


A Half Century of Stewardship: programmatic review of conservation by Marin RCD & partner organizations (1959-2009)


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Dedication and Acknowledgements – This report is dedicated to Don McIsaac, Waldo Giacomini and Paul Sheffer who worked most of their lives to assist Marin's agricultural community and land managers in effective stewardship. Thank you to Marin County's landowners, agriculturalists, field technicians and soil conservationists for sustaining local food production and the conservation of Marin's natural resources by investing time and money to implement conservation practices over the last 50 years. Many generously shared information about how local streams and riparian areas changed following Marin RCD and NRCS projects. Thank you to the State Water Resources Control Board and American Recovery and Reinvestment Act (ARRA). Marin RCD partners and funders should be proud for working together across five decades supporting Marin landowners to install restoration projects and conservation practices. A special thank you to the following individuals for contributing to this document:

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Cover Photographs – Examples of the first biotechnical erosion control projects constructed in 1990 by Marin RCD and partner organizations in the Walker Creek Watershed. Depicted are pre-project conditions during high flows at a mainstem site compared with the resulting riparian forest in 2010 (top), and post-implementation willow walls with stable streambanks at the site in 2010 (bottom).

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EXECUTIVE SUMMARY

The Marin Resource Conservation District (Marin RCD) is founded and operates upon the understanding that the functions of the landscape are the foundation to sustainable agricultural systems. In 1937 Franklin Roosevelt said, "The Nation that destroys its soil destroys itself." A local extension of this underlying impetus and approach comes from Don McIsaac, past Marin RCD Board of Directors President. In 1990, he stated "All of our work is done in a cooperative basis and in the spirit of trust and working together to improve our lands. We appreciate all of the landowners who have allowed us to do erosion control on their property…. We must continue to care for and improve what we have, so it will be available for future generations to enjoy." This paradigm has encouraged a sense of purpose and humility that has enabled Marin RCD and partnering organizations to learn valuable lessons and advance the practice of conservation and restoration in service to Marin's farmers and ranchers.

Over the last 50 years, Marin RCD has adapted to the needs of the community while adhering to its founding principles. Landowners have collaborated with Marin RCD and numerous organizations to meet these new challenges and maintain Marin County's unique pastoral landscape. What began as a commitment to support ranch productivity through protection of soil from erosion and pasture improvement, evolved into compliance support for State, Federal, and local environmental laws and integration of emerging natural resource protection objectives. Water pollution became a concern with the passage of the 1969 California Porter-Cologne Act and the 1972 Federal Water Pollution Control Act (a.k.a. 'Clean Water Act'). The Endangered Species Act of 1973 ushered in a need for studying fish populations and watershed functions to preserve and restore habitat for threatened and endangered species. The National Shellfish Sanitation Program of 1999 and the earlier 1993 California Shelfish Protection Act elevated the need to protect water quality for shellfish harvesting in the Tomales Bay Watershed. Today, water quality for many Marin County streams is regulated by Total Maximum Daily Loads (TMDLs) and Conditional Waiver programs from the San Francisco Regional Water Quality Control Board (SFRWQCB).

This report offers rare insight into the history of stewardship by Marin County landowners, summarizing the trends and evolution in the conservation practices implemented through Marin RCD, Natural Resources Conservation Service (NRCS), and other partner organizations from 1959 to 2009. Combined, this partnership has directed over 3.3 million dollars to watershed plans and erosion control surveys with more than 23 million dollars to on-farm conservation practice implementation. This has resulted in the development of approximately 1,393 plans and 3,579 conservation practices implemented. The types of practices and projects implemented have changed and increased over time. During the 1960s, sustainable agriculture and the goal to keep sediment out of Tomales Bay were the focus through cross-fencing, pasture improvement, and ponds and water development. In the 1970s, water quality became critical for the dairy industry leading to manure management system installations and

upgrades that protected surface water and provided nutrients for pasture management. The 1980s was a period focused on erosion control to repair degrading headcuts and eroding streambanks, through which NRCS practices and bioengineering techniques were adapted and brought to Marin farms. During the 1990s, priority was placed on stream ecosystem restoration through control fencing and native tree and shrub planting. In the last ten years, climate change, local food systems, stream flow, and instream habitat have received more attention. Today the Marin RCD and its partners are coordinating all of these objectives with reemerging issues like management of invasive weed plant species. Marin RCD continues to improve and coordinate on-farm conservation planning and practice implementation while providing leadership for new countywide initiatives, including the Oral History Project, West Marin Composting Project, and Marin Carbon Project.

Lessons learned in completing conservation projects and practices include steps in the implementation process, specifically farm and ranch solicitation and project design, installation, and maintenance. Marin RCD works with land managers who contact staff directly following an annual request-for-projects that is sent to landowners by mail. Careful attention is applied to the design of each project by understanding the underlying causes of site degradation to avoid pitfalls from treating symptoms and appearances or focusing projects too narrowly. During project installation, construction monitoring is conducted by engineers or other project planners to ensure design specifications are followed and contractors' questions are answered as soon as possible. Project maintenance and site management have become increasingly important for maintaining project effectiveness and landowner satisfaction.

Existing monitoring and research conducted in west Marin County watersheds provides estimates and documentation of the benefits restoration projects and conservation practices are having for landowners and the environment. Some accomplishments by Marin RCD, landowners, and partner organizations include:

- Improved water quality with measurable improvements in Stemple Creek and shellfish production preserved in Tomales Bay
- Erosion prevention and sediment delivery to streams equaling 669,423 ±346,843 cubic yards
- Saved coho salmon & preserved steelhead populations
- Preserved red-legged frog habitat
- Improved wildlife diversity with 300 percent increase in neomigratory bird species following riparian revegetation
- Bolstering dairy farmers
- Preserved municipal water supply for Marin County in Stafford Lake watershed
- Streamlined permitting for landowners' conservation projects
- Improved ranch viability with higher weaning weights

- Supported partnering organizations, agencies, and local contractors
- Educated youth and adults about land stewardship in Marin County
- Increased stewardship ethic through increased participation in grant programs
- Landowners proud

With such accomplishments over the first 50 years, the second half century will be exciting for Marin County agriculture, the Marin RCD, and its partners. There is still more to be done and new challenges will arise. Current emerging issues include:

- Increasing instream habitat of Walker Creek
- Improving pasture production
- Controlling invasive plants (weeds)
- Permitting for water storage projects and maintaining stock pond dams
- Increasing plant community diversity at revegetation projects
- Restoring native grasslands
- Securing funding to continue and expand project monitoring
- Responding to climate change and increasing carbon sequestration

Already Marin's farmers and ranchers and the Marin RCD partnership are initiating projects to address many of these issues. The partnership will continue to provide leadership and looks forward to continued success in the future.

Merv McDonald discussing his ranch plan and reviewing completed projects to improve Walker Creek. The aerial photo of the property, circa late 1960s, illustrates extensive gravel bars and bare streambanks prior to on-farm conservation. Conservation practices implemented with partnership assistance include prescribed grazing plans, watering facilities, control fencing of streams and riparian revegetation to reduce erosion and improve fish habitat while increasing ranch viability. Results include vegetated streambanks, stable channels and native tree canopy cover with higher calf weaning weights and cows per acre.

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INTRODUCTION

The Marin Resource Conservation District (Marin RCD) was originally formed in 1959 as the Marin County Soil Conservation District (Figure 1) serving as the local advisory board for technical assistance and conservation projects implemented by the USDA Soil Conservation Service, which became the Natural Resources Conservation Service in 1994. This formal relationship provides access to federal cost share programs and technical support for Marin County's agricultural producers and other land managers. It also generates studies of local soil, water and vegetation conditions used by landowners, consultants, and most sectors of government.

This 50-year programmatic review documents natural resource and habitat conservation and restoration efforts completed by landowners through this relationship and Marin RCD's larger program partnership from 1959 to 2009. Conservation projects and practices implemented were cataloged to document trends over this time period. This includes the landowners, organizations, and groups that partner with Marin RCD to support agriculture sustainability and natural resource stewardship in Marin County. This report also describes the intended and unexpected outcomes from conservation and restoration efforts using a combination of anecdotal observation and local, state, and national research results. Accordingly, this report captures lessons learned by Marin RCD and partners, so they can continue to inform and guide future project planning and implementation. Additionally, by quantifying the extent and cost of conservation and documenting the resulting benefits to biodiversity and other ecosystem services, this report will support Marin agriculture with verification of value-added products such as payments for watershed services (Majanen et al. 2011) and other emerging environmental markets (Willamette Partnership 2011).

With more than a billion dollars spent nationwide to improve streams and rivers (Bernhardt et al. 2005), several programmatic reviews of natural resource conservation and watershed restoration efforts have been recently conducted at national (Bernhardt et al. 2007, Bernhardt et al. 2005, Palmer et al. 2005), state (Kondolf et al. 2007), and watershed scales (Christian-Smith and Merenlender 2010). These reviews have been particularly critical of the limited information that is available to know what has been accomplished as result of this restoration investment (Christian-Smith and Merenlender 2010, Kondolf et al. 2007) including an article in the New York Times (Dean 2008). They have typically focused on funding sources or limited to time scales of less than 20 years. In addition, they did not incorporate the context and history of privately owned working ranches and farms as it relates to on-farm conservation.

Accordingly, this five decade retrospective provides a longer term view of the evolutions and outcomes in on-farm conservation and stewardship. The accomplishments and work completed by landowners with technical and/or financial assistance from Marin RCD and partnering organizations represent the interdependence between sustainable agricultural systems and healthy natural resources. This collaborative process is ongoing to build

trusting relationships with farm families while incrementally encouraging changes to improve land management. Marin RCD's clear intentions and organized objectives began over 50 years ago, with dedicated people laying a foundation of stewardship that continues today. This report contains landowner accomplishments documented through Marin RCD and partner agency programs. It does not capture the individual land stewardship efforts completed independent of official programs based on the education and technical assistance provided.

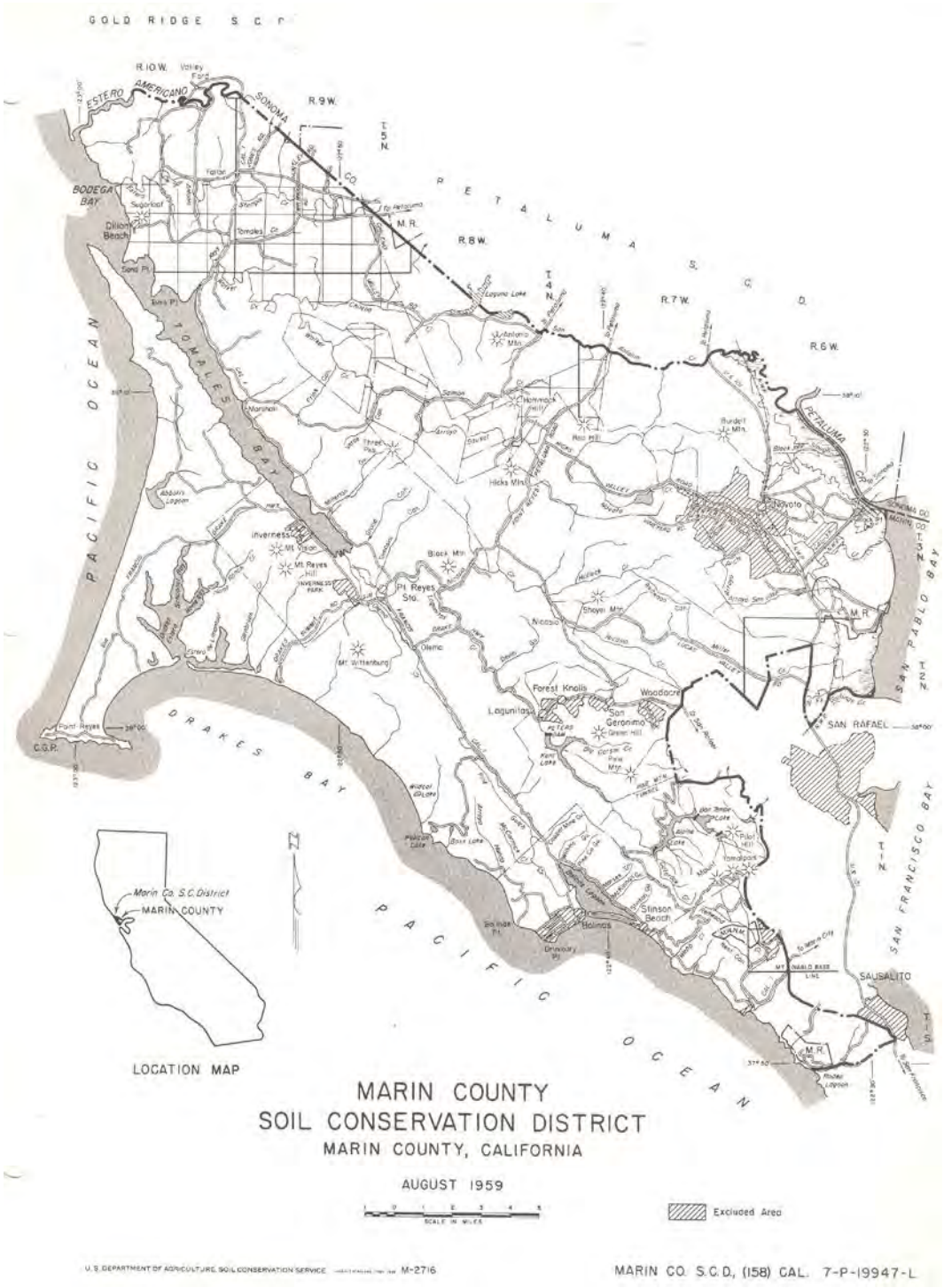


Figure 1: The Marin Resource Conservation District (formerly named Marin County Soil Conservation District) original boundary established in 1959.

History

The Marin RCD was established in accordance with Section 9208 of Division 9 of the Public Resources Code. A public vote elected the original five members to the Board of Directors on May 19, 1959 (Appendix A) and the first Board Meeting was held on June 24. The district's land area encompassed the rural areas of Marin County originally totaling 294,456 acres (88% of the county) with approximately 500 farms and ranches on 236,956 acres. Agricultural production included over $10 million of Grade A milk with over 18,000 cattle and nearly 14,000 sheep sold (SCS 1959).

Though Marin County agriculture has undergone various changes, Marin RCD began with similar goals and objectives as it has today. The original Conservation Program & Work Plan, finished in July 1959, states:

> "The principle aim of this district is to effect, gradually but surely, a steady improvement in the use of Marin County's vital resources of soil, water, vegetation, and wildlife. It is our firm conviction that the land of this district should be so used that it will produce crops and livestock of good quality, in amounts commensurate with land-use capabilities, permanently without soil depletion…. Our district has been formed to serve its landowners at their request, with no thought of domination or interference with their affairs, but to assist them in making the safest and most efficient use of their farms and ranches."

With the Work Plan's focus on controlling soil erosion, it also explained, "Wastage of irreplaceable topsoil is weakening our land. It is also depleting the absorptive ability of our watersheds, causing more loss of precious moisture and greater harm from flash floods." Other important issues included flood control, rangeland improvement, forest management, conservation of arable lands (irrigation, crop choice, weed control, soil health, etc.), watershed projects (stock ponds and water rights), and education and public relations to deliver a comprehensive district-wide program for Marin County land managers.

Landowners and managers began working with Marin RCD as official cooperators by forming voluntary agreements between the district and the individual land occupant or group, association, or entity of government to provide services according to their Farm or Ranch Conservation Plan. These cooperator agreements enabled

Stopping gully erosion like this was a motivation for forming the Marin RCD.

technical assistance to be available from the U.S. Department of Agriculture Soil Conservation Service (now Natural Resources Conservation Service) for implementing each conservation practice (Appendix B). By 1968, over 200 cooperators were working with Marin RCD (SCS 1968), increasing to 280 by 1979 (SCS 1980).

Marin RCD board member, Don McIsaac, and consultant, Liza Prunuske, look over a site impacted by erosion in 1986.

Originally, monthly public meeting were held by the Board of Directors with a dedicated Recording Secretary paid for by an annual grant from the County of Marin. Multiple elections have occurred over the last 50 years to fill available director seats. The minimum commitment is still a voluntary four-year term, with most staying much longer and devoting enormous amounts of time and energy to sustain local agriculture by delivering the Marin RCD mission. The following individuals have served or are serving as Marin RCD Board members:

- Waldo Giacomini (President) 1959 – 1990
- Domingo Grossi, Jr. 1959 – 1973
- David Leveroni, Jr. 1959 – 1973
- Louis Albini 1959 – 1977
- Thomas Furlong, Jr. 1959 – 1971
- Walter Weyman 1971 – 1975
- Donald McIsaac (President) 1973 – 1996
- William Barboni 1973 – 1995
- Otto Quast 1975 – 1989
- Edward Pozzi 1977 – 2000
- Richard Plant 1989 – present
- Hank Corda (President) 1990 – present
- Sally Gale 1996 – present
- Robert Giacomini 1997 – present
- Steve Doughty 2000 – present

In 1968, 1980 and 1990, the Conservation Program Work Plan was updated to prioritize activities in response to land use changes and is now entitled, The Marin County Resource Conservation District Long Range Plan. By 1979, Marin County agricultural land slightly decreased to approximately 230,000 acres with approximately 270 farms and ranches. The district boundaries decreased to 257,000 acres (77% of county)

reflecting the expansion of urban areas since 1959 (SCS 1980). Public recreational lands had also expanded to 51,400 acres following the development of the Point Reyes National Seashore (PRNS) which maintained certain agricultural operations. As a result, State and National Parks sought to meet their stewardship needs as cooperators with Marin RCD and NRCS. Private pasture and rangeland was the district's top priority which totaled 147,700 acres. The conclusion of the 1980 Long Range Plan includes the "Eleventh Commandment" first delivered in 1939 by the Assistant Chief of the US Soil Conservation Service:

> "Thou shalt inherit the Holy Earth as a faithful steward, conserving its resources and productivity from generation to generation. Though shalt safeguard thy fields from soil erosion, thy living waters from drying up, thy forests from desolation, and protect thy hills from overgrazing by thy herds, that thy descendants may have abundance forever. If any shall fail in this stewardship of the land, thy fruitful fields shall become sterile stony ground and wasting gullies, and thy descendants shall decrease and live in poverty or perish from the face of the earth." (Lowdermilk 1954)

Since 1980, landowners' need for conservation assistance increased during an era of watershed management and planning. This growth occurred iteratively through each watershed as Marin RCD provided service – Lagunitas during the early 1980s, Walker Creek in the late 1980s, and Stemple Creek in the early 1990s. This watershed approach is reflected in Marin RCD's 1990 Conservation Program Work Plan which reiterates the overall mission and purpose "to reduce soil erosion and improve water quality in rural Marin County" while focusing on (SCS 1990):

- Walker Creek watershed – enhancement projects focusing on reducing sedimentation into Tomales Bay;
- Stemple Creek – begin watershed plan to reduce soil erosion and protect Estero San Antonio;
- Dairy Waste – continue technical support to dairy farmers; and
- Range management – continue making recommendations to ranchers to improve pasture and range conditions.

Figure 2: Current RCD Board members (upper; ©Art Rogers Photography, www.artrogers.com.) at a monthly meeting in 2009 – from left to right, Steve Doughty, Bob Giacomini, Sally Gale (Vice-President), Nancy Scolari (Executive Director), Richard Plant, and Hank Corda (President). Previous RCD Board members (lower) at a monthly meeting in 1990 – from left to right, Don McIsaac (President then), Bill Barboni (Vice-President), Ed Pozzi (Secretary/Treasurer), Richard Plant, Hank Corda (President now), Waldo Giacomini (past President), and Otto Quast.

Watersheds, Floods, Regulations & Permits

Watershed and natural resource management has evolved over the last 50 years and the landowners working with Marin RCD have been leaders in this change. They worked towards the most practical solutions that meet the conservation needs of grantors, society and each ranching operation (Rilla et al. 1995, SCS 1990). Supporting agriculture following extreme winter storms has been a critical role of Marin RCD and its partners. Flood events have stressed and destabilized portions of Marin's watersheds in the early 1960s and several times in the 1980s and 1990s (SCS 1980, SCS 1968). By securing grant funds to conduct sediment surveys and erosion control plans, Marin RCD's conservation program has purposely prioritized the most unstable erosion sites to fix, addressing the causes of degradation with state-of-the-art design and implementation adapted to each watershed (Figure 3).

Figure 3: Major watersheds of rural Marin County include Tomales Bay with Walker and Lagunitas creeks, Stemple, Americano, Pacific Ocean streams, and San Pablo Bay. Map provided by Marin County Public Works Stormwater Pollution Prevention Program.

The ability for people to come together in response to damaging flood events has been a mutual source of pride for the entire community. This process was led by landowners contacting Marin RCD, NRCS and other partners to systematically treat their stewardship challenges and heal their watershed which included Lagunitas, Walker, Stemple (i.e. Estero de Americano), Stafford Lake (Novato Cr.), and Tomales Bay. The watershed approach to implementing conservation practices was an opportunity to work together with partnering organizations including the County of Marin, Southern Sonoma County RCD, Gold Ridge RCD, Marin Agricultural Land Trust, UCCE, NRCS and many others (Rilla et al. 1995, SCS 1980).

The Tomales Bay watershed is approximately 255 square miles including Lagunitas and Walker creeks in addition to numerous small streams along the east and west shore draining the idyllic and picturesque pastoral landscape that epitomizes west Marin. The health of Tomales Bay has long been a concern of the community and resource agencies with siltation evident following large storms in the early 1960s (Fischer et al. 1996, Haible 1980). The first large study lead by Marin RCD was a "Master drainage and sediment control plan for the Lagunitas and Walker Creek watersheds." It established that it was not feasible to fix or control the sedimentation of Tomales Bay with large reservoirs and dams (Nolte 1965). Public meetings were held by Marin RCD to educate the community about farm conservation plans, proper pasture use (now identified as prescribed grazing), and erosion control. In the 1970s, the State Water Resource Control Board (SWRCB) mandated new pollution control requirements for dairies to protect water quality and Tomales Bay. As a result, Marin RCD, NRCS and the County of Marin hired an engineer to plan dairy facility upgrades that met SWRCB compliance (Jarvis et al. 1978, Rafter et al. 1974). The Tomales Bay Watershed Council (TBWC) was formed in 2000 with grants led by Marin RCD to complete the Tomales Bay Watershed Stewardship Plan (TBWC 2003). In addition, a pathogen Total Maximum Daily Load (TMDL) was established in 2005 for Tomales Bay to protect water quality for recreation and shellfish harvesting and Marin RCD provides funding and technical support for landowners to adopt voluntary resource conservation practices that meet TMDL objectives. The continued production of oysters in Tomales Bay and milk on the surrounding hillsides is a testament to Marin landowners' success in watershed management, although further stewardship efforts are necessary to meet the TMDL goals.

The Lagunitas Creek watershed was severely impacted by the January 1982 flood with observations of small swales unraveling overnight becoming gullies 100 feet wide and 20 feet deep. Marin RCD responded with a multi-agency partnership led by Prunuske Chatham Inc. between NRCS, Trout Unlimitted, Marin County Fire Department, Ca. Department of Fish and Game (CDFG), and Marin Conservation Corps to prioritize sites, control erosion, and put the watershed back together. They also tested instream enhancement techniques and fish stream improvement practices using boulders and logs (Kelley

1989), which Marin Municipal Water District (MMWD) has expanded on since the 1990s. Of the wild coho salmon remaining along the central California coast from Humboldt to Santa Cruz counties, nearly 10 to 16 percent of the population spawns in the Lagunitas Watershed (MCCDA 2004). These remaining wild coho and steelhead populations are further testament to stewardship achievements by landowners and Marin RCD's leadership including recent direction provided by the *Limiting Factors Analysis* (Stillwater Sciences 2008).

A Marin RCD workshop with Steve Chatham leading tours of erosion control project sites in the Walker Creek Watershed (1989).

The Walker Creek watershed had extensive gully and streambank erosion during the March 1986 flood. As a result, landowners and Marin RCD implemented numerous projects by 1990, including the first willow walls and other biotechnical repairs, under the direction of Prunuske Chatham (PCI). These were new at the time because of the dependence on vegetation establishment for long-term stability. The techniques were published by Marin RCD and partners in *Groundwork* (Prunuske et al. 1987), shared in numerous workshops from 1988 to 1993, and are now used internationally and across California (Flosi et al. 2004, Wehren et al. 2002). In 2001, the Walker Creek Watershed Enhancement Plan was completed under the direction of watershed landowners (PCI 2001). The conservation practices implemented since the 1980s have increased the extent Walker Creek's riparian forests and the diversity of neotropical migratory birds (Kreitinger and Gardali 2006). Coho salmon, planted from 2003 to 2008 (3,900 juveniles and 264 adults), have returned for multiple years (MMWD 2010) which indicates significant improvements in watershed conditions resulting from the hard work by Marin landowners. There is now the potential for instream enhancement practices to be successful that was not realistic in the 1980s (Rich 1989, Emig 1984, Kelley 1976).

Marin RCD board member, Ed Pozzi, leads partners on a tour of the Estero de San Antonio as part of the Stemple Creek Watershed Project (circa 1991).

The Stemple Creek (Estero de San Antonio) watershed was the first to regulate agriculture for water quality pollution in California with a Total Maximum Daily Load completed by the North Coast Regional Water Quality Control Board during the 1990s (Salisbury 1997). In cooperation with Southern

Sonoma County RCD, Marin RCD and NRCS received grants to help landowners complete numerous conservation projects in Marin and Sonoma Counties, published the Watershed Enhancement Plan in 1994 (Prunuske et al. 1994), and initiated a long lasting partnership with the Shrimp Club, a nationally-recognized project of Brookside School in San Anselmo, to implement riparian revegetation. The Shrimp Club and its successor, STRAW (Students and Teachers Restoring a Watershed), have planted over eight miles of native trees, shrubs and grasses in numerous Marin County watersheds to improve water quality and habitat. In 2005, NRCS' Conservation Effectiveness Assessment Program (CEAP) funded a water quality study of Stemple Creek to calibrate models (Ritchie et al. 2004) and UC Cooperative Extension found continued reduction in ammonia compared to previous monitoring conducted by CDFG (Lewis et al. 2008, Rugg 2002).

The Estero Americano watershed is located north of Stemple Creek and is very similar in land use and unique topography. Gold Ridge RCD implemented erosion control projects on some of the largest gullies in the 1980s and recently received grant funding to upgrade dairy facilities, survey sediment sources, control erosion and publish a guide for enhancing nutrient management in pastures (Hickey et al. 2010). Such opportunities to work together with neighboring RCDs and other partner organizations have provided an efficient and effective approach to sharing the work load and setting priorities for Marin RCD's conservation program.

Numerous small streams drain directly to the Pacific Ocean from west Marin including the land above Drakes Bay and Bolinas Lagoon. Marin RCD and NRCS, in partnership with National Park Service, increased their support of agricultural managers and lessees with conservation planning assistance such as prescribed grazing, Residual Dry Matter (RDM) objectives, stock pond maintenance, and water developments. Bolinas farmers are currently leading a pioneering water rights planning effort, with the RCD's assistance, to transition water sources for organic row crop production to off-stream sources that will reduce the use of water from Pine Gulch Creek and increase summer stream flow for coho salmon and Bolinas Lagoon.

