Riparian Zone Monitoring Report

Results for Stability, Sediment Loads & Revegetation Survival from Conservation Practices 2008-2011

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INTRODUCTION

The conservation practices implemented from 2008-2009 by Marin RCD and partnering organizations were monitored to document changes in quantitative effectiveness at restoration sites over time for further understanding agricultural sustainability and ecosystem services. Consistent and systematic monitoring of project outcomes will continue to improve conservation practices while providing funding and permitting agencies feedback to support Marin RCD's future restoration projects and Permit Coordination Program. Monitoring of Marin RCD's conservation practices evaluates the effectiveness of projects at the site or ranch scale since water quality and fisheries of the Tomales Bay Watershed are evaluated by partnering organizations. The changes documented in stability, plant diversity and habitat structure at restoration project sites provide evidence of water quality and wildlife improvements based on existing scientific research.

The protocols used were outlined in the Riparian Zone Monitoring Plan (RZMP) which provides a science-based guide to standardize project monitoring using site-specific objectives for any stream from headwater creeks or gullies to large streams or small rivers. The RZMP components were based on existing protocols with field-testing conducted at numerous project sites from 2008 to 2011 as a collaborative effort among Marin RCD partners including USDA Natural Resources Conservation Service (NRCS), Students & Teachers Restoring A Watershed (STRAW), Prunuske Chatham, Inc. (PCI), Marin Agricultural Land Trust, San Francisco Bay Regional Water Quality Control Board, Southern Sonoma County Resource Conservation District, Point Reyes Bird Observatory Conservation Science (PRBO), California Department of Fish and Game, Point Reyes National Seashore (PRNS), Marin Municipal Water District (MMWD), and The Nature Conservancy.

Marin RCD's partnering organizations collaborated on monitoring roles with certain tasks shared and other components led by specific groups to ensure quality control (below, revised RZMP Table 5). Implementation monitoring documented what was done where and were completed after the project is installed for all practices. Effectiveness monitoring evaluated project performance and site characteristics related to project objectives with qualitative (Project Assessment Checklist), semi-quantitative (Revegetation Survival), and quantitative (Line-Intercep Transect) methods. Validation monitoring of habitat use includes bird populations by PRBO, fisheries by MMWD or PRNS, and water quality by Tomales Bay Watershed Council.

Task (monitoring form)	Timeline	Partner Roles	% of Projects
Monitoring Plan Checklist	Pre-project	MRCD, NRCS, STRAW, UCCE	100%
Objectives/ Targets		MRCD, all partners	100%
Map/ Site Sketch	Post-project completed < 3 years	MRCD, NRCS, PCI, STRAW	100%
Revegetation Data		MRCD, NRCS, PCI, STRAW	100%
Revegetation Survival		STRAW, UCCE	90-100%
Project Assessment Checklist	Post-project & repeated 2-5 years	MRCD	90-100%
Landowner Questionnaire		MRCD	90-100%
Photo-points	Pre-project, post-project, & repeated 3-10 years as funding is available	MRCD, all partners	90-100%
Sediment Load Estimates		MRCD, PCI, UCCE	90-100%
Streambank Stability Transect		UCCE	10-25%
Vegetation Transects		MRCD, UCCE, STRAW	10-25%
Instream Habitat Transect		UCCE, PRNS, MMWD	10-25%
Stream Shade (Densiometer)		UCCE, STRAW	10-25%
Tag Lines/ Cross-sections		PCI, STRAW, UCCE	10-25%
Bird Surveys		PRBO	10-25%

Eight sites were quantitatively monitored for streambank stability, sediment loads and vegetation with line-intercept transects totaling 37,424 feet for pre-project, baseline data during 2008 and post-project surveys were repeated in 2011 by UCCE with in-kind funding from Marin Community Foundation. Streambank and gully erosion were the focus of quantitative monitoring because they were the primary project objectives, but sheet and rill erosion will be estimated in the future. Potential erosion (PE) and sediment loads were calibrated with assistance from PCI staff during project implementation showing that the data collected from UCCE transects was consistently in the low range compared to engineer estimates. The actual volume of *Sediment Saved* for each site was calculated by subtracting the post-project potential erosion from pre-project values and estimating erosion that occurred since implementation (below):

Sediment Saved = (Pre-project PE) – (Post-project PE) – (Post-project Erosion)

Revegetation survival was collected for the five sites with planting of native species by STRAW and UCCE, and cross-sections were measured at two large biotechnical projects by PCI and STRAW. The quantitative effectiveness attributes monitored at each site (below) includes pre-project transects for vegetation on the upper bank, stream shade with Deniometer, and instream habitat which are monitored ever 5-10 years as changes occur and funding is available.

