

# The Feasibility of Water Quality Markets for Rangelands in California's Central Valley

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*Conservation Economics and Finance Program White Paper*

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## Table of Contents

<b>List of Tables</b> .....	<b>vi</b>
<b>List of Figures</b> .....	<b>vii</b>
<b>Acknowledgements</b> .....	<b>viii</b>
<b>Executive Summary</b> .....	<b>ix</b>
<b>1.0 Introduction</b> .....	<b>1</b>
1.1 Background.....	1
1.2 Overview of Water Quality Trading Programs .....	1
1.3 Purpose of the Report.....	3
1.4 Report Organization.....	3
<b>2.0 The Experience with Water Quality Markets and Trading in the United States</b> .....	<b>4</b>
2.1 Review of Water Quality Trading Programs in the U.S. ....	4
2.2.1 <i>Clean Water Services/Tualatin River (Oregon)</i> .....	6
2.2.2 <i>Rahr Malting Company Trading Program (Minnesota)</i> .....	7
2.2.3 <i>Great Miami River Watershed Trading Pilot (Ohio)</i> .....	8
2.2.4 <i>Cherry Creek Reservoir Watershed Phosphorous Trading Program (Colorado)</i> .....	9
2.2.5 <i>Long Island Sound Nitrogen Credit Exchange Program (Connecticut)</i> .....	9
2.2.6 <i>Grassland Area Farmers Tradable Loads Program (California)</i> .....	10
2.3 Voluntary Programs.....	11
2.3.1 <i>Elkborn Creek BMP Demonstration Project (Kentucky)</i> .....	11
2.3.2 <i>Flint Creek Watershed Project (Alabama)</i> .....	12
2.3.3 <i>Tuscumbia-Fort Payne Aquifer Protection Project (Alabama)</i> .....	12
2.3.4 <i>San Francisco Bay Mercury TMDL (California)</i> .....	13
2.3.5 <i>Florida Ranchlands for Environmental Services Program (Florida)</i> .....	13

2.4	Source Water Protection Programs.....	14
2.5	Issues and Conditions for Success .....	16
2.5.1	<i>Demand side challenges</i> .....	16
2.5.2	<i>Supply side challenges</i> .....	17
2.5.3	<i>Joint demand and supply challenges</i> .....	18
<b>3.0</b>	<b>Potential for Water Quality Trading in Central Valley Rangelands .....</b>	<b>20</b>
3.1	Water Quality Institutions of California .....	20
3.1.1	<i>State water quality institutions</i> .....	20
3.1.2	<i>Regional water quality institutions</i> .....	21
3.2	Types of Water Quality Problems Involving Central Valley Rangelands .....	22
3.3	Regulatory Drivers: Total Maximum Daily Loads (TMDLs) Affecting Rangelands. ....	24
3.4	Non-regulatory Drivers Affecting the Central Valley .....	28
<b>4.0</b>	<b>Rangeland Conservation Best Management Practices to Improve Water Quality.....</b>	<b>30</b>
4.1	Best Management Practices (BMPs) to Improve Water Quality on Rangelands .....	30
4.2	Effectiveness of Rangeland Conservation Practices to Improve Water Quality.....	32
4.2.1	<i>Prescribed grazing</i> .....	32
4.2.2	<i>Riparian fencing and water development</i> .....	33
4.2.3	<i>Riparian buffers</i> .....	35
4.2.4	<i>Other practices</i> .....	38
4.2.5	<i>Multiple Best Management Practices</i> .....	40
<b>5.0</b>	<b>Conclusions .....</b>	<b>42</b>
5.1	Market Structure and Viability .....	42
5.2	Market Drivers .....	43
5.3	Demand and Supply of Water Quality Credits.....	43
5.4	Policy Recommendations .....	44

6.0 Literature Cited.....	46
7.0 Appendices.....	54

## **List of Tables**

Table 2.1. Selected TMDL Driven Trading Programs .....	6
Table 2.2. Non-regulatory projects: voluntary projects and TMDLs.....	11

## List of Figures

Figure 3.1. California’s Regional Water Resource Boards .....	22
Figure 3.2a Water quality limited segments in the northern California Rangeland Conservation Coalition area.....	26
Figure 3.2b Water quality limited segments in the southern California Rangeland Conservation Coalition area.....	27

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## Executive Summary

Healthy rangeland and riparian systems provide clean water while supplying wildlife and other ecosystem service benefits to California's Central Valley. Much of the Central Valley rangelands are privately owned and managed for livestock production. Although ranchers in California have expressed interest in providing clean water and other ecosystem services, the opportunity for them to benefit from their efforts are limited. Water quality trading programs can potentially compensate landowners for enhancing water quality and quantity while providing wildlife and habitat co-benefits. This report compares existing water quality trading programs in the U.S., identifies the features of successful programs and then assesses their applicability to rangelands in the Central Valley of California. It also identifies conservation practices available to ranchers for delivering clean water and other environmental and wildlife benefits that can potentially be sold.

A review of water quality trading programs in the United States indicated that there are several programs at various stages of development and implementation across the country that provide models and insight on how to design a successful water quality program that engages ranchers. Traditional water quality trading programs are driven by Clean Water Act regulations that require states to identify impaired waters and implement Total Maximum Daily Loads (TMDLs) that set the limits on pollutants in streams and rivers. TMDLs are the key drivers required to get trading started, creating demand for water quality credits from regulated entities as they strive to meet these regulatory standards. Regulatory drivers for pathogens, sediment, temperature other pollutants that ranchers are well placed to address in the Central Valley are limited. There are few active TMDLs in place for these pollutants on Central Valley rivers and streams limiting opportunities for the establishment of water quality trading programs for ranchers. Non-regulatory drivers for abating point sources may provide an alternative mechanism for improving water quality. Voluntary mechanisms such as source water protection is a promising alternative that can provide funding and ensure water quantity and water quality for California utilities, in addition to all the co-benefits, such as wildlife habitat that are achieved by the conservation of privately-owned rangelands.

Water quality trading programs need to engage all stakeholders in program design, including regulators, buyers, ranchers, third party negotiators/aggregators and, credit verifiers. This ensures transparency, builds trust in the credits and trading system, increases innovative and flexible solutions and lowers transaction costs. Stakeholder involvement is also essential for the development of science-based, cost effective and simple monitoring programs to quantify the water quality services produced.

Identifying buyers for water quality is a major challenge for establishing water quality trading programs. The most successful programs are those where the buyer(s) is known from the onset and actively seek out sources of water quality credits from working lands. There is further need to identify and engage potential buyers of water quality services, e.g. water management districts, private and public utilities, and other regulated entities.

To develop water quality trading programs, stakeholders will need answers to questions regarding which best management practices (BMPs) or combination of BMPs are best for their specific situation and stream. Our review of best management practices suggests that pollution problems can be reduced through selected rangeland management practices. Such practices include the installation of riparian buffers, fencing, water point development and managed grazing. Furthermore, ranchers in California are interested in providing ecosystem services such as cleaner water and wildlife habitat and there is scientific evidence to support the effectiveness of several conservation practices to improve water quality which could become the basis for a payment for ecosystem services program. However, link between rangeland management and hydrology is complex and therefore effectiveness of practices to improve water quality is dependent on site-specific conditions. The emerging field of rangeland ecohydrology offers a framework to understand the role of rangelands in the water cycle and how to design effective best management practices to improve water quality.

For effective development of water quality trading and payments for watershed services markets in general, regulators, water quality credit buyers and sellers need to recognize the potential role of privately-owned rangelands in achieving water quality goals. Any regulatory or voluntary market structure for achieving water quality improvements in the Central Valley needs to be oriented towards engaging ranch landowners. We recommend increased outreach to land owners, the private sector and general public on the role and value of rangelands as providers of ecosystem services and specifically water quality and quantity. California should seek to implement a state-wide policy that recognizes the importance of ecosystem services. Formal recognition can help to encourage the incorporation of ecosystem services into county, watershed and habitat management planning efforts. Programs that aim to secure beneficial land uses through conservation easements and BMPs in order to protect both water supplies and water quality and other ecosystem services could become an important tool for the conservation of privately-owned rangelands in the Central Valley of California.

## **1.0 Introduction**

### **1.1 Background**

This white paper constitutes a final report to the Compton Foundation to present the results of an investigation of the feasibility of water quality markets and trading for Central Valley rangelands.

California has more than 18 million acres of rangelands within and encircling the Central Valley and the interior Coast Range. Much of the Central Valley's grasslands and foothills are privately-owned and managed primarily as rangelands for livestock production. Rangelands also produce a myriad of ecosystem services, which include wildlife habitat, watershed protection, open space and mitigation to climate change (Kroeger et al., 2009). Rangelands also have great influence on the quality of surface waters. Eight of California's twelve major drainage basins are dominated by rangelands and close to all surface water in California passes through rangelands (UC ANR, 1996).

Research has shown that rangeland management has a direct impact on watershed health and subsequent water quality. By restoring and maintaining healthy grassland and riparian areas, landowners ensure a reliable source of clean water for urban, recreational, and agricultural uses. The provision of watershed ecosystem services from rangelands has been recognized (Havstaad et al., 2007). However, the absence of markets for these public good services means that landowners are often not paid and do not receive any benefits from the positive actions they take on their land and continued stewardship that benefits the end users. This lack of incentives for rangeland conservation and stewardship further accelerates the conversion of rangelands to more lucrative uses such as urban development and intensive agriculture. As thousands of acres of rangelands in California's Central Valley are converted to other uses the ecosystem services that they provide are lost. Water quality trading and other payments for ecosystem services (PES) programs that compensate ranchers for the public services they are providing to society have the potential to increase and diversify ranchers' income, by providing financial incentives to adopt rangeland conservation practices. These practices increase the sustainability of ranchlands and reduce the cost of maintaining healthy watersheds that provide clean water.

### **1.2 Overview of Water Quality Trading Programs**

Water quality trading (WQT) programs use economic incentives to improve water quality, allowing pollution dischargers to meet environmental objectives at a lower cost and with more flexibility than through strict regulation. Various sources of pollution are generally located in the same watershed or sub-watershed and often face different costs to control a given pollutant. Those that face lower costs are in a position to reduce their pollution discharges more quickly and generate pollution reduction credits that they can, then, trade to other entities (PRI, 2006; US EPA, 2004). For example, entities such as cities, private companies, and public water management agencies that are regulated under the Clean Water Act can meet their regulatory obligations by installing abatement technologies to reduce their pollution or by purchasing pollution reduction credits from other regulated entities or unregulated nonpoint sources such as farmers and ranchers. These trading schemes usually address a specific water quality parameter such as phosphorous, nitrates, salinity or biological oxygen demand. The schemes can involve several thousand dischargers, or only two.

Water quality trading structures range from bilateral trades where a discharger and the supplier of credits negotiate a one-time deal to clearing-house type structures where contracts are brokered between agents that do not contact each other (Woodward and Kaiser, 2002). Woodward et al. (2002) identified four market structures for water quality trading:

- i. Exchanges: like that of the New York stock exchange where information flows freely between buyers and sellers, transactions are fluid, and the product traded is uniform.
- ii. Bilateral negotiations: that requires considerable effort by both buyers and sellers to negotiate terms of the trade and exchange information, but allow exchange of a non-uniform product.
- iii. Clearing house: a structure that cuts all regulatory and contractual links between buyers and sellers where the state or another authorized entity acts as a clearing house for all exchanges; paying for reduction credits from various sources and selling the credits to dischargers that need to exceed their allowable loads.
- iv. Sole source offsets: where a discharger is allowed to meet water quality standards at one point if pollution is reduced elsewhere onsite or offsite.