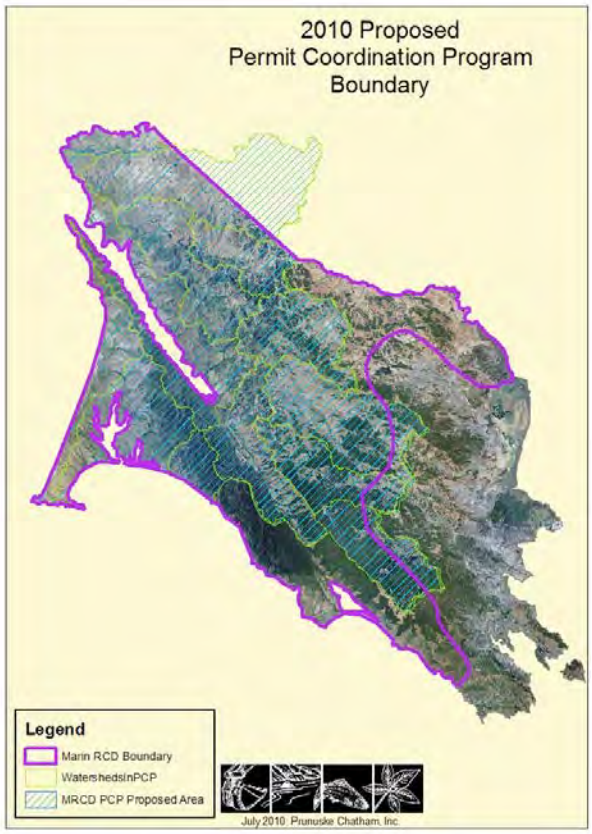
Marin RCD covers the Stafford Lake watershed and San Antonio Creek in rural Marin County that drain into San Pablo Bay. In 1985, the Stafford Lake Watershed Erosion Control Project began to protect water quality and preserve Marin County's municipal water supply for North Marin Water District (NMWD). As a tributary to the Petaluma River, San Antonio Creek was included in the Watershed Enhancement Plan led by Southern Sonoma County RCD in 1999.

Marin RCD currently implements the majority of conservation practices under its Marin Coastal Watersheds Permit Coordination Program (PCP) in the Tomales Bay, Stemple, Novato, and Pacific Ocean watersheds (PCI 2010). Since number of permits and time spent on permitting the conservation practices implemented has increased over the last 30 years, implementing conservation projects in a timely manner has continued to be a challenge. Marin RCD began its PCP in 2003 for landowners to streamline the permit

process for commonly utilized conservation practices that are similar across watersheds. This was done to remove the burden and disincentive to participate in conservation programs that permitting represents to many landowners (MRCD 2009).

The PCP has saved landowners significant time and money with numerous partner agencies benefiting from the program's leadership, broad support, organization and transparency. It was expanded in 2010 to include 17 NRCS conservation practices adapted to local Marin County conditions (PCI 2010):

- Access road
- Animal trail & walkway
- Critical area planting
- Filter strip
- Fish passage
- Stream habitat improvement
- Grade stabilization structure
- Grassed waterway
- Lined waterway
- Pipeline
- Sediment basin
- Spring development
- Streambank protection
- Stream channel stabilization
- Structure for water control
- Underground outlet
- Water & sediment control basin



Partnering Organizations

Marin RCD has collaborated with numerous organizations since 1959. The following partners and funders provided assistance to implement conservation projects in rural Marin County:

- Association of Bay Area Governments
- Bella Vista Foundation
- Ca. Association of Resource Conservation Districts
- Ca. Cattlemen's Association
- Ca Dept. of Fish and Game
- California Department of Food and Agriculture
- Ca Dept. of Forestry and Fire Protection
- Ca. Department of Conservation
- Ca. State Parks
- Ca. Wildlife Conservation Board
- Conservation Corps North Bay – previously Marin Conservation Corps
- County of Marin
- David L. Klein Foundation
- Dean Witter Foundation
- U.S. Environmental Protection Agency

- Gold Ridge RCD
- Hog Island Oyster Company
- Inverness Foundation
- Lagunitas Creek Advisory Group
- Lagunitas Creek Citizens Advisory Committee
- Lia Fund
- Marin Agricultural Land Trust
- Marin Community Foundation – previously Buck Fund
- Marin County Agricultural Commissioner
- Marin County Department of Public Works MCSTOPPP (Stormwater Pollution Prevention Program)
- Marin County Fire Department
- Marin County Farm Bureau
- Marin Municipal Water District
- Marin Organic
- National Fish and Wildlife Federation
- North Marin Water District
- Point Reyes National Seashore
- Point Reyes National Seashore Association
- Point Reyes National Seashore Ranchers' Association
- Prunuske Chatham, Inc.
- Rathman Family Foundation
- Salmon Protection & Watershed Network
- San Francisco Bay Regional Water Quality Control Board
- San Francisco Foundation
- Sotoyome RCD
- Southern Sonoma County RCD
- State Coastal Conservancy
- State Water Resources Control Board
- Stemple Creek Landowners Group
- STRAW (Students Teachers Restoring A Watershed) – previously Shrimp Club
- Sustainable Conservation
- Tomales Bay Agriculture Group
- Tomales Bay Association
- Tomales Bay Watershed Council
- Trout Unlimited
- University of Ca. Cooperative Extension
- US Fish and Wildlife Service
- USDA Natural Resources Conservation Service – previously Agriculture Soil Conservation Service
- Walker Creek Watershed Landowner Group
- Western United Dairymen

These partners have provided Marin RCD top-down and bottom-up resources to support its mission with cost-effective solutions for landowners. The local partners from the community groups and individuals have provided guidance, funding, in-kind contributions and inspiration that have increased the credibility and accountability of Marin RCD to meet community needs over the years. For example, letters of support for each grant application were provided by oyster growers, environmental groups and government representatives. The NRCS office in Petaluma has been an important federal partner since 1959 by providing planning and technical support, as well as financial assistance through cost share programs to implement conservation practices and improve management systems. The cost share funds usually provided 50 percent of project costs through federal USDA Farm Bill programs such as NRCS Agricultural Conservation Program (ACP), Emergency Watershed Protection (EWP), and Environment Quality Incentives Program (EQIP) since 1996. These have been integrated with Marin RCD grant funds often from state or county partners to increase the number and scale of projects implemented. To fix the historically problematic gullies, streambanks and other water quality concerns grant funds were used to reduce the landowners' cost share

responsibility to 25 percent and this incentive worked to get work completed that would not have been possible.

Money, Grants & Projects

Over the last 50 years, Marin RCD has grown in capacity to bring in financial resources for the community to improve natural resources and maintain agriculture (Figures 4 and 5). The County of Marin has consistently supported Marin RCD with annual financial allocations since its inception, beginning with $750 per year in 1959, $1-2,000 per year during the 1970s, and over $10,000 per year starting in 1989. Grant awards have risen and fallen over the last 50 years driving fluctuations in the Marin RCDs annual expenses. This includes spikes resulting from such initiatives as the Tomales Bay study in the 1960s, dairy facility upgrades in the 1970s, erosion control projects during the 1980s, and multiple projects and programs since then. For example, 2006 was the year with the most expenses including numerous ongoing conservation projects as well as intensive studies such as the *Lagunitas Creek Limiting Factors Analysis* and the *Geomorphology of the Walker Creek Watershed* (Table 1).

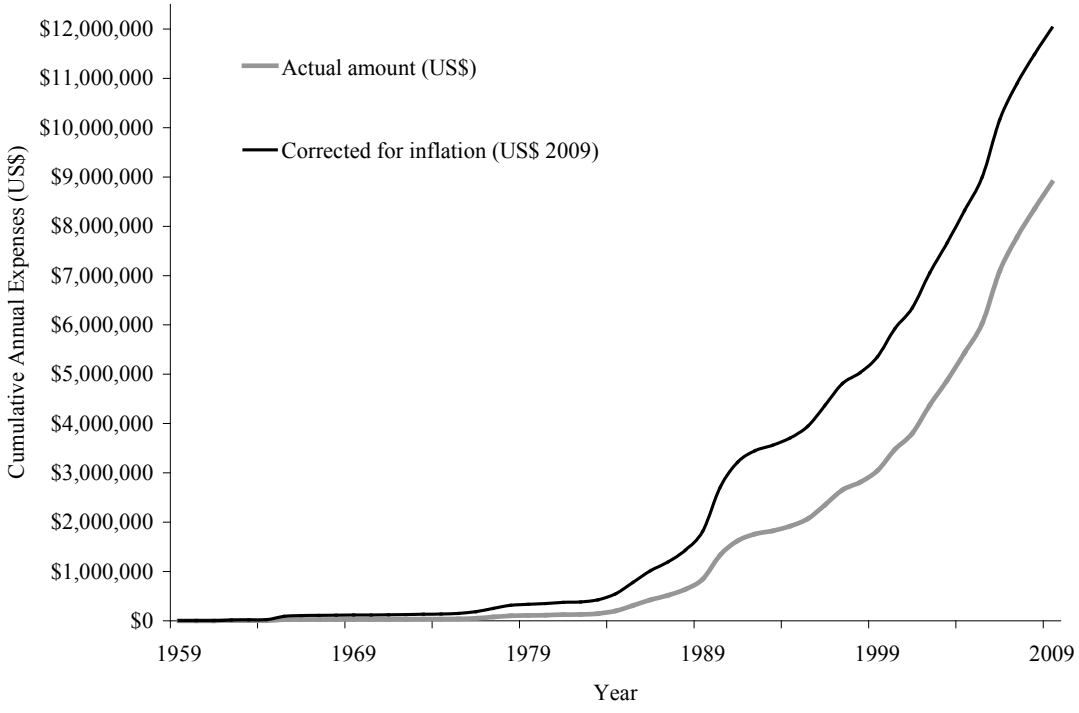


Figure 4: Marin RCD cumulative annual expenses, not including subcontracts to partnering organizations, by year for actual cost amounts and costs corrected for inflation to 2009 dollars.

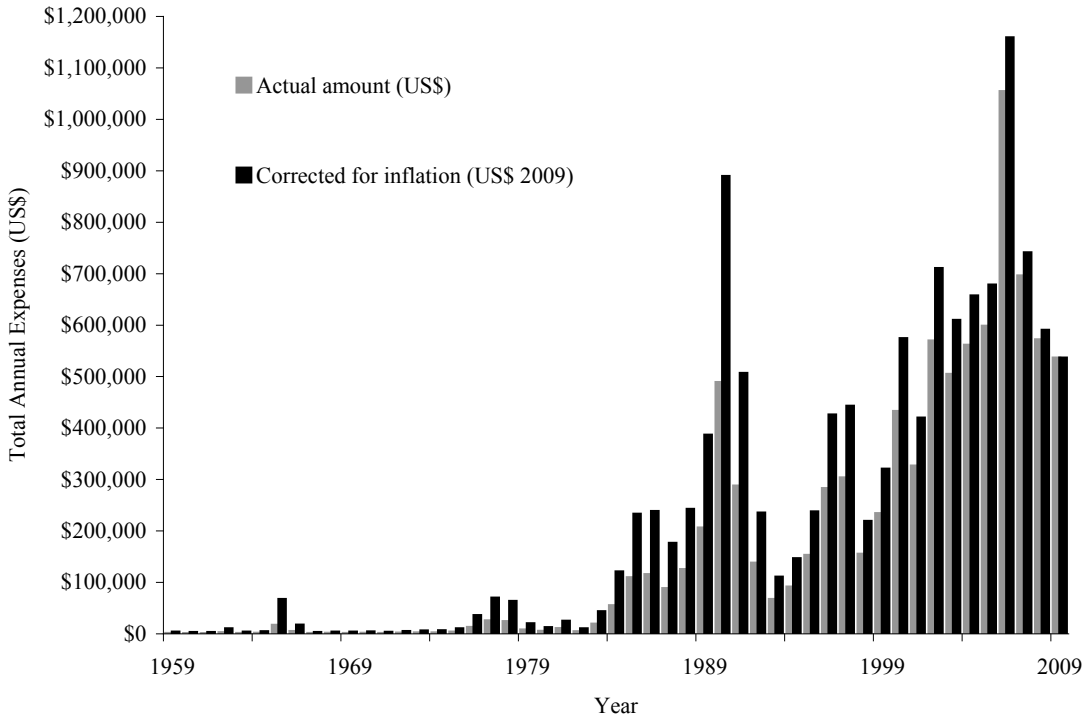


Figure 5: Marin RCD annual expenses, not including subcontracts to partnering organizations, by year for actual and corrected for inflation to 2009 dollars.

Table 1: Total expenses for conservation projects implemented by watershed from Marin RCD grants, NRCS programs and other partners such as MMWD, PRNS and STRAW. The Tomales Bay subtotal includes Walker, Lagunitas and the small watersheds along east/ west shore of the Bay. The District total includes all the land within the Marin RCD boundary. The total amount may be greater than the sum of subwatersheds because certain grant funds were intended and organized at the scale of the District or Tomales Bay watershed. The plans, studies, monitoring and education completed are also itemized with the total amount directly spent by Marin RCD in each watershed.

Watershed	Costs for Projects Implemented ($)				Marin RCD Plans, Studies, Monitoring & Education	Marin RCD Total
	Marin RCD	NRCS	Other Partners	Total		
Walker	$2,347,578	$3,515,927	$361,525	$5,925,030	$256,400	$2,603,978
Lagunitas	$1,205,039	$1,032,529	$4,237,943	$6,475,511	$850,003	$2,055,042
Tomales Bay east/west shores	$115,912	$1,177,393	$67,178	$1,360,483	$0	$115,912
Tomales Bay subtotal	**$5,120,616**	**$5,725,849**	**$4,666,646**	**$15,213,111**	**$2,582,595**	**$7,703,211**
Pacific Ocean	$213,211	$1,898,953	$105,000	$2,112,164	$0	$213,211
Stemple (San Antonio)	$636,587	$2,404,638	$207,019	$3,041,225	$142,900	$779,487
Americano		$73,153	$75,339	$148,492	$0	$0
San Pablo Bay	$78,800	$768,135	$120,000	$966,935	$0	$78,800
District total	**$7,338,348**	**$10,922,554**	**$5,174,004**	**$23,434,906**	**$3,308,715**	**$10,647,062**

Of the total $26,743,620, nearly 87.6% ($23,434,906) was spent on conservation projects by Marin RCD and partners (Table 1) to implement 683 projects with 3,579 practices and 1,393 plans or surveys covering 639,251 acres. Total funding spent on conservation projects in the Tomales Bay Watershed was at least $15,213,111 to implement 396 projects with 2,138 practices. Though Marin RCD annual expenses total $8,890,360, numerous projects and studies were completed by subcontracting with partnering organizations. As a result, Marin RCD grants received through 2009 total $10,647,062 with $7,338,348 spent on conservation project design and implementation as well as $3,308,715 for watershed plans, studies, monitoring and landowner education (Figure 6). Projects implemented by Marin RCD partnering organizations total $16,096,558 with $10,922,554 for NRCS projects and $5,174,004 from other partners.

Annual spending on cost share programs by NRCS has steadily increased over the years. In the 1970s, funds allocated to Marin County were usually less than $30,000 per year with individual landowners generally receiving payments of $2,500 or less. During the 1980s, annual NRCS funding for Marin County ranged from $35,000 to $100,000 per year with the higher payments available from Emergency Watershed Protection (EWP) programs to clean up after large flood events. In the 1990s, NRCS cost-share policies shifted from the Agricultural Conservation Program (ACP) to the Environmental Quality Incentives Program (EQIP) with individual payments increasing to over $10,000 and Marin County totals ranged from $80,000 to over $300,000 for flood response years. Following 2000, individual producers were able to receive over $100,000 contracts for barns and other water quality related facilities not previously available for cost share programs with annual spending totaling over a million dollars.

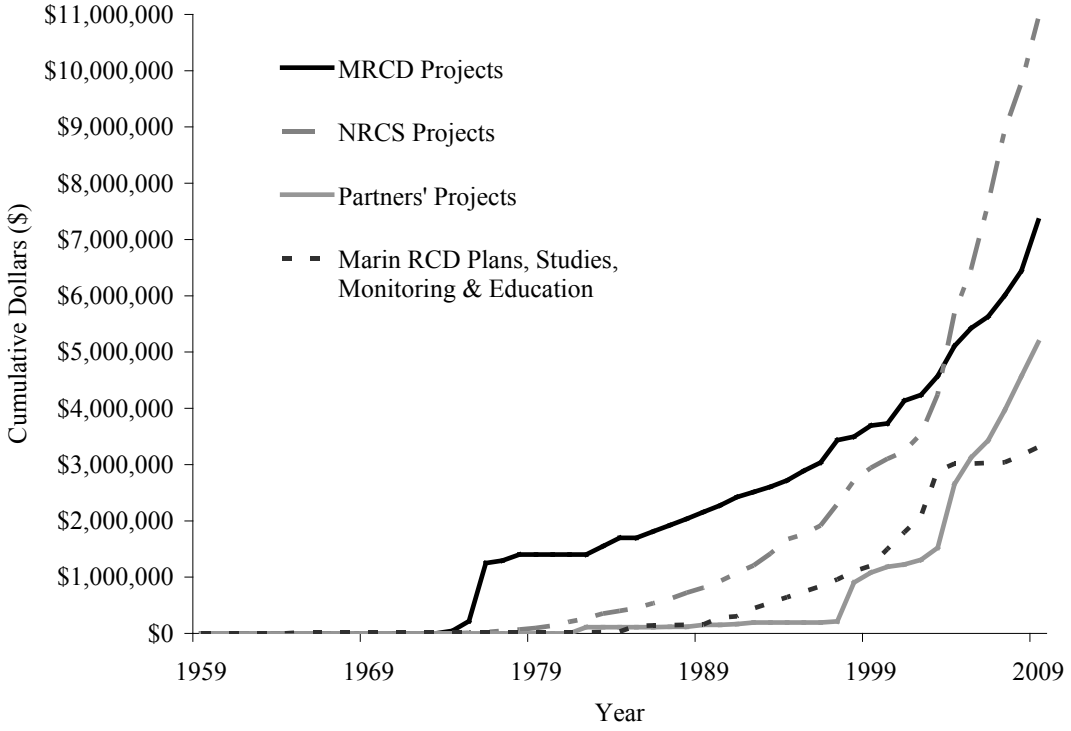


Figure 6: Cumulative dollar amount spent by Marin RCD for conservation projects and other plans, studies, and outreach compared to NRCS and other partners' project costs in Marin County agricultural land.

The first large study by Marin RCD was in 1965 entitled the *Master Drainage and Sediment Control Plan for the Lagunitas and Walker Creek Watersheds* with a minimal cost of $18,750 (Nolte 1965). In 1974, Marin RCD's Dairy Waste Survey Report (Rafter et al. 1974) outlined infrastructure needs at each dairy in the county for waste management systems upgrades to meet compliance with new pollution control requirements from the State Water Resource Control Board (SWRCB). Over the next four years, an enormous amount of work was completed including over 100 practices implemented annually at 10 to 16 dairies per year as well as numerous designs and plans that landowners may have completed without financial assistance (Figure 7). Funding from the County of Marin paid for the engineering plans and designs as well as 25% of the actual construction costs and this provided collateral for bank loans of the remaining 75%. Marin RCD combined this County support with technical assistance from NRCS and small grants from USDA Rural Environmental Assistance Program. By 1978, 64 projects were completed with 574 conservation practices installed across the county. Of the 77 dairies in existence in 1974, 59 still remained in Marin County by 1979, having survived the recession, drought and new SWRCB regulations (Jarvis et al. 1978). The program to support landowners with dairy operations saved 77% of Marin's milkshed and stopped the hemorrhaging of the local industry. This was a result of Marin RCD's partnership with the County of Marin and NRCS with leadership from members of the Marin County Board of Supervisors, such as Gary Giacomini, and the Sonoma-Marin Farm Bureau's Dairy Waste Committee, such as Earl Holtz.

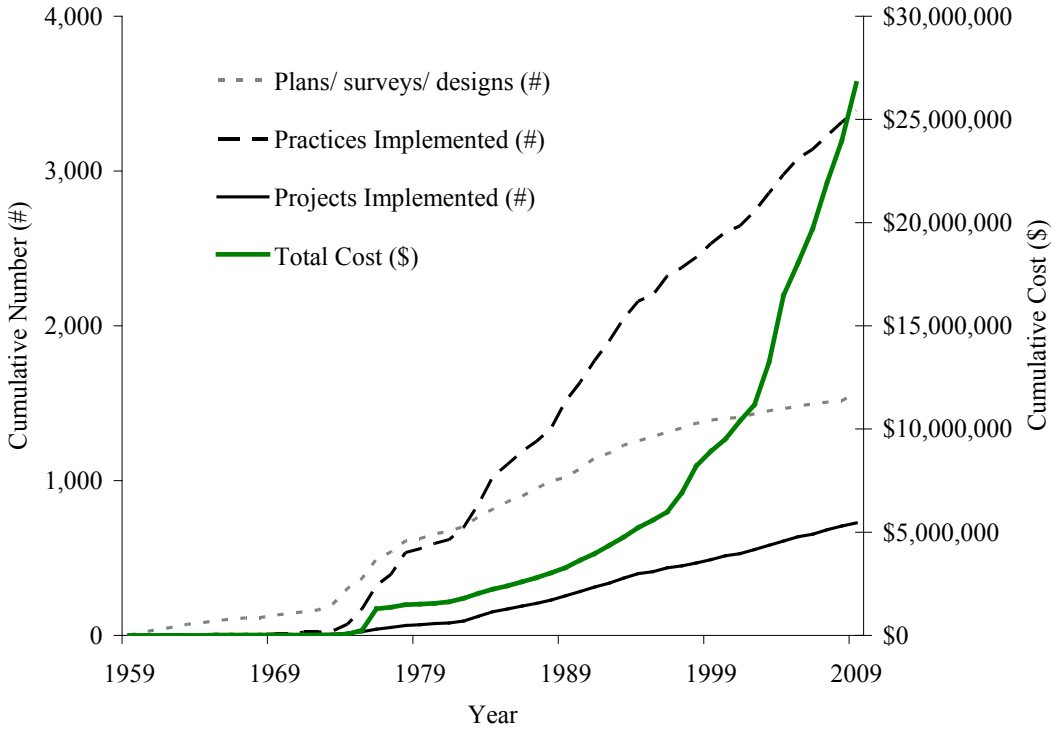


Figure 7: Cumulative number of plans, practices, and projects with total project cost from all Marin RCD and partnering organizations by year.

Following the 1982 flood, an era of watershed restoration began with over 75 grants awarded to Marin RCD since then. Credit for this accomplishment goes to the many partner organizations and in particular the technical advisory support of Liza Prunuske and Steve Chatham (Table 2). Grants for Lagunitas Creek watershed began in 1982 and the State Coastal Conservancy awarded Marin RCD a $1,000,000 grant in 1986 for the Walker Creek Watershed Enhancement Program to reduce the sedimentation of Tomales Bay and restore anadromous fish habitat over the next ten years. Marin RCD grants have continued to fund stewardship projects, watershed plans and technical studies as well as specific projects since 1990 such as the West Marin Co-Compost Project (Appendix A). In 2008, the SWRCB awarded Marin RCD over $1,000,000 for the Conserving Our Watersheds grant to continue the stewardship program by completing dozens of conservation practices, provide ranch planning assistance, conduct this 50-year review, and systematically monitor new projects.

A majority of the projects and practices implemented were in the Tomales Bay watershed (58% and 60%, respectively). Similarly, 57% of the area surveyed for management and stewardship plans and 47% of the total number were completed in the Tomales Bay watershed. Marin County landowners used greater than 10 types of plans with certain ones updated a few times over the last 50 years such as Conservation, Prescribed Grazing and Waste Management plans. As a result, the total area receiving plans in the Tomales Bay watershed was 2.6 times larger than the size of the watershed (139,780 acres).

Table 2: Total projects and practices implemented as well as the number and acres receiving plans and surveys by watershed. The Tomales Bay subtotal includes Walker, Lagunitas and the small watersheds along east/ west shore of the Bay. The District total includes all the land within the Marin RCD boundary.

Watershed	# Implemented		Plans & Surveys	
	Projects	Practices	(Ac)	(#)
Walker	164	958	109,785	251
Lagunitas	179	881	150,277	199
Tomales Bay east/west shores	53	299	106,172	208
Tomales Bay subtotal	**396**	**2,138**	**366,234**	**658**
Pacific Ocean	80	444	123,348	251
Stemple (San Antonio)	112	556	59,364	259
Americano	22	139	5,801	29
San Pablo Bay	73	302	84,503	196
District total	**683**	**3,579**	**639,251**	**1,393**

MANAGEMENT, PROJECTS & PRACTICES

Marin RCD and partnering organizations assisted landowners in stewardship activities to improve land management and complete projects with specific conservation practices. This section itemizes the number and extent for each type of management system planned and conservation practice implemented on the ground over the last 50 years in rural Marin County. In other words, what exactly was the $26 million dollars spent on? Plus, when were the conservation practices used and how did the technology evolve to serve Marin County's particular needs?

The conservation practices implemented have utilized previous plans that indicated where to do what type of work and designs that detailed specifications for how to implement a practice in a specific location. For example, planning for dairy upgrades included pond size requirements for each facility with viable locations to construct them, associated infrastructure needed and maintenance requirements. Similarly, watershed enhancement efforts utilized erosion control plans with sediment surveys to provide a guide for prioritizing sites based on cost-effective treatments. This allowed access to more grant funds to accomplish the tasks itemized in the plans. The plans increased the efficiency and overall success of conservation in Marin County. Research in restoration outcomes has found greater success of individual conservation projects when they were guided by an existing plan such as watershed management, erosion control, or other document (Kondolf et al. 2007).

The data collected for this report was taken from archived files, reports and interviews with staff at Marin RCD, NRCS and other partnering organizations. The practices implemented, year constructed, cost estimate and subwatershed location was compiled in a database for each project with documentation of being completed in Marin County. Landowner or ranch names or other identifying feature were not included in the database. Plans, specifications and project designs were also noted since landowners often implemented projects on their own without federal financial assistance. Therefore, the projects and practices included are minimum estimates of the actual work implemented on the ground of rural agricultural land in Marin County over 50 years. This is not a complete summary of all restoration and conservation activities in the county because projects on urban or public land without agriculture were not included.

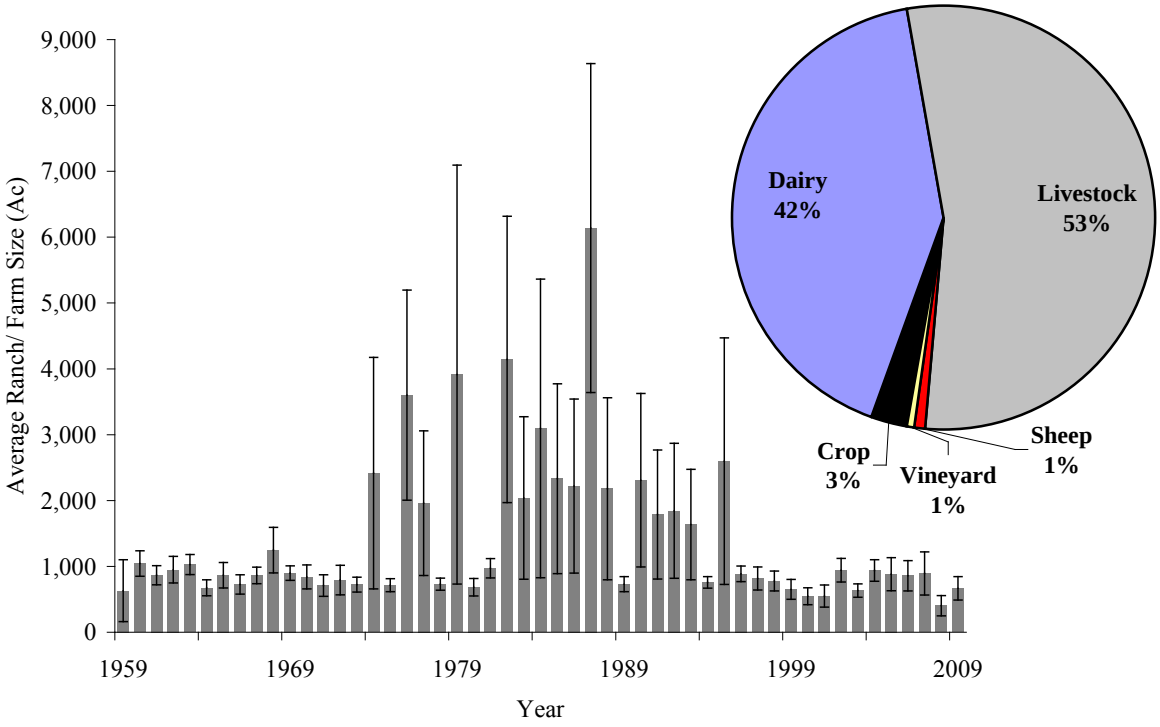


Figure 8: Average ranch, farm or property size (acres) where conservation projects and plans were implemented 1959 to 2009 with standard error bars (bar chart, left). The agricultural land use of properties that received conservation assistance from NRCS in Marin County (pie chart, right).