Site	Year Monitored							
	Survival	Stability	Sediment Load	Floodplain Vegetation	Upperbank Vegetation	Instream Habitat	Shade	Cross-section
Clark Summit Gully	2009,10,11	2008,11	2008,11	2008,11	2008		2008	2010
Barboni Road Streambank	2009,10,11	2008,11	2008,11	2008,11	2008			
Barboni Sheep Field Streambank	2009,10,11	2008,11	2008,11	2008,11	2008	2008	2008	2010
Barboni Riparian Fence	NA	2008,11	2008,11	2008		2008		
Gallagher Riparian Fence	NA	2008,11	2008,11	2008,11	2008			
PRNS Giacomini Riparian Fence	NA	2009,11	2009,11	2009,11		2008		
Furlong Gully	NA	2008,11	2008,11	2008				
Yuhas	2010,11							
Blue Mountain	2010,11							

RESULTS & SITE SUMMARIES

The summary of monitoring results includes both overall trends and site specific responses during the initial three years post project. Overall, the sediment savings data showed the greatest short-term changes with 2,825 cubic yards (CY) of sediment saved and provided feedback on project success to meet primary objectives.

Though multiple conservation practices are often implemented at any one site, the use of standardized monitoring methods across sites provided the ability to compare outcomes of common restoration techniques. The locations selected for biotechnical treatments and grade stabilization conservation practices were based on site-specific surveys of potential erosion and sediment delivery. As expected, they had the largest benefit to reducing sediment loads within three years post-project. In contrast, riparian revegetation was implemented where streambank stability and potential sediment loads were low so the sediment savings was expected to be slower. Fences were used at most all sites with livestock access and fencing alone was used where stability was high with existing riparian vegetation so the success of passive restoration was expected. The relative comparison of potential erosion controlled for transect distance (CY/ ft) shows that revegetation sites (1,500 ft) had more erodible volume per foot than fenced only sites (11,000 ft). The integration of multiple conservation practices appears to have maximized the success and efficiency of watershed improvements in Marin County.

Practice Type	Project Phase	Stability (%)	Potential Sediment Erosion (CY)	Sediment Saved (CY)	Potential Erosion: Distance (CY/ ft)
Fence	pre	75%	1,433	505	0.14
	post	85%	841		0.08
Revegetation	pre	60%	581	152	0.40
	post	71%	404		0.27
Biotech &/or	pre	59%	2,210	2,169	1.62
Grade Structure	post	80%	40		0.03

In addition to conservation practices, standardized monitoring allowed for comparisons of site location such as gully vs. stream landform, or watershed position (below). The relative potential erosion ratio (CY/ ft) compares the two gully sites (4,400 ft) with six stream sites (14,300 ft) to quantify the larger sources of sediment from upland locations. The similar post-project values further support the success of how Marin RCD and its partners utilized site-specific restoration methods and conservation practices.

Landform	Project Phase	Stability (%)	Potential Sediment Erosion (CY)	Sediment Saved (CY)	Potential Erosion: Distance (CY/ ft)
Gully	pre	64%	2,164	1,807	0.48
	post	89%	349		0.08
Stream	pre	73%	2,059	1,019	0.14
	post	80%	936		0.07

Clark Summit Farm

The gully at Clark Summit Farm had numerous active headcuts with 20 year old redwood board checkdams decomposing and beginning to fail. Potential sediment delivery ranged from 800 to 1,300 cubic yards before project implementation. The two grade stabilization structures in the biotech section were highly successful and revegetation has established healthy sedge, rush and willow to ensure against further headcuts and downcutting of the channel. However, the lower section continues to have erosion potential if large storms come before vegetation is fully established and approximately five to ten years will be needed to monitor this section to show similar improvements in stability as measured in the above sections.

Section	Year	Stability (%)	Potential Sediment Erosion (CY)	Sediment Saved (CY)
upper	2008	44%	208.6	
	2011	78%	22.6	185.6
biotech, GSS	2008	16%	421.2	
	2011	97%	1.9	419.2
lower	2008	68%	351.3	
	2011	72%	299.1	49.0

Two cross-sections were measured in 2010 by PCI and STRAW above each grade stabilization structure to quantitatively document the volume of erosion, if it occurs. The accompanying new water trough, tank, pipeline and pump provide clean water to cattle, pigs and chickens (located near the center of animals in top of photo, below).