These four structures represent different levels of transaction costs (negotiation, contracting and information exchange costs) and hence cost savings. In the right circumstances, water quality markets can be a useful tool that complements other regulatory and voluntary incentives to improve and maintain water quality.

Water quality trading can generate economic, environmental, and social benefits. The economic benefits include allowing pollution dischargers to take advantage of economies of scale, and treatment efficiencies that vary from source to source, reducing the overall costs of achieving water quality objectives in a watershed (Cochran and Logue, 2011) and providing the means to manage growth while protecting the environment. Environmental benefits include (i) achieving water quality objectives more quickly, encouraging further adoption of pollutant prevention and innovative technologies; (ii) engaging more nonpoint sources in solving water quality problems; and (iii) providing co-benefits such as improved habitat and ecosystem protection (Cochran and Logue, 2011). From a social standpoint, WQT efforts have helped foster productive dialogue among watershed stakeholders (Mcgrath, 2008) and helped create incentives for water quality improvement activity from a full range of dischargers (Selman et al., 2008).

The effectiveness and efficiency of WQT programs largely depend on local biological and social conditions, as well as on careful attention to program design (PRI 2006; Abdalla et al., 2007; Ribaudo and Gottlieb, 2011). This study provides a first step to understanding whether existing WQT programs can provide a good model for the creation of programs accessible to ranchers in the Central Valley to address water quality issues.

### **1.3 Purpose of the Report**

The purpose of this report is to assess the feasibility of establishing water quality trading programs in the Central Valley of California that are accessible to ranchers. The report provides information to landowners, policy makers, agencies, as well as private sector and environmental organizations that are involved in the implementation of water quality trading and payments for ecosystem service programs. This report also offers recommendations for structuring water quality markets in which California ranchers could participate.

### **1.4 Report Organization**

The next chapter of this report summarizes experiences of water quality markets and trading in the United States. It draws lessons on conditions for successful program design and implementation.

Chapter 3 examines the institutional and policy environment for water quality markets in the California Central Valley by identifying the different types of water quality problems facing Central Valley watersheds and the potential regulatory and non-regulatory drivers that exist to address them. Total Maximum Daily Loads (TMDLs) are generally the primary regulatory drivers to stimulate water quality markets. By setting limits on allowable pollutant levels, TMDLs can motivate trading, driving polluting sources to seek lower cost and environmentally equivalent pollutant reductions (US EPA, 2004). This section identifies which TMDLs are in place in the Central Valley and explores their relevance for rangelands. In addition, section III reviews rangeland management practices that can be applied by private landowners to reduce water pollutants, and explores potential funding sources to address pollution from source water protection areas, such as rangelands.

Finally, chapter 4 synthesizes the findings from chapter 2 and chapter 3 and provides recommendations for water quality market design and structure for rangelands in the Central Valley focus area. In addition, this section gives policy recommendations to advance the development of water quality markets as a whole.

## **2.0 The Experience with Water Quality Markets and Trading in the United States**

Water quality trading in the United States is driven by regulatory standards, and by voluntary actions that provide financial or in-kind incentives to landowners who implement water quality improving practices (Stanton et al., 2010). The Clean Water Act (CWA) is the main regulatory driver of water quality trading. The CWA regulates discharges of pollutants into the waters of the United States and regulates quality standards for surface waters through Total Maximum Daily Loads (TMDLs). A TMDL quantifies a maximum amount of a particular pollutant that can be discharged and still protect the beneficial uses of the water body. Under the CWA, point sources are regulated through a permit system that specifies how much of a particular pollutant they can discharge. Point sources can meet their obligations by reducing their own effluent discharge or through discharge reductions from other regulated point sources or unregulated nonpoint sources (US EPA, 2004). TMDLs have become a widespread means of pollution control for the EPA, and there are over 4000 TMDLs developed to address impaired waters throughout the country (Ribaudo and Gottlieb, 2011).

Water quality trading programs have taken hold rapidly in the United States. As of 2008, there were sixty-six programs at various stages of development within the United States (Stanton et al., 2010). The growth of water quality trading programs was fueled by increased enforcement of TMDLs throughout the 1990's, the EPA's endorsement of water quality trading via its Water Quality Trading Policy of 2003, and federal government support of market-based water quality initiatives through grants from the EPA and USDA (Selman et al., 2008). The trading programs range from large formal water quality markets to smaller one-to-one trades. In general, farmers and ranchers have had little incentive to improve water quality, primarily because as nonpoint sources they are not directly regulated under the CWA. The benefits of water quality improvements also accrue off-farm to downstream users, and few landowners are willing to incur the costs of undertaking water quality improving practices when they will not receive much, if any, of the benefits. Water quality trading expands the options for point sources to meet their regulatory obligations and to consider agriculture as a source of water quality offsets (Ribaudo and Gottlieb, 2011). It also presents an opportunity for farmers and ranchers to benefit directly through payments to create offset credits by implementing best management practices (BMPs) such as riparian re-vegetation and grazing management. Trading with farmers and ranchers has the added advantage of generating environmental co-benefits beyond improved water quality such as reduced erosion, flood control, improved habitat and restoration of wetlands (US EPA, 2003). However, water quality trading involving nonpoint sources such as farmers and ranchers has been limited. Ribaudo and Gottlieb (2011) identified a total of only 15 programs since 1980 that have involved point source-to-nonpoint source trading. However, the development of water quality markets can provide a more flexible and cost effective approach to reduce pollution.

### **2.1 Review of Water Quality Trading Programs in the U.S.**

We review a range of water quality trading programs and a selection of non-market programs focused on water quality improvements in this section. We first review six regulatory-driven water

quality trading programs; and then we review source water protection programs. Finally, we present a selection of non-regulatory driven programs where no trading has taken place, but where water quality improvements have been achieved through education and voluntary actions by landowners. These three broad categories of programs present a cross-section of program types and performances that provide lessons in design and implementation relevant to California rangelands.

## **2.2 Regulatory Driven Programs**

Among the numerous water quality trading programs active in the U.S., we chose to focus on six in particular: Clean Water Services/Tualatin River, Rahr Malting Company Trading Program, Great Miami River Watershed Trading Pilot, Cherry Creek Reservoir Watershed Phosphorous Trading Program, Long Island Sound Nitrogen Credit Exchange Program, and the Grassland Area Farmers Tradable Loads Program.

### **Case study selection**

The six programs were selected for review according to the following criteria. Each of these programs has experienced at least one trade or offset, as identified by Selman et al. (2008), and four of these six programs involve trading with nonpoint sources, a sector of particular relevance to California rangelands. To observe a wide range of market structures, we selected two bilaterally structured programs (the Grassland Area Farmers Tradable Loads Program and the Rahr Malting Company Trading Program), two sole-source offset programs (the Cherry Creek Reservoir Watershed Phosphorous Trading Program and Clean Water Services/Tualatin River), and two clearinghouse structures (the Long Island Sound Nitrogen Credit Exchange Program and the Great Miami River Watershed Trading Pilot). Each program snapshots a different state, enabling comparison with the selected program near our region of interest in California (the Grassland Area Farmers Tradable Loads Program). In addition, both successes and failures were observed in water quality market strategies, three of the six programs were perceived to have experienced some level of ascertainable success - either in market design or in the achievement of their water quality goals - where the remaining three did not. Finally, to the extent available, selections were made so as to observe at least one example for each of the pollutants of greatest concern to Central Valley rangelands: sediment (the Rahr Malting Company Trading Program), temperature (Clean Water Services/Tualatin River), and nutrients (the Cherry Creek Reservoir Watershed Phosphorous Trading Program, the Long Island Sound Nitrogen Credit Exchange Program, and the Great Miami River Watershed Trading Pilot).

Table 2.1. Selected TMDL Driven Trading Programs

<i>Program Name</i>	<i>State</i>	<i>Pollutant</i>	<i>Market Structure</i>	<i>Trading Structure</i>
Clean Water Services/ Tualatin River	OR	Temperature & CBOD5	Sole-Source Offsets *	PS-PS
Rahr Malting Company Trading Program	MN	Sediment & Phosphorous, Nitrogen, CBOD5	Bilateral	PS-NPS
Great Miami River Watershed Trading Pilot	OH	Phosphorous & Nitrogen	Clearinghouse	PS- PS/NPS
Cherry Creek Reservoir Watershed Phosphorous Trading Program	CO	Phosphorous	Sole-Source Offsets	PS- PS/NPS
Long Island Sound Nitrogen Credit Exchange Program	CT	Nitrogen	Clearinghouse	PS-PS
Grassland Area Farmers Tradable Loads Program	CA	Selenium	Bilateral	NPS-NPS

\* Sole-source offsets are used for thermal loading only. A bilateral structure was formed for trading of Oxygen Demanding Parameters; however, there has not been trading for Oxygen Demanding Parameters yet in this market.

PS = point source discharger, NPS= Nonpoint source discharger

### ***2.2.1 Clean Water Services/Tualatin River (Oregon)***

In 2001, Oregon Department of Environmental Quality set a TMDL for the Tualatin River Sub-basin, which set wasteload allocations for thermal loading (temperature) and oxygen demanding parameters in the sub-basin. Clean Water Services (CWS), the public utility, operates four wastewater treatment plants in the Tualatin sub-basin that provide wastewater treatment services to over 500,000 residents. The new TDML severely limited CWS pollution impacts for temperature on the Tualatin. To meet the thermal load allocation, CWS estimated that it would need to reduce thermal load from two of its plants by 95% (Cochran and Logue, 2011). A municipal watershed-based National Pollutant Discharge Elimination System (NPDES) permit was received that allows thermal loading offsets through three abatement strategies: riparian reforestation to increase shade, augmentation of river flow, or the use of effluent for irrigation. In the program, thermal credits are generated by riparian shading projects and are measured on a project-by-project basis depending on the amount of Solar Load blocked by the project. CWS supported voluntary agricultural programs to facilitate the implementation of projects in rural areas. The first, Enhanced Conservation Reserve Enhancement Program (ECREP) provides substantially higher payments levels than those available under the existing Farm Service Administration Conservation Reserve Enhancement Program (CREP) and technical assistance to encourage farmer participation. The second, Vegetated Buffer Areas for Conservation and Commerce, gives less compensation but is less restrictive than CREP.

#### *Results*

As of 2008, sixty-three projects on private lands had been implemented that planted 1.6 million native trees. The plantings generated temperature credits held by CWS. CWS was able to generate all of the credits needed for compliance within the first five year permit cycle using stream flow augmentation (75%) and riparian shading (25%) (Cochran and Logue, 2011). The full benefits of



riparian shading projects are not expected to materialize until 20 years after initial project implementation. In addition, an estimated 70% of the stream is still in violation of the state's water quality criterion for temperature, and in Oregon's most recent 303(d) listing sent to the EPA under the Clean Water Act, the Tualatin Sub-basin was ranked first of the 12 listed water bodies for the severity of its water quality violation (Learn, 2009). Cost savings from the program, however, are large; for example, the cost savings from enabling offsetting, rather than forcing sources to install cooling technologies is estimated at \$42 million over the program's first five years by CWS (US EPA, 2007).