All interested landowners, land managers and agricultural producers were included as cooperators able work with Marin RCD and benefit from the technical and cost share assistance available. Over 330 landowners have received assistance from Marin RCD and partners with at least 230 landowners implementing conservation practices using cost-share funding and over 68 landowners using both planning and financial help. The size of properties, farms and ranches participating in programs available from the RCD and its partners has changed slightly over the years (Figure 8). Small ranches ranging from 10 to 100s of acres have been consistently included in Marin RCD programs as well as larger agricultural producers. From the late 1970s to early 1990s significantly larger land holdings participated in the programs. Some of the 1000s of acre properties included plans for land acquired by government agencies. Agricultural land use is predominantly beef cattle now in Marin County with a shift over the last 50 years from dairy to livestock operations, as previously discussed.

Surveys, Plans, & Systems

As landowners and managers signed up with Marin RCD as official Cooperators, this allowed technicians from NRCS to work with them on short and long range plans specific to their ranch or farm. The majority of plans were completed by NRCS to design numerous practices including ponds and pasture use with Marin RCD and its partnering

organizations. It often took many years and even a generation or two before landowners were able to implement the planned practices.

Types of Plans Utilized

NRCS Farm Conservation Plans were provided to all Marin RCD Cooperators during the 1960s and 70s (Figures 9 and 10). They organized existing soil information, surveyed new soil attributes and estimated the extent of soil types observed to incorporate 30 years of data into the Marin County Soil Survey when it was published in 1985. The Conservation Plans also offered guidance for other challenges or improvements a particular landowner and manager was contemplating such as prescribed grazing (proper pasture use), stock ponds, fencing, water distribution, wildlife management, etc. They have evolved over the years and are now an incremental planning process supporting NRCS' EQIP and other programs. Currently, internet based access to soil information is available from NRCS (http://websoilsurvey.nrcs.usda.gov/app/) and UC Davis (http://casoilresource.lawr.ucdavis.edu/drupal/node/902).

Waste Management Systems became required plans for dairy operations in 1974, as previously discussed (Jarvis et al. 1978, Rafter et al. 1974). The Clean Water Act was passed in 1972 and milk prices decreased during the recession of the early 1970s, Marin County dairymen needed more cows to maintain a viable operation and stay in business. This produced more manure than existing facilities could handle so systems were expanded with the capacity to contain waste through the wet season and where to

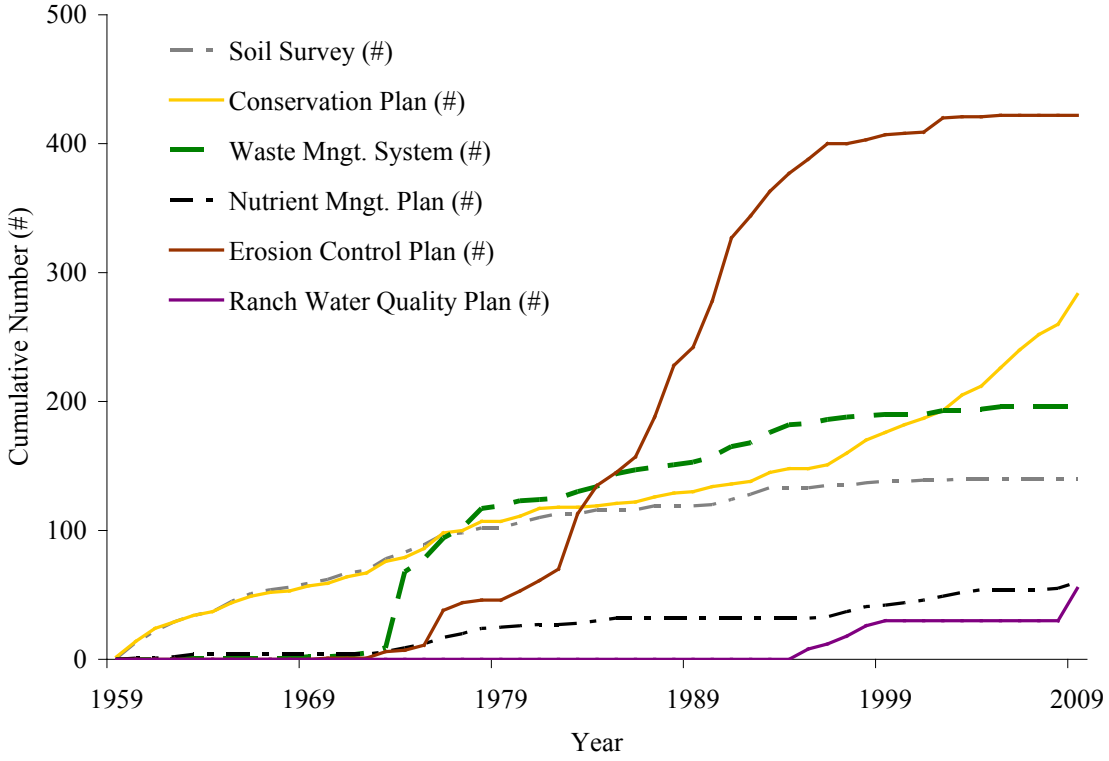


Figure 9: Cumulative number of each type of plan guiding ranch or farm operations prepared over time.

distribute it during the dry season. The amount of work outlined in each plan was prioritized since it often took years to accomplish depending on capital available and cost share programs to construct or enlarge manure lagoons, irrigation plans, pipelines, freshwater diversions and barns. Most Waste Management System plans functioned for about 20 years and were updated during the 1990s. Of the 196 Waste Management Plans written, at least 68 were implemented (Appendix B).

Nutrient Management Plans also began during the 1960s and have been continuously refined as the science improved describing the uptake of available nutrients for various soil types and plant species. The purposes of nutrient management plans are to adequately supply nutrients for plant production, properly utilize manure or organic by-products as a plant nutrient source, to prevent agricultural non-point source pollutants such as pathogens and nutrients from entering surface and ground water resources, and to maintain or improve soil quality. Western United Dairymen currently provides this service for NRCS cooperators and Gold Ridge RCD published a guidance report for landowners with dairies in coastal California (Hickey et al. 2010).

Erosion Control Plans outlined alternative treatment options to repair unstable locations around the ranch or farm and were common components of Watershed Management/Enhancement Plans. They prioritized gully, road, streambank and rangeland improvements (e.g. PCI 2001, Prunuske et al. 1994). Treatments often

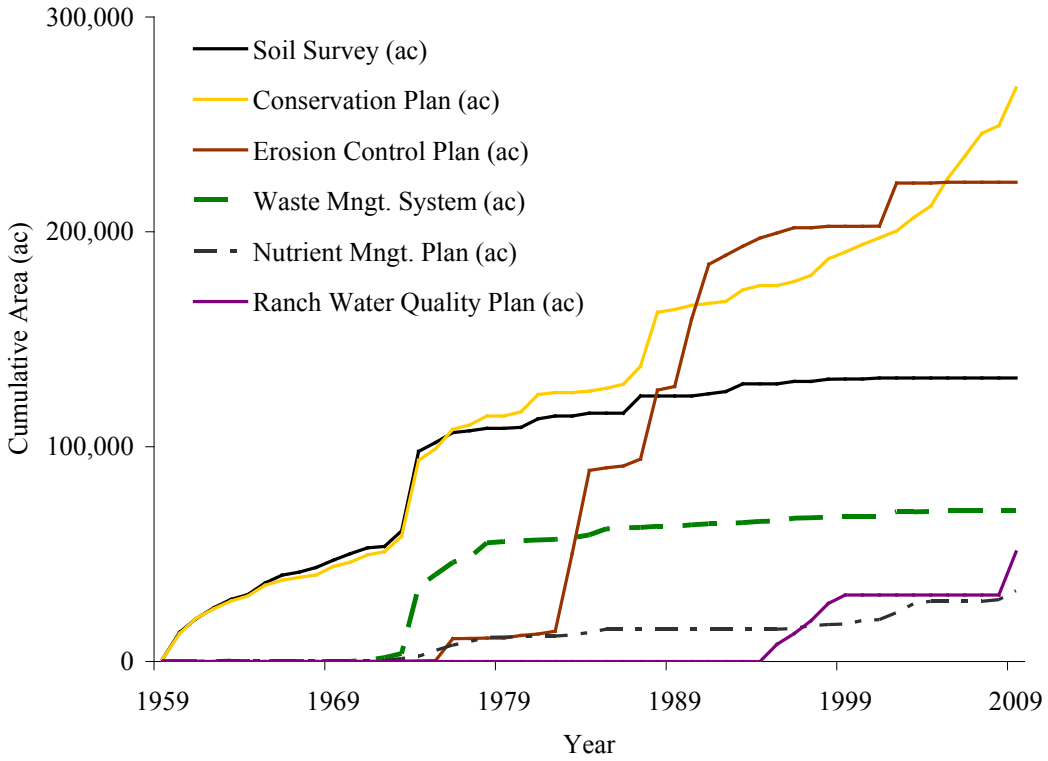
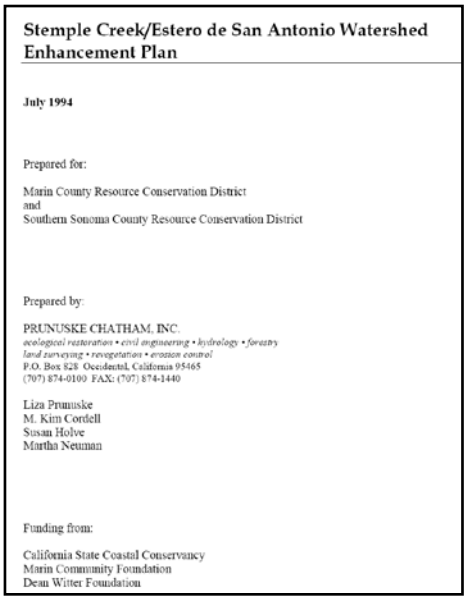


Figure 10: Cumulative land area of each type of plan guiding ranch or farm operations prepared over time.

included channel stabilization or streambank protection practices following biotechnical specifications in *Groundwork* (Prunuske et al. 1987) and NRCS guidelines (USDA 2010a) in addition to pasture and rangeland management practices (USDA 1997). The erosion control plans have been used to guide the conservation work by landowners, Marin RCD and partners since they were completed in the 1980s and 90s. This systematic watershed approach was utilized to select project sites for restoration by Marin RCD and landowners since 1982 which was rarely accomplished by other groups across the United States (Kondolf et al. 2007).



Stemple Creek/Estero de San Antonio Watershed Enhancement Plan

July 1994

Prepared for:

Marin County Resource Conservation District
and
Southern Sonoma County Resource Conservation District

Prepared by:

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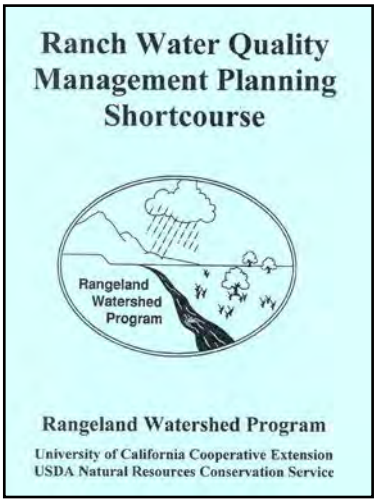
California State Coastal Conservancy
Marin Community Foundation
Dean Witter Foundation

Before scientists gave it merit and developed the associated jargon, Marin RCD and partners planned and prioritized watershed projects using a threshold approach with a recognition that "a system can appear resilient to changes in the environment, only to reach a critical threshold of rapid and unexpected change" (Suding and Hobbs 2009). Cost-effective approaches required this understanding to minimize the vulnerability of crossing a threshold and maximize realistic objectives. If a site further unraveled, it became more difficult or impossible to reverse degradation and increased overall system susceptibility which also caused greater costs to fix nearby sites (Jackson and Hobbs 2009). This approach was critical to set cost-effective conservation priorities in Marin's agricultural watersheds. Similar to the NRCS Conservation Planning process, Marin RCD's erosion control and watershed enhancement plans used fundamental questions to guide the prioritization of restoration project sites and options for conservation practices implemented within each site similar to Miller and Hobbs (2007).

1. What is the range of potential management options available?
2. Which options are essential, desirable and unnecessary?
3. What is most important to do first?
4. Are there some things which need to be done, without which it is not worth doing any of the others? This is particularly relevant when considering whether biotic or abiotic thresholds have been crossed, and which require intervention.
5. Will some recommendations cost a lot more than others?
6. Are some actions likely to be seen in a negative light by neighboring landowners, thus requiring additional communication in advance?
7. What are the consequences of partial fulfillment of the recommendations (either the individual recommendations or the full set)?
8. If partial fulfillment of recommendations will not actually achieve the goals set for the restoration project, is there any point in embarking on it in the first place?

Ranch Water Quality Plans began as voluntary documents in 1995 with collaboration between NRCS, U.C. Cooperative Extension (UCCE), Point Reyes National Seashore and Marin RCD. The Ranch Water Quality Management Planning Shortcourse delivered by UCCE farm advisors trained livestock managers to voluntarily evaluate their ranch for water quality improvements and prioritize conservation projects (UCCE and NRCS 1995). Research later revealed the implementation of the prioritized water quality projects depended on cost-share funding available. Landowners did their own work if costs were less than $1,000, but only did projects greater than $10,000 if financial assistance was available (Larson et al. 2005).



In 2008, the SWRCB started a Conditional Waiver for Grazing Land in Tomales Bay watershed – a new regulatory requirement for livestock ranches to comply with the Tomales Bay Pathogen TMDL. In conjunction with nine partnering organizations, UCCE facilitated a revised Ranch Water Quality Plan that is now required by the water board and is referred to as the "little blue binder" (SFBRWQCB 2009). Partnering organizations are assisting landowners to complete their plans which remain on the farm/ ranch or appropriate office. The plan includes a list of completed water quality projects in addition to pasture assessment, stream assessment, future project priorities, monitoring requirements and an annual certification form that is submitted to the water board every year (George et al. 2011). The Marin RCD is assisting agricultural producers to comply with TMDL requirements by working with landowners to implement voluntary projects for improving water quality.

Projects & Practices Implemented

This section focuses on the extent and number of conservation practices constructed, installed and implemented in Marin County over the last 50 years. An estimate of the number of projects designed is included for certain practices and all the practices are summarized in Appendix B. The results are presented in subsections organized by groupings of conservation practices with 1) land management for pastures or silage fields, 2) ranch/farm infrastructure such as water development, 3) waste management systems, and 4) erosion control/ habitat conservation.

For this report, **projects** are defined as a temporary endeavor undertaken in a designated land area to create a specific product or management environment for the purpose of delivering a specific result. Conservation **practices** are defined as specific control

measures consisting of managerial, vegetative, and structural techniques to reduce the loss of soil and water. NRCS implemented the majority of projects and practices over the last 50 years in Marin County with 64% and 68%, respectively (Figures 11 and 12). Marin RCD totals account for 19% of projects and 21% of practices implemented and partnering organizations have gotten more active since the late 1990s.

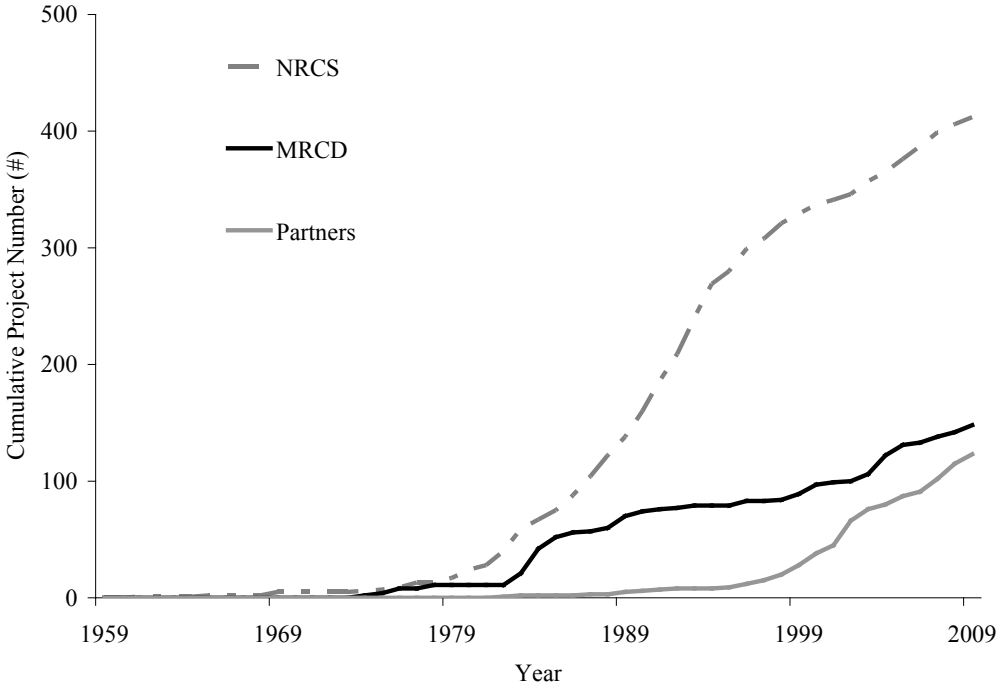


Figure 11: Cumulative number of projects implemented by landowners, Marin RCD, NRCS and other partnering organizations.

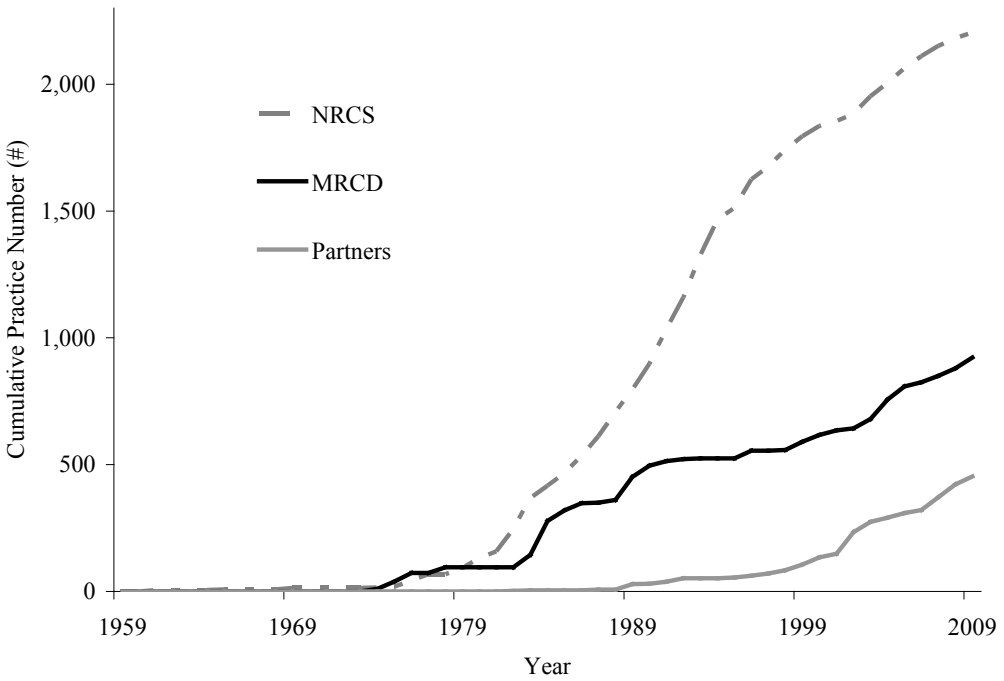


Figure 12: Cumulative number of conservation practices implemented by landowners, Marin RCD, NRCS and other partnering organizations.

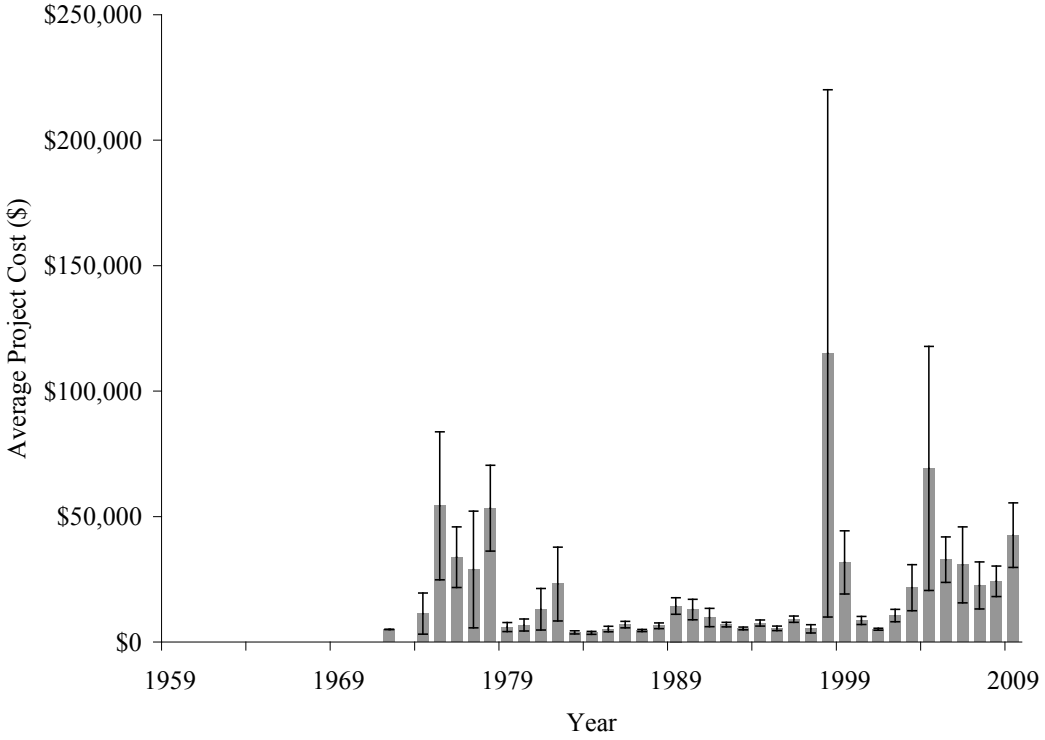


Figure 13: Average project cost 1975 to 2009 with standard error bars (data was not readily available before 1975).

The conservation practices implemented at any one project depended on numerous factors including the ability to afford the construction costs and the availability of financial assistance from cost share or other grant programs. The average project cost was greater in years when more grant support was available to pay for the most expensive projects (Figure 13). This includes the 1970 dairy improvements when operators used loans to get work done, cleanup following flood years was noticeable in 1982 and 1997-98, and RCD grant-funded projects in 1989-90. Conservation projects and practices have increased in relative cost with 2009 projects at least twice as much as 1984, though Figure 13 depicts more annual variation. For example, standard barbed wire fence was about $2/ft in the 1980s, $3-5/ft in the 1990s and $4-8/ft in 2009 depending on the roughness of the terrain, according to NRCS cost-share payments. In addition, Marin County projects are some of the most expensive in the United States because of the cost of living and transportation of materials.

Rangeland & Crops

NRCS' Prescribed Grazing Plans (previously called Proper Pasture Use) were very popular in Marin County during the 1960s (Figure 14, Table 3). They guided livestock

managers to utilize existing science in calculating the carrying capacity of their pastures and rangeland as well as maintaining residual dry matter (Bartolome et al. 2006). These

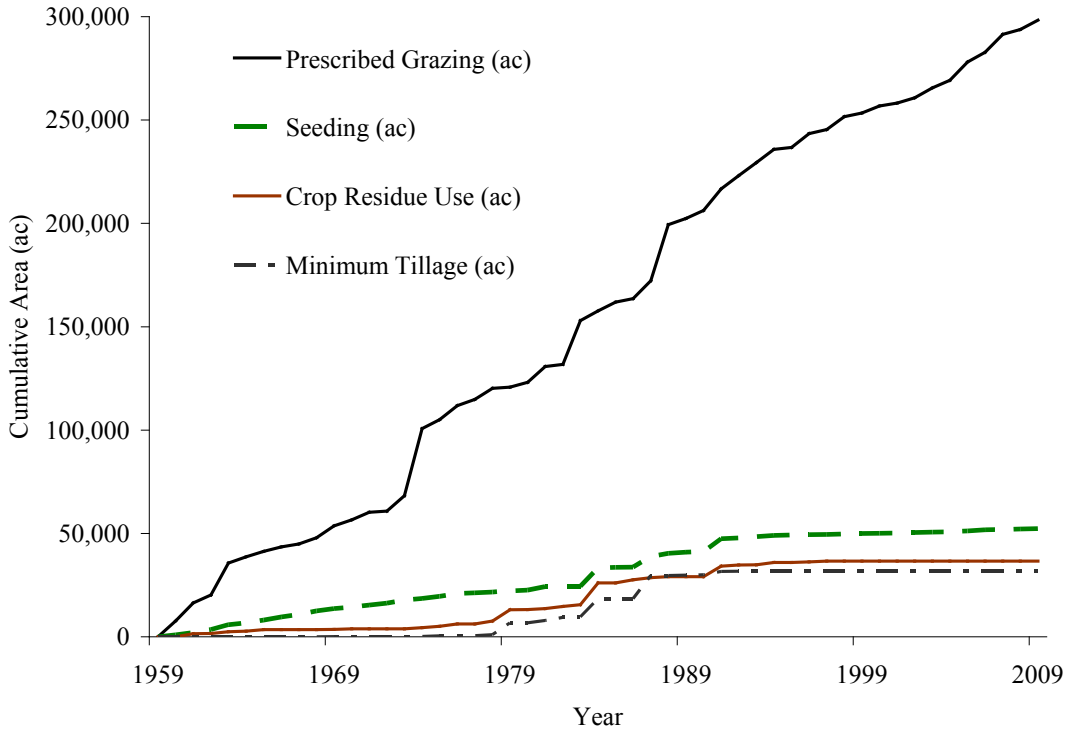


Figure 14: Cumulative land area for pasture, range and crop production related conservation practices from 1959 to 2009 planned and implemented by landowners, Marin RCD and partnering organizations.

Table 3: Total pasture, range and crop production related conservation practices implemented and designed by landowners, Marin RCD and partnering organizations.

Conservation Practice	**Designed & Implemented**		**Designed Only**	
	#	Extent	#	Extent
Brush control (ac)	9	771	27	8,137
Conservation cropping system (ac)	4	135	24	8,887
Crop residue use (ac)	13	6,525	40	30,059
Irrigation water management plan (ac)	9	239	19	1,286
Minimum tillage (ac)	10	3,865	21	27,920
Pasture/range fertilization (ac)	10	1,394	59	9,618
Pasture/range seeding (ac)	149	15,770	87	35,785
Prescribed grazing (ac)	189	101,299	187	196,960

calculations are based on forage production estimates from the Marin County Soil Survey which have been recently updated by NRCS using Ecological Site Descriptions (USDA 2010b). This tool improves pasture management for various reasons including healthier livestock, less feed costs and less erosion resulting from better animal distribution and forage utilization. In the 1970s and 80s, rotational grazing systems began to be installed and incorporated into prescribed grazing plans for increasing pasture production, vegetative cover and perennial grass abundance (Bush 2006). To refine grazing schedules further, efficient methods have been provided for use in California riparian or wetland areas (Ward et al. 2003). The Prescribed Grazing Support Tool assesses pasture specific management, the timing of livestock use and the constraints to productivity (forage available, water troughs, compaction, erosion) using Animal Unit Days (AUD) for planning rest periods and other conservation alternatives (USDA 2009).