Revegetation by STRAW was successful with 79% survival establishing seven native woody species (below) and future riparian forest habitat.

Species	Number Planted	Total Alive	% Survival	<3ft, LV	<3ft, HV	>3ft, LV	>3ft, HV
Acer negundo	29	26	89.7%	1	2	5	18
Aesculus californica	10	5	50.0%	2	2	0	1
Crataegus douglasii	6	5	83.3%	1	0	0	4
Fraxinus latifolia	5	5	100.0%	0	0	0	5
Juglans californica var hindsii	15	9	60.0%	0	8	0	1
Quercus agrifolia	30	24	80.0%	0	13	0	11
Sambucus nigra	18	15	83.3%	2	10	0	3
Total	**113**	**89**	**78.76%**	**6**	**35**	**5**	**43**
				7%	***39%***	***6%***	***48%***

Barboni Ranch

The restoration sites prioritized at Barboni Ranch for Marin RCD grants were the product of an updated Conservation Plan by NRCS including streambank protection, pasture management, fencing and water development. The monitoring results reflect the level of planning in addition to landowner support and dedication to stewardship. Potential sediment delivery from the three sites ranged from 800 to 1,400 cubic yards before project implementation. Overall, the combined monitoring results provided an 82% reduction of potential sediment delivery from 1,059 to 189 CY.

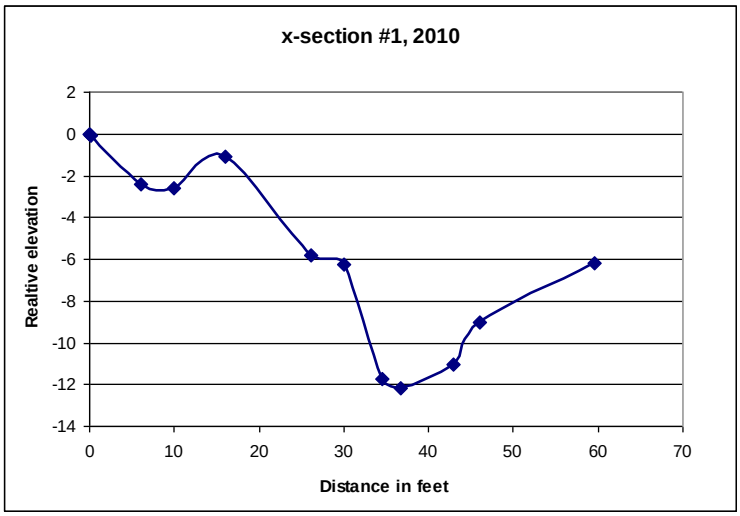
Site	Section	Year	Stability (%)	Potential Sediment Erosion (CY)	Sediment Saved (CY)
Road Stream-bank Biotech		2008	29%	162.0	
		2011	93%	0.2	161.7
Sheep Field Stream-bank	lower	2008	19%	20.1	
		2011	86%	0.4	19.4
	biotech, GSS	2008	8%	555.9	
		2011	54%	16.1	539.3
	middle	2008	40%	123.5	
		2011	45%	59.5	44.0
	wooded	2008	46%	37.8	
		2011	60%	10.7	25.5
	upper	2008	58%	86.5	
		2011	76%	44.6	39.4
Riparian Fence	wooded	2008	81%	32.0	
		2011	84%	27.5	3.2
	open	2008	75%	7.7	
		2011	81%	5.9	-0.5
	wooded	2008	73%	33.9	
		2011	78%	27.7	4.3

The road streambank site protected an important ranch access driveway with biotechnical willow wall and fascine in addition to a diverse species mix with shade-tolerant native grasses to ensure long-term stability (right, before planting). As shown by the 99% reduction in potential sediment volume and vigorous survival (below), the project site was highly successful. Because of the steep slope and proximity to ranch road (right), the site will also be qualitatively monitored by the landowner for signs of instability and success of revegetation was critical for long-term success. Though total survival was low, the density and diversity of the revegetation design ensured the establishment of adequate cover to accomplish the biotechnical targets (below).

