference in designing projects, reviewing project proposals, and making funding decisions. This task will support team members to integrate coastal watershed condition results into the RSU planning process and ensure that the resulting strategy includes quantifiable and spatially-explicit habitat goals for priority watersheds (stream and riparian) to augment the goals for coastal wetlands currently being developed.

We will then repeat this effort for the central coast region, working with regional partners (RB3 and MBNMS) to ensure their visions and strategies for wetland, stream and watershed management ("Vision of Healthy Watersheds for the Central Coast", and "Water Quality Protection Program") are included and addressed.

A final step will involve a comparison of the results between the south coast and central coast watersheds, providing insight into differences in condition, vulnerability, and regional priorities. This will provide a path forward for repeating this process in other regions of the state.

Deliverables: Regional Condition Assessment Maps of priority watersheds to aid strategic planning of watershed restoration and management efforts within Southern and Central California.

Task 5: Enhance platform for data dissemination and output tracking

Description: This task will produce a user-friendly data exploration tool that allows easy exploration of combinations of condition and vulnerability to develop watershed prioritizations. We will build on readily available data management platforms, such as ESRI Open Data Portal, Tableau, or EcoAtlas. We will upload condition assessment and management prioritization maps to the existing user-friendly data exploration tool (EcoAtlas). In addition, we will expand the functionality of Project Tracker for use by regional partners to track progress on watershed protection actions.

Deliverables: Expanded EcoAtlas and Project Tracker data management and dissemination systems, populated with all relevant information collected by this project

TRANSFER OF RESULTS

In accordance with the objectives of CCWG, the results will be available for download on the CCWG website, which currently acts as a clearing-house for the Central Coast. Additionally, L 1, 2 and 3 data products will be uploaded to the State's data portals (EcoAtlas.org, cramwetlands.org, ccamp.org). CCWG will hold trainings and presentations with regional partners (Regional Water Boards, county IRWMPs, USFWS, Morro Bay NEP, MBNMS, etc.) to support adoption of monitoring tools for regional use. The assessment results will be summarized and presentations will be given at several conferences (SRF, H2O, etc.), to the CWMW, and to the California Water Quality Monitoring Council. Additionally, through the CWMW and SWAMP, tools and products will be transferred to other regions of the state. Finally, the inventory and assessment data can be used in the next State of the State Wetlands report, due in 2020.

OUTPUTS, OUTCOMES AND TRACKING

The completion of this project will result in the development of tools to estimate current condition of riparian resources and regional goals for riparian protection and restoration. These tools can then be transferred to other regions of the State where similar limitations undermine efforts to monitor and track these resources.

i. Outputs (project products)

This project will validate new methodologies to rapidly assess riparian condition, use recently developed wetland and riparian mapping tools to inventory streams and riparian areas, assess their vulnerability, develop regional goals for protection and management, and integrate this information into wetland protection and watershed planning processes on the central and south coast. The project will result in the following products:

- The establishment of the Riparian Technical Advisory Committee (TAC) who will define the necessary steps to implement a regional riparian goals program that best meets the needs of our regional partners.
- A validated Riparian Rapid Assessment Method, with accompanying online data repository.

- Regional Board staff trained in RipRAM
- An assessment framework/approach for integrating multiple data layers on “health” and “vulnerability” to produce an overall assessment of management needs
- Regional Maps of priority watersheds for protection along with rationale and recommended funding sources
- Data management and dissemination system, with project tracking functionality integrated into existing data management systems
- A summary of results and presentations at various State wetland symposia.

ii. Outcomes (project objectives)

Development of appropriate assessment tools for riparian areas is a necessary part of a comprehensive monitoring strategy for aquatic resources and will assist in building State capacity to implement more effective wetland protection programs. This project directly links to Core Elements as they relate to Monitoring/Assessment and Regulatory Approaches. It also supports the state WRAMP, endorsed by the CWQMC. Outcomes include:

- Supporting a watershed-based approach for State and Federal wetland assessments to better address cumulative impacts and identify and protect critical watershed processes;
- Supporting consistency with the WRAMP through development of standardized assessment approaches (RipRAM), information collection, and reporting on streams and associate riparian areas;
- Support for establishment of regional goals for the central and southern California regions
- Building capacity to measure and report on the extent, function, condition, and sources of significant stressors to the condition of streams and riparian areas in currently inaccessible areas, which can feed into the next State of the State's Wetland Report.
- Supporting Regional Board wetland and riparian protection policies through establishment of a Riparian TAC.
- Providing Regional Board staff with a tool for assessment of riparian health
- Providing a means for Regional Board staff to assess and map the status of riparian health throughout the Region that is consistent with state-wide approaches.