Pasture Seeding is an integral component for minimizing the potential for sheet and rill erosion by maintaining greater than 60% cover (Singer et al. 1982) while enhancing productivity in pastures, rangeland or hay and silage fields (Bartolome et al. 2006). In 1961, Marin RCD purchased a Brillion pasture seeder to encourage seeding with appropriate technology. It was rented to landowners for ten years and donated to Tomales High School in 1971. In 1991, Marin RCD purchased a no-till drill which is still available for rent along with a soil aerator. The no-till drill seeder is an important tool in providing alternative options for pasture management. A technology transfer has slowly occurred as dairy operators recently purchased their own equipment after learning the improvements created by Marin RCD's no-till drill.

In the 1970s, plans for Crop Residue Use educated many dairy operators about managing crops, hay or silage fields for maintaining adequate cover to protect topsoil from winter rain impacts. To increase on-farm production in the 1980s, the use of pastures decreased and shifted to silage field management. As a result, Minimum Tillage approaches were encouraged by NRCS and Marin RCD in addition to removing certain fields, or locations within a field, from production. Highly Erodible Land (HEL) determinations became required in the late 1980s to receive certain cost share assistance.

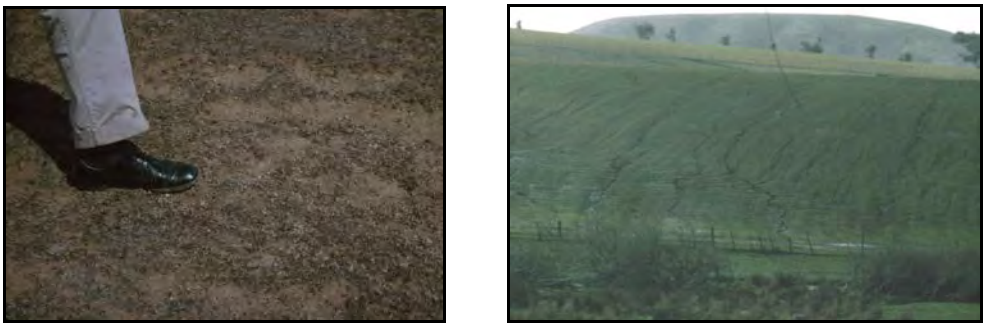


Figure 15: NRCS and Marin RCD educational material from the 1960s depicting examples of sheet erosion (left) and rill erosion (right).

The Brush Control practice was utilized in Marin County until the 1980s with 8,908 acres designed and implemented (Table 3). This rangeland improvement often entailed the removal of woody vegetation that may be competing with desired grasses and limiting forage production overall. Historically, this practice included tree clearing, but research has shown greater pasture production near existing oak trees (Dahlgren et al. 2003). The practice is now used to remove exotic and invasive shrubs such as broom or gorse.

Water Development & Ranch Infrastructure

Agricultural production in Marin County has been limited by water availability and still is today. Developing the infrastructure for farming and ranching operations correctly from the start is vital for long-term sustainability. Stock Pond construction often benefitted from the NRCS technical assistance for appropriate placement, including considerations for geologic fault lines, spillway specifications and water rights (Figure 16). Marin RCD and NRCS helped cooperators plan and design stock ponds from the 1950s to 1980s (Figure 17, Table 4). In addition to the 304 designed stock ponds, 24 were planned and constructed with financial assistance. Additionally, a minimum of 73 dams were repaired following winters with large floods, many with NRCS emergency funding programs, saving 1,000s of cubic yards of sediment from entering local water ways. However, repairing dams has become more difficult if they are regulated by State jurisdiction and numerous landowners in Marin County have spillways with high costs and liability for repairs, but are not able to receive government assistance. Because of the liability and difficulties in securing water rights, few new dams have been constructed with cost share funding since the 1980s.

Figure 16: An example stockpond providing a critical source of clean water for ranch operations (left), failed spillway undermined by erosion caused by subsurface piping (middle) that was repaired by NRCS in 1985 and continues to function today (right). Photos by NRCS.

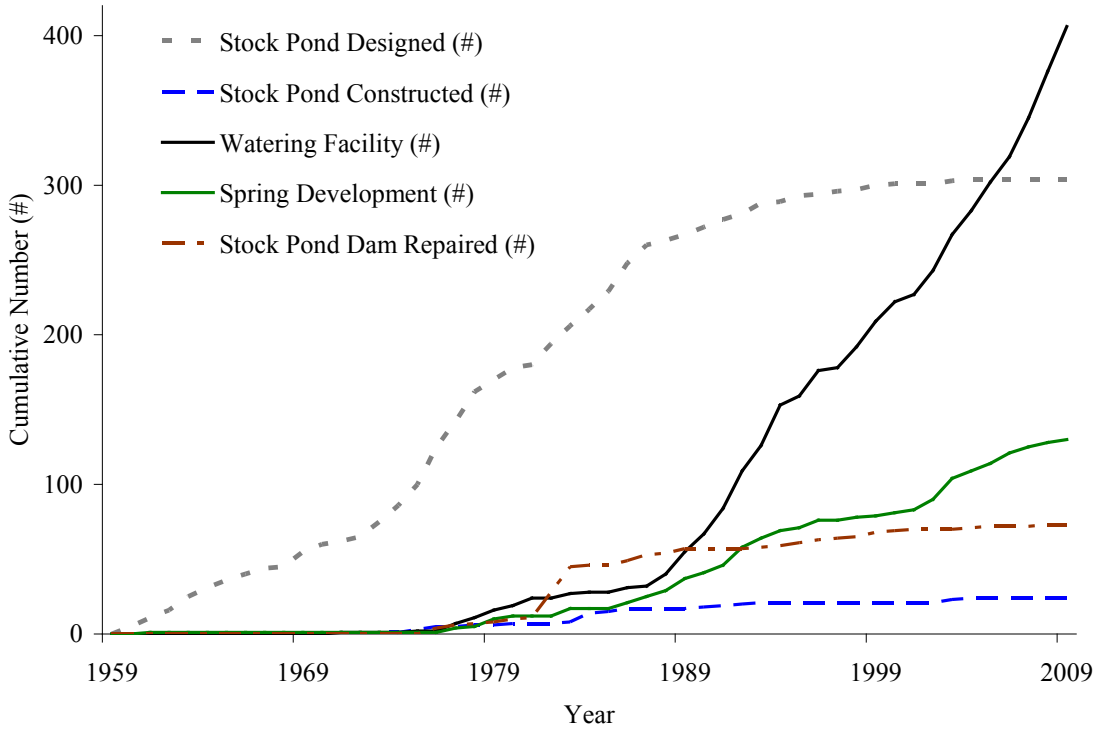


Figure 17: Cumulative number of water development related conservation practices from 1959 to 2009 planned and implemented by landowners, Marin RCD and partnering organizations.

Table 4: Total water development and infrastructure related conservation practices implemented and designed by landowners, Marin RCD and partnering organizations.

Conservation Practice	Designed & Implemented		Designed Only	
	#	Extent	#	Extent
Access road (ft)	151	70,943	38	21,335
Animal trail/ walkway (ft)	60	3,391	15	1,020
Fencing (ft)	524	726,626	143	162,738
Pileline (ft)	161	326,935	34	49,768
Spring development (#)	130	-	83	-
Stock pond (#)	24	-	304	-
Stock pond dam repair/ maintenance (#)	73	-	127	-
Stream crossing (#)	7	-	?	-
Structure for water control (#)	35	-	17	-
Subsurface/ tile drain (ft)	15	6,300	6	4,806
Water trough (#)	185	-	76	-
Watering facility (#)	406	-	112	-

Marin's groundwater is rarely consistently reliable and watering facilities are critical for improving water quality and continuing agriculture in the county. Watering Facilities include both water troughs and tanks to help maintain water pressure within a system that consistently delivers water (Figure 18). This practice provides clean water for livestock that improves animal health, productivity and distribution as well as reducing erosion. This often entails placing water troughs on ridge tops in combination with feed racks and molasses, salt, Magnesium or other supplements to reduce livestock traffic in or near streams. Recent research has shown that meeting livestock water and supplement needs away from the stream reduced livestock time in the stream corridor and therein the risk of nonpoint source pollution while improving aquatic habitat in the stream (Tate 2011, George et al. 2007). Often these practices are implemented as the first step toward improving a degraded stream, followed by exclusionary or control fencing if necessary.

Figure 18: Watering facility examples in a flat combined with control fencing of the stream in background (left), and two troughs and tank combined with spring development (middle, right).

Fortunately, springs are often abundant on west Marin ranches. Where viable, Spring Development practices have provided the source of water for livestock watering facilities. Springs have become more important in the last 20 years as stock ponds have become more expensive to construct and difficult to permit. Tanks are often needed because spring flow is slow with minimal or variable pressure. To increase freshwater sources available on the farm, Gold Ridge RCD has recently completed Water Conservation practice pilot projects in Sonoma County involving the collection of runoff from barn roofs into large tanks (Bush and Lewis 2010).

Pipelines are critical to effectively transport clean water for livestock or wastewater to the desired location on the ranch. Marin RCD and partners have installed at least 326,935 feet of pipeline in rural Marin over the last 50 years (Table 4). This includes respective pipelines for wastewater and freshwater uses.

Fences are critical to ranch and livestock management and were one of the first practices planned by NRCS and Marin RCD (Figure 19). The 524 fences completed a total of 726,626 linear feet (137 miles)

and were all designed to subdivide pastures or rangeland as cross-fencing (Figure 20, Table 4) with perimeter fencing excluded. This infrastructure was an important component of conservation, prescribed grazing, and erosion control plans. A well planned fence can have numerous positive outcomes such as increased productivity, reduced soil erosion, and easier herd management. Considerable thought is given to avoid confining animals or creating new livestock trails unintentionally. About 32% of the total fencing was used to control or exclude livestock access to streams, gullies, wetlands, or other waterways for 228,432 feet (43 miles) in Marin County (Figure 26, Table 6 on page 44). Wildlife friendly and electric fencing are now commonly utilized and flood-friendly fencing is a current challenge.

Figure 19: Examples of how fencing has been used to reduce erosion from uplands hillsides by subdividing pastures to change livestock distribution near unstable or sensitive areas (left), small gully tributaries (middle), and lowland floodplains with a new design where a small section is easily removed prior to flooding (right).

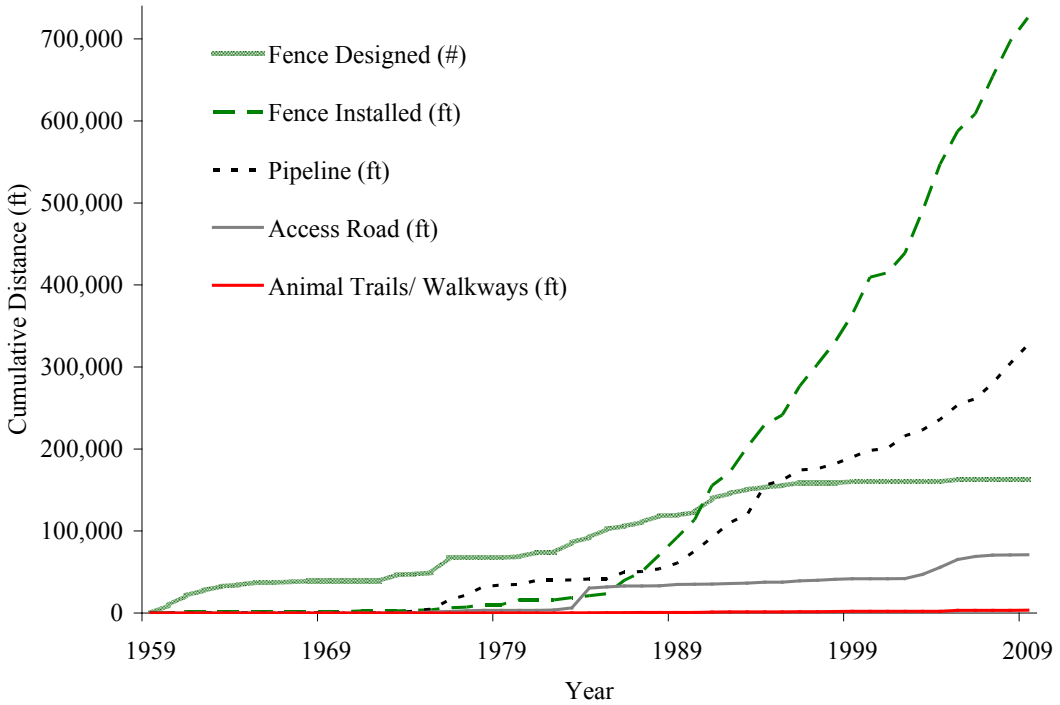


Figure 20: Cumulative distance of ranch infrastructure related conservation practices from 1959 to 2009 planned and implemented by landowners, Marin RCD and partnering organizations.

Access Roads provide seasonal or all year ranch and farm access for equipment and vehicles. Historically, ranch roads were constructed with inboard ditches which are now avoided. Unless well designed, installed, and managed, roads can be sources of chronic fine sediment sources and generate large volume episodic sediment pulses when culverts fail. Access road installation and maintenance by landowners, Marin RCD and partners total over 70,943 feet, with much of this occurring in the Lagunitas Creek Watershed following the 1982 storm (Figure 21). This included road out-sloping, installing water bars, upgrading culverts or stream crossings, decommissioning selected road segments, and stabilizing ditches constructed by Marin County Fire Department and designed by Prunuske Chatham, Inc.. Due to past logging activities, Lagunitas Creek Watershed had a greater density of rural roads than Walker Creek Watershed and, consequently, more road related erosion occurred in the 1980s.

Figure 21: Examples of ranch road maintenance implemented in Lagunitas Creek Watershed following the 1982 flood in cooperation with Marin County Fire Department showing extensive erosion around a culvert outlet (left), and an upgraded road with out-sloped grade and water bar (right).

Animal Tails and Walkways have been very useful to guide livestock distribution away from sensitive areas and improve access to acceptable pastures. This reduces the transport of potential pollution from sediment, nutrients or pathogens in addition to decreasing the amount of time livestock walk in mud and have wet feet.

Structures for Water Control, such as drop inlets and culverts, were popular during the 1970s for providing small scale grade stabilization, access across small waterways, and to transport water without significantly modifying grazing management. Marin RCD and partners have modified the implementation of this practice,

Sediment plugged inlet caused failure of Water Control Structure.

using larger culverts to upgrade crossings so they are less likely to be blocked during large storms (PCI 2010). This reduces diversion potential or redirection of runoff to unintended locations where more erosion often occurs.

Waste Management Systems

Conservation practices for managing manure at dairy operations are based on the Waste Management System plans for manure containment and storage, and the Nutrient Management plans (Figures 9 and 10) that describe how to optimize manure use as a liquid and/or solid fertilizer resource. Accordingly these practices are generally implemented as a package or complete system and include loafing barns, storm water drainage, storage, transfer and other infrastructure (Figure 22, Table 5). Control and reuse of dairy manure began voluntarily in the 1960s and became mandatory in the 1970s, resulting in an increase of planned and constructed waste management systems during that time period. The implementation of these practices was partially supported through a 25% cost-share from the County of Marin under Marin RCD's leadership during the 1970s, as well as through special provisions from NRCS programs since the 1980s. With few exceptions, dairies that were not able and willing to implement manure control infrastructure or plans went out of business. Since 2000, regulatory agencies are working cooperatively to assist dairy producers' conservation practices that improve forage production and water quality from pastures and corral or dry lot areas in addition to maintaining waste management systems (Lewis et al. 2005).

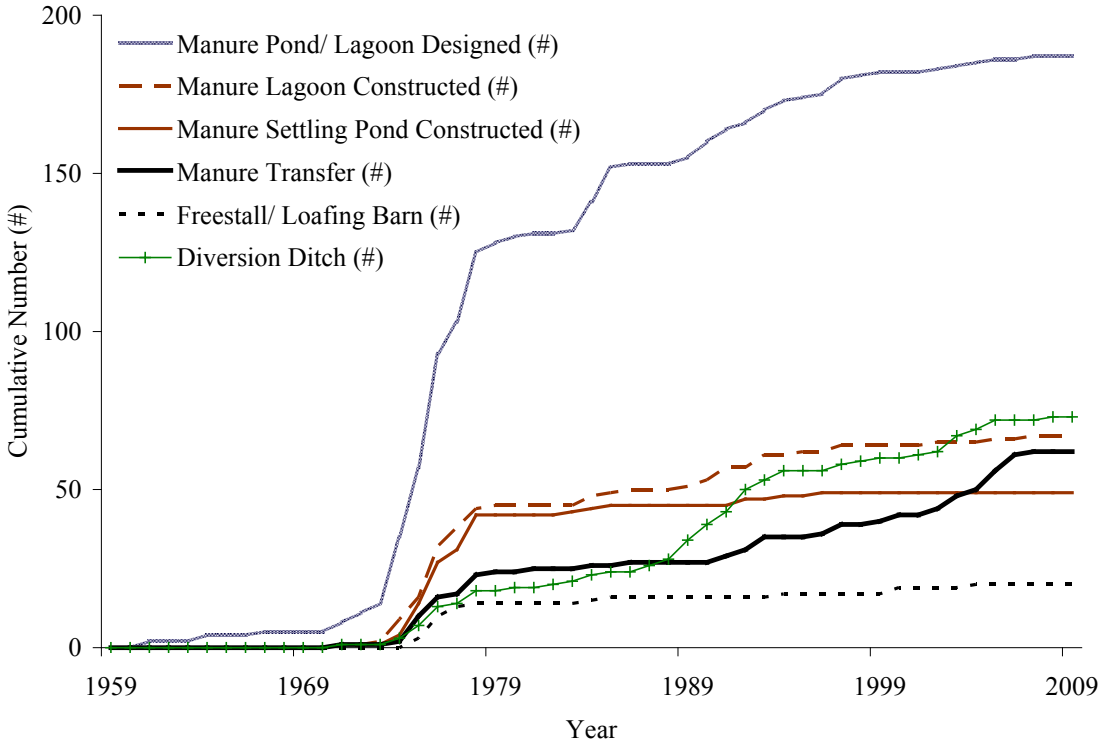


Figure 22: Cumulative number of waste management related conservation practices implemented from 1959 to 2009 planned and implemented by landowners, Marin RCD and partnering organizations.

Table 5: Total dairy waste management related conservation practices implemented and designed by Marin RCD and partnering organizations.

Conservation Practice	Designed & Implemented		Designed Only	
	#	Extent	#	Extent
Diversion ditches (ft)	73	40,748	30	20,900
Filter strip (ft)	7	4,000	2	700
Loafing/ freestall barn (#)	20	-	35	-
Manure lagoon/ pond (#)	64	-	79	-
Manure settling pond (#)	45	-	108	-
Manure lagoon/ pond enlarged (#)	24	-	11	-
Manure waste transfer (#)	62	-	20	-
Nutrient mngt. plan (#)	31	-	33	-
Roof runoff structure (#)	34	-	4	-
Waste mngt. system (#)	68	-	196	-

Though a large capital investment, the ability to hold, manage and apply fertilizer on the farm enabled dairy operators to grow more feed, import less rations, and reduce costs for inputs. Loafing and freestall barns offered housing for dairy cows and calves to avoid water quality impacts during the winter and facilitate livestock management. In addition to the spike in barn installation during the 1970s, more barns have continued to be constructed as part of complete waste management systems since that time. In conjunction with barns, Roof Runoff Structures are implemented to separate clean drainage directly into gutters away from the livestock access and feeding areas near the barn roof. The Waste Transfer practice improves the functionality of waste systems by transporting liquid or solid dairy manure from barns to adequate storage areas, such as lagoons, and then to pastures and fields. These systems enhance management abilities and facilitate manure nutrient use as a fertilizer resource. This includes manure solid separators that provide manure management options for composting and increase the capacity for manure lagoons to handle waste water.

Each dairy facility generally consists of manure settling ponds to collect solid material before the liquid enters a secondary lagoon from which it may be applied to pastures at appropriate times. These systems have been expanded in capacity over the years with at least 45 Settling Ponds and 64 Lagoons constructed. In 1999, Marin RCD initiated a methane digester pilot project by retrofitting and covering a lagoon to create anaerobic conditions with a grant for Advanced

Methane digester pilot project.

Integrated Pond Systems. The landowner uses the electricity produced for cars, trucks, ATVs and other ranch operations in addition to increasing the storage capacity of wastewater and improving water quality.

Utilizing wastewater as a resource for pasture fertilizer has shown the economic and water quality benefits of maintaining nutrients on the farm (Hickey et al. 2010). The timing and distribution of irrigation is critical and depends on the sprinkler type, chemistry of the wastewater, freshwater available for dilution, and capacity of ponds to be able to wait until optimum field conditions. The ideal sprinkler system offers even distribution with minimal maintenance such as provided by the "moving big gun" which mechanically pulls it through the pasture over 1000 feet and NRCS has provided extensive assistance with this technology. Freshwater sources provide dilution to wastewater irrigation chemistry and water conservation projects collecting runoff from barn roofs into large tanks (Bush and Lewis 2010) offer potential "fertigation" systems similar to those used by dairies receiving excess wastewater from the City of Santa Rosa.

Moving big gun sprinkler.

Diversion Ditches were designed by NRCS extensively and have continued to be implemented in Marin County (Figure 22, Table 6). They offer a reliable method for transporting concentrated flow to a desired location, such as a stock pond, or keeping relatively clean runoff segregated from sources of pollutants, like bare soil, compost piles, corrals and other livestock high use areas. However, maintenance is needed where livestock trail across the ditch or sediment accumulates.

Filter Strips are wide ditches that maximize laminar flow conditions designed to collect sediment and filter pollutants from small drainages within the ranch or farm, such as stormwater runoff from corrals or dry lots. This practice was historically implemented to filter wastewater as an alternative to waste management systems. In cases where herd size grew, treatment capacity was often overwhelmed by the increased supply of manure. Marin RCD and partners have responded to these changing capacity requirements and challenges to installation at specific locations in order to provide maximum length with appropriate gradients on hillside and lowland locations (Figure 23). Filter strips provide an ideal option for high functioning vegetative buffers to reduce pathogens in stormwater runoff (Lewis et al. 2010, Lewis et al. 2009, Tate et al. 2006, Tate et al. 2004).

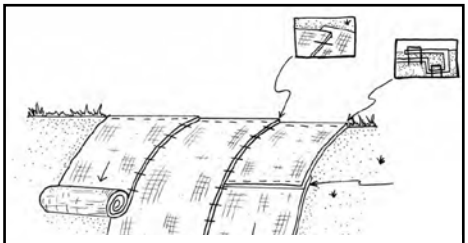
Figure 23: Examples of Filter Strips to treat surface water runoff from corrals depicting an overview of a hillside site with over 400 feet of laminar flow conditions following the contour (top), and a flat bottomland location where the site's treatment distance and laminar flow conditions were maximized (bottom). Designed by NRCS.

Erosion Control & Habitat Enhancement

Similar to the evolution of conservation practices used for waste management systems, Marin RCD, landowners and partnering organizations collaborated with scientists, managers and environmentalists to adapt national conservation practices for meeting the erosion control and habitat enhancement needs of Marin County in a process that built the overall science of watershed restoration, as suggested by Bernhardt et al. (2007). The practices included Critical Area Planting, Channel Stabilization, Streambank Protection and Riparian Revegetation among many others. Though the primary objective was often controlling erosion, enhancing and maintaining wildlife habitat were considered for each project site and both needs were prioritized. The selection process of restoration sites was guided by Watershed Enhancement and Erosion Control Plans for Lagunitas, Walker and Stemple Creek watersheds since the early 1980s (see page 26-27) as recommended by Kondolf et al. (2007). Current erosion control and habitat enhancement projects focus on restoring ecological functions and hydrologic processes in an ecosystem approach at each site that will sustain objectives over time with minimal future maintenance (FISRWG 1998, PCI 2010).

Critical Area Planting has always been a component of any grading or construction project conducted by Marin RCD to minimize surface erosion and increase site stability following dam construction, access road installation, or other projects that disturb soil.

This practice has transitioned from the 1960s seeding of annual and perennial rye grasses to current revegetation techniques using various native grass species as seed and/or plugs. In many cases, seeding and plug planting is coupled with erosion control fabric to prevent sheet and rill erosion or potential project failure.



Design by Prunuske Chatham, Inc.

Critical Area Planting incorporated revegetation technologies using willow that were tested in the 1960s and 70s to fix gully erosion by Marin landowners with the assistance of NRCS. In the 1980s, willow became regularly incorporated into Marin RCD practices as soft approaches that allow for shifting and settling of soil, but provide for long-term site stability (Figure 24). This includes tree planting as cuttings, sprigs or poles and "bioengineering" or "biotechnical" specifications of high density willow woven into a wall, mattress, wattle, or brush layer as living checkdams or headcut repairs as described in *Groundwork* (Prunuske 1987). These soft approaches to channel stabilization and streambank protection have been improved upon over the last 30 years by Marin RCD and its partners to now offer an effective, low cost option that has proven successful in Marin County conditions.

Figure 24: The specification for planting a willow cutting or sprig and surveying a newly planted site with some rabbit damage in 1988 (top). Design and photos by Prunuske Chatham, Inc.

Though riparian revegetation is not an official NRCS conservation practice, the methods used to establish native trees, shrubs and/or native perennial grass species using browse protection, weed mats and irrigation are now common (Figure 25). They may be included as specifications within multiple other practices such as critical area planting, tree/ shrub establishment, or streambank stabilization and are often smaller areas within larger sections of control fencing. Though trees were the focus during the 1980s, shrub species have been included since the 1990s to enhance habitat available for neotropical migrating species in particular (Kreitinger and Gardali 2006). Species other than arroyo willow have often been preferred by landowners utilizing revegetation which has increased the use of larger trees such as box elder (Figure 25), oak, alder, Oregon ash and

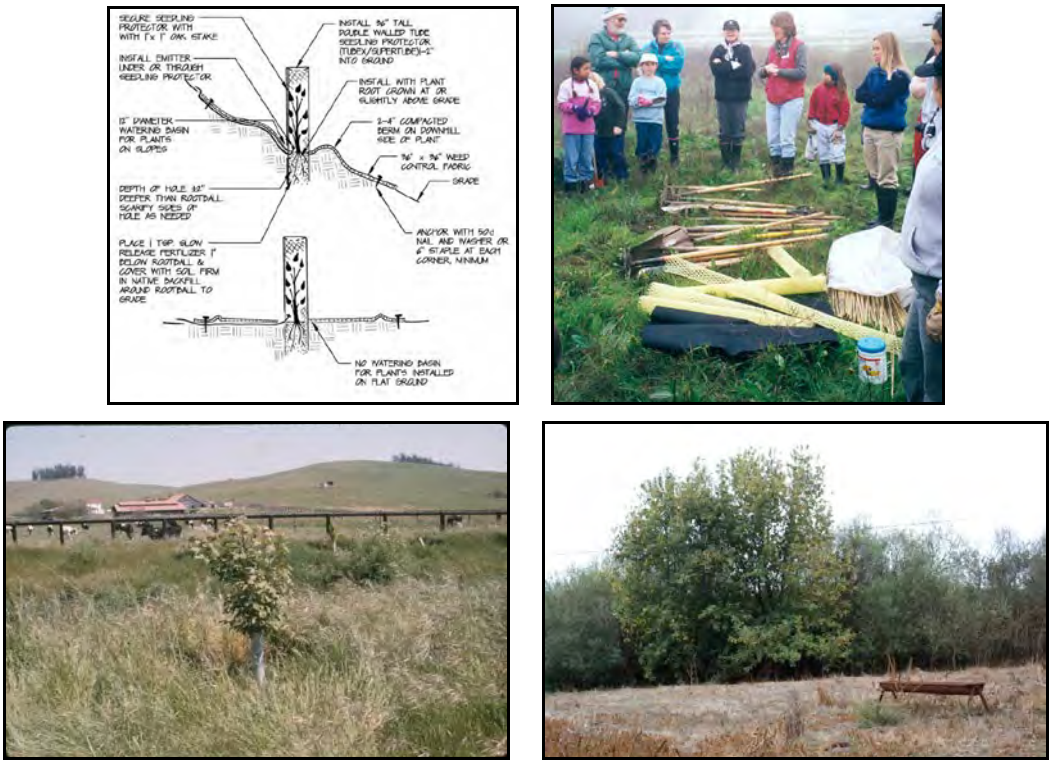


Figure 25: Other tree species and shrubs receive browse protection because they grow slower and are more sensitive to damage, with Liza Prunuske teaching and inspiring children participating in revegation and streambank protection on a Marin County ranch (top). Large tree species with upright growth, such as this box elder (*Acer negundo*) planted in 1995 along Stemple Creek, are able to compete with arroyo willow and provide dense shade within 15 years since planting (bottom). Design by Prunuske Chatham, Inc. and photos by STRAW.

shining willow, where appropriate. The cost of native grass and forbs species can be prohibitive for large scale understory restoration.