Species	Number Planted	Total Alive	% Survival	<3ft, LV	<3ft, HV	>3ft, LV	>3ft, HV
Quercus agrifolia	1	1	100.0%	0	3	0	3
Salix lasiolepis	25	25	100.0%	70	29	7	12
Umbellularia californica	1	0	0.0%	0	0	0	0
Ribes speciosum	10	6	60.0%	6	1	1	0
Symphoricarpos albus	10	9	90.0%	2	12	0	6
Corylus cornuta	3	2	66.7%	3	3	4	4
Rhamnus californica	4	0	0.0%	7	4	0	0
Lonicera hispidula	10	8	80.0%	6	1	0	0
Polystichum munitum	5	4	80.0%	0	4	0	0
Athyrium filix-femina	5	3	60.0%	0	2	0	1
Festuca californica	30	15	50.0%	0	15	0	0
Festuca idahoensis	219	75	34.2%	10	65	0	0
Festuca rubra	40	30	75.0%	0	30	0	0
Bromus californica	30	25	83.3%	20	5	0	0
Carex barbarae	35	27	77.1%	61	16	0	0
Juncus patens	10	9	90.0%	17	2	0	0
TOTAL	**438**	**239**	**54.6%**	**202**	**192**	**12**	**26**
				85%	*80%*	*5%*	*11%*

The sheep field site was monitored as five subsections within the riparian fence based on the location of specific conservation practices, geomorphology and existing vegetation. The biotechnical willow fascines have grown slow because of poor soil conditions and deer browse; however, numerous shoots are above browse height and 99% is alive with sedge and rush established at the base of streambank. The 98% reduction in erodible sediment volume was the result of successful design and construction of grade stabilization structure to repair headcutting tributary swale, sloping back the streambank and continuous willow establishment. A couple rocks slumped at the top of the headcut repair and will be monitored further.

Photographs show the sheep field biotechnical streambank stabilization site before (above) and during implementation of grade stabilization structure and willow fascines (below). Cross-sections were measured by PCI and STRAW (example below).



The four non-biotechnical sections were also planted with native species and the resulting sediment reductions were highly variable ranging from 52-97%. The middle section with lower success (52% sediment load reduction) resulted from two bank washouts (5-15 CY each) during winter 2010 and deer browse caused significant mortality of willow sprigs. Though perennial grass is filling-in thick over most of the site, the blowout locations may need a small willow wall or other biotechnical treatment that includes temporary deer protection. Overall, the sheep field streambank site has extensive revegetation with successful establishment of multiple native species (below). Though most are less than 3 feet tall (still susceptible to browsing) and low vigor (LV), the 47% with high vigor (HV) provides confidence that the revegetation will be resilient to potential disturbance. Example field forms for survival, streambank stability line-intercept transects, and Project Assessment Checklist are available in Appendix A.

Species	Number Planted	Total Alive	% Survival	<3ft, LV	<3ft, HV	>3ft, LV	>3ft, HV
Biotech section:							
Quercus agrifolia	10	6	60.0%	0	3	0	3
Aesculus californica	10	4	40.0%	1	3	0	0
Umbellularia Californica	4	0	0.0%	0	0	0	0
Ribes speciosum	15	8	53.3%	6	1	1	0
Baccharis pilularis	30	20	66.7%	2	12	0	6
Corylus cornuta	23	14	60.9%	3	3	4	4
Rhamnus californica	23	11	47.8%	7	4	0	0
Lonicera hispidula	15	7	46.7%	6	1	0	0
Salix lasiolepis (123 sprigs)	123	118	95.9%	70	29	7	12
Carex barbarae	150	77	51.3%	61	16	0	0
Juncus	60	19	31.7%	17	2	0	0
STRAW sections:							
Acer negundo	20	15	75.0%	1	4	0	10
Aesculus californica	12	6	50.0%	0	6	0	0
Corylus cornuta	5	3	60.0%	1	2	0	0
Fraxinus latifolia	20	12	60.0%	3	7	0	2
Heteromeles arbutifolia	5	4	80.0%	0	4	0	0
Juglans hindsii	12	10	83.3%	1	9	0	0
Quercus agrifolia	5	5	100.0%	0	4	0	1
Quercus lobata	15	8	53.3%	0	6	0	2
Sambucus nigra	20	13	65.0%	6	7	0	0
Symphoricarpos albus	15	12	80.0%	1	11	0	0
TOTAL	**592**	**372**	**62.8%**	**186**	**134**	**12**	**40**
				50%	***36%***	***3%***	***11%***

The third site at Barboni Ranch (riparian fence site) was located in the pasture upstream of the sheep field. Fencing was used to control livestock access to the riparian area with the goals of both preserving existing resources and increasing streambank stability. Because of extensive existing native trees, low potential erosion (74 CY) and fairly stable streambanks (78%), the area is managed as a riparian pasture with light, dry season grazing. Improvements and measurable changes were expected to be slower at this site so further monitoring will be repeated les frequently at five to ten-year intervals.