The CWS/Tualatin river example is one of the few examples in the country to address temperature, a pollutant of concern in the Central Valley and successfully engage private landowners. The program also realized ecological benefits beyond reduction in temperature, as buffers reduce sediment, nitrates, and phosphorus. In addition, the models used to calculate shade offsets may be transferrable to the Central Valley.

### ***2.2.2 Rahr Malting Company Trading Program (Minnesota)***

The Rahr Malting Company (Rahr) in Minnesota estimated that it could increase production by 20% and still reduce costs if it established a new wastewater treatment plant rather than using the existing regional treatment plant. However, a 1985 wasteload allocation in place for the lower 26 miles of the Minnesota River meant that Rahr could only use this new wastewater treatment plant if it could do so without contributing to the pollutant loading levels of the river. Rahr teamed up with the Minnesota Pollution Control Agency (MPCA) in an NPDES permit that allowed Rahr to discharge from its new wastewater treatment facility on condition that it established a \$250,000 trust fund to pay for BMPs on farms that would offset all of Rahr's pollutant loading from the new facility in 5 years. The permit that was finalized in 1997 incorporated trading between Rahr and local nonpoint sources (Breetz et al., 2005; US EPA, 1999). A program was also created to fund BMPs in agricultural lands upriver. Particular attention was focused on selecting BMPs that would produce the desired water quality outcomes; Rahr chose practices that were additional to what farmers were typically already doing, and that could be easily and visually tracked and monitored (US EPA, 2007). Four nonpoint sources for BMP implementation projects were selected by MPCA and funded by Rahr to generate credits and achieve the required reduction of 150lbs/day in oxygen demanding parameters. The BMP projects included riparian re-vegetation, streambank stabilization and livestock exclusion from riparian areas. Reductions in sediment, phosphorous, and nitrogen loading from the BMPs were converted into reductions in oxygen demanding parameters (CBOD<sub>5</sub>) with the use of conversion ratios and trades were monitored by the Commissioner of the MPCA. Since nonpoint source participation was voluntary and not guaranteed, to ensure it received a dependable supply of credits, Rahr accepted an especially stringent phosphorous cap of 2mg/L. This yielded a credit of 30 phosphorous units to be applied to the cumulative load reduction specified for each year (US EPA, 2007).

### *Results*

By funding BMPs on farms, Rahr was able to increase production by 20% while simultaneously cutting costs of abatement. We chose to observe this program for several reasons. It involved sediment off-setting, an issue that also affects the Central Valley. The program began with an identified demand source (the buyer) that had to search for a credit supply, and was able to comply with regulations while achieving both cost savings and increases in production. It also provides interesting features regarding potential market development involving point sources in our focus area and the creation of a trust fund is highly innovative. Lastly, the Rahr program is voluntary and engages landowners in coming up with practices that can be easily monitored.

### **2.2.3 Great Miami River Watershed Trading Pilot (Ohio)**

Prompted by concerns over impending development of strict TMDLs for phosphorous and nitrogen in the remaining sub watersheds of the Great Miami River, the Great Miami Pilot formed under the Water Conservation Sub-district of the Miami Conservancy District (Miami CD) in 2006. The 10-year pilot program functions as a credit bank, supplying credits to facilities under threat of regulation before permit limits are established. To generate credits, the Miami CD appealed to local farmers and Soil and Water Conservation Districts to develop BMP projects. Applications that promised the greatest phosphorous reductions at the lowest cost were entered into a reverse auction by the Miami CD for funding (USEPA, *Toolkit*, 2007). Reverse auctions were funded by prospective waste water treatment plants that voluntarily signed up to the trading program prior to the enactment of TMDLs and a USDA grant of about \$1 million.

### *Results*

By 2009, four rounds of reverse auctions had been held, 50 projects had been funded, and the projects had produced a total of 324 tons of phosphorous reduction (Selman et al., 2009). The projected cost savings from the trading program were estimated to exceed \$350 million when the program was launched in 2005 (USEPA, 2008). Although it is thought possible to cover all costs of installing BMPs under the program, landowner or farmer participation has been limited and efforts are underway to improve farmer participation. Under the program, the polluter allows farmers to develop or choose their own BMPs, which may increase the likelihood of farmers participating. However, about 40% of the rivers and streams in the watershed have yet to meet Ohio's water quality standards and evaluations of the program's success remain mostly speculative (US EPA, 2008).

The Great Miami Pilot could be a particularly interesting program to follow in the coming years to see whether this buyer is permanent, or if it will be discontinued before the program has accomplished its water quality objectives. Polluter sources allowed farmers to develop or choose their own BMPs which may increase the likelihood of farmers participating.

#### ***2.2.4 Cherry Creek Reservoir Watershed Phosphorous Trading Program (Colorado)***

In 1997, the Cherry Creek Control Regulation #72 (the Regulation) for the Cherry Creek and the Chatfield reservoirs prescribed guidelines for phosphorous trading for regulated sources in the reservoirs. The State of Colorado initiated offsetting with nonpoint sources as early as 1985, and in 2001, added revisions to the original regulation. The Regulation developed a Total Maximum Annual Load (TMAL) regulating both point sources and nonpoint sources in the reservoirs. Under the Regulation's revised guidelines, already-existing point sources could buy and sell credits from one another through private project trades (offsets) authorized by the Water Quality Authorities of the two basins. Phosphorous discharge from new or expanding facilities is offset with nonpoint source projects in local urban regions that reduce total phosphorous loading to the reservoirs (Selman et al., 2008). In addition, buyers may purchase credits from the Watershed Authorities' Reserve Fund (the Reserve Pool), which supplies 432 lbs of phosphorous credits generated from two long-term abatement projects: the Historic Trade Project and the New Trade (US EPA, 2007; Breetz et al., 2004).

#### ***Results***

The program has had broad participation by a variety of groups. To date, seventeen point sources, including twelve wastewater treatment plants and numerous nonpoint sources have participated in the program since its inception. Although most regulated facilities have been discharging below their regulated load, eleven trades have occurred, four in Cherry Creek and seven in Chatfield, with one involving a nonpoint source (Selman et al., 2008; US EPA, 2007). Growth of the program is believed to be unlikely. The program inadequately accounts for all the facets decreasing of equivalency of trade and financial incentives have been insufficient to stimulate increases in trading (US EPA, 2007).

#### ***2.2.5 Long Island Sound Nitrogen Credit Exchange Program (Connecticut)***

In 2001, the state of Connecticut established a TMDL for nitrogen deposits in the Long Island Sound region as part of a 15-year nitrogen reduction plan in which total nitrogen discharges by all point sources (publicly owned treatment works) were capped at their historic levels and then gradually lowered until they reached specified targets. In 2002, the Connecticut Legislature created the Nitrogen Credit Exchange because it projected that doing so would enable a cost savings of approximately \$200 million over the 15-year period. With the establishment of the Exchange, each yearly or semi-yearly lowering of the nitrogen deposit caps meant that credits were removed from the market, a device that increases pressure on dischargers and incentivizes trading. Point sources buy and sell credits. Credits from nitrogen reductions in watersheds close to the pollution impact zone in the Long Island Sound are more "valuable" than credits from reductions from more distant sources that are naturally attenuated. This difference in credit value encourages trading by making it attractive for sources close to the pollution impact to remove more nitrogen than the permit requires and sell credits.

### *Results*

The Long Island Sound Program is the largest and longest-running active water quality trading program in the country (US EPA, 2008). Since 2001, 31 nitrogen removal projects have been implemented in the area by various companies, which have reduced the total nitrogen load from the 79 publicly owned treatment works by 15,500 lbs per day (US EPA, 2008), and 12 million credits have been bought or sold, accumulating an estimated total market value of \$30 million (Selman et al., 2008). The treatment works buy and sell credits. Credits from nitrogen reductions close to the pollution impact zone in the Long Island Sound are more “valuable” than nitrogen reductions from more distant sources that are naturally attenuated (US EPA, 2008). This difference in credit values drives the trading, making it attractive for point sources close to the problem to remove more nitrogen than the permit requires and sell credits, while point sources further away may find it less expensive to buy credits rather than upgrade facilities (US EPA, 2008).

We chose to study the Long Island Sound program primarily because it has been deemed the largest and longest-running active market in the country, and if for that reason alone, is an instrumental model for market development. The removal of credits from the market over a phased time frame enables continuous and growing demand, while still providing suppliers the time to accommodate the increased regulation.

### ***2.2.6 Grassland Area Farmers Tradable Loads Program (California)***

The Grassland Area Farmers (Grassland group) was formed in 1996 by several irrigation and drainage districts in the San Joaquin Valley grassland drainage area for the purpose of using the San Luis Drain for agricultural drainage. The Grassland group entered into a use agreement with the Federal Bureau of Reclamation, enabling the group to use the drain for agricultural wastewater disposal as long as they did not exceed specific selenium load limits. To meet these limits, the Grassland group adopted numerous BMPs and undertook restoration efforts to improve the drainage channels. In 2001, a TMDL for selenium was developed for the area and gave the districts individual selenium load allocations. Establishment of the TMDL induced the creation of a long-term tradable loads program, which was initiated in 1998 by the Grassland group to ease the burden of selenium reduction. The districts then have the choice of meeting their load allocation or buying/trading load allocations from other districts. Open communication between participating districts combined with assistance from the Regional Drainage Coordinator in the negotiation process make transaction costs negligible.

### *Results*

Between 1998 and 1999, trading districts wrote formal bilateral trade agreements (Woodward and Kaiser, 2002). This changed after 1999, informal agreements were made by the districts, at nearly negligible transaction and negotiation costs. Trades were executed by simply requiring certification by the Regional Damage Coordinator (Woodward et al., 2002). These transactions are cheap and efficient, and numerous informal trades have occurred. Risks and uncertainties typically associated with nonpoint source-to-nonpoint source trading are alleviated by this program through a rigorous

monitoring system that combines monitoring done by individual districts and by the Bureau of Reclamation, the monitoring provides a measure of accountability akin to that of a point source-to-point source program. As part of the selenium reduction efforts originally performed to secure the use agreement, excess drainage has been removed from more than 93 miles of channels. From 1996 to 2000, overall selenium loading was reduced by 54%, boron loading by 14%, and overall drainage volume by 41% (Young, 2001).

This program deals exclusively with nonpoint source-to-nonpoint source trading in California. It illuminates the conditions necessary to maintain such a trading structure, including the need for a very valuable incentive package, minimized transaction and negotiation costs through informal trading, an extremely good monitoring plan, and a structure that is flexible to the uniqueness of each nonpoint source operation while still protecting participants’ sense of community-autonomy.

### 2.3 Voluntary Programs

In addition to water quality markets and trading programs, we also researched selected water quality projects involving rangelands and ranching, and one TMDL in San Francisco, California that has the potential to give rise to markets. The projects we chose—the Elkhorn Creek BMP Demonstration Project (Kentucky), as well as the Flint Creek Watershed Project and the Tuscumbia-Fort Payne Aquifer Protection Projects (both in Alabama)—All these projects were funded by EPA section 319 grants and focus specifically on water quality issues associated with livestock. The pollutants of greatest concern in each of these projects were fecal coliform bacteria and sediment, two of the pollutants also identified as pollutants of particular concern in the California rangelands (Tate et al., 2000). In addition, each project demonstrates the willing and interested participation by a local community in water quality issues before regulations were put in place mandating these activities. Finally, San Francisco was selected for study to gain a better understanding of the California TMDL formulation process.