Marin RCD and its partners have implemented over 137 Riparian Revegetation projects that installed at least 35,372 native trees and shrubs to enhance habitat on 133,554 feet (25 miles) of streambank in Marin County (Figure 26, Table 6). STRAW completed the majority of this work in the Walker and Stemple Creek watersheds. In addition to designing projects with native species acceptable to each landowner, the STRAW revegetation program educated thousands of Marin and Sonoma county youth about conservation and watershed restoration while conducting the maintenance on their plantings. Overall survival of revegetation for non-willow species increased over the last ten years from about 50% to greater than 80% because of improved selection of species and irrigation methods with drip systems or DriWater tubes (STRAW unpublished data). Other revegetation lessons include not planting trees under power lines, immediately upstream of bridges, blocking landowner's line of sight, and next to fences for maintaining access, vegetation management or reducing long-term pressure on fences.

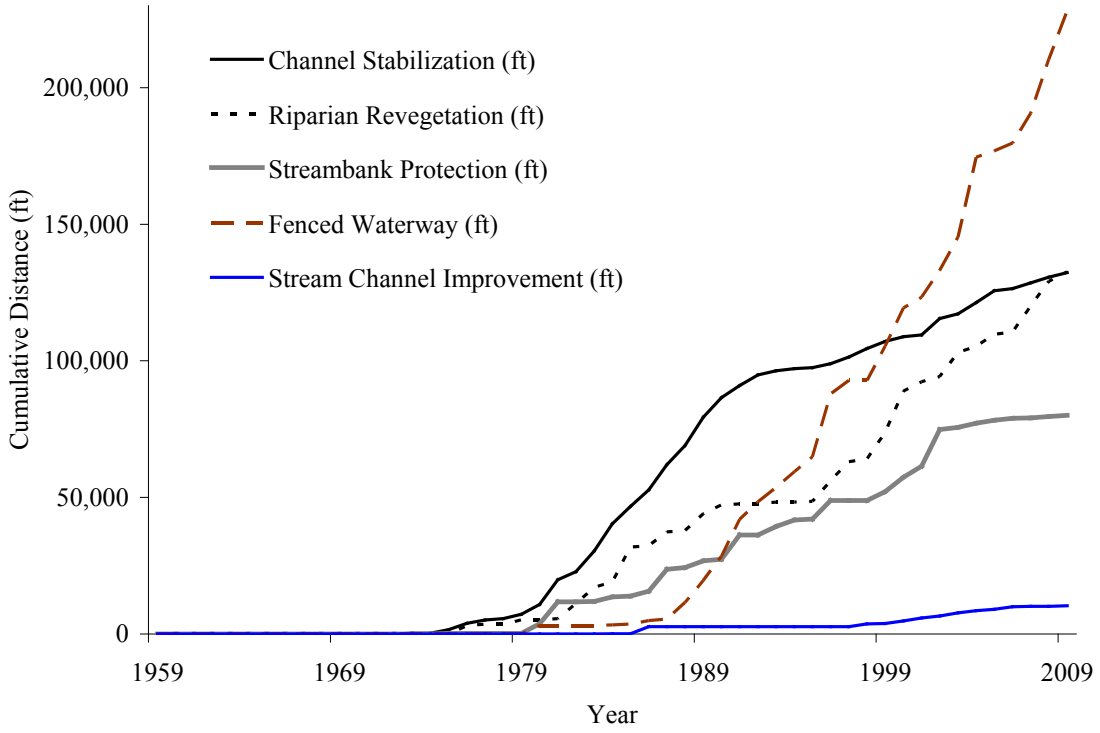


Figure 26: Cumulative distance of erosion control and habitat improvement related conservation practices from 1959 to 2009 implemented by landowners, Marin RCD and partnering organizations.

Table 6: Total number of erosion control and habitat enhancement related conservation practices implemented and designed by Marin RCD and partnering organizations.

Conservation Practice	Designed & Implemented		Designed Only	
	#	Extent	#	Extent
Channel stabilization (ft)	253	133,120	158	76,490
Critical area planting (ac)	334	630	176	232
Fenced waterway (ft)	109	228,432	12	33,770
Grade stabilization structure/ checkdam (#)	668	-	116	-
Grassed waterway (ft)	39	13,215	14	14,120
Headcut repair (#)	472	-	168	-
Landslide stabilization (ac)	21	21	4	35
Lined waterway (ft)	52	8,394	19	3,385
Riparian revegetation (ft)	145	133,554	9	2,650
Sediment basin (#)	24	-	17	-
Stream channel improvement (ft)	107	10,285	9	1,075
Streambank protection (ft)	95	80,008	31	34,227
Trees/ shrubs planted (#)	137	35,372	8	976

Fencing of waterways equals 43 miles and increased since 1989 (Figure 26) following early lessons at erosion control project sites where project success was less than expected. The fence location was originally placed near the stream in order to maximize pasture area and reduce the amount of grazing land lost. However, this lead to failures when the streambank slumped during extreme flood years and weeds may be worse where vegetation management was not possible. As a result, control fences currently designed are placed back from the stream to maintain management options for the landowner within the riparian corridor. Lowland areas such as Stemple Creek are particularly troublesome because fences in the floodplain collect debris during large flood events and require maintenance. Current challenges include how to establish trees and shrubs along streams for landowners with reservations about invasive weed species and long-term maintenance.

Debris trapped by fence in lower Stemple Creek following large storm. Photo by STRAW.

Channel Stabilization and control of gully erosion processes have been an important part of sustaining water quality and sustainable agriculture in Marin County over the last 50 years (Figure 27). This practice came into use during the 1970s to address large existing gullies, and became a widespread practice during the 1980s to effectively transport rain water off agricultural land with minimal topsoil loss or sediment transport (Figure 26).

Figure 27: Some of the "worst erosion in Marin County" was like this Walker Creek property when channel stabilization and revegetation began in 1970 (top left), nine years later streambanks are more stable with trees establishing (top right), the project leader posing with successful plantings (bottom left), and 35 years later the gully is completely stable with diverse habitat including arroyo willow, shining willow, red alder and other shrub species (right). NRCS Designed.

Unstable gullies and channels contain headcuts indicative of future erosion potential so locating and fixing them before they cross a stability threshold and unravel into larger gully systems has been a focus of Marin RCD and its partners with over 133,120 feet (25 miles) of channel stabilized including 668 Grade Stabilization Structures and 472 headcut repairs implemented (Table 6).

Grade Stabilization Structures were the most commonly utilized practice to stabilize stream channels and the current designs used by Marin RCD and partners have fine-tuned the loose rock checkdams, implemented over 20 years ago, with various improvements to specifications. They are now built at a 3:1 grade using a mix of rock sizes to reduce structure movement and potential subsurface erosion. Further refinement of this practice includes boulder grade control structures at larger gully sites or willow walls at small sites and the area above the checkdam is filled-in to directly deliver channelized flow to the structure spillway (Figure 28).

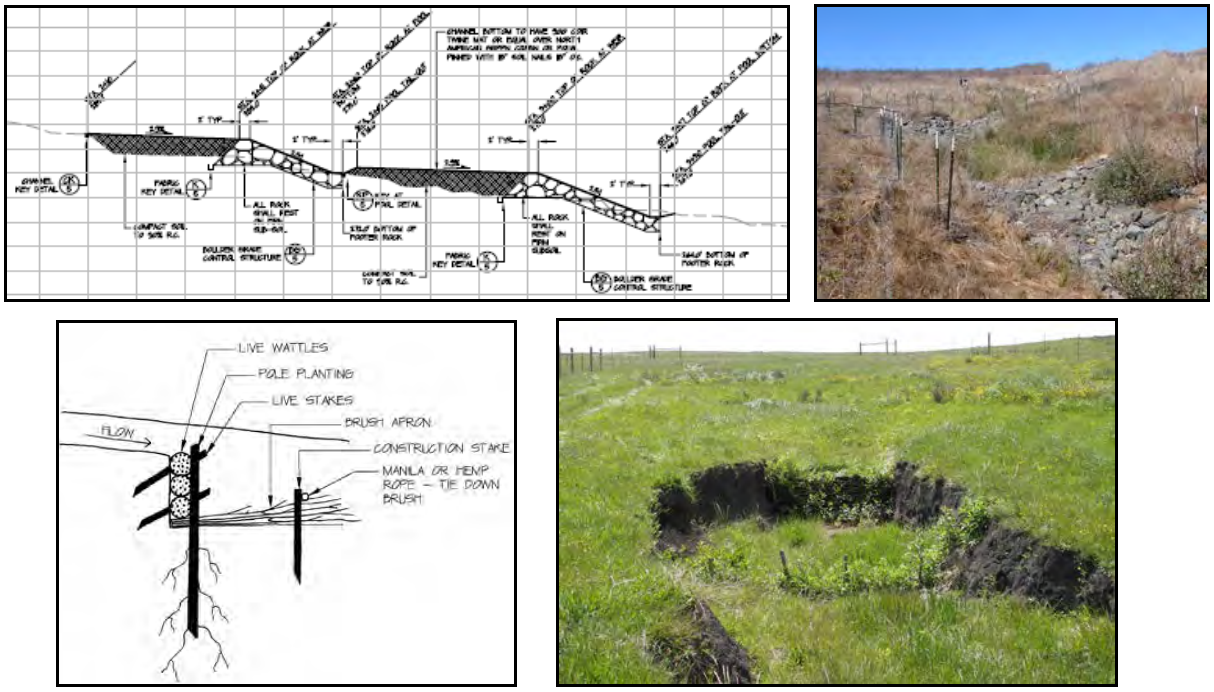


Figure 28: Recently constructed channel stabilization projects in 2008 showing two boulder rock Grade Control Structures with fill soil above them in the as-built profile view and one year after construction including control fencing and revegetation with willow, rush and box elder (top). A specification for willow wall headcut repair (left), and a series of willow wall grade stabilizations structures less than a year old in Point Reyes National Seashore (bottom). Designed by Prunuske Chatham, Inc.

The Grade Stabilization Structures currently used by Marin RCD have evolved from large scale Sediment Basins similar to the dams built for stock ponds began in 1970s and 80s with large grade stabilization structures for erosion control (Figure 29). Simultaneously, the basins and ponds also stabilized channels, repaired gullies, and

trapped large quantities of upstream sediment. In addition to trapping sediment, basins often provided multiple benefits to ranch operations including access over wet crossings and freshwater sources without fencing or losing forage producing land. The spillways of basins and grade stabilization structures present repair and maintenance needs similar to stock ponds and dams for both were phased out of use by the early 1990s. As an alternative spillway repair, Marin RCD and Prunuske Chatham developed a "roughened ramp" to replace a potentially failing spillway in 2005.

Currently, Sediment Basins are designed as smaller structures for trapping specific soil texture size classes and often located above culverts, or Structures for Water Control, to reduce plugging during large storm events (Figure 29). This saves sediment transport downstream and reduces maintenance requirements. These modified Sediment Basins are also installed upstream of Filter Strips, reducing the sediment load and potential to overburden the designed treatment capacity of a Filter Strip.

Figure 29: Examples of Sediment Basins depicting a large-scale design constructed in the 1980s (left), and a smaller version with a paved access ramp to facilitate maintenance built in 2005 (right).

Redwood board checkdams for small scale Grade Stabilization Structures were extensively utilized until the 1980s (Figure 30). They often functioned successfully for years until undermining of the structure occurred, often following "gully washer" storm events, allowing subsurface water to scour around or under checkdams. Or, the boards deteriorated from rot after about 30 to 40 years allowing potential new headcuts to develop depending on vegetation establishment. Similarly, concrete is no longer used because of water undermining structure integrity and gabions have been found to unravel eventually if not colonized by vegetation. Other early lessons from 1982-84 included the use of geotextile fabric installed behind dams, keeping dams less than 3 feet tall, and considering grazing management or control fencing.

Figure 30: Examples of redwood board checkdams used as Grade Stabilization Structures with a recently constructed site in the 1980s (left), and a 30 year old site with deteriorated checkdam but vegetation such as *Juncus* has stabilized potential soil erosion (right). Designed by NRCS and Prunuske Chatham.

Figure 31: A series of seven small Grade Stabilization Structures were installed in the gully as loose rock checkdams above a Sediment Basin in 1989 with preproject photo (top left), aerial view design (top right), immediately following construction (middle left), the site two years later (middle), checkdam structure functioning as designed (middle right), four years (bottom left), and six years later (bottom right). Designed by Prunuske Chatham and NRCS.

By the late 1980s, Grade Stabilization Structures no longer used redwood board checkdams. Instead, new loose rock checkdam structures were designed and installed (Figure 31). Marin RCD treated numerous large gully systems identified as top priority on erosion control plans with multiple conservation practices that applied previous lessons learned. Through the combination of appropriate rock size and weight with geotextile fabric, these were designed to remain functional in perpetuity with minimal maintenance required.

Lined Waterways with rock (Figure 32) and Grassed Waterways (Figure 33) have slowly replaced redwood board checkdams, Structures for Water Control, and Culverts where possible. They have become increasingly popular during the last 20 years because they provide a self-sustaining system that requires less maintenance and is generally less prone to failure.

Figure 32: Photo monitoring of a grade stabilization project with functional redwood board checkdams before March 1986 storms (top left 2 photos), following March 1986 storms (top right 2 photos), the emergency repair installed a Lined Waterway with control fencing (bottom left 2 photos), and one year later in June 1987 (bottom right). Designed by NRCS.

Grassed Waterways function to transport water where concentrated flow does not have the power or velocity to justify a Lined Waterway. They may be used in combinations with grade control structures if the site is unstable as shown by active headcuts, slope, drainage area, and soil type. Grassed Waterways were constructed extensively during the late 1980s and early 90s as a resilient low cost alternative because minimal rock was needed (Figure 33). They are still used today where appropriate.

Figure 33: A Grassed Waterway practice installed in Lagunitas Creek Watershed in 1988. Designed by NRCS.

The relative importance of Grade Stabilization Structures and revegetation combined with improvements to the design of rock-lined waterways was learned in the early 1990s at a site in the Walker Creek Watershed. The pre-project gully erosion was extensive and caused by unstable geology combined with expansive and heavy soils that drain slowly. In 1992, Subsurface Drains, Rock Lined Waterway and Fencing practices were installed. Revegetation was not included in the original project design due to the inability to irrigate plantings at the remote site location. However, the project unraveled by 1996 when a geotechnical study was conducted and a minimal repair planted willow with remaining rock to stabilize the soil slumps (Figure 34). Depending on the gradient of the site, rock-lined waterways are now designed as a defined channel with capacity for the potential flow volume from the worst case storm events (i.e. 50 to 100 year flood).

Figure 34: An eroding gully pre-project (left), after implementation of Lined Waterway and other practices in 1992 (middle), and four years later the site had unraveled (right).

Streambank Protection became increasingly important in Marin County following the 1982 flood (Figure 35) as large sections of land unraveled and washed away virtually overnight. The techniques have evolved to establish vegetated buffers along stream locations that were previous sediment sources. The bioengineering, or biotechnical, soft techniques were similar to grade stabilization methods, but designed for localized stream conditions as described in Groundwork (Prunuske et al. 1987) following pilot projects by Marin RCD in the 1980s designed by Prunuske Chatham and NRCS. The source of this innovation included the need to find low cost and effective practices so that more sites and streambanks could be treated with practices that were credible to project funders and granting agencies. The vegetated boulder revetment method was adapted from traditional hard structures for streambank protection such as rip-rap or wire gabions. In this design, willow poles are planted behind and between an engineered rock toe placed on top of filter fabric covering unstable fill or alluvium (Figure 35).

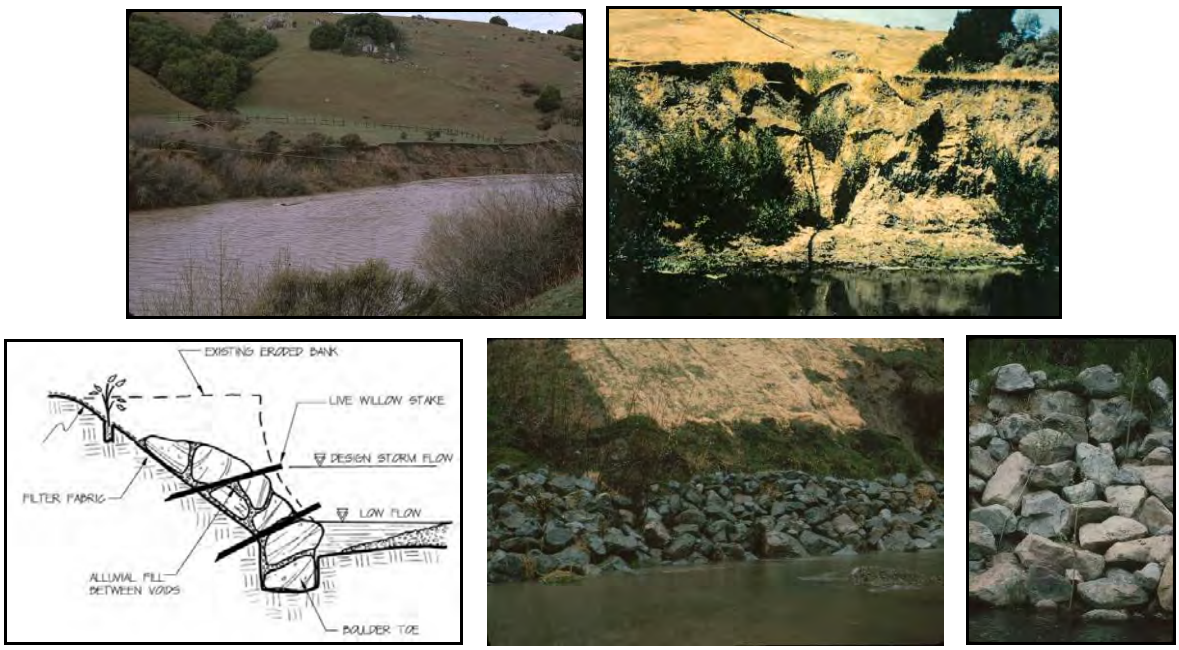


Figure 35: One of the first vegetated boulder revetment techniques adapted for the Streambank Stabilization practice at "one of the worst actively eroding streambanks" in Marin County before the project in 1985 (top), practice design and following installation with willow sprouts barely visible (bottom). Designed by Prunuske Chatham, Inc.

On smaller streams with less erosive power, completely soft approaches to streambank stabilization such as willow walls were also developed during the 1980s by Marin RCD and its partners. This technique has been perfected iteratively through the 1990s to offer the Streambank Stabilization practice a completely soft approach applicable to most creeks in Marin County. Since 2000, willow walls (Figure 36), willow revetment, willow wattles and brush mattresses were further adapted to repair larger unstable streambanks (Prunuske et al. 1987, PCI 2010). In total, over 78 willow biotechnical treatments have been installed totaling approximately 3,157 feet. Lessons learned include using straight and pliable branches, tying them down together, and completely backfilling soil behind willow walls. Today, Marin school children commonly construct willow walls under the supervision of STRAW, Prunuske Chatham, Inc. and Marin RCD.

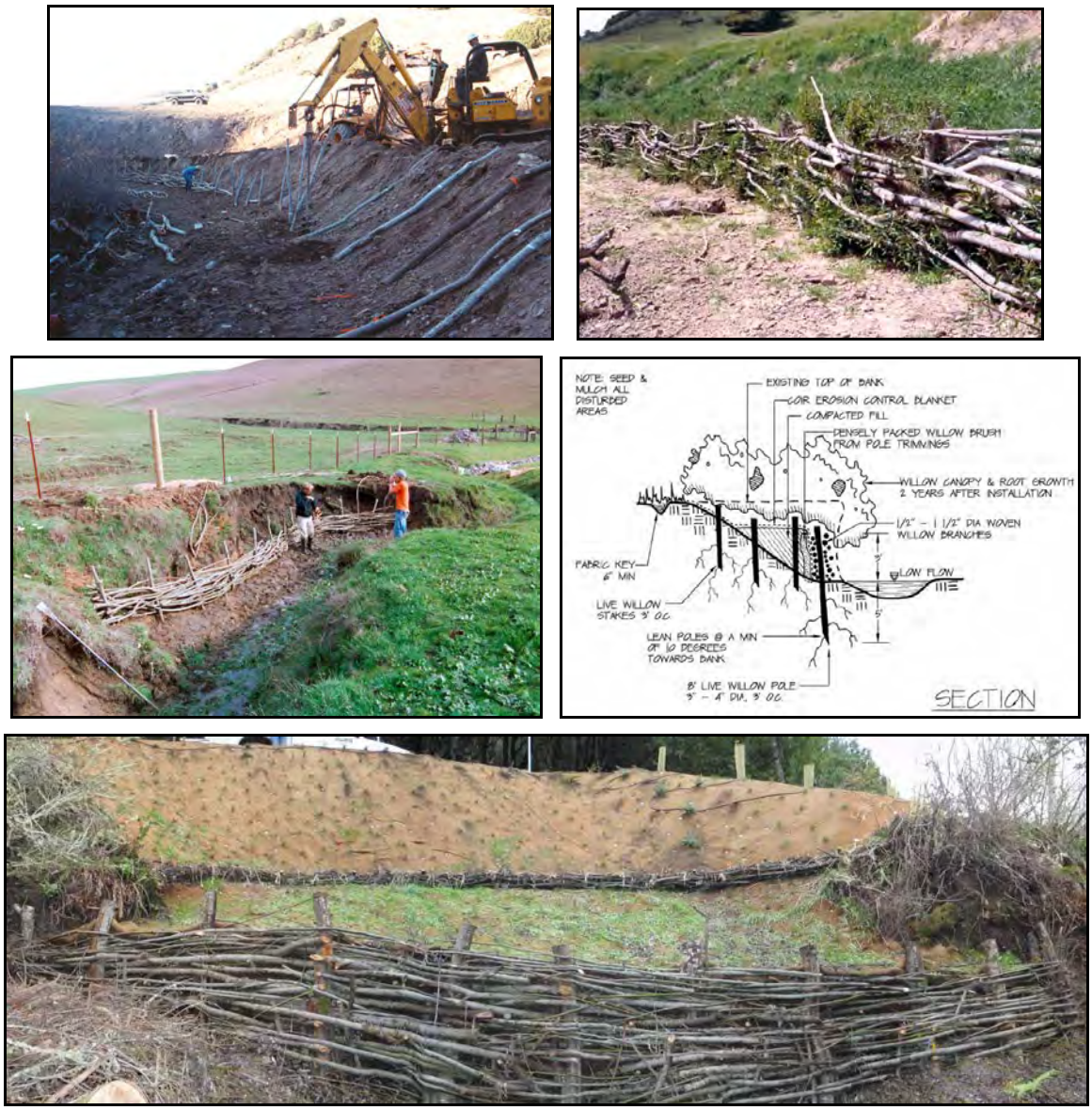


Figure 36: An example of the first willow walls constructed in 1990 in the Walker Creek Watershed (top), another later example constructed in 1994 (middle left), a recent design specification (middle right), and a recently constructed willow wall stabilizing the streambank toe below a threatened ranch road with willow fascine and revegetation using native grass seed, sedge/rush plugs, and shrubs in 2008 (bottom). Designs by Prunuske Chatham, Inc.

The Stream Channel Improvement conservation practice was previously focused on enhancing the depth and number of instream pool habitat, but are now intended to improve aquatic habitat conditions overall. Marin RCD began researching and testing instream fish habitat improvement practices in 1983 with CDFG, Trout Unlimited, NRCS, Prunuske Chatham and others. The first to be installed was a "Hewett Ramp" in mainstem Lagunitas Creek (Figure 37). Made of redwood boards, the structure concentrated flow, provided cover, and scoured out a downstream pool. It functioned as designed for several years until the March 1986 storms.

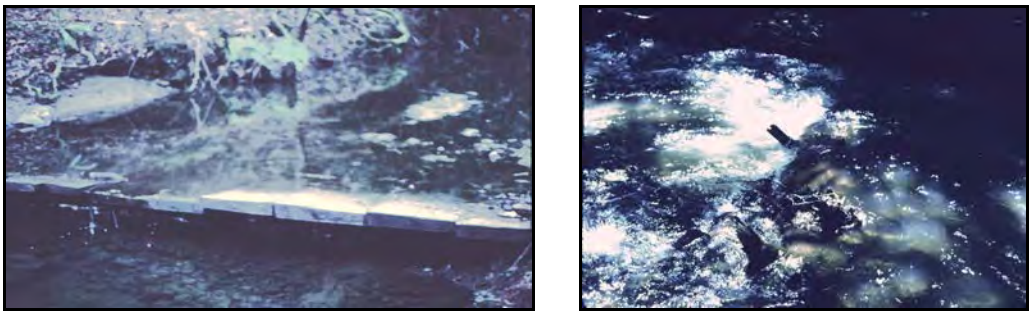


Figure 37: The first Stream Channel Improvement practice used a "Hewlett Ramp" design to confine high flows that scour deeper pools to improve habitat for steelhead and coho salmon. Designed by Prunuske Chatham, Inc and Trout Unlimited.

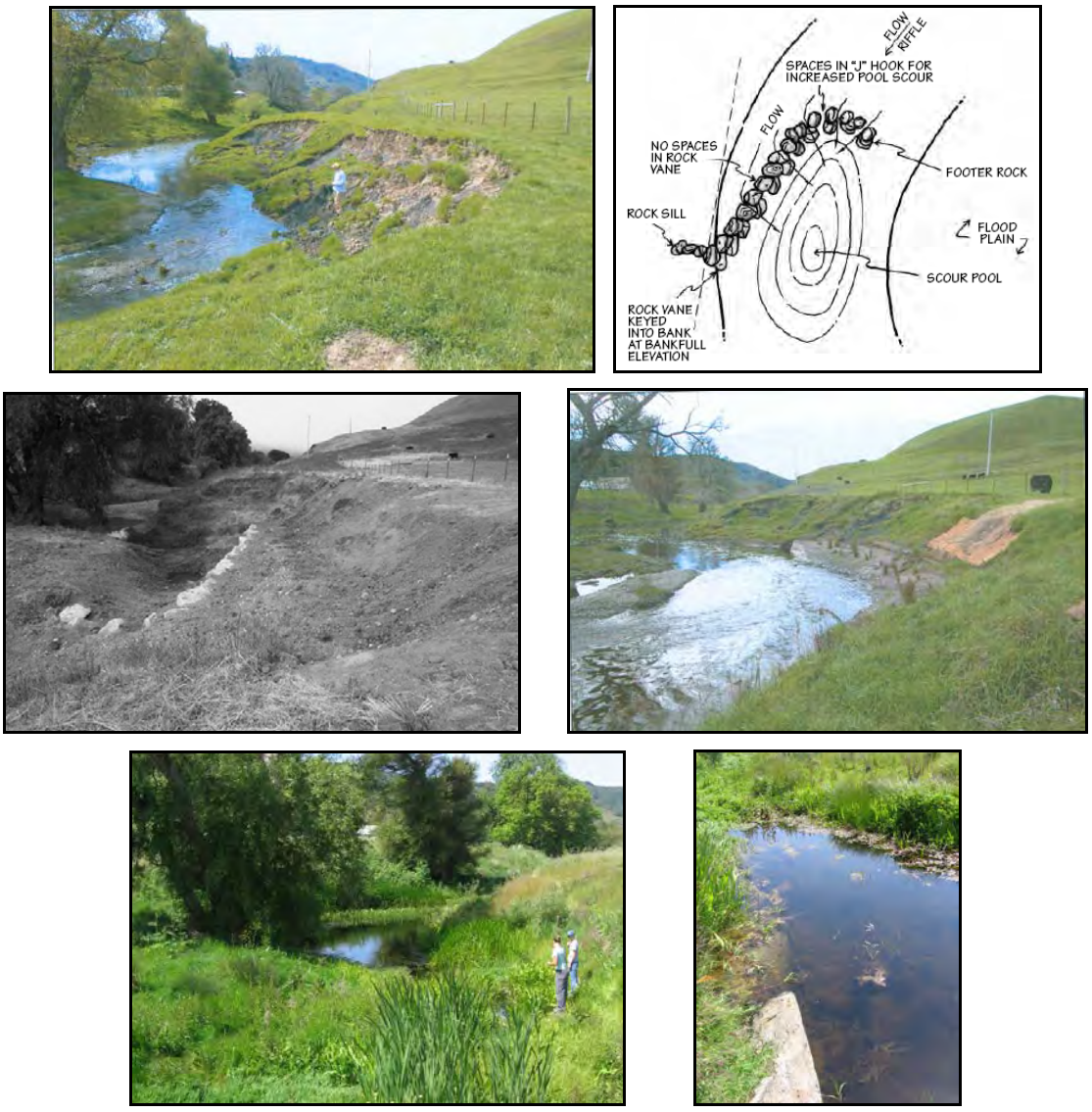


Figure 38: A recent Stream Channel Improvement practice in Walker Creek watershed implemented using J-hook instream enhancement techniques before the project in 2003 (top left), practice design (top right), during and following installation (second row), and five years later with the intended deep pools for aquatic species and well vegetated, stable streambanks (bottom). Designed by Prunuske Chatham, Inc. Photos by STRAW.

Similar to adaptations of other conservation practices, Marin RCD and partners tested natural design alternative options in the late 1980s, incorporating boulders or logs to increase habitat complexity in Lagunitas Creek for juvenile coho and steelhead species (Kelley 1989). The results helped to fine-tune the science of restoring salmon habitat and were included in CDFG's Restoration Manual (Flosi et al. 1998) and recent editions of *Groundwork* (Prunuske et al. 1987). These included techniques such as J-hooks (Figure 38) to use the stream's hydrologic processes to sustain fish habitat improvements over time. Overall, Marin RCD and its partners have installed 107 Stream Channel Improvement projects across 10,285 feet (1.9 miles) of stream habitat.

LWD placed in Lagunitas Creek by MMWD.

Large woody debris (LWD) projects have been used to improve instream habitat and have been extensively implemented in Lagunitas Creek by MMWD (Andrew et al. 2010) to provide winter rearing habitat and refuge from high flood flows for juvenile coho salmon as described in Marin RCD's *Limiting Factors Analysis* (Stillwater Sciences 2008). The larger and more complex woody debris jams provided the best habitat for juvenile coho salmon because they created slackwater conditions throughout all stages of the hydrograph (Stillwater Sciences 2008) and cover from predation during the summer (Ferguson 2005). Four types of structures were used by MMWD in their LWD restoration program on Lagunitas Creek:

- Creek constriction: logs on both sides of the banks to constrict creek flow into the center of the channel.
- Obstruction logs: produce a perpendicular or angled barrier to creek flow.
- Divide log: uses a log parallel to the stream flow sometime accompanied by a perpendicular log to catch small woody debris.
- Channel-spanning log: uses one or two logs that cross the creek and force water under and over the logs.

Walker Creek received minimal Stream Channel Improvement projects because erosion control and riparian vegetation establishment were the priorities (PCI 2001). The importance of maintaining woody debris in streams to native fish habitat has been the subject of landowner education and research by Marin RCD and partner organizations such as CDFG, NPS, MMWD, SWRCB, NRCS and UCCE (Opperman et al. 2006).

OUTCOMES FROM CONSERVATION PROJECTS

The number and extent of conservation practices implemented by Marin's farmers and ranchers is one measure of conservation success while the increasing number of landowners participating in stewardship over time offers an indication of social success in the agricultural community by Marin RCD and its partners. Of equal importance as a measure of success, although more difficult to confirm, are the beneficial environmental and agricultural productivity outcomes. Marin RCD and its partners have progressively increased their efforts to document these outcomes in the short and long-term. These efforts include research studies and monitoring programs to understand conservation practice effectiveness. Collectively, these studies and programs provide useful indications of benefits to local food production, erosion control, water quality, wildlife habitat and air quality.

Local Food Production

The connections between land stewardship, environmental compliance and agricultural viability have been the cornerstone of Marin RCD operations since its inception. One example is its efforts to support local dairies as they faced numerous changes in prices, products and land management. Beginning with Point Reyes Butter in 1862 and California Cooperative Creamery in 1913, the hard work and creativity of these dairymen has established a tradition of high quality local dairy products. This backbone was tested in the early 1970s as the industry faced new pollution control requirements, previously discussed. Numerous operators were prepared to sell their herds at a loss or leave Marin County altogether at the time. The Marin RCD and its partners with financial support from the County of Marin delivered solution that afforded individual farmers flexibility in developing and implementing waste management plans and appropriate practices. Those that implemented plans early and took advantage of cost share programs to construct practices remained in the dairy business. Many of those that are no longer dairying transitioned to grazing cattle and sheep as an alternative.

Beef cattle and other grazing livestock operations continue to be a diverse and widespread industry with Marin's nonirrigated coastal pastures providing valuable forage. Producers and landowners that

implemented conservation practices have often improved rangeland resources that enable higher stocking rates, from 20 to 15 acres per cow per year, and consistently higher weaning weights, from 600 to 800 pounds (Macon 2002). Starting in 2008, new more stringent water quality regulations were applied to livestock ranches and Marin's agriculture resource agencies provided leadership to help landowners meet compliance with the Water Board's Conditional Waiver for Grazing Operations. Following public workshops, 85% of livestock managers in the Tomales Bay Watershed were in compliance and completed the required paperwork. During 2009, the partnering organizations collaborated to develop a local ranch planning template including forms for annual certification, evaluation of water quality management needs, and identification of future conservation projects.

Shellfish production in Tomales and Drakes Bays is world renowned and its continued existence is a testament to agriculture producers' dedication to stewardship and improvements in watershed management over the last 50 years. Oysters, clams and mussels total about $2.9 million per year in Marin County which would not be possible without the conservation practices implemented by Marin County landowners and RCD partners given the increasingly stringent water quality standards and wildlife concerns.

Soil Conservation & Sediment Saved

Siltation of Tomales Bay and turbidity of Marin County streams were some of the first environmental concerns since the 1950s and 1960s, respectively (Fischer et al. 1996). Stopping soil and sediment from washing away safeguards ranch productivity and protects downstream natural waterways from siltation. The loss of this fine grained sediment, through soil erosion, is the greatest negative impact to soil productivity and farm sustainability while simultaneously representing the greatest negative impact to wildlife through siltation of spawning gravels and aggradation in downstream estuaries. Accordingly, saving topsoil, controlling erosion, and protecting waterways from sedimentation were the most common objectives of conservation projects implemented by Marin RCD and its partners.

Methods used to estimate sediment saved have changed over the last 25 years. These include the Universal Soil Loss Equation (USLE), Revised USLE (RUSLE), and RUSLE2 for quantifying sheet and rill erosion amounts (Tiwari et al. 2000). To standardize these methods and the resulting sediment saved data, we used background research (Wei et al. 2009, Spaeth et al. 2003) that formed the Rangeland Hydrology Erosion Model (RHEM). Direct measurements and lateral recession rates were used for streambank and gully erosion types (Rosgen 2001, Lewis et al. 2000, Steffen 1982).

Table 7: Sediment saved estimates by watershed including the total, minimum and maximum with the sample size (#) and percent (%) of projects that collected sediment data.

Watershed	Sediment Saved (CY)			Projects With Data	
	Total	**Min.**	**Max.**	**#**	**%**
Walker	266,365	116,567	416,164	68 of 164	41%
Lagunitas	110,731	58,699	162,762	89 of 179	50%
Tomales Bay east/west shores	42,355	27,500	57,209	11 of 53	21%
Tomales Bay subtotal	**419,451**	**202,767**	**636,135**	**168 of 396**	**42%**
Pacific Ocean	80,391	37,612	123,171	37 of 80	46%
Stemple (San Antonio)	56,423	25,233	87,613	39 of 112	35%
Americano	61,527	38,260	84,795	17 of 22	77%
San Pablo Bay	51,631	18,709	84,553	15 of 73	21%
District total	**669,423**	**322,580**	**1,016,266**	**276 of 683**	**40%**

Of the 276 projects with data, the total sediment saved for Marin County since 1983 equals 669,423 (± 346,843) cubic yards, with 419,451 (± 216,684) cubic yards for Tomales Bay specifically. The amounts varied by watershed (Table 7) depending on the types of projects implemented, funding sources, soils and geology. Since data was only available for 40 percent of the implemented projects, a realistic extrapolation of total sediment saved over the last 50 years by conservation practices is about 1 million cubic yards of sediment in Marin County and over 600,000 cubic yards in Tomales Bay.

The sediment saved data was collected by NRCS, Prunuske Chatham, Erickson Engineering, MMWD, STRAW and UCCE to estimate streambank and gully erosion types. NRCS also provided sheet/rill type of erosion data using the Universal Soil Loss Equation (USLE) with the K soil loss factor from the USDA Soil Survey. The accuracy of the USLE model has been extensively questioned and has been found to overestimate erosion from western US rangeland watersheds so a correction factor of 0.48 (Spaeth et al. 2003) was used to calculate minimum estimates in Tables 7 and 8. The minimum estimate also assumes that a particular practice was only in place for ten years. In contrast, the maximum estimate assumes the same practice was in place since it was installed and no correction factor was applied to sheet/rill erosion. Overall, we have more confidence in the minimum estimates for sheet/rill erosion while the maximum estimates may more accurately quantify the streambank, gully and landslide erosion type results (Table 8).

Table 8: Sediment saved estimates by erosion type for all watersheds combined.

Erosion Type	Sediment Saved (CY)		
	Total	**Min.**	**Max.**
Sheet & Rill	542,311	228,966	855,656
Streambank	14,883	10,155	19,611
Gully	109,507	81,325	137,689
Landslide	2,721	2,133	3,310
Total	669,423	322,580	1,016,266

Excluding sheet and rill erosion types, gullies in the Walker Creek Watershed were the largest sources of sediment in Marin County controlled by Marin RCD and partner projects (Figures 23 and 29). Marin RCD's strategic approach to improving watersheds purposefully targeted the most degraded sites and implemented site-specific solutions.

Water Quality of Marin's Creeks

Documenting water quality outcomes in Marin County's creeks from conservation practices is a more recent endeavor, starting roughly in the 1990s. As a result, 1950s and 60s baseline watershed scale ambient water quality data is sparse, limiting comparison with current conditions and exploration of trends and changes as a result of conservation practice implementation. Currently, the Tomales Bay Watershed Council is undertaking a trend water quality monitoring program to fill this gap. In addition to the few ambient water quality studies, there is considerable water quality information gathered to understand the benefits of specific conservation practices to reduce numerous pollutants in runoff including sediment, nutrients, temperature, and pathogens. This information is from studies in Marin County and other watersheds in California.

Logically given the previous section's sediment saved results, turbidity or suspended sediment would have concurrently decreased over time as the largest sources of sediment were fixed and previous sediment deposits in the stream channel were naturally flushed through the system over time. However, due to insufficient baseline data it has been difficult to quantify improvements in stream clarity or ascertain if spawning gravel embeddedness decreased (Opperman et al. 2005). At a minimum, the amount of sediment saved from waterways indicates that siltation of Tomales Bay was reduced by 419,425 cubic yards compared to what could have eroded without the conservation work done by landowners, Marin RCD and partnering organizations. Erosion control practices implemented in the Walker Creek floodplain also reduced Mercury transport to Tomales Bay (Marshall 2007).

Containment of nutrients such as nitrogen or phosphorus sources was a large reason for the 1970s waste management system plans. These were implemented to prevent potential

fish kills from ammonia toxicity and to realize economic benefits of manure use as fertilizer. The conservation practices associated with manure management infrastructure were also installed to reduce delivery of microbial pollution to stream and bay waters and its impacts to recreation and shellfish harvesting. The SFBRWQCB monitored Tomales Bay during the late 1970s and confirmed water quality improvements resulting from the installation of waste management systems (Jarvis et al. 1978).

From 1991 to 2002, California Department of Fish and Game (CDFG) staff conducted bi-weekly winter season stream sampling and analysis for un-ionized ammonia in Marin and Sonoma Counties (Rugg 2002). Results from the Stemple Creek watershed indicate a decreasing or improving trend over that time period (Figure 39). The timing of the reduction circa 1995 follows the completion of numerous educational workshops and conservation practices to improve water quality such as fencing, watering facilities, waste management systems, nutrient management plans, and prescribed grazing plans. Through the USDA's Conservation Effectiveness Assessment Program (CEAP) Marin RCD, Southern Sonoma RCD, NRCS and UCCE intensively sampled and analyzed storm runoff and stream samples during the 2005 and 2006 winters in Stemple Creek (Lewis et al. 2008, USDA 2005). The CEAP study was intentionally designed to understand water quality conditions when the watershed was influenced by storms, with elevated stream discharge and greatest potential for pollution transport.

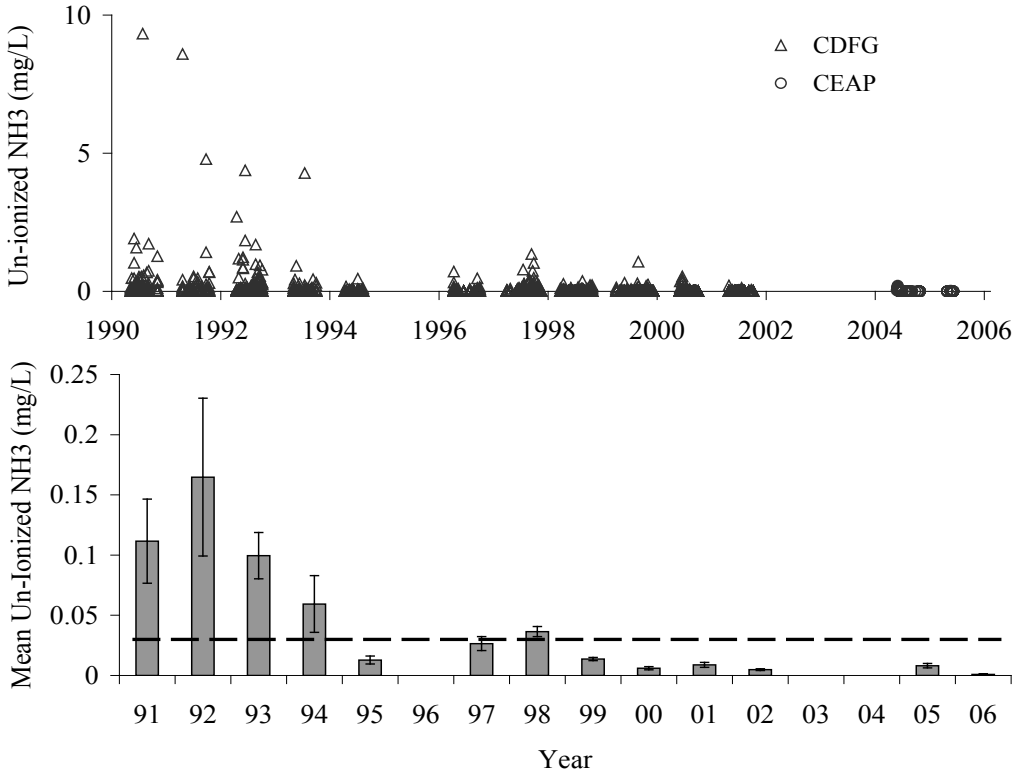


Figure 39: Stemple Creek Watershed water quality monitoring results from CDFG 1991-2002 and CEAP 2005-2006 for un-ionized ammonia data (top), and mean values by year with standard error bars (bottom) including the US EPA criteria of 0.025 mg/L (dash line) for reference (Lewis et al. 2008).

Stemple Creek results indicate that conditions were the same or improved as those documented in 2002 by the CDFG program (Figure 39). This is encouraging documentation that measurable reductions in acute toxicity of this pollutant have been achieved in the watershed through conservation projects completed and corrective action taken by agricultural producers with Marin RCD's leadership (Prunuske 1994). Other watersheds that received similar conservation efforts could expect similar reductions, including Walker Creek.

Other water quality studies have been conducted to understand how conservation practices reduce fecal coliform and specific pathogenic organisms such as *Giardia* and *Cryptosporidium* in storm water runoff from pastures that receive manure (Lewis et al. 2010) and from corrals or dry lots (Lewis et al. 2009). For pasture management, application of manure to pastures more than two weeks in advance of storm associated runoff was related to a ≥80% reduction in fecal coliform compared to applications within two weeks before a runoff event. For every 10 meters (32.8 feet) of vegetative buffer length, a 24% reduction in fecal coliform was documented (Figure 40). The capacity and maintenance of waste management system reduced fecal coliform in applied manure by 75%, 90% and 99% compared to fresh manure when manure holding times were 20, 66 and 133 days, respectively. While these successes have been achieved, there are still conditions of concern for maintaining high quality storm water runoff in certain parts of the watersheds.

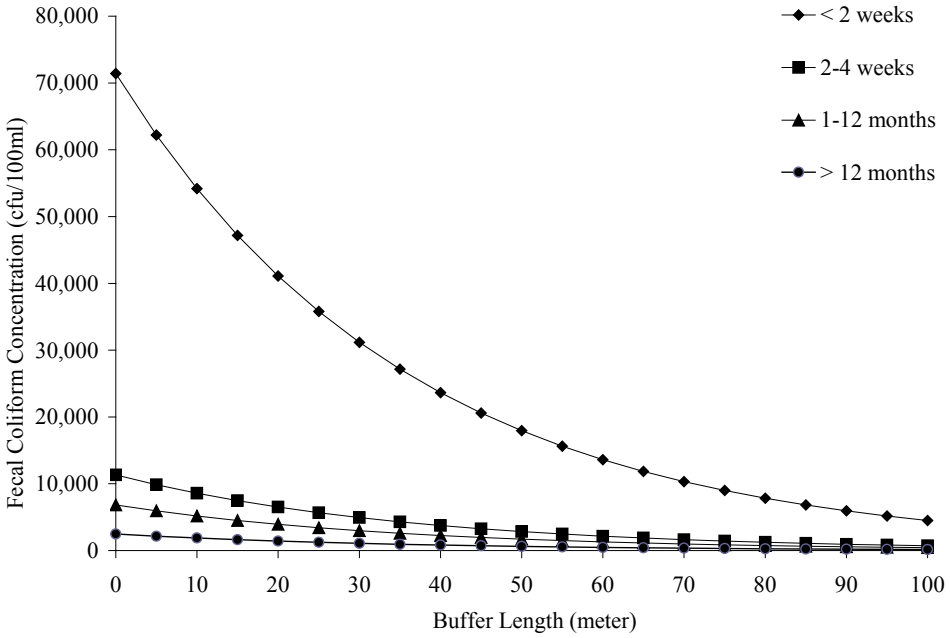


Figure 40: Results for pasture management from data-driven model of fecal coliform concentration as influenced by the amount of time since manure was spread and the length of vegetated buffer strip. The storm size (i.e. 24-hour cumulative precipitation) was also a significant factor in the model and held constant at 0.5 inches in this graph (Lewis et al. 2010).

Livestock management to improve water quality from dry lots, corrals and high use areas is usually obtained through a combination of conservation practices and generally includes reducing storm water flowing onto the area from uphill or barns, increasing vegetative cover and treating any resulting runoff with vegetated buffers. For example, Scenario 5 (Figure 41) quantifies the benefits to water quality gained from combining common practices – 1) decreasing winter use, 2) placing these areas on relatively level ground, 3) increasing ground cover by seeding and/or mulching areas in advance of winter (Lennox et al. 2007), and 4) installing vegetated buffers (Lewis et al. 2009). These common practices and others have been used to systematically treat potential water quality problems in Stemple and Tomales Bay watersheds in particular. However, combining all four practices is not necessary at all sites to fix water quality and the effectiveness of certain practices has been enhanced to compensate for not being able to implement other practices at any one site.

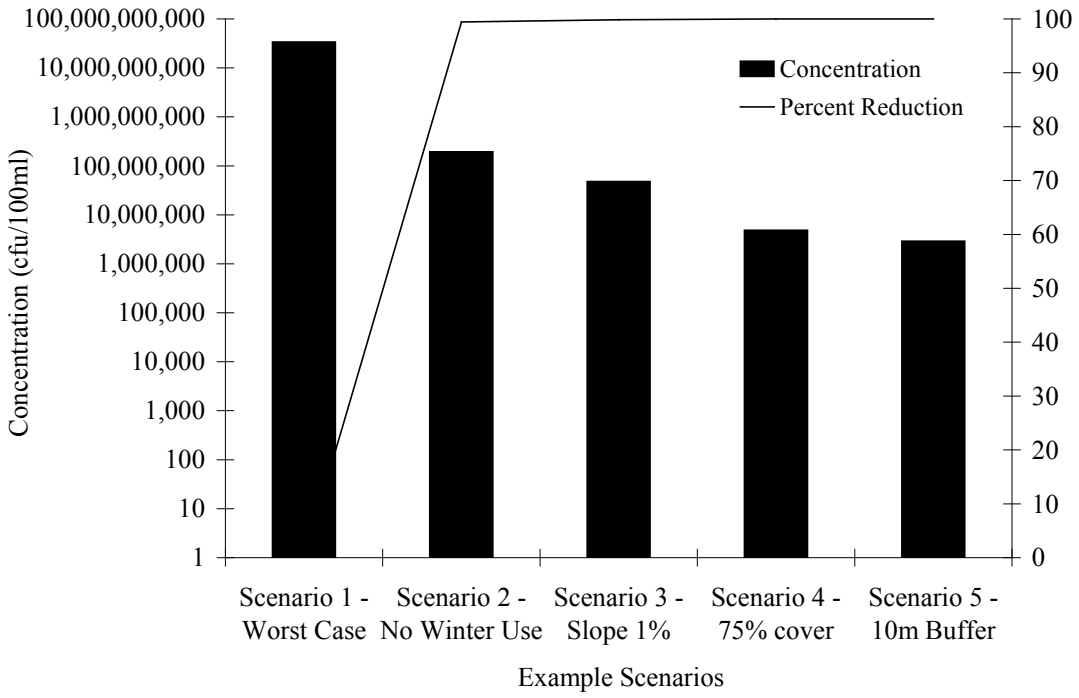


Figure 41: Results for corral and dry lot management from data-driven model of fecal coliform bacteria concentration (**bars**) and percent reduction (**line**) generated from Scenario 1, or Worst Case example, to Scenario 5 with successive implementation of each conservation practice studied. The worst case (scenario 1) is for a high use area that includes winter use, is on an area with a 10% slope, has only minimal ground cover of 5%, and has no vegetative buffer strip below it. Conservation practice implementation for each successive scenario is indicated by the legend. For example, Scenario 3 represents a high use area with a slope of 1% and no winter use. 24-hour precipitation was held constant at 0.5 inches (Lewis et al. 2009).

Stream temperature became recognized as a limiting factor for sustaining salmon populations by the 1980s. In response, agricultural producers worked with Marin RCD partners to shade the stream by implementing riparian revegetation with extensive tree planting (Brown 1969) along Walker Creek where combinations of gravel mining, intensive livestock grazing and large floods had removed existing canopy cover. Gravel bars were wide and fully exposed to solar radiation with less than 10% shade (Figure 42). After 20 years of prescribed grazing, watering facilities, streambank stabilization and control fencing a mature riparian canopy shades over 90% of this reach, resulting in stream temperatures that are supportive of over summering juvenile salmon and steelhead (MMWD 2010, Brown 1969). With these conservation practices in place and functioning, the coho and steelhead trout over summering in these streams have a greater chance for survival in the Walker Creek Watershed.

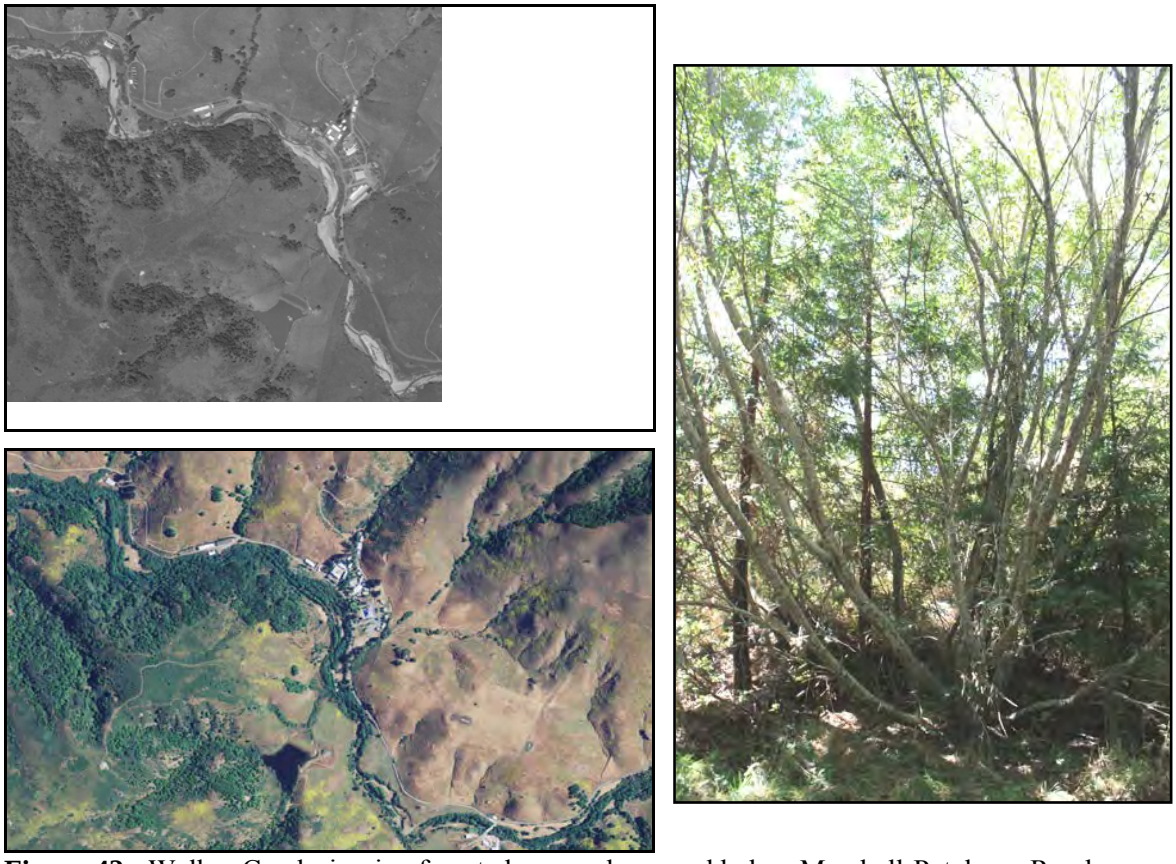


Figure 42: Walker Creek riparian forest changes above and below Marshall-Petaluma Road since 1984 (top left), to 2009 (bottom left) composed of primarily arroyo willow and red alder with four 20-year old redwoods growing into the canopy (right).

Fish & Aquatic Wildlife

Numerous species of aquatic fauna use Marin County streams during various stages of their life cycle. Conservation practices that have restored and protected the habitat used by this wildlife have the potential to increase their population extent and sizes. While

specific quantitative information is not available directly from conservation project sites, improvements to multiple habitat traits and habitat use by aquatic wildlife has been documented in numerous watershed studies, baseline documents and scientific research.

A research study led by UCCE evaluated outcomes from revegetation project sites implemented by Marin RCD and partners since 1970 (figure 43). Improvements to wildlife habitat were measured including deeper pools and narrower stream channels (Lennox et al. 2011). The accumulation of LWD and woody debris jams, as shown in Figure 44, provides greater complexity of instream habitat, including deeper pools (Beechie and Sibley 1997) and cover (Lehane et al. 2002, Cederholm et al. 1997) that support increased abundance of coho salmon and steelhead (Ferguson 2005). The increase of intercepted solar radiation over time (Figure 43) can be expected to support reduced stream temperatures at restored sites, as observed elsewhere in the region (Opperman and Merenlender 2004, Brown 1969).

Protecting and enhancing salmon and steelhead trout populations in Marin County have been a very important reason for carrying out the conservation practices and restoration projects discussed previously. Streambank stabilization, riparian revegetation and stream channel improvement practices, in addition to reducing erosion and improving water quality, enhanced stream channel morphology for coldwater fisheries (Lennox et al. 2011, Opperman and Merenlender 2004, Wehren et al. 2002). Thick willow regrowth

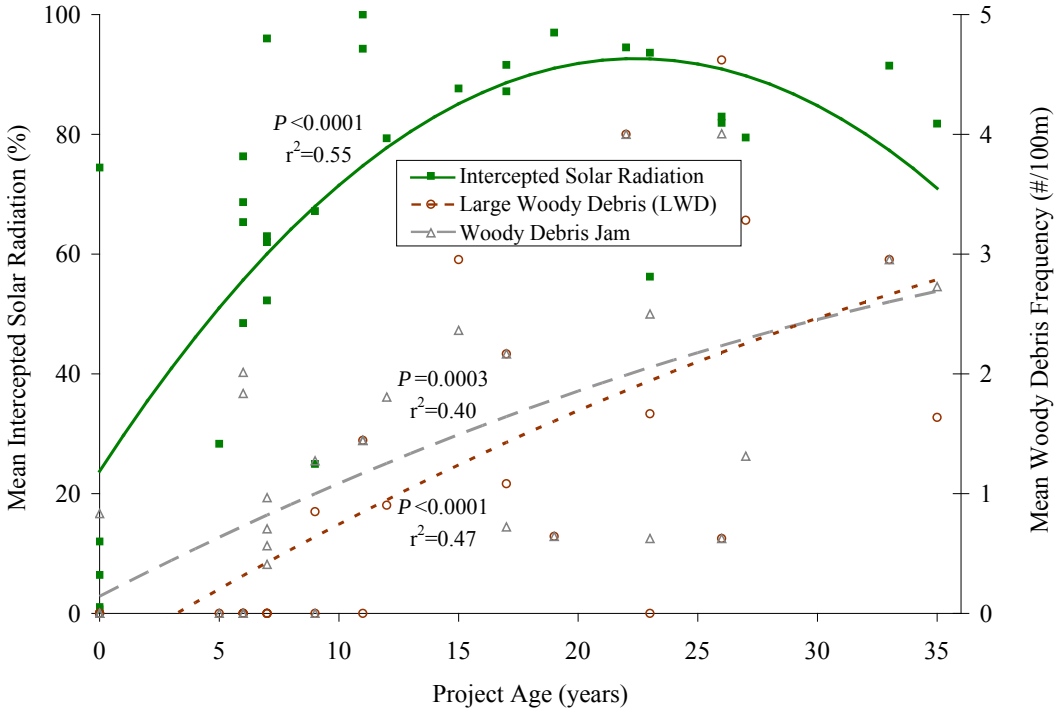


Figure 43: Aquatic habitat trajectory for solar radiation, small and large woody debris as a function of the project age at revegetation sites (n=31) going back to 1970 in Marin County (Lennox unpublished data).

has created localized sedimentation on the floodplain and facilitated alder tree colonization in certain locations. Alders grow rapidly and some eventually fall over or are uprooted by floods, becoming wood in the streams that alter floodplain dynamics and stream channel morphology. This process of vegetation altering landscapes and improving stream health over time has been termed "fluvial geomorphic succession" (Corenblit et al. 2007). This is where "living wood" builds woody debris jams that enhance and sustain high quality fish habitat for coho salmon and steelhead trout as documented in Russian River tributary streams (Opperman and Merenlender 2007). In Lagunitas Creek, fish habitat use surveys confirmed that stream channel improvement practices which incorporated multiple pieces of large woody debris (LWD) had the greatest coho densities relative to other sites (Ferguson 2005).

Near Marshall-Petaluma Road in Walker Creek, Hammack (2005) noted that the "spacing and depth of pools is likely to increase as woody debris is added to the system." This appears to be slowly occurring in discrete locations where the debris collects naturally. Approximately one woody debris jam per 500 meters of stream has established over the last 20 years of conservation practice implementation. This wood offers important protection to rearing juveniles and returning adult coho and steelhead from predators.

Looking to the future and the conservation objective to provide habitat for multiple life stages of coho and steelhead begs the question what else is needed? Currently, most of the fish present in Walker Creek are found hiding in locations under woody debris or living wood including roach, young-of-year steelhead and coho, and two-plus year old steelhead (Figure 44). Mainstem Walker Creek now provides over wintering, rearing, and spawning habitat (MMWD 2010, Hammack 2005). However, fine sediment intrusion into pools, riffles and runs is still an issue, resulting in infrequent and rare deep pools that occur primarily at bedrock outcrops and debris jams (Hammack 2005). Since shallow pools and runs or glides still dominate the habitat types available, stream channel improvement practices are a logical next step for landowners and Marin RCD partners over the next 20 years.

Figure 44: Walker Creek downstream of Marshall-Petaluma Road. depicting the aquatic habitat outcomes from streambank stabilization following 20 years with woody debris jam consisting of a conglomerate of a few pieces of LWD with numerous small debris held together by "living wood" from willow trees growing in to the channel (top), fish using cover and the 3+ feet deep pool created by the woody debris jam (bottom left), and a shallow pool without woody debris or the resulting stream channel complexity (bottom right).

An existing example of this is found in Salmon Creek a tributary to Walker Creek. Hammack (2005) hypothesized that areas with wide channels and mature riparian vegetation provide spawning and rearing habitat. Fishery surveys have confirmed this at Marin RCD conservation project sites (MMWD 2010). Approximately four feet of stream channel depth incised since willow walls were constructed in 1990 over a large reach of stream extending above and below Marshall-Petaluma Road. This deepening of the channel threatened project success in the short-term but increased site complexity over the long-term by recruiting woody debris and "living wood" (Figure 45). Alder trees colonizing the willow wall progressively maintained site stability. The stream bed material is generally coarser (large gravel and cobble) than other portions of the watershed and provides the greatest potential habitat for successful spawning by coho and steelhead.

Figure 45: Salmon Creek 1990 willow wall project site where red alder and willow trees fell over in the stream with "living wood" collecting woody debris and creating aquatic habitat complexity with undercut banks and meanders in the channel (top left), a shallow pool with fine sediment indicating further improvements may be beneficial (top right), a narrow stream channel lined by willow, alder and woody debris shows the four feet of incision below trees that established soon after project implementation when the stream bed was higher (bottom left). A fallen dead log not connected to debris jams or living trees has had no affect on stream channel morphology (bottom right).

Another example is in Chileno Valley, demonstrating Marin RCD and its partners' efforts to balance multiple objectives in an ecosystem approach to conservation and restoration projects. In this case, control fencing was set back to maximize potential wildlife habitat in riparian areas with options to graze livestock at the site to maintain long-term stream health (Figure 46, Appendix C). Hammack (2005) noted that the "establishment of riparian vegetation in the entrenched channel lead to development of well-defined channel features such as pool-riffle complexes, inset floodplains, and high-flow side channels. Dense, woody vegetation in an incised channel both concentrates flow to scour pools and sorts riffle gravels as well as slowing overbank flows for deposition of fines on the floodplain. This process increases flow differentiation, leading to the creation of the complex habitat structure necessary for a healthy stream system."

Figure 46: Photo-point sequence of riparian revegetation project site at a tributary to Walker Creek documents the vegetation response at zero (top left), two (top right), eight (bottom left), and twelve years (bottom right) since project implementation. Designed by Prunuske Chatham, Inc. Aerial photos and bird monitoring results are available in Appendix C.

Overall in Walker Creek, coho salmon were gone by 1948. Efforts to restore the fishery in the 1970s and 80s planted more than 69,000 juvenile coho. Regrettably, none were found during surveys in the 1990s. Recent plantings of coho salmon from 2003 to 2008 included 3,900 juveniles and 264 adults by CDFG. These released fish have led to some successful adult returns and spawning for multiple years (MMWD 2010). Though it is impossible to state a definitive causal mechanism for why the recent introductions were successful, the improvements in watershed conditions resulting from implemented conservation practices were an important factor in addition to ocean conditions, annual rainfall and fish stocking techniques.

Lagunitas Creek coho salmon and steelhead populations have been well documented by MMWD since the mid 1990s (Andrew et al. 2010). Despite the decline in returning adult coho in 2008 and 2009, due to poor ocean conditions, there have been twelve years of increasing juvenile coho salmon abundance until 2007. Steelhead abundance in Lagunitas Creek has not measurably changed since 1995. However, the results are variable and monitoring may have missed population changes during the 1990s. Lagunitas Creek steelhead may be now considered a preserved and nearly sustainable fishery with subpopulations at dynamic equilibrium in multiple tributaries, while current coho salmon populations are in flux and variable, but may have been saved from collapse as a result of the conservation work by landowners, Marin RCD and partnering organizations to keep the watershed from unraveling, but continued monitoring is needed.


Photo by Mark Jennings

California red-legged and other native frogs are uniquely adapted to our Mediterranean climate, maturing into adults within a few months before seasonal wetlands, stream corridors, small lakes, and stock ponds dry up annually. The dams designed, constructed and maintained by landowners with assistance from Marin RCD and NRCS have provided open, deep water for aquatic organisms in addition to providing water for agricultural uses. Earlier stocking of ponds with fish reduced amphibian abundance through predation. However, the planted fish did not often reproduce and the frogs usually returned to successfully breed in the ponds. Frog habitat enhancement has only recently been a specific objective of conservation efforts, such as coastal lagoon and estuary restoration projects by the National Park Service at the Giacomini Wetlands and Horseshoe Pond. Nonetheless, the stock ponds and sediment basins have created California red-legged frog breeding habitat in Marin County (Fellers 2010, Fellers and Guscio 2002) and California (Bulger et al. 2003). Additionally, important summer refugia for these amphibians were enhanced by conservation practices that increased riparian vegetation and vegetated buffers (Fellers and Kleeman 2007).


Photo by Larry Serpa

California freshwater shrimp were known to inhabit Stemple Creek and other Marin County streams. They inspired the STRAW program's education and tree planting projects because their preferred habitat is root masses growing into the water column (Fong and Vandenberg 1998). Though Marin's freshwater shrimp populations are anticipated to have increased because their habitat has significantly improved with restoration of riparian vegetation by STRAW and other Marin RCD partners, the trends in specific populations from Stemple (Figure 47) and Walker creeks have not been recently determined (Serpa 2010). Lagunitas Creek freshwater shrimp populations have been extensively monitored relative to other Marin County streams and a preliminary trend of decreasing abundance has been documented (Andrew et al. 2010).

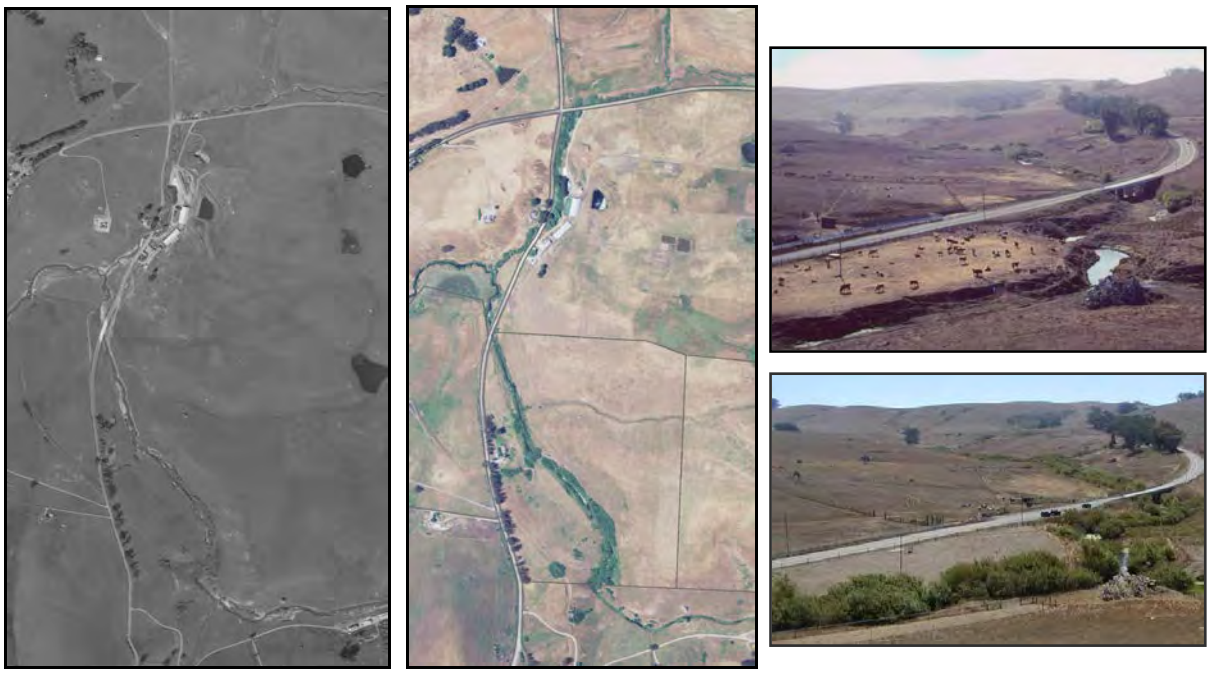


Figure 47: Stemple Creek enhancement project sites implemented from 1994 to 1999 were known to support Ca. freshwater shrimp. The aerial photos before conservation practices in 1984 (far left), compared to 15 years later in 2009 (middle left), a photo from the ranch house taken in 1994 (top right), and a follow up photo 10 years later in 2004 (bottom right).

Birds, Terrestrial Wildlife & Vegetation Management

Attracting terrestrial wildlife such as birds, and increasing their populations are now common objectives of conservation projects for agricultural producers and Marin RCD partners. Reestablishing native trees and shrubs is done to provide cover and food resources that were not available before the project was implemented. Numerous lessons were learned from erosion control projects implemented in the 1980s and early 90s. For example, wildlife habitat changed over 20 years as vegetation established and matured with new plant species colonizing over time (Figure 48) to the benefit of birds and other wildlife diversity by providing components of high quality habitat (Kreitinger and Gardali 2006).

Managing invasive and exotic plant species at older conservation projects is increasingly challenging, as we learn which ones increase over time and outcompete native plants becoming pests that may degrade wildlife habitat (NPS 2010, Cal-IPC 2006). However, realistic expectations are needed that integrate site specific objectives and large scale vegetation management plans such as the pilot project recently started by MALT to control distaff thistle. Annual weeds such as thistles and poison hemlock can impact pasture production or forage quality and they often produce seeds within control fencing which has discouraged the adoption of conservation practices. Some cost-effective

Figure 48: Two years after project implementation of bank stabilization, lined waterway and control fencing in 1991 (top left), four years later in 1993 with planted willows becoming thick and alder seedlings colonizing the vegetated boulder revetment (top right), 20 years later at the same location from above (middle left), alders falling over building floodplain behind them (middle right), and showing 30 feet of floodplain development with restored alder forest habitat (bottom).

solutions for control of such weeds are available like herbicide, large mowers, targeted grazing (ASI 2006), or possibly training livestock to eat certain species (Voth 2010). However, 20 years post conservation practice implementation different weed species are found at riparian revegetation project sites, including Himalaya blackberry, Harding grass, velvet grass, distaff thistle, broom (Oneto et al. 2006), gorse, Eucalyptus, and Monterey pine with an occasional thistle (Figure 49). In addition to native shrub, PRBO monitoring has shown that Himalaya blackberry offers food resources used by migratory bird species along Lagunitas Creek, such as Swainson's thrush (White et al. 2005), and tradeoffs exist to balance plant diversity and wildlife habitat objectives over time.

Figure 49: Examples of invasive exotic plant species that colonized conservation project sites after 20 years including distaff thistle with annual grasses (top left), Himalaya blackberry (top right), broom in a sunny gap of the canopy (bottom left), and Monterey pine with velvet grass and Italian thistle (bottom right).

The composition of vegetation has become increasingly important for maintaining wildlife habitat (Gardali and Holmes 2011, Gardali et al. 2006, Kreitinger and Gardali 2006). For example, planting multiple species and the presence of non-willow tree species such as oak, ash or box elder and have been found to be important habitat features associated with a greater diversity of migratory bird species. In addition, alders and tree willows, such as shining willow (*Salix lasiandra*), provide the classic gallery riparian forest structure with tall canopy forming species as described by Kreitinger and Gardali (2006).

Direct planting approaches (i.e. active revegetation) have similarly increased in importance to ensure long-term riparian forest diversity and habitat quality at conservation project sites implemented by Marin RCD and its partners (Lennox 2007). Native species that colonize sites where they were not planted include California blackberry, coyote brush, arroyo willow and alder, if conditions are right. However, most native species need seed sources on site in order to reproduce and colonize after livestock are controlled and some rarely do even where mature individuals are present (Figure 50). The larger seeded tree species migrate shorter distances and often need animal vectors, such as acorns cached by scrub jays, while the smaller seed producing species are able to colonize faster without planting where livestock access was reduced, controlled or eliminated (i.e. passive revegetation options) (Lennox 2007).

Figure 50: Examples of native tree species response to conservation after 20 years. A small old box elder tree (yellow leaves) was present when the project was implemented is now surrounded by coyote brush and Ca. blackberry (top left), one box elder seedling has successfully colonized the shaded floodplain (top right), a couple live oaks have established above browse height at a drier site (bottom left), and a planted shining willow is taller than arroyo willows (bottom right).

A five-year old planted currant shrub already used for nesting (photo by STRAW).

Since the quality of wildlife habitat is often related to the diversity and structure of vegetation, quantifying riparian forest outcomes offers multiple measurements of long-term project success (Figure 51). Tree abundance and diversity at restored sites increased rapidly through the first 20 years post implementation before leveling-off in an indication of long-term project success (Lennox et al. 2011). In contrast, shrub diversity continued to increase beyond thirty years indicating the potential for a very large number of shrub species is possible in Marin's riparian areas. Exotic shrubs also increased over time which further supports the approach of including understory plant species during revegetation and the long-term need for vegetation management at conservation project sites (Lennox et al. 2011). Other studies have also shown that many native understory plants rarely colonized restoration sites along the Sacramento River and invasive exotic species often came in fastest (Holl and Crone 2004). However, certain native perennial herbaceous plants such as mugwort (*Artemesia douglasiana*) were necessary to attract specific ground nesting bird species (Golet et al. 2011, Golet et al. 2008).

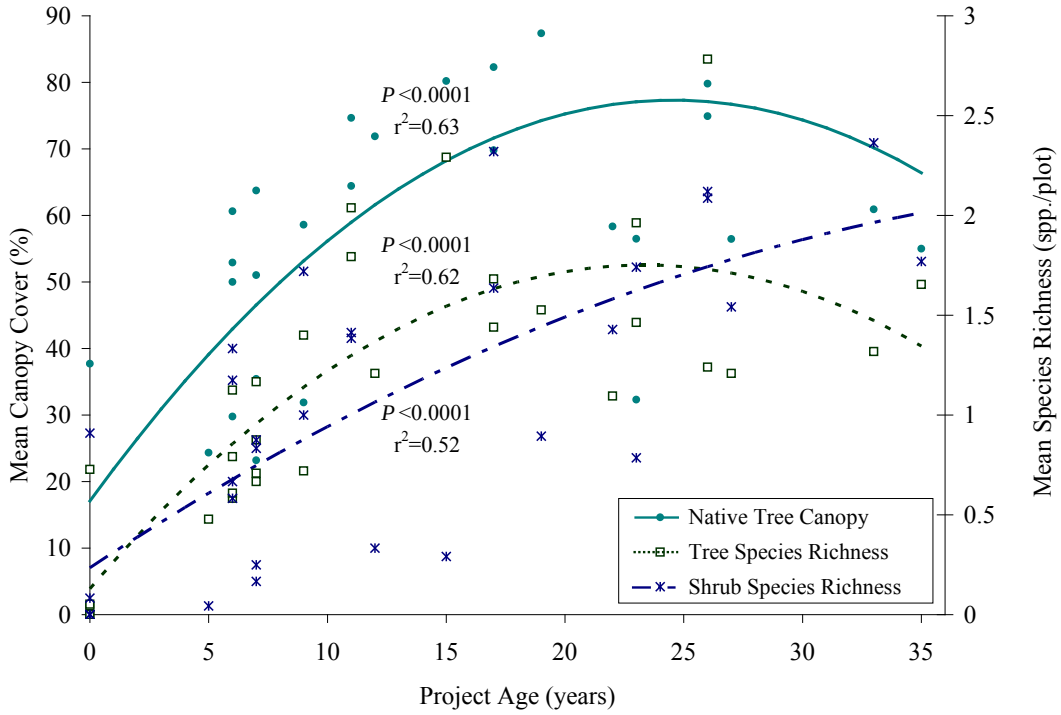


Figure 51: Riparian habitat trajectory for native tree canopy cover, tree and shrub species richness as a function of project age at revegetation sites (n=31) going back to 1970 in Marin County (Lennox unpublished data).

PRBO Conservation Science has taken the lead to study the response of birds in Marin County to conservation practices and riparian revegetation efforts (Kreitinger and Gardali 2006). They documented improved wildlife diversity with 300 percent increase in migratory bird species. Typically, sites without extensive woody vegetation start with about 10 bird species and can have over 30 species after restored riparian vegetation matures over 15 to 20 years (Figure 52). As trees and shrubs grow to replace annual grasses and forbs, riparian forest structure evolves to provide adequate canopy midstory and understory habitat, attracting different species to each level of the forest (Figure 52). By manipulating the species planted during revegetation, long-term riparian forest composition and the resulting restored habitat structure has been altered to the benefit of varying bird species habitat needs (Gardali and Holmes 2011, Kreitinger and Gardali 2006).

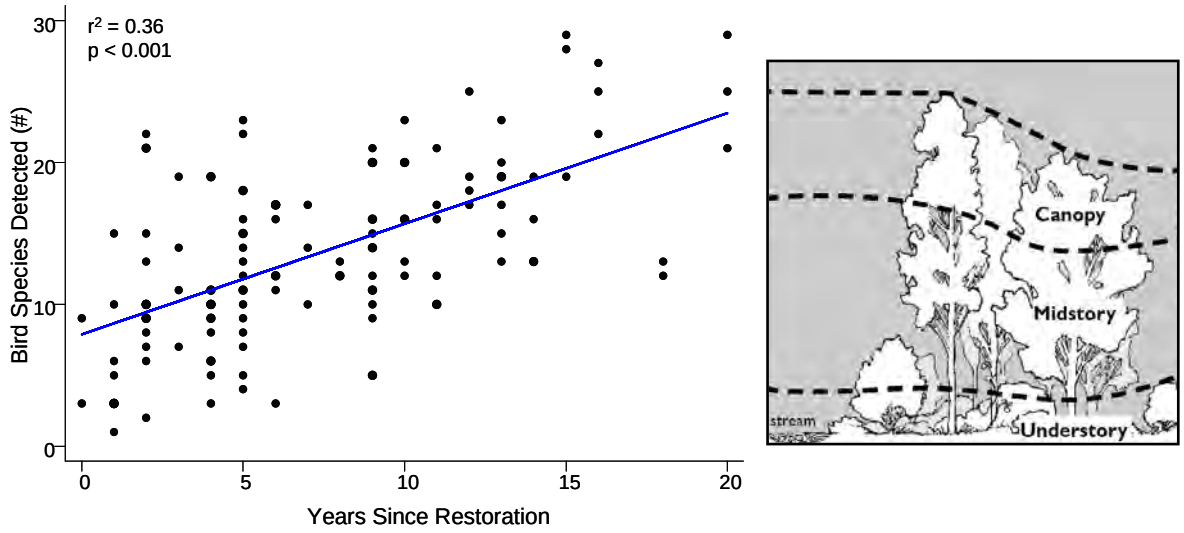


Figure 52: The number of bird species increased as the age of restoration increased in Marin and Sonoma Counties (left, Gardali unpublished data) as vegetation grew over time following project implementation creating three habitat levels of riparian forest structure – canopy, midstory, and understory (right, Kreitinger and Gardali 2006).

Landowners have been very interested in learning which bird species are using the habitat created by conservation practices as an indicator of project success. PRBO has educated agricultural producers and Marin RCD partners with letters to landowners summarizing the bird monitoring results for specific project sites (Appendix C) with stewardship recommendations such as avoiding livestock grazing or vegetation removal during the spring nesting season to increase wildlife diversity (Kreitinger and Gardali 2006). 38 bird species were encountered at restored riparian forests in Marin County. Their common names and nesting locations include:

- Allen's Hummingbird (near ground)
- American Crow (canopy)
- American Goldfinch (mid-story)
- American Robin (mid-story or canopy)
- Anna's Hummingbird (canopy)
- Ash-throated Flycatcher (cavity in branch)
- Bewick's Wren (cavity in branch)
- Black Phoebe (structures such as bridge)
- Black-headed Grosbeak (mid-story)
- Brown-headed Cowbird (other birds' nests)
- Bushtit (mid-story or canopy)
- California Quail (ground)
- California Towhee (near ground)
- Chestnut-backed Chickadee (cavity in branch)
- Cliff Swallow (cavity in branch)
- Common Merganser (ground)
- Downy Woodpecker (cavity in branch)
- European Starling (cavity in branch or structure)
- Hairy Woodpecker (cavity in branch)
- House Finch (canopy)
- Hutton's Vireo (canopy)
- Lazuli Bunting (near ground)
- Lesser Goldfinch (canopy)
- Orange-crowned Warbler (near ground)
- Pacific-slope Flycatcher (mid-story or canopy)
- Purple Finch (canopy)
- Song Sparrow (near ground)
- Spotted Towhee (near ground)
- Steller's Jay (canopy)
- Swainson's Thrush (near ground)
- Tree Swallow (cavity in branch)
- Violet-green Swallow (cavity in branch)
- Warbling Vireo (canopy)
- Western Scrub-jay (mid-story or canopy)
- Western Wood-pewee (canopy)
- Wilson's Warbler (near ground)
- Winter Wren (near ground)
- Wrentit (near ground)


Woodrat nest made of piled sticks at a 19-year old project site.

In addition to increased bird abundance and diversity, other terrestrial wildlife commonly responds to the implemented conservation practices and utilize restored habitat. In the first few years, moles, voles, rabbits and gophers have been observed to increase as grass becomes thick and waterfowl take refuge at newly constructed ponds and wetlands. Bobcats, coyotes, badgers and mountain lions have been observed at Marin RCD project sites which are a result of the open space, high quality habitat in west Marin and the banquet of small mammals available under the tall grass. Following about 20 years, dusky-footed woodrats build nests in mature riparian forests and they provide a multiplier effect further enhancing Marin County's food chain and wildlife community. For example, dusky-footed woodrats have been found to be a favorite prey of Northern Spotted Owls in Muir Woods National Monument (NPS 2008). Research studies have documented enhanced wildlife populations using restored portions of the Sacramento River including coyotes, weasels, skunks, house cats, bobcats, waterfowl, bees, ground-dwelling beetles, crevice-roosting bats and numerous rodent species (Golet et al. 2011, Golet et al. 2008).

Air Quality

Rangeland and lowland riparian areas in Marin County are being investigated for how land management practices mitigate climate change and function as long-term sinks for atmospheric carbon. Though air quality improvements were not direct objectives of conservation practices, the 50 years of stewardship work on pastures and waterways by landowners, Marin RCD and partners may have indirectly reduced greenhouse gases that provide additional justification of value-added products for emerging environmental markets.


Researchers sampling rangeland soil. Photo by Paige Green (MALT).

The Marin Carbon Project was formed to establish a foundation to understand soil carbon sequestration on local rangelands, grasslands and open space. Soil surveys have been completed to learn the potential for specific conservation practices to enhance sequestration of atmospheric carbon dioxide as organic matter in rangeland and agricultural soils. Soil carbon sequestration is the process of moving carbon dioxide from the

atmosphere into the soil. Through the process of photosynthesis, plants pull carbon dioxide out of the atmosphere and transfer that carbon below ground via root exudates and sloughing of roots; and to the soil surface when they drop leaves or other plant parts, and when they die. In this way, atmospheric carbon dioxide becomes soil organic matter. Whichever land management practices prove to sequester carbon in a way that is economically viable, the Marin Carbon Project and its partners will help ranchers and rangeland managers maximize financial compensation available as a result (Wick and Haskel-Seidner 2009).

Soil organic matter is approximately fifty percent carbon. Over the past 150 years we may have lost fifty to eighty percent of our topsoil worldwide. The soil-derived change in atmospheric carbon dioxide concentration suggests the potential for conservation practices to sequester significant amounts of atmospheric carbon dioxide in the soil as organic matter. Increasing soil organic matter has innumerable benefits in addition to helping to slow or reverse global warming. Improved soil water holding capacity, improved soil fertility, improved soil tilth, improved water quality, decreased need for petroleum-based pesticides and fertilizers, decreased erosion and increased production are all well-documented effects of increasing soil organic matter (Wick and Haskel-Seidner 2009). The Marin Carbon Project is a collaboration between UC Berkeley, UC Davis, UC Cooperative Extension, Marin Organic, Marin Agricultural Land Trust, Marin Resource Conservation District, the USDA Natural Resources Conservation Service and Nicasio Native Grass Ranch.

Riparian areas in Mediterranean climates have been referred to as "hot-spots" of potential soil carbon sequestration. The increased availability of water and soil moisture, relative to the rest of the landscape, affords greater vegetation biomass and therein the potential for larger above and below ground carbon and nitrogen pools.

Surveying soil carbon at a restored stream.

Corollary investigations in riparian areas and woodland stand establishment offer examples of the potential role that these parts of the landscape have in the production and sequestration of both nitrogen and carbon above and below ground. In Texas, riparian revegetation to woody species increased soil carbon by three times and soil nitrogen by five times over a 40 year period since project implementation (Bush 2008). The 25 miles of riparian revegetation in Marin County over 50 years documented in this report provide a foundation for interpreting research results and applying them towards emerging environmental markets. By verifying below ground sequestration outcomes for carbon and nitrogen cycles from conservation projects, air quality improvements can be added to the list of ecosystem services and further quantify value-added agricultural products.

CONCLUSIONS & NEXT STEPS

Marin County landowners and their success over the last 50 years came from strong and effective relationships, clarity and commitment to mission, and a willingness to adapt, learn and improve. The partnership between Marin RCD, partnering agencies and agricultural producers has been successful for five decades because it has done all three.

As a current Marin RCD Board member recently stated "our strength lies with our partnerships." These working relationships are evident in so many places. More ranchers and farmers, than ever before, are bringing project ideas to the table for Marin RCD assistance. So much so, that current funding support cannot meet the demand. Marin RCD has extensively collaborated with numerous local and federal organizations while leading partnerships such as watershed enhancement plans, Lagunitas Limiting Factors Study and Grazing Land Conditional Waiver Program. With the ranchers and farmers, relationships are based on trust forged at kitchen tables and in back pastures, through which integrated farm family goals of agricultural production and resource conservation developed. With area conservation groups, these are decades-long collaborations that have capitalized on the respective strengths of each partner to increase the capacity of the conservation team in capturing resources and implementing larger and more complex projects.

The Marin RCD began with the singular mission to deliver soil and water conservation solutions to farmers and ranchers. Staying focused and committed to that mission has allowed its Board and staff to consistently provide a critical and valued service to Marin's agricultural producers and the land they own and manage.

While staying true to their mission of on-farm conservation, Marin RCD partners have led the response to new challenges. Examples include dairy manure management in the 70s, gully erosion prevention in the 80s, and salmon habitat restoration in the 90s. It also includes cutting edge methods for practice implementation like the Permit Coordination Program. Today the conservation partnership is finding options and solutions for soil carbon management through the Marin Carbon Project and local composting facilities through the Marin Compost Project.

Spending its early years planning and relationship building provided Marin RCD and partners a deep understanding of farmers' needs, the extent and complexity of resource problems, and the options and approaches available to address both. From this foundation Marin RCD, its partners, and Marin's farmers and ranchers have built a body of work that is impressive in volume and beneficial impacts.

Over 230 landowners participated in cost-share programs and another 100 received technical assistance, resulting in 1,393 plans developed and over 3,579 conservation

practices implemented in Marin County. In total, landowners using assistance from Marin RCD partners fenced more than 43 miles of stream for livestock management, stabilized 25 miles of channel including over 472 headcut repairs, protected 15 miles of streambank, and revegetated 25 miles of riparian forest with over 35,372 native trees and shrubs planted. In addition to restoring habitat, ecological functions and hydrologic processes within agricultural operations to maintain local food production, the practices controlled about 669,243 cubic yards of sediment delivery to nearby streams, by conservative estimates.

Partnership efforts to document outcomes are revealing the benefits from these practices. Farm production has increased as evidenced by better forage quality, reduced payouts for feed, and increased livestock gain. Farm bottom line paybacks have resulted from practices designed to improve livestock distribution, pasture utilization and manure handling for pasture management. These same practices have been designed and implemented with integrated resource conservation objectives, including improvements to water quality, restoration of stream corridors, and wildlife habitat enhancement. Documented benefits include reductions in delivery or sediment, pathogens, and nutrients to water ways, increases in habitat quantity and connectivity, and growth in the diversity and abundance of wildlife.

This work and the benefits derived required financial support equaling approximately 23 million dollars not including corresponding landowner cost-share contributions. These costs and need for funding support persist to ensure projects are well designed, permitted, installed, monitored and maintained. Thus far these efforts have been supported through grants, County of Marin support, and contributions from farmers and ranchers. With the increased recognition of ecosystem provision on working farms and ranchers and the value these provide to local communities, there may be the opportunity to secure payments for the services that conservation and restoration provide. The costs and the resulting benefits presented in the report will be useful to emerging environmental markets in determining the value and payouts for ecosystem services. The information will also be useful for the rancher and farmer to communicate their environmental stewardship to consumers, adding value to their direct and locally available products

As increased participation in Marin RCD programs demonstrates, the demand for on-farm conservation will continue to grow. This presents a monumental challenge with regard to securing sufficient funding to meet this demand. It also increases the importance and need for continued use of the permit streamlining and other approaches that increase efficiency in design and implementation of effective practices on-farm. These and other challenges will arise. But if the past is an indicator of the future, the next 50 years of on-farm conservation in Marin is in good hands – the hands of its farm families and the Marin RCD partnership.

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APPENDIX A: TIMELINE OF MARIN RCD

Year	Marin RCD Historical Note
1959	five original Board of Directors elected & first meeting of Marin RCD (as Marin County Soil Conservation District) as 158th district in Ca - outlined Conservation Program & Work Plan
1959	Memorandum of Understanding between Marin RCD, State of Ca, and USDA
1959	oppose the taking of 55,000 acres of agriculture land by National Park Service
1961	contracted Nolte Civil Engineers to investigate siltation of Tomales Bay
1961	purchase Brillion Seeder for range and pastures rented for $10/day or $1/acre
1962	held public meeting about Marin RCD activities to study and solve TB siltation
1964	support wildfire fuel reduction plan by Gold Ridge RCD & NRCS
1965	"Master drainage and sediment control plan for the Lagunitas and Walker creek watersheds" report by George Nolte Consulting Civil Engineers funded by State Soil Conservation Commission and County of Marin
1966	increase monthly salary of recording secretary from $25 to $30
1968	revised conservation program work plan entitled Long-Range Program
1969	support the completion of Point Reyes National Seashore to include agriculture
1970	grant the Brillion pasture grass seeder and equipment carrier to Tomales High School
1971	train 110 teachers in stewardship, conservation & agriculture providing them with specific curriculum materials
1973	dairy upgrades will be studied as a package deal including funds to implement improvements
1973	NRCS began detailed Soil Survey report of county and it was completed in 1978
1974	Dairy Waste Survey Report (70 of 77 dairies participated) outlined cost estimates and loan options to upgrade dairy waste facilities for compliance with new water quality regulations funded by County of Marin and USDA Natural Resouce Conservation Service (NRCS was Soil Conservation Service) in partnership with Marin-Sonoma Farm Bureau Animal Resource Mngt. Committee (was Dairy Waste Committee)
1976	"Vegetation analysis for a portion of Walker Creek, Marin County" by Dr. Harris, UC Berkeley
1977	election of Board of Directors to fill three available seats
1978	"Relationship between streamflow and salmonid habitat in Walker and Lagunitas creeks" by D. Kelley in partnership with Marin Municipal Water District (MMWD)
1979	Bay Area Surface Runoff Plan with Association of Bay Area Governments (ABAG)
1979	published Long Range Plan in cooperation with USDA NRCS
1980	dairy tour and luncheon for People's Republic of China Soil and Water Team
1980	letter to Marin County Planning Commission requesting consultation with Marin RCD before establishing conservation and soil erosion policies
1980	"Holocene profile changes along a Ca coastal stream" by W. Haible from UC Berkeley Geology
1980	MOU between Council of Bay Area RCD's & Regional Water Quality Control Board
1982	emergency funds made available to assist clean up following large January storm
1982	Lagunitas Creek restoration program funded in partnership with MMWD, Circuit Rider Productions, & Marin County Conservation Corps (MCC)
1982	support increasing flows in Lagunitas Creek by Marin Municipal Water District with Lagunitas Creek Citizens Advisory Committee
1982	work with Marin County Planning Department on proposed grading ordinance
1983	Walker Creek revegetation & restoration planning with Circuit Rider Productions, MCC and MMWD
1983	letter supporting State Coastal Conservancy's interest to improve the Tomales Bay Watershed
1983	Lagunitas Watershed Erosion Control Program with Prunuske Chatham
1984	support Farm Bureau's agricultural education program
1984	president Waldo Giacomini honored for his 25 years of service to Marin RCD by Ca RCD Association
1984	Otto Quast received specieal recognition from the Conservation Society of American for his involvement in Marin RCD
1984	award received - County of Marin Resolution of Commendation

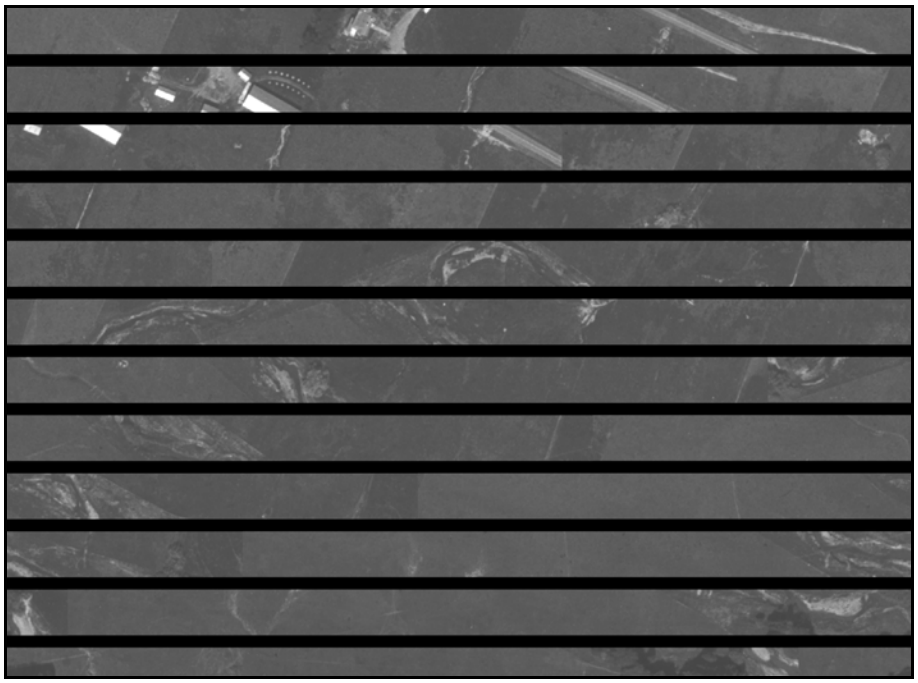
Year	Marin RCD Historical Note
1984	100s of volunteers help to stabilize gullies, roads & streambanks in Lagunitas Creek watershed with Trout Unlimitted
1984	Liza Prunuske submitted paper to International Erosion Control Association on Lagunitas Watershed Erosion Control Program
1985	workshops held on streambank/gully stabilization, soil surveys, & road maintenance at Lagunitas Creek watershed restoration projects
1985	Department of Public Works collaborated with Marin RCD to speed permits for implementing time-sensitive projects done such as erosion control and dairy waste pond construction
1985	Stafford Lake Watershed Erosion Control Project with North Marin Water District
1985	Marin RCD 25th Birthday Anniversary spring party
1986	Walker Creek restoration program funded for ten years to inventory erosion problems, fix them, and document effectiveness by the State of California Coastal Conservancy
1987	"Groundwork: a handbook for small-scale erosion control in coastal Ca" published by Prunuske Chatham with Marin County Stormwater Pollution Prevention Program (MCSTOPPP)
1988	Stemple Creek Watershed Inventory of Erosion Sites with Prunuske Chatham, Southern Sonoma County RCD (SSRCD), & NRCS
1989	first willow walls & other biotechnical streambank stabilization methods used in Walker Creek watershed by Prunuske Chatham with tours of project sites provided for partners & landowners
1989	Gambonini Mercury Mine Investigation by Robert Miller & Associates
1989	Walker Creek Fish Restoration Study by A. Rich & Associates
1989	"Feasibility of increasing fish populations in Lagunitas Creek by placing boulders & logs" by D. Kelley & Associates with Prunuske Chatham & Ca Deparment of Fish & Game
1991	no-till drill seeder purchased for rent from Marin RCD
1992	San Geronimo Bedload Sediment Reduction Program completed by PCI for MMWD
1994	Estero de San Antonio/Stemple Creek Enhancement Plan with Prunuske Chatham, NRCS, & SSRCD
1994	USDA Soil Conservation Service (SCS) becomes Natural Resource Conservation Service (NRCS)
1997	Equine Facilities Assistance Project with Horse Council & MCSTOPPP
1998	award received - Marin Conservation League Ted Wellman Water Award
1999	Advanced Integrated Pond System methane digester pilot project
1999	Walker Creek Watershed Enhancement Plan with Prunuske Chatham
1999	Petaluma River Watershed Enhancement Plan with SSRCD
2000	Tomales Bay Watershed Council (TBWC) starts & coordinator position funded
2000	election of Board of Directors to fill three available seats
2001	Walker Creek Watershed Enhancement Program
2003	Tomales Bay Watershed Stewardship Plan completed with TBWC
2003	soil aerator purchased & no-till drill maintenance - both available for rent
2003	Marin Coastal Permit Coordination Program streamlined permits for project implementation with Prunuske Chatham and Sustainable Conservation
2003	Tomales Bay Watershed Stewardship Plan Implementation with TBWC
2004	Stafford Lake Erosion Site Assessment with NMWD
2004	Tomales Bay Watershed Enhancement Program
2004	award received - USDA NRCS Partners in Conservation Award
2005	Geomorphology of the Walker Creek Watershed by L. Hammack of Prunuske Chatham
2005	Lagunitas Creek Watershed Enhancement Program completed
2005	award received - California Governor's Environmental and Economic Leadership Award
2007	Estero Americano Watershed Management Plan with GRRCD
2008	Lagunitas Creek Limiting Factors Analysis for Coho Salmon & Steelhead by Stillwater Sciences
2008	West Marin Compost Project
2008	Marin Coastal Permit Coordination Program 5-year review
2008	Oral History Project
2008	Carbon Sequestration Research with Marin Carbon Project
2009	Pine Gulch Creek Enhancement Project - water rights planning
2009	Conditional Grazing Waiver planning leadership with numerous partnering organizations

APPENDIX B: CONSERVATION PRACTICES UTILIZED

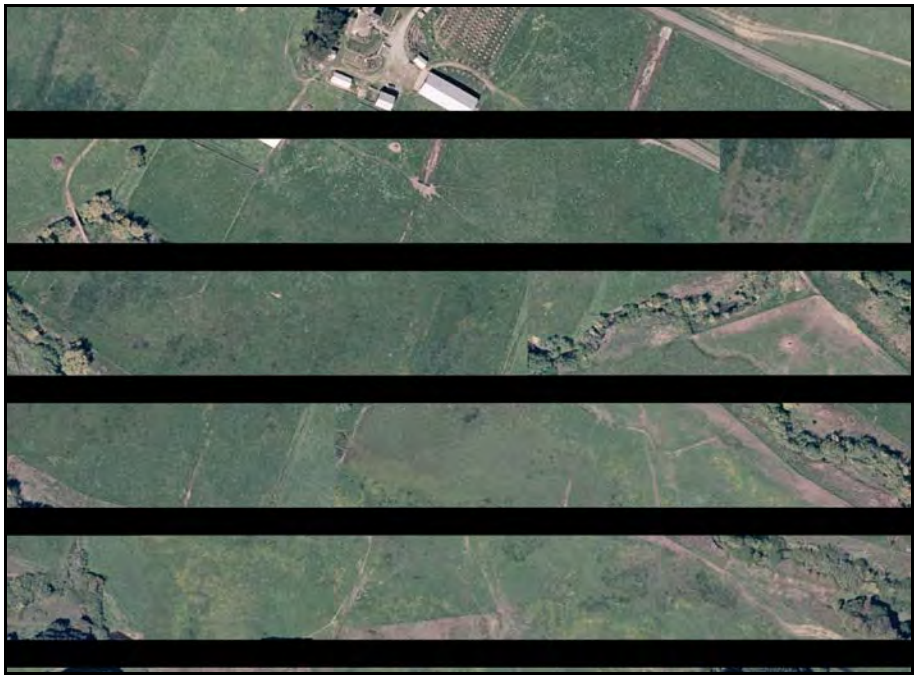
Conservation Practice	Designed & Implemented		Designed Only	
	#	Extent	#	Extent
Access road (ft)	151	70,943	38	21,335
Animal trail/ walkway (ft)	60	3,391	15	1,020
Brush control (ac)	9	771	27	8,137
Channel stabilization (ft)	253	133,120	158	76,490
Conservation cropping system (ac)	4	135	24	8,887
Critical area planting (ac)	334	630	176	232
Crop residue use (ac)	13	6,525	40	30,059
Diversion ditches (ft)	73	40,748	30	20,900
Fence/ fencing (ft)	524	726,626	143	162,738
Fenced waterway (ft)	109	228,432	12	33,770
Filter strip (ft)	7	4,000	2	700
Grade stabilization structure/ checkdam (#)	668		116	
Grassed waterway (ft)	39	13,215	14	14,120
Headcut repair (#)	472		168	
Irrigation water management plan (ac)	9	239	19	1,286
Landslide stabilization (ac)	21	21	4	35
Lined waterway (ft)	52	8,394	19	3,385
Loafing/ freestall barn (#)	20		35	
Manure lagoon/ pond (#)	64		79	
Manure settling pond (#)	45		108	
Manure lagoon/ pond enlarged (#)	24		11	
Manure waste transfer (#)	62		20	
Minimum tillage (ac)	10	3,865	21	27,920
Nutrient mngt. plan (#)	31		33	
Pasture/ range fertilization (ac)	10	1,394	59	9,618
Pasture/ range seeding (ac)	149	15,770	87	35,785
Pileline (ft)	161	326,935	34	49,768
Prescribed grazing (ac)	189	101,299	187	196,960
Riparian revegetation (ft)	145	133,554	9	2,650
Roof runoff structure (#)	34		4	
Sediment basin (#)	24		17	
Spring development (#)	130		83	
Stock pond (#)	24		304	
Stock pond dam repair/ maintenance (#)	73		127	
Stream channel improvement (ft)	107	10,285	9	1,075
Stream crossing (#)	7		?	
Streambank protection (ft)	95	80,008	31	34,227
Structure for water control (#)	35		17	
Subsurface/ tile drain (ft)	15	6,300	6	4,806
Trees/ shrubs planted (#)	137	35,372	8	976
Waste mngt. system (#)	68		196	
Water trough (#)	185		76	
Watering facility (#)	406		112	

APPENDIX C: EXAMPLE RANCH WITH BIRD MONITORING RESULTS OF CONSERVATION PROJECT SITES

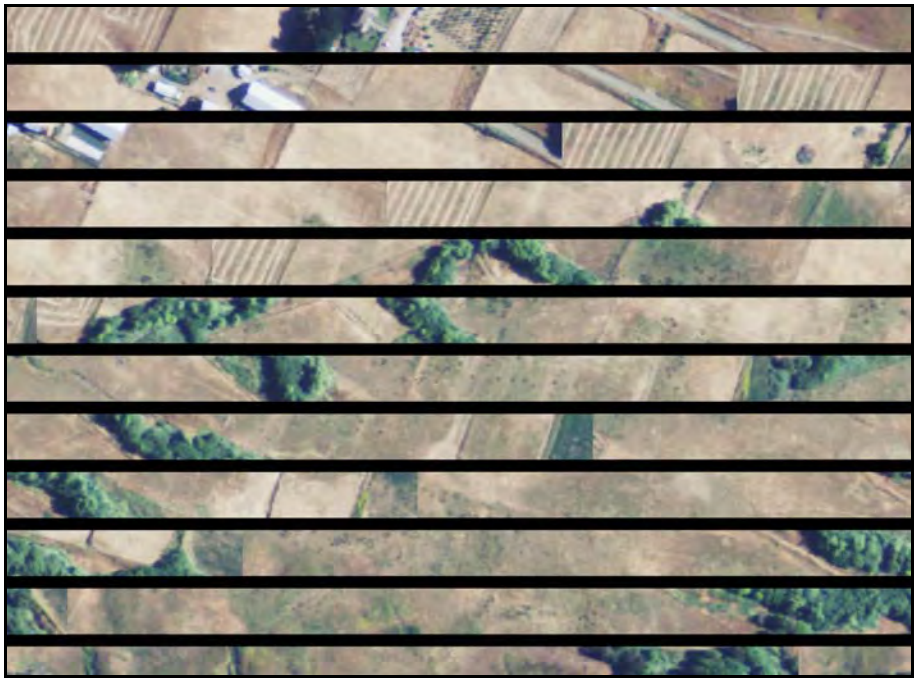
Aerial photo from 1997 (below) following livestock control fencing and extensive riparian revegetation with native trees, shrubs and grasses.



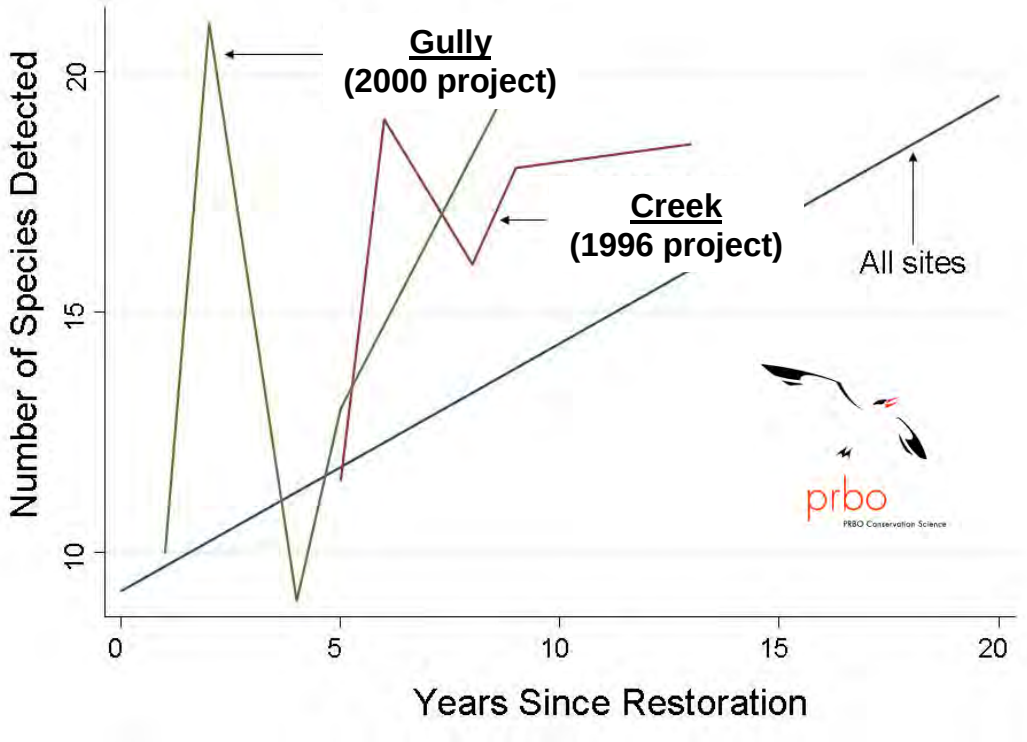
By 2004 (below), the bridge was installed and multiple gullies also received control fencing with revegetation. Woody vegetation has become established along the stream and more bare soil is evident outside of the riparian area's control fencing.



In 2009 (below), trees cover most of the stream and bare soil is not clearly visible on the ranch as Prescribed Grazing Plans show results. Over $250,000 have been spent on conservation practices and projects at this ranch over the last 20 years.



Point Reyes Bird Observatory monitoring results from this ranch of bird diversity (below) comparing the riparian area site (creek) to the upland site (gully).



The bird species listed below were detected between May-June 2009 in the conservation project sites of the ranch. Most of these species were likely nesting in the riparian (creek-side) zone, but those confirmed nesting (nests or young found during counts) are listed in **bold**, some unlikely breeders are listed in *italics*, and any non-native species are followed with * (Gardali unpublished data).

Bird Species Detected:	Nest Location in Riparian Area:
1. Allen's Hummingbird	near ground
2. American Crow	canopy
3. **American Goldfinch**	mid-story
4. American Robin	mid-story or canopy
5. Anna's Hummingbird	mid-story
6. Ash-throated Flycatcher	cavity in branch or structure
7. Black-headed Grosbeak	mid-story
8. Black Phoebe	creek bank, bridge or other low structure
9. Brown-headed Cowbird	lays eggs in other birds' nests
10. **Bushtit**	mid-story
11. **California Towhee**	near ground
12. Chestnut-backed Chickadee	cavity in branch or structure
13. Cliff Swallow	creek bank, bridge or other low structure
14. Downy Woodpecker	cavity in branch or structure
15. European Starling*	cavity in branch or structure
16. House Finch	mid-story
17. House Sparrow	cavity in branch or structure
18. Lark Sparrow	near ground
19. **Lazuli Bunting**	mid-story
20. Mourning Dove	mid-story
21. Nuttall's Woodpecker	cavity in branch or structure
22. Oak Titmouse	cavity in branch or structure
23. Orange-crowned Warbler	near ground
24. Purple Finch	canopy
25. Red-winged Blackbird	near ground
26. Savannah Sparrow	near ground
27. **Song Sparrow**	near ground
28. Spotted Towhee	near ground
29. Swainson's Thrush	near ground
30. Warbling Vireo	canopy
31. **Western Bluebird**	cavity in branch or structure
32. Western Scrub-jay	mid-story or canopy
33. Wilson's Warbler	near ground

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