Gallagher Ranch

The Gallagher Ranch implemented numerous conservation practices with NRCS and Marin RCD including water development and replacing a circa 30 year-old riparian fence to control cattle access to Lagunitas Creek. Because of the active floodplain pasture location, a break-away and easy-to-takedown design was constructed (right).

Section	Year	Stability (%)	Potential Sediment Erosion (CY)	Sediment Saved (CY)
lower	2008	85%	100.0	
	2011	88%	83.4	11.6
below	2008	93%	14.7	
bridge	2011	96%	9.5	3.3
above	2008	82%	40.7	
bridge	2011	88%	28.1	8.6
open	2008	3%	314.1	
	2011	15%	180.5	78.6
upper	2008	87%	13.9	
	2011	90%	10.6	1.3

Similar to the previous site discussed, the majority of riparian area (2000 ft) has existing native trees, low potential erosion (14-100 CY) and fairly stable streambanks (82-93%). As a result, mutual goals exist to both preserve existing resources and restore habitat by increasing streambank stability and riparian vegetation cover for coho salmon. However, a 190 ft open section of the site was devoid of riparian vegetation (right) so it will continue to be monitored with line-intercept transects into the future. Though not directly planted, willows are naturally regenerating and ground cover improved while streambank stability increased to provide moderate sediment savings from 2008 to 2011. The lower section with 100 CY potential sediment volume will be qualitatively monitored because the decadent box elders could topple down allowing the streambank to unravel. This section has shallow flat water aquatic habitat and is an option for instream enhancement practices such as large woody debris.

Giacomini Ranch, PRNS

John West Fork Creek was fenced for less than a half mile to exclude livestock from important spawning and rearing coho salmon habitat. Water developments were implemented and a stream crossing was installed downstream of the riparian fence between exclusionary fences. The site is forested with deep shade of Douglas fir, bay, buckeye, oaks and willows with large woody debris aggrading the channel for most of the site, except for a 300 ft upper section which was monitored in 2009 and 2011 with no significant change in sediment saved. However, two unstable potential landslide streambanks are precariously held together by trees that are leaning over with undercut roots (right). In addition, cape ivy, poison oak and California blackberry slightly increased in cover.

Section	Year	Stability (%)	Potential Sediment Erosion (CY)	Sediment Saved (CY)
unstable	2009	67%	111.6	
	2011	74%	118.1	-7.3

The stream crossing was moderately successful – stable but poor in appearance with rock settling to expose the underlying geotextile fabric. West of the crossing in 2009, rills and small headcuts were developing in the sensitive, blue-goo type of soil and PRNS staff successfully used brush and fencing to divert livestock and vehicle traffic; however, a 1.5 ft headcut remains caused by overland flow down the trail parallel to older fence (right). Small willow walls and/or brush mattress may suffice to stabilize the 10 to 70 CY of potential sediment erosion near the headcut.

The stream channel in middle section of the site is aggrading with a wide, dynamic floodplain until the transition point delineating the lower site where multiple trees have fallen in to stabilize the channel bed which will be qualitatively monitored. The lower section of the site enters a slightly incised alluvial valley with perennial pools maintaining coho salmon over summer where the habitat and population monitoring begins conducted by PRNS (left, pink flagging marks coho habitat use). This site is an example of where one agency's monitoring program ends is where another program begins. The monitoring results will be discussed between partners to prioritize future conservation projects.

Furlong Ranch

The gully at Furlong Ranch has two old earthen dam stockponds and one spillway was highly unstable with 800 to 1800 CY of potential erosion. An active headcut downstream of the spillway could have delivered an additional 180 to 250 CY and jeopardized the spillway repair. The project effectiveness rating is Excellent on the Project Assessment Checklist (PAC) and the rock work completed for lined waterway and Grade Stabilization Structures (GSS) was very stable and beautiful.

Section	Year	Stability (%)	Potential Sediment Erosion (CY)	Sediment Saved (CY)
upper	2008	67%	112.8	
	2011	97%	3.8	104.3
pond 2 GSS	2008	44%	885.1	
	2011	97%	8.0	876.9
lower GSS	2008	87%	185.4	
	2011	97%	13.3	171.7

Blue Mountain Ranch

The revegetation work by STRAW, blackberry eradication and erosion control with rock lined waterway have been successful, except the toyon (*Heteromeles*) and thimbleberry (*Rubus*) had low survival.