Table 2.2. Non-regulatory projects: voluntary projects and TMDLs

<i>Name</i>	<i>State</i>	<i>Pollutant</i>
Elkhorn Creek BMP Demonstration Project	KY	Sediment, Nutrients, & Pathogens
Flint Creek Watershed Project	AL	Nutrients & Fecal Coliform Bacteria
Tuscumbia-Fort Payne Aquifer Protection Project	AL	Pesticides, Herbicides, & Fecal Coliform Bacteria
San Francisco Bay Mercury TMDL	CA	Mercury
Florida Ranchlands for Environmental Services Program	FL	Phosphorous

#### 2.3.1 Elkhorn Creek BMP Demonstration Project (Kentucky)

The Elkhorn Creek Watershed in Kentucky has been listed as impaired for sediment and pathogen loading resulting from livestock production and the direct access of livestock to the stream. To mitigate these pollution problems and avoid establishment of a TMDL, four demonstration farms were chosen to showcase alternative livestock management practices focused on water development (ramp pumps, pasture pumps, and limited access watering points) (US EPA, 2002). The project used demonstrations farms field days to encourage discussion of how best to apply the new practices.

Stream data was collected one year prior to the use of the new practices and will take place again two years after to observe changes in nitrogen, ammonia, total phosphorus, pH, temperature, conductivity, turbidity, and fecal coliform bacteria levels (US EPA, 2002).

The use of local examples has proven a very powerful tool for garnering support for the new practices. Demonstration farms could be a strategy to garner community-wide support not only for pollution abating practices, but also for future participation in a water quality trading. The trading program is also unique because it engaged landowners in coming up with practices based on local conditions and was driven by voluntary pre-compliance. Outreach was a non-regulatory driver and the project offered a strong monitoring program.

### ***2.3.2 Flint Creek Watershed Project (Alabama)***

In 1994 the Watershed Conservancy Agency was formed to address the effects of local dairy production on stream quality in the Lawrence and Morgan counties. Projects to mitigate these effects were co-funded with section 319 grants, US Department of Agriculture programs, Soil and Water Conservation District cost-share funds, and corporate donations. Projects were largely outreach in nature but also included activities like well sampling and riparian zone management. Improvements in fecal coliform levels were recorded at 11 of the 13 sampling sites. Nitrate concentrations decreased at three sites, turbidity decreased at two, and ammonia concentrations decreased downstream of a sewage lagoon (US EPA, 2002). This project is relevant to because of its success in achieving improvements to water quality simply through outreach efforts and information on well water quality. Outreach and monitoring were effective non-regulatory drivers.

### ***2.3.3 Tusculumbia-Fort Payne Aquifer Protection Project (Alabama)***

The Tennessee River Valley is one of Alabama's most rapidly developing areas in agricultural production, recreation and industry. The Highland Rim Region accounts for roughly 4,500 square miles of the Tennessee River drainage basin and due to agricultural production and poorly maintained wastewater treatment plants suffered contamination by fecal coliform and pesticides (US EPA, 2002). As the first phase of the Tusculumbia-Fort Payne Aquifer Protection Program, the University of West Alabama conducted a pilot study in Lauderdale County with the voluntary assistance of 100 homeowners to collect information about on-site sources of this contamination. Of the 100 wells and springs in the 14 water systems examined, 32% contained some level of fecal coliform bacteria. Additionally, there was an 83% probability of contamination in shallow wells when drain field lines ran toward the well, while there was only a 23% probability of contamination when drain field lines ran away from the well (US EPA, 2002). The second phase of the program featured a combination of a three-year outreach program and educational campaigns. The first Groundwater Festival was held in 1998 in Madison County and involved the participation of over a thousand local elementary students. With the success of the pilot, three more festivals were held in three other counties, each one unique to the concerns of the county. Festivals have been held annually, and participation has increased more than five-fold since the 1998.

This project demonstrates the potential for voluntary community involvement in water quality issues, and the usefulness of thorough scientific studies conducted to ascertain contamination by pollutants of greatest interest to our focus. These scientific processes could potentially provide the basis for a monitoring program as part of a rangeland water quality trading market or payment program.

#### ***2.3.4 San Francisco Bay Mercury TMDL (California)***

In 2003, the San Francisco Estuary Institute conducted a local fish survey and found that screening values for mercury on average were exceeded by 38%. A TMDL was developed for the San Francisco Bay area in 2006 to set a mercury concentration limit. The TMDL aimed to reduce mercury concentrations by 50% through reductions in sediments, fish tissue, and bird eggs. In February of 2010, all involved parties ratified the TMDL. Given the magnitude of the mercury reductions demanded by the TMDL, a trading program is being considered for development. This program is an example of a California TMDL and sheds light on the basic steps involved in formulation of a TMDL. Furthermore, because of the rigorous reductions demanded by the TMDL, it shows particular potential for market development in the coming years.

#### ***2.3.5 Florida Ranchlands for Environmental Services Program (Florida)***

FRESP a pilot PES program was developed by a coalition of partners including the World Wildlife Fund, ranchers, researchers, state and federal agencies to address water quality and quantity problems in the lake Okeechobee Watershed located in the Northern everglades. FRESP enables ranchers in south-central Florida to sell water retention, reduced phosphorous loading and wetland habitat expansion to state agencies and other willing buyers. Land use and hydrological changes in the Okeechobee watershed have resulted in fragmented wildlife habitat and accelerated movement of water and nutrients that increased the nutrient loads into the lake and caused extreme water-level fluctuations (Bohlen et al., 2009). Measures to address these problems under the Greater Everglades Restoration Program created large public demand for increased water retention and reduction of runoff in the lake watershed. State agencies recognized that the additional storage capacity required would be difficult to achieve through public works projects alone and considered the options of retaining water on private lands in the region, creating an opportunity for a program to pay ranchers for storing and filtering water on their lands (Bohlen et al., 2009).

Under the program ranchers receive payments for implementing water management practices that combine modified land management and low-tech water control infrastructure on their land to increase water retention and reduce nutrient runoff (Horne, 2011). The water management practices on ranches are planned to complement public investment in regional water storage and water treatment facilities. Water management practices have the advantage that a large number of them can be designed, permitted, constructed and operational within one to two years, unlike larger infrastructure projects (Horne, 2011). The sale of water storage services also provides additional income to ranchers that face low-profit margins discouraging landowners from selling land for intensive uses that could degrade water quality and wildlife habitat (Lynch and Shabman, 2011).

### *Results*

The pilot phase provided information on dealing with implementation challenges related to the transaction costs such as documenting services, negotiating and executing contracts, and dealing with regulatory issues that were encountered in the program. The pilot phase showed that water management practices on private ranchlands have the potential to improve water retention and reduce phosphorous loads. Compared to regional water infrastructure, water management practices were rapidly implemented and cost less (Horne, 2011). In addition, FRESP successfully developed a streamlined process for regulatory compliance, established the technical feasibility of water management practices, established administrative feasibility and established accepted procedures for service estimation. The FRESP was the initial pilot phase of the PES program which included a sample of 8 ranchers and has been scaled up into the Northern Everglades and Estuaries PES. In January 2011, the South Florida Water Management District launched the scaled up Northern Everglades and Estuaries PES program and committed to purchase water retention services from ranchers. The water management district offered ten-year contracts to secure water retention services.

FRESP provides example of managing and reducing transaction costs in a PES program. The program successfully engaged regulatory agencies from the onset of the program and worked to stream line permitting processes that are present in many PES contexts particularly those involving water resources. The program is also unique in that it focuses on payment for environmental outcomes rather than installation of practices. The water management practices applied by ranchers are not prescribed, rather the land manager is encouraged to use and modify existing system to produce the services, giving the land owner the flexibility to be creative and use an approach that is most efficient and effective for his/her land and minimizes land taken out of production (Horne, 2011). In addition, the water management practices are monitored for performance (nutrients filtered and volume of water stored) unlike many programs where outcomes are assumed to flow from installation of a BMP.

## **2.4 Source Water Protection Programs**

Source water protection programs are one of the ways in which watershed managers are taking advantage of specific land uses to influence the quality of water supplies. Watershed managers realize that improving land stewardship and protecting the water at its source ensure their water supply for future generations, and the costs of treating water can be substantially reduced or avoided when it arrives downstream. Source water protection programs can incentivize farmers and ranchers through conservation easements and management practices that help protect water quality and quantity. Generally, a public or private utility company funds easements and pays upstream landowners in the watershed to manage the land ensuring protection of the water supply and improving water quality. These programs are typically motivated by the desire of utilities to avoid direct water quality control regulatory constraints and to ensure future water supplies.



Perhaps the best known and longest running source water protection program is the New York City program. In the 1990's, the level of pollutants in Catskills-Delaware watershed was rising, fueled by increased exurban development, industrialized agriculture and deforestation. Rather than building a new water treatment facility, city officials decided to tackle the source of the problem. In 1997, the city signed a memorandum of agreement that committed the city to spend \$1.5 billion over 10 years to restore and protect the Catskill and Delaware watersheds and invest in measures that improve the local economies of watershed communities.

The New York City Department of Environment (NYC DEP) works with land trusts and the Watershed Agricultural Council, a farmer led organization, to either purchase fee simple lands or conservation easements that will enhance water quality. The land owned and managed by the NYC DEP is split between fee simple purchases 60%, conservation easements (40%) purchased by the NYDEP and by the Watershed Agricultural Council (WAC). The City dovetailed their land acquisition program with a voluntary program called the Whole Farm Plan that works with the farmer to design and implement a plan that maintains BMPs for 10 years at little to no cost to the farmer. Farmers who enroll in the plan are exempt from regulations that enforce water quality compliance or monitoring programs. The innovative measures taken by the city have achieved significant reduction in phosphorous loading in the watershed. The City was also able to overcome the legacy of resistance and distrust by watershed inhabitants due to past land acquisitions in the watershed by working with stakeholders to develop a program that speaks to the needs of all parties concerned. For the landowners, the flexibility of the Whole Farm program enticed participation, and for the cities' managers, broad participation by all stakeholders secured a long term sustainable supply of clean water. The New York City program is a long running program, still active and unique in that it is completely self sufficient in terms of funding. Financing for this program comes from additional taxes on residents' water bills and from bonds issued by the city (Postel and Thompson, 2005). The program has also inspired the creation of similar programs in the West such as the Santa Fe Municipal Restoration Project and the more recent Denver Forests-to-Faucets' program.

The Santa Fe watershed is unique in that the city was not yet facing pressures to build more treatment facilities; rather the watershed service payment system sought to fund the maintenance of forest restoration activities as an insurance policy against future threats, such as forest fires, to the municipal water supply (Mcgrath, 2008). At a cost of \$1000 to \$2,000 per acre, forest thinning and burning to restore forest health and natural fire regimes is a cost that land management agencies find difficult to afford. The program is designed to provide funding to the US Forest Service for forest restoration treatments in critical areas of the Santa Fe watershed. The costs of the program will ultimately be passed to consumers in the form of a rate increase. The project has already produced beneficial outcomes that include: increased awareness and education about watershed health and protection by water consumers; genuine collaboration between water consumers and forest managers; and long term funding of true watershed maintenance costs (Mcgrath, 2008).

The Denver Forests-to-Faucets program, established in 2010, is a similar program focusing on reducing the risk of wildfire, restoring wild areas, and minimizing erosion and sedimentation of reservoirs. Denver Water, the water utility company, works together with the Rocky Mountain Forest Service to restore forest health and habitats in five large priority watersheds that span three forests. The large scope of this project makes it a unique source water protection program.

These programs are examples of “user contribution payment for ecosystem services programs” where the cost of providing ecosystem services used to deliver clean water is passed on to consumers who are the direct beneficiaries of these ecosystem services. Where successful, these types of programs can provide a sustainable long-term supply of funding to secure ecosystem services and subsequent water quality. These programs also rely heavily on utilities, state agency and consumer acceptance of the role and value of certain land uses in providing ecosystem services, such as clean water. They are instructive, providing potential sources of demand for watershed services and examples of processes to engage stakeholders in program design. Sediment is not easily regulated under conventional water quality markets and these programs have successfully reduced sediment, in addition to other pollutants such as phosphorous.

## **2.5 Issues and Conditions for Success**

A functioning market requires both willing buyers and willing sellers. For the buyers, the product being purchased (improved water quality) must be clearly measurable. For the sellers, who are the landowners producing improved water quality, returns to implementing BMP’s must equal or exceed the costs of adoption and implementation. In addition, the institutional framework must exist that encourages trading. There must be demand drivers, and often these are regulatory in nature. Review of the literature and case studies highlighted in this report identified some of the challenges to establishing sustainable water quality markets and the underlying conditions for success. From the programs we reviewed, we identified issues that limit successes and conditions that are necessary for successful implementation of water quality trading programs. The issues included factors that motivate buyers to engage in trading, factors that influence the level of landowner participation in supplying ecosystem services, the type of the pollutant to be reduced, and the trading environment.

### ***2.5.1 Demand side challenges***

#### *Weak Regulatory Drivers*

In the absence of strict legislation, creating demand for credits is often the hardest part of program success and the first reason cited for failed programs. For many of the programs that are inactive, the programs were set up in anticipation of a TMDL being issued for the basin, which never materialized. Examples include the Lower Boise River and Great Miami River nutrient trading programs (Selman et al., 2008; Ribaudo and Gottlieb, 2011). The TMDL creation process itself is lengthy, and if a regulatory driver is the intention, then programs should be built around TMDLs that are in the advanced stages of development. TMDLs’ limits on discharge need to be binding on point sources to stimulate trading.

In addition to having a TMDL in place, regulated entities need to be aware of the possibility of using ecosystem services alternatives (green infrastructure) to engineered solutions (gray infrastructure). In our review of the Rahr Malting Company, Clean Water Services and City of New York, each of the regulated entities realized the opportunity that ecosystem services provided as a cheaper and long-term solution to water quality problems. In addition, the regulatory environment allowed for the organizations to pursue this path. In the case of City of New York, the regulatory agencies had to accept ecosystems services as a management option; in the case of Clean Water Services, use of riparian shading was built into the regulatory permit recognizing it as a legitimate approach to address the temperature pollution problem.

#### *Risk of non-delivery*

For point sources regulated by NPDES permits, the fear of fines for noncompliance ensures that there is pressure to achieve and secure pollutant load reductions. This means that although buying credits may be cost-efficient, buying comes with the risk that the supplier will default on their contract and the buyer will have to pay for the supplier's faulty or mismanaged BMP project through noncompliance penalties or other mitigation. If the risk of non-delivery is perceived to be high, then the regulated point source may prefer to install expensive abatement technologies that it has control over to guarantee delivery of secure reductions, rather than purchasing credits. The question of who is liable if pollution abatement does not occur need to be explicitly addressed at the onset of a trading program (Woodward et al., 2002).

#### *Steady Credit Supply Flow*

Consistent supply flow of offsets from nonpoint source suppliers (usually farmers and ranchers) is a concern of most prospective buyers. Buyers want to buy long-term credits and have a dependable stream of credits that keeps up with their needs. Nonpoint sources, on the other hand, sometimes struggle to predict with certainty the amount of credits they can afford to sell and how many they will generate from BMPs. To overcome this, the selection of practices is important, the BMP's implemented need to not only be workable for the farmer, they also need to be easily monitored and measured for performance. Rigorous monitoring and measurement builds trust in the credits by both landowners selling the credits and buyers that purchase the credits. Part of this challenge is technical; the more reliable and effective the BMP, the greater the likelihood of success.

### **2.5.2 Supply side challenges**

#### *Fear of regulation*

Ranchers are generally averse to actions that would entail increased regulation; they value their autonomy. External intervention in the affairs and practices of nonpoint source production of any kind is usually unwelcome. Although the establishment of TMDLs may affect ranching activities, ranchers who are nonpoint sources are not directly regulated under the Clean Water Act and many would like it to remain that way. The fear is that any level of engagement in water quality trading will invite regulatory oversight which will in turn restrict on-farm activities (King, 2005; Abdalla et al., 2007; Ribaudo and Gottlieb, 2011). For example, inspection and monitoring of ranches and BMPs may be too stringent and, from the rancher's perspective, it may not be worth the gains from

participating in a trading program. Program designers have to be aware of this and ensure that there is trust between landowners and the entities with whom they interact for program implementation. Regulatory entities and implementing entities like regional water quality control boards have to be aware of this privacy need, and be sensitive to the ranchers' concerns. Using a simple top-down approach will most likely result in low participation by ranchers; rather ranchers need to be actively engaged in the program design process.

#### *Competing Policies*

Point source polluters in particular will have difficulty generating excess credits if they are already utilizing all available abatement methods to meet their own restrictions. Theoretically, water quality markets function best where users have widely differing compliance costs. While this is a challenge for the point source sector it presents an opportunity for private landowners such as ranchers to supply excess credits to the market by implementing practices that improve water quality.

#### *Pollutant Specifics*

The type of the pollutant to be controlled is important. The pollutant must be suitable for trading, and bio-accumulatives such as mercury cannot be easily traded because of the difficulty of removing it from a hotspot while protecting nearby habitat (US EPA, 2004). Another example is thermal loading to rivers and streams, which is complicated within the trading structure because the effect on local fish populations of excess thermal loading in one stream segment cannot be undone by reductions to thermal loading in another. These kinds of pollutants do not allow for offsite offsets and trading is restricted to the watershed, leaving little prospect for expansion or scaling up of markets. This is particularly important for our study area where sediment has been identified as a problem. There is doubt over the success of sediment offsetting at a large scale. Anywhere sediment is deposited it will be problematic to local habitat and beneficial uses, regardless of whatever sediment load reduction has been arranged elsewhere. Rather, offsetting must be done within the same watershed and it must be relevant in terms of that watershed's unique use values.

### **2.5.3 Joint demand and supply challenges**

#### *Transaction Costs*

Market and trading programs are based on the promise of cost-saving, as minimizing transaction and negotiation cost is critical to program success. The costs of identifying trading partners, discovering information on the credit and negotiating trades can easily reach levels where they discourage trading (Abdalla et al., 2007; Woodward et al., 2002), as can costs of monitoring and enforcement. Large transaction costs eat up the revenue stream to farmers and ranchers, and they discourage trading altogether for potential buyers.

One way around this is to encourage third party aggregators that can facilitate trading. Transactions tend to be higher when trading involves nonpoint sources (Abdalla et al., 2007). If farms and ranches who supply credits are widely distributed across the watershed and only supply a few credits each, buyers who demand large number of credits are faced with high transaction costs to find enough sellers to meet their needs (Abdalla et al., 2007; Ribaudo and Gottlieb, 2011). Aggregators

can pool together credits from many landowners and provide a single point of contact for buyers, reducing the costs of trading. On-line credit registries (Selman et al., 2008) can also serve the same purpose. Standardized methods to measure provision of services and calculate credits, and transparent processes for trading help to minimize transaction costs. It is important to realize however, that there is a trade-off between monitoring and measurement and ease of implementation. While policies that require strict monitoring and extensive reporting ensure that trading meets environmental quality goals, they can also impose substantial costs on buyers, sellers and regulators, eroding incentives to trade (Woodward et al., 2002).

### **3.0 Potential for Water Quality Trading in Central Valley Rangelands**

There are more than 40 million acres of rangeland in California making it the state's most extensive land type, and approximately half of that is privately owned (SWRCB, 2005). Eight of California's twelve major drainage basins are dominated by rangelands, and because they are located between forested areas and major river systems, close to all surface water in California passes through rangelands. As a result, rangelands have great influence on the quality of surface waters (UC ANR, 1996). This section gives an overview of the institutions and regulations specific to water quality management in California, as well as water quality problems affecting the Central Valley.

#### **3.1 Water Quality Institutions of California**

State and Federal water quality management institutions have overlapping roles in California. The State Water Resources Control Board is at the heart of California's water quality management system and oversees the Porter Cologne Water Quality Control Act. This act is California's major water quality management legislation, setting the goal of regulating activities in California to achieve high water quality. The Porter Cologne Act, adopted in 1969, predates the federal Clean Water Act adopted in 1972 (Littleworth and Garner, 1995). Together, the two pieces of legislation are the basis of water quality management in the state. At the federal level, the United States Environmental Protection Agency (US EPA) is responsible for water quality standards while the United States Geological Survey (USGS) primarily engages in water quality monitoring.

##### ***3.1.1 State water quality institutions***

The State Water Resources Control Board (SWRCB) is the lead state water quality management agency in California. It has jurisdiction throughout California and protects water quality by setting statewide policy and coordinating, supporting, and reviewing the Regional Water Quality Control Boards' efforts and actions. These institutions regulate discharges to surface waters under the federal Clean Water Act and the state Porter-Cologne Water Quality Control Act.

The State Water Resources Control Board is also responsible for preparing water quality standards and submitting them to the US EPA for approval as required under the Clean Water Act. These standards can take the form of Total Maximum Daily Loads (TMDLs), which set limits on the amount of pollutants that are released into water bodies and still maintain beneficial uses, forcing polluters to either employ abatement technologies or purchase pollution credits to offset emissions. In most states the TMDL is written by the State Water Resources Control Board and then submitted to the US EPA for approval. In California, however, TMDLs are written at the regional level by whichever of the nine Regional Water Quality Control Boards presides over the waterbody. From there, the TMDL and Implementation Plan are submitted to the State Water Resources Control Board for review, before making their way to the US EPA for final approval. In order for a TMDL to be installed in a watershed, the state in which the watershed is located must first report to the US EPA that the waterbody is impaired, or polluted to such an extent that it no longer satisfies the state's water quality criterion. This process is prescribed under the federal Clean Water Act of 1972 in section 303(d), and these 303(d) listings are required from the states every two years.

### ***3.1.2 Regional water quality institutions***

There are nine Regional Water Quality Control Boards in California that exercise rulemaking and regulatory activities by basins (Figure 3.1). They provide local implementation of statewide policy and regulations, set water quality standards, implement provisions in plans and policies, issue waste discharge permits, determine compliance with permit requirements, and take enforcement actions against violators. Each Regional Water Quality Control Board has the lead in permitting and management within its specified basin. They regulate discharges of waste into waters by issuing Waste Discharge Requirements (WDRs) that specify the allowable nature of the discharge to dischargers (point source and nonpoint source). The discharger submits a Report of Waste Discharge to the local Regional Water Quality Control Board, which is essentially a permit application for the WDR.

The state's Porter-Cologne Act also gives the state and regional boards the authority to develop and implement non-point source control programs for diffuse sources contributing to a violation of water quality standards, such as farms and ranches. The State's Non-Point Source Management Plan, adopted in 1988 and modified in 2004, provides a strategy for implementing best management practices (BMPs), principally through cooperative agreements between regulatory agencies and the parties being regulated. Under this plan, the California Regional Water Quality Control Boards use three tools to obtain non-point source regulatory compliance. The first is a WDR permit, and second is a waiver from WDRs. Waivers are conditional with specific directives and requirements intended to reduce nonpoint source discharge and impacts from permitted activities. Of particular significance to rangelands is the state's Conditional Grazing Operations Waiver Program that waives WDRs for grazing operations. In addition the Central Valley Regional Water Quality Control Board, the largest of the state's regional water boards, adopted the Irrigated Lands Regulatory Program (ILRP) in 2003, which imposed new rules on farmers and ranchers to monitor and test for water quality in nearby waterways, report findings to the regional board and implement steps to reduce discharges identified to have come from agricultural operations. Other regional boards have adopted similar conditional waiver programs for agricultural discharges including; (i) the Central Coast region, which adopted a waiver program that requires all irrigators, not just those who discharge into groundwater and surface water, to be a part of the program; (ii) the Los Angeles region, which covers watersheds in Los Angeles and Ventura counties; (iii) the San Diego region; and (iv) the Lahontan region, which adopted a conditional waiver program for irrigated and non-irrigated grazing land. The third tool is basin plan prohibitions that restrict pollutant discharges contained in a plan and serve as a tool for immediate enforcement action to control discharge (George et al., 2011).

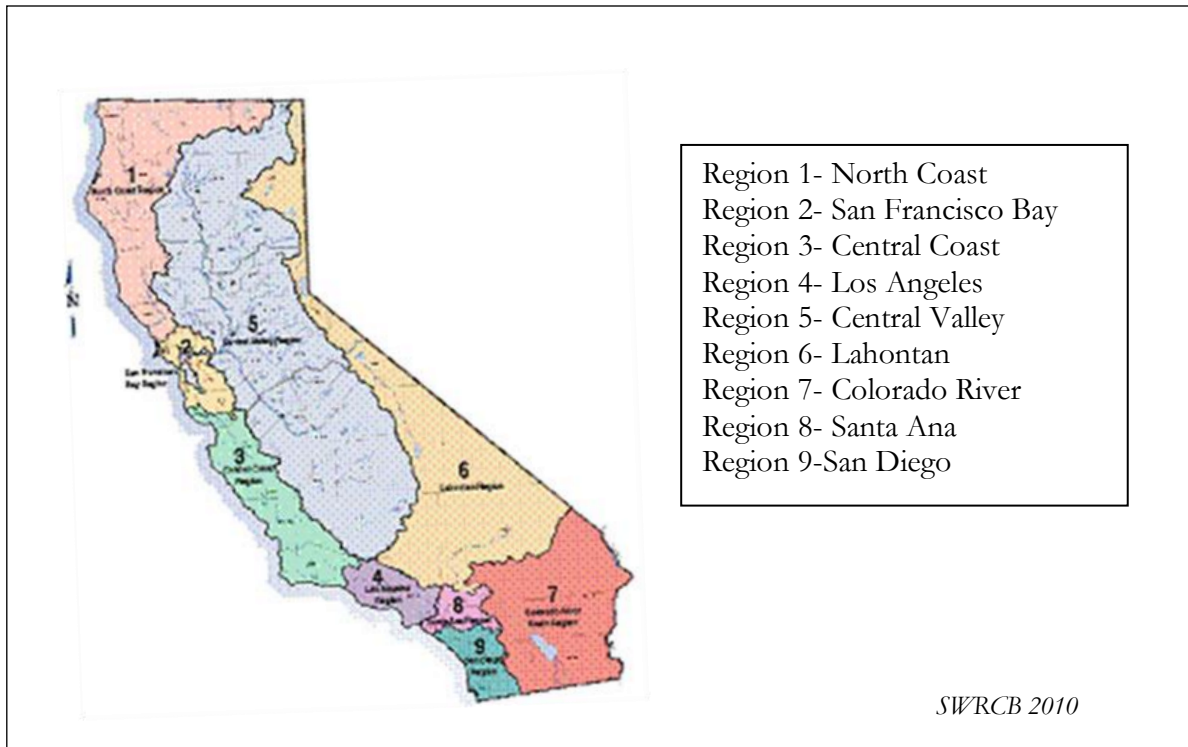


Figure 3.1. California’s Regional Water Resource Boards

Point source discharges (discharges from a single source) into state waters are regulated through the National Pollutant Discharge Elimination System (NPDES) permit program instituted by the Clean Water Act. The NPDES permit program is administered by the State Water Resources Control Board and Regional Water Quality Control Boards as part of its WDR program in California. NPDES permits are issued principally for discharges from wastewater treatment plants, industrial facilities and stormwater discharges from large municipalities.

*The Central Valley Regional Water Quality Control Board*

The Central Valley Regional Water Quality Control Board oversees the Central Valley watersheds and is responsible for the management of water quality in the region. The Central Valley Region is the State’s largest region, encompassing 60,000 square miles, or about 40% of the State’s total area (SWRCB, 2009). It includes the Sacramento and San Joaquin rivers and their tributaries, which together drain the major part of the valley through an inland Delta into San Francisco Bay. The Central Valley Regional Water Quality Control Board is the implementing agency of the Sacramento and San-Joaquin River Basin Plan and Tulare Basin Plan that together cover the Central Valley region. For any water quality program in the Central Valley this board would be at the forefront of enforcement activities.

**3.2 Types of Water Quality Problems Involving Central Valley Rangelands**

California’s Central Valley is made up of three hydrologic regions; the Sacramento River basin, the San Joaquin River basin and the Tulare Lake basin. The three watersheds support a productive and diverse agricultural area, with over 250 different crops, and also supply drinking water to a



population of 4.4 million people (USGS, 2010). The return flows from agriculture, grazing, urban and storm water runoff can carry dissolved solids, nutrients, increased temperatures, and pesticides into streams and rivers of the region, damaging their uses (US EPA, 2003; SWRCB, 2009). This section identifies the major pollutants and location of existing water quality problems in the Central Valley focus area. While ranching activities can contribute to water quality problems, they are also able to reduce pollution levels through the implementation of BMPs. To engage ranchers, trading and market programs must include pollutants that are directly connected to rangeland production and management activities and amenable to cost effective treatment measures.

#### *Sediment*

Sedimentation is the most prevalent source of water pollution. Erosion assessments in California estimate that sheet and till erosion is a severe problem averaging 313 tons per acre per year from one-third of private rangelands. Another potential source of sediment comes from over 9,000 miles of streambank erosion (UC ANR, 1996). Sediment carried into streams from these sources causes excess turbidity that is harmful to aquatic life and makes water less useful for recreation. Sedimentation also increases the costs of pumping and treating water for municipal and industrial use (SWRCB, 2009).

#### *Bacteria and pathogens*

Pathogenic contaminants are the most common surface water impairment in California and pose a substantial health concern (Knox et al., 2007). Bacteria and pathogens come mainly from animal confinement facilities (e.g. stockyards, dairies, poultry ranches) and unconfined grazing animals on rangelands (SWRCB, 2009). Other sources of pathogens include human recreation and wildlife (Casemore et al., 1997; Atwill et al., 2001). Runoff from confinement facilities mostly includes animal waste which can produce significant amounts of fecal coliform, ammonia, nitrates, and dissolved solids. The greatest potential for water quality problems has historically stemmed from the overloading of the facilities' waste containment and treatment ponds during the rainy season and inappropriate application of wastewater and manure to fields (SWRCB, 2009). Most of these facilities are not operating under WDRs. However, waste management at all confined animal facilities must comply with specific regulations, and large facilities must obtain an NPDES storm water permit. Riparian buffers on rangeland, less than two meters wide, can reduce the above pathogen loading in streams by 90% to 100% (Knox et al., 2007; Tate et al., 2006).

#### *Temperature*

Water temperature is an important indicator of the overall health of a stream. Temperature affects the health of watersheds in three main ways. First, it affects the tolerance of some aquatic species to survive at varying temperature ranges. Second, many biological reactions including those involved in decomposition and respirations are temperature dependent. Third, the capacity of water to dissolve oxygen is dictated by temperature. Dissolved oxygen is essential for fish and other aquatic organisms. Cold water fish and other aquatic organisms are particularly sensitive and require consistently high dissolved oxygen levels (Baltz et al., 1987; Jacobsen, et al., 1997)

### **3.3 Regulatory Drivers: Total Maximum Daily Loads (TMDLs) Affecting Rangelands.**

All markets require a driver, a reason to trade. The need to comply with TMDLs sometimes provides a strong regulatory driver for water quality trading. By setting limits on the discharge levels, TMDLs can force polluters to reduce pollution either by installing abatement technology or if that is too costly, by purchasing pollution reduction credits. Most successful trading programs are driven by TMDLs. A necessary requirement for water quality trading is that there be a pollutant commodity that can be controlled, measured and traded by both point and nonpoint sources in a watershed (USEPA, 2004). This section reviews the existing water quality problems to identify areas where pollutant problems exist that can potentially be addressed by a market solution. Not all pollutants are well suited to trading. Markets require a pollutant whose impacts and dynamics are well understood and for which reduction credits can be readily supplied in quantities large enough to meet the need of buyers who must comply with regulatory requirements.

A large number of the watersheds within the Central Valley are listed as impaired by the US EPA with pollutants such as dissolved nutrients, pesticides, sediment, pathogens, salinity and metals. These pollutants degrade habitat for aquatic species, reduce water quality for agriculture and compromise the health of human populations that depend on them. The 303(d) list provides a way to identify and prioritize water quality problems and also serves as a guide for developing and implementing watershed pollution reduction plans to achieve water quality standards and protect beneficial uses (George et al., 2011).

Although watersheds in the Central Valley are listed for numerous impairments, there are few approved TMDLs active in the California Rangeland Conservation Coalition focus area (Figures 3.2 and 3.3). Among the impaired watersheds, there are few TMDLs in place for pollutants such as pathogens, sediment and none for temperature (Appendix 1); all of which are pollution problems that can be reduced by selected rangeland management practices. These practices include installation of riparian buffers and fencing, water point development and managed grazing. A far larger number of TMDLs within the focus area are for metals, nutrients and pesticides, which rangeland landowners cannot easily address. For those waterbodies where TMDLs are in place, the sources of these pollutants have been identified for each of the impaired segments, and include: agriculture, livestock grazing, recreational and tourism activities, hydromodification/flow modification, resource extraction (abandoned mines), and highway/road/bridge construction (SWRCB, 2010). These sources would be the main potential buyers of water quality credits.

However, pollution from pathogens may not be amenable to trading remedies with ranchers due to the widely dispersed nature of the problem. Transferring pollution rights from a point source of pathogens, such as a livestock lagoon, to a distant rangeland likely does not provide a remedy to the local water user concerned with pathogen pollution. In this case trading may be restricted to a single watershed. Pathogens may be better treated through source water protection remedies that can address pollution sources over large drainage areas.

Another challenge to developing markets is that specific pollution problems differ from watershed to watershed which could mean that any developing markets would be ‘thin’ (i.e. few buyers and/or sellers). Payments for ecosystem services such as source water protection programs may be a more feasible option for rangelands pending further development of TMDLs.

Most notably, TMDLs for sediment or temperature pollution that ranchers are well placed to reduce are not yet completed and active, with expected completion dates set within the next 10 years (SWRCB, 2010). Although TMDLs are not complete, the looming threat of a TMDL in the future may be sufficient to drive pre-compliance markets in watersheds where pollution dischargers do not want to come under direct regulatory oversight. In pre-compliance markets demand is driven by the anticipation of regulation in the future, buyers and sellers invest while the prices of generating and buying credits are low with the expectation they will reduce the cost of compliance in the long term, sell the credits for a profit in the future, or both. Reducing the cost of future compliance is a significant concern among ranchers, the majority of ranchers who installed BMPs under the voluntary California Rangeland Water Quality Management Plan were motivated by the desire to reduce future regulatory burden (George et al., 2011). The TMDL process can take many years to complete which presents an opportunity for pre-compliance trading.



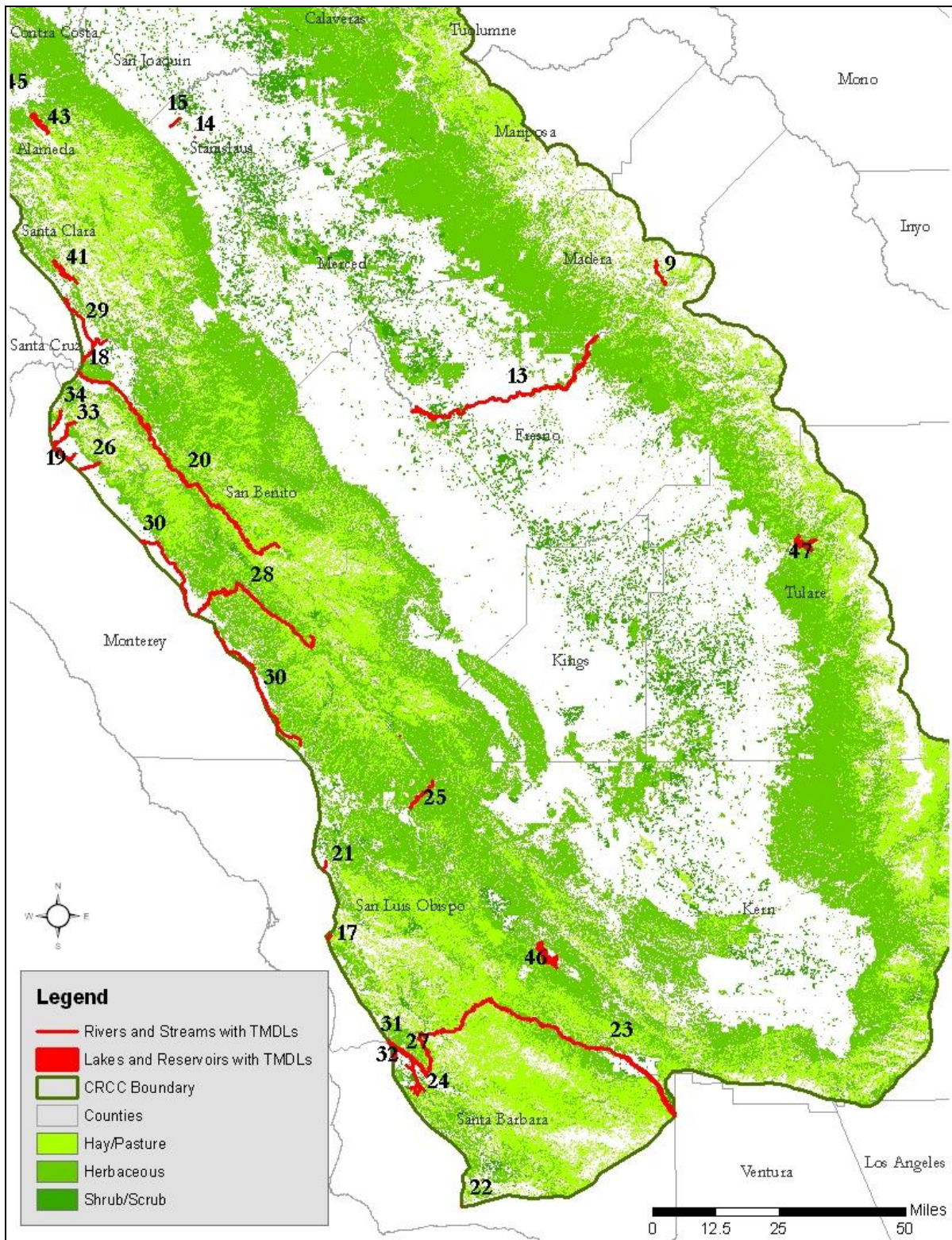


Figure 3.2b Water quality limited segments in the southern California Rangeland Conservation Coalition area.

### 3.4 Non-regulatory Drivers Affecting the Central Valley

A number of programs are voluntary and do not rely on regulatory drivers such as TMDLs to directly stimulate trading. A recent study of market-based watershed programs found that buyers of watershed ecosystem services, which include water quality, are driven by three main factors: avoiding costs of more expensive alternatives to improve water quality, reducing risks of an impending threat to water quality; and pre-compliance to prepare for possible future regulation (Majanen et al., 2011). Along with economic considerations, environmental stewardship is also a strong motivator for buyers of water quality credits.

Non-regulatory drivers are important to water quality trading programs due to the voluntary nature of many programs addressing agricultural pollution, especially pollution from rangeland (King and Kuch, 2003; King, 2005). Voluntary programs involving non-point sources are often driven by the strong environmental stewardship ethic of the landowner. In these cases, the landowner has a personal commitment to preserving environmental quality. Surveys of ranchers in the Central Valley have shown that ranchers have a strong sense of environmental stewardship and desire to safeguard the natural environment (Huntsinger, 2007; Cheatum et al., 2011). However, the very real costs of environmental interventions such as BMP's can be a disincentive. Without cost share the private installation costs for practices such as riparian restoration can almost double, but with agency cost share support private investment in practices can be a financially viable option (Kroeger et al., 2010). Several programs such as EQIP provide cost-share that can lower those costs. A significant driver for voluntary participation by landowners are market-based incentives that can result in increased income by improving agricultural productivity or through marketing of green products (e.g. Trout Unlimited's 'trout unlimited' branded wine in the water-for-wine program) (Dowd et al., 2008). These types of incentives have dual benefits in that they not only appeal to landowners' sense of environmental stewardship, but also provide financial benefits through increased productivity

Two programs that influence voluntary action to improve water quality in California are described below.

#### *California Rangeland Water Quality Management Plan*

California's Non-point Source Pollution Control Program emphasizes self-determined or voluntary pollution prevention (SWRCB, 2000). In 1990, California's range livestock industry led by the California Cattlemen's Association, developed a program of voluntary compliance with the Federal Clean Water Act, federal and state coastal zone regulations, and California's Porter-Cologne Act, which provides for regulation of water quality by the State Water Resources Control Board (SWRCB) and 9 Regional Water Quality Control Boards (SWRCB, 2004; George et al., 2011). This initiative led to the development of the California Rangeland Water Quality Management Plan (CRWQMP) for nonfederal rangelands, which was approved by the SWRCB in 1995 (SWRCB 1995). Many entities were involved in the development of the management plan including regulatory agencies, state advisory committees, private consultants, US Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), and University of California Cooperative Extension (UCCE). The management plan provides for development and implementation of ranch

water quality plans on a voluntary basis. In 1994, UCCE and NRCS began to develop education programs to support landowners in the development of individual water quality management plans. These plans focused on nonpoint source assessment, development of water quality protection objectives, implementation of practices, and monitoring in the short and long-terms. Several workshops targeting landowners have been conducted throughout the state by UCCE (George et al., 2011).

The program has been effective; the majority of ranchers who developed management plans went on to implement BMPs (Larson et al., 2005). A survey of more than 700 program participants found that the main reason for implementing BMPs was to control nonpoint source pollution and support industry water quality initiatives because it was perceived as a means to prevent future regulation. The water quality education program was not only successful at changing ranching practice but it also encouraged ranchers to become more involved in water quality issues by starting watershed groups, joining state advisory boards and participating in research to address water quality issues on rangelands (George et al., 2011). Voluntary education programs like the CRWQMP can be an effective non-regulatory driver for achieving water quality goals.

#### *Integrated Regional Water Management (IRWM) Grant Program*

The IWRM grant program administered by the Department of Water Resources (DWR) provides funding to multi-stakeholder groups for planning and implementing integrated water management activities that promote sustainable water uses, reliable water supplies, better water quality, environmental stewardship, efficient urban development, protection of agriculture, and a strong economy (DWR, 2011). Funded by a state bond of proposals IWRMPs are an institution that among other things encourage improvements in water quality without the use of regulation. There are currently nine funded multi-stakeholder groups across California developing IRWM plans. IWRM groups present a potential structure to facilitate a water quality trading or payment program in the Central Valley.

#### 4.0 Rangeland Conservation Best Management Practices to Improve Water Quality

Rivers and streams that flow through rangelands provide human and livestock drinking water as well as fish and wildlife habitat, all of which are uses that can be adversely impacted by runoff of pathogens, nutrients and soil particles. Compared with other agricultural land uses, healthy rangelands have the capacity to decrease erosion, and the likelihood of nutrient contamination of water may be much lower than that of other forms of more intensive agriculture. Plant root systems form dense mats that effectively serve as filters to remove contaminants before they can seep into the groundwater. Adequate plant cover also improves soil health by improving soil tilth due to the activity of earthworms, soil insects, and microorganisms (Hubbard, 2004). In addition, the presence of grazing animals can build soil organic matter reserves, resulting in soils having increased water-holding capacity, increased water-infiltration rates, and improved structural stability (Tisdale et al., 1985; Greenhalgh and Sauer, 2003). The role of rangelands in watershed function is influenced by an interaction between biotic and abiotic features and complex interactions between animals, plants and soils. Water remains the most important resource of concern in California. As increasing demand and climate change puts pressure on water supplies in California it becomes critical to understand the interactions between the water cycle and the distribution, structure, function and dynamics of biological communities (Nuttle, 2001; Hannah et al., 2004). These interactions are the focus of study of the emerging cross-disciplinary field of rangeland ecohydrology, a cross-disciplinary field that links rangeland ecology with hydrology (Wilcox and Thurow, 2006).

#### 4.1 Best Management Practices (BMPs) to Improve Water Quality on Rangelands

The United States Department of Agriculture Natural Resources Conservation Service (NRCS) offers technical assistance to ranchers in the implementation of voluntary practices for water conservation and water quality improvements. There are six main categories that include different practices from the NRCS Field Office Technical Guide (George and Jolley, 1995).

1. Ranch Plan: Landowners can seek assistance from a variety of sources to create a ranch plan addressing multiple objectives including maintaining or improving water quality. The goals of the plan need to be linked to water quality problems (impaired beneficial uses) as identified by the Regional Water Quality Control Boards from the local basin or sub-basins. Ranch plans to address water quality can be created by government agencies, holistic resource management or private consultants.
2. Grazing Management: Practices that manage vegetation through grazing to achieve specific objectives includes:
  - a. Prescribed grazing: Defined by the NRCS as “The controlled harvest of vegetation with grazing or browsing animals, managed with the intent to achieve specified objectives, including maintaining and improving water quality and quantity”:



- b. Use exclusion: Use exclusion of animals, people, or vehicles from an area to protect, maintain, or improve the quantity and quality of the plant, animal, soil, air, water, and aesthetics resources and human health and safety.
- 3. Structural Range Improvements: Infrastructure that may be used to facilitate proper grazing use. These practices should be planned, constructed, and utilized in a manner to enhance or maintain water quality. These management practices should be linked in the ranch plan, to proper grazing use and other ranch water quality goals.
  - a. Access roads
  - b. Fencing
  - c. Grade stabilization
  - d. Pipelines
  - e. Ponds
  - f. Sediment basins
  - g. Spring Development
  - h. Stock Trails or Waterways
  - i. Streambank Protection
  - j. Troughs and Tanks
  - k. Landslide Treatments
  - l. Wells
  - m. Stream Crossing
- 4. Land Treatments: Land treatments to manage vegetation, practices to reduce erosion or improve wildlife habitat should be planned, implemented, and maintained to minimize adverse impacts on water quality.
  - a. Brush Management
  - b. Prescribed burning
  - c. Critical Area Planting
  - d. Range Seedings
  - e. Grazing-land Mechanical Treatments
  - f. Stream Corridor Improvement
  - g. Wildlife Wetland Habitat Management
  - h. Woodland Development or Restoration
  - i. Wildlife Upland Habitat Management
- 5. Livestock Management Practices: Livestock management practices such as disease control, feeding, and mineral supplement placement should be done in a manner to protect water quality.
  - a. Livestock parasite control
  - b. Supplemental feeding and minerals: feeding practices that minimize livestock concentration near water bodies and facilitate more uniform livestock distribution

6. Facility Citing/Design Criteria: The consideration for the location of facilities in proper proximity to water bodies for water quality protection, not associated with a particular practice.

Ranchers may apply directly to NRCS for financial or technical assistance to implement these agricultural water enhancement activities. In addition, ranchers may also apply for assistance from the Agricultural Water Quality Enhancement Program (AWEP) through an entity that submits a proposal on behalf of a group of agricultural producers. Eligible entities include: a Federally-recognized Tribe, state, unit of local government, agricultural or silvicultural association, or other group of agricultural producers.

#### ***4.1.1 Agricultural Water Enhancement Program (AWEP)***

The Agricultural Water Enhancement Program (AWEP) was established in the 2008 Farm Bill. The program provides financial and technical assistance to agricultural producers to implement activities that improve water quality and conserve surface and ground water. As part of the Environmental Quality Incentives Program (EQIP), AWEP operates through voluntary program contracts with producers to plan and implement conservation practices in project areas established through partnership agreements.

## **4.2. Effectiveness of Rangeland Conservation Practices to Improve Water Quality**

While numerous studies have shown overgrazing to be detrimental to water quality by increasing sediment and soil losses (Trimble, 1994), grazing livestock can also be used to combat these very negative effects (Nagle and Clifton, 2003). A well managed grazing plan, riparian fencing and vegetative buffers have all been shown to have positive impacts on sediment and soil loss parameters. We provide some of the evidence found in the literature on the effectiveness of these practices.

### ***4.2.1 Prescribed grazing***

Grazing management practices can be used to achieve water quality improvements on rangelands. Soil vegetative cover is widely recognized as a critical factor in maintaining soil surface hydrologic condition and reducing soil erosion (Gifford, 1985). Grazing systems aimed at modifying vegetation attributes to ensure sufficient vegetative cover, to protect soil surface condition (e.g., porosity, aggregate stability, and organic matter content) will in turn affect dependent hydrologic properties such as infiltration rates. High stocking rates, regardless of grazing system, that reduce soil surface vegetative cover below a site-specific threshold will increase detachment and mobilization of soil particles due to raindrop impact, decrease soil organic matter and soil aggregate stability, increase soil surface crusting and reduce soil surface porosity, and thus decrease infiltration and increase soil erosion and sediment transport (Blackburn, 1984). Site-specific vegetation cover requirements will vary depending on cover type (e.g., vegetation, litter, or rock), soil type, rainfall intensities, and water quality goals (Gifford, 1985).

The response of soil hydrological characteristics to grazing largely parallel those of other ecological variables because stocking rate is the most important driver regardless of grazing system (Wood and Blackburn, 1981a&b; Thurow, 1991). A few studies have directly examined grazing systems (deferred rotation, rest rotation, and rotational deferment) in comparison with continuous grazing. At moderate stocking rates, at which most extensive rotational systems were studied, rotational grazing systems lead to similar or improved soil hydrologic function compared to moderate continuous grazing (Ratliff et al. 1972; McGinty et al. 1979; Wood and Blackburn 1981b, 1984). As evidenced by Wood and Blackburn (1981) and Thurow et al. (1986), these hydrological responses to grazing system appear to be strongly contingent on plant community composition, with midgrass-dominated communities having greater hydrological function than shortgrass dominated communities. Gifford and Hawkins (1976) emphasize the importance that range condition or plant community composition has on the hydrological function of a site through time in response to grazing system.

Gary et al. (1983) found that intensive rotational grazing and grassy buffers were effective stream rehabilitation tools. Areas where intensive rotational grazing was used had significantly less soil erosion and fine substrate in the river channel. A study in Wyoming showed that short-duration grazing rotation schemes and deferments until fall replaced continuous grazing on 280,000 acres encompassing 112 km of perennial streams in 10 BLM grazing allotments and increased water quality due to improved stream stability and the recovery of riparian areas (Ellison et al., 2009).

Livestock grazing can be beneficial by removing excess nitrogen from natural systems. Nitrogen deposition from air pollution is increasingly being recognized as a serious problem in California because it stimulates growth of exotic annual grasses and other invasive species at the expense of native plants, altering ecosystem dynamics. Because cattle prefer the annual grasses that are able to absorb nitrogen from air pollution, they are an effective means of removing some of this excess nitrogen input and reducing the impact on affected communities (Weiss, 1999). A study conducted in the California foothills (Jackson et al., 2006) found that moderate grazing lowered nitrate concentrations in spring-fed herbaceous wetlands. The authors attributed this difference to enhanced nitrogen uptake by plants and enhanced rates of microbial denitrification in the sites grazed by cattle. In addition, clipping grass buffers to remove biomass has been shown to enhance their capacity to absorb nitrogen from runoff because it stimulates plant growth, thus increasing nitrogen uptake (Bedard-Haughn et al., 2005). In riparian areas, grazing management in riparian areas should be directed to maintain specific vegetation attributes such as desirable species composition, adequate cover, biomass root mass and root density will enhance the health of riparian areas and their capacity to provide water quality and other ecosystem services (George et al. 2011).

#### ***4.2.2 Riparian fencing and water development***

Ranchers in California often implement riparian fencing and water development practices in combination. This strategy has been adopted for the purpose of (i) protecting riparian areas and

improving water quality, with potential benefits to aquatic habitat; and (ii) increasing livestock access to under-utilized forage. By developing additional watering points livestock more evenly utilize the forage of the property. The latter outcome has the impact of creating healthier range conditions, which in turn benefits several wildlife species and can control the spread of exotic invasive weeds. There are also private benefits to ranchers from the adoption of fencing riparian areas and water development. These benefits take the form of improved forage utilization, better animal health and higher beef production due to better water quality, more reliable water sources, and erosion control in riparian zones (Belding et al., 2000). Fencing riparian areas prevents livestock from trampling riparian areas and causing increased erosion of sediment and direct deposits of fecal matter into streams. Removing a stream from use as a drinking water source is an added expense to the producer. While producers can receive assistance to construct exclusion fencing, they must finance a significant portion of the projects themselves. The Environmental Quality Incentives Program (EQIP) conducted by the Natural Resources Conservation Service (NRCS) is the main source of funding for fencing and water development.

Riparian fencing has beneficial impacts on degraded stream banks (Owens et al. 1996, Line 2003). Owens et al. (1996) found exclusion of cattle by fencing reduced the annual sediment concentration by over 50% and average annual soil losses declined from 2.5 to 1.4 Mg/ha. The trade-off for the rancher is that fencing will exclude cattle from forage that may be higher in nutritional value compared to other grazed areas. There is a potential for up to 6 times more forage in riparian areas, which may also be higher in crude protein concentrations (Bailey, 2005). The opportunity cost for a rancher is that although exclusion is important for water quality and rangeland sustainability in the long run, fencing riparian areas cuts cattle off from valuable forage and can decrease ranch income.

Alternatively, installing off-stream water sources can also contribute to reduced sedimentation. Off-stream water source by itself may not be effective since animals are also seeking shade from riparian areas (Line et al., 2000). Godwin and Miner (1996) conducted studies on the effectiveness of alternate water sources in Oregon under wet and dry pasture conditions. They found an alternate water source reduces the amount of time that cattle spend in riparian areas, however water quality was not measured. Development of alternative water sources has also been shown to reduce nutrient runoff. In a study by Sheffield and collaborators (1997) providing cattle with an off-stream water source in combination with rotation grazing reduced stream bank erosion by 77% and total suspended solids by 90%.

One alternative management strategy is the creation of riparian pastures. With this management method, stream-side areas are grazed for short periods when the stream is least sensitive to the effects of grazing (Agouridis et al., 2005). The peer-reviewed literature generally supports the hypothesis that grazing exclusion can promote recovery of riparian plant community composition in degraded riparian systems (Briske, 2011).

### ***4.2.3 Riparian buffers***

Restoring or establishing vegetated riparian buffers can be an affordable and easy-to-maintain tool for rangeland managers to reduce runoff into local watersheds. Vegetated buffers not only can attenuate water temperature, but they can also reduce erosion, nutrient and pathogen contamination in agricultural areas (Osborne and Kovacic, 1993). Buffers consisting mainly of grasses provide a high level of sediment filtration with a moderate level of dissolved nutrient filtration (Dosskey, 1998). Sovell et al. (2000) detected a greater percentage of fine sediment and higher turbidity levels in the streambed of wooded buffer sites as compared to grass buffer sites along streams in Minnesota. A riparian BMP that combines both vegetation types, either in series or within one area, should produce significant water quality improvements in waterways located along grazing areas (Lowrance et al., 2002). As for flood control, Line et al. (2000) witnessed decreases in discharge following the development of a 16 m wide riparian buffer along a North Carolina stream traversing grazed pastures. Based on reviews of the effects of vegetative buffers in rangeland ecosystems and grasslands/pastures, including Castelle et al. (1994), Schmitt et al. (1999), Dosskey (2001), Dorioz et al. (2006), and Mayer et al. (2007) vegetative buffers can be effective at filtering most waterborne pollutants including sediment, nutrients, pathogens and pesticides and the effectiveness of buffers is dependent on site-specific conditions (Briske, 2011).

#### *Erosion control*

A physical component of water quality is the sediment runoff into surface waters caused by erosion. Severe erosion has the potential to claim land that could be used for grazing. Additionally, sediment runoff into water bodies can fill small streams and/or increase the turbidity of the water, which is harmful to aquatic species and overall water quality (Lewis et al., 2002). Vegetated buffers can reduce stream bank erosion and increase water infiltration by providing a root structure to hold soils together (Beschta, 1997). The primary relationship between soil erosion and water quality is that soil erosion increases runoff into surface waters, which in turn increases turbidity and nutrient content. Here, runoff refers to nutrients (nitrogen, phosphorous), pathogens (*E. coli*, *C. parvum*), and sediment/soils (Hubbard et al., 2004). A vegetative buffer strip acts as a sponge that filters and can reduce the amount of runoff (Hubbard