Species	Number Planted	Total Alive	% Survival	<3ft, LV	<3ft, HV	>3ft, LV	>3ft, HV
Acer negundo	20	20	100.0%	0	0	2	18
Rhamnus californica	7	7	100.0%	0	6	0	1
Crataegus douglasii	7	7	100.0%	1	3	1	2
Symphoricarpos albus	30	28	93.3%	4	22	1	1
Rubus parviflorus	21	7	33.3%	3	4	0	0
Heteromeles arbutifolia	2	0	0.0%	0	0	0	0
Myrica californica	23	23	100.0%	0	12	0	11
Aristolochia californica	10	9	90.0%	1	8	0	0
Lonicera hispidula	3	2	66.7%	0	0	0	2
Fraxinus latifolia	15	15	100.0%	2	4	1	8
Juglans californica var hinds	8	8	100.0%	1	7	0	0
Sambucus nigra	20	17	85.0%	6	4	0	7
Garrya elliptica	5	5	100.0%	1	2	0	2
Festuca californica	10	10	100.0%	0	10	0	0
Total	**181**	**158**	**87.29%**	**19**	**82**	**5**	**52**
				12%	52%	3%	33%

Yuhas Ranch

The revegetation by STRAW along a tributary to Stemple Creek was highly successful (below).

Species	Number Planted	Total Alive	% Survival	<3ft, LV	<3ft, HV	>3ft, LV	>3ft, HV
Acer negundo	15	13	86.7%	1	6		6
Aesculus californica	12	12	100.0%		6		6
Pseudotsuga menziesii	5	5	100.0%	3	2		
Quercus agrifolia	5	5	100.0%				5
Quercus lobata	5	5	100.0%	1	2		2
Juglans californica var hinds	15	15	100.0%	3	12		
Rhamnus californica	10	10	100.0%		8		2
Sambucus nigra	15	12	80.0%	3	3		6
Crataegus douglasii	5	5	100.0%	1	4		
Total	**87**	**82**	**94.25%**	**12**	**43**	**0**	**27**
				15%	52%	0%	33%

SUMMARY

Site conditions monitored post implementation offered indications of project success and whether the conservation practices installed have the desired trajectory towards long-term watershed recovery efforts to control erosion and sedimentation, increase aquatic, riparian, and upland habitat and stabilize eroding stream channels. Within three years, saving 2,825 cubic yards (CY) of sediment erosion and establishing five new riparian forests provided significant quantitative feedback that projects performed as planned and satisfying landowner concerns. Within 10 years, the baseline vegetation data collected will be used to similarly quantify successional changes in plant community and habitat structure including unintended outcomes such as weed infestations. After 20 years, indirect improvements in aquatic habitat will be monitored for changes caused by trees and other woody vegetation interacting with flood events to alter stream channel morphology and habitat complexity. Though project funding may end when the grant terminates, the monitoring program is providing a long-term process to learn more about the ability for riparian vegetation to improve watersheds and sustain ecosystem services in Marin County for generations to come.

The RZMP formalized the monitoring approach for Marin RCD and partner organizations with lessons learned to improve the process for future participating landowner, grantors and the community at large while informing the sciences of agricultural sustainability and ecological restoration. The collection of pre-project baseline data was critical to understand and quantify the short-term changes documented and will be continued. Monitoring challenges included how to systematically assign quantitative objectives and targets to each project, partner roles that ensure quality control, and overall organization. In addition, specific protocols will be discussed further in future reports such as the Project Assessment Checklist, Landowner Questionnaire and the Rangeland Hydrology Erosion Model (sheet/ rill sediment sources) as partnering organizations standardize their use and interpretation.

The practical benefit resulting from monitoring is having a jump-start on observing potential impacts to projects success and responding with adaptive management to improve maintenance which has become an incentive for landowners to participate in conservation programs. Future opportunities resulting from Marin RCD's standardized monitoring program is greater power to leverage grant funds for implementing more conservation projects, documenting ecosystem services, and validating value-added agricultural products. The stewardship work by community residents, landowners, ranchers, farmers, consultants, restoration practitioners, agencies, scientists, oyster growers, and other stakeholders will continue to inspire the monitoring of Marin RCD's conservation practices and restoration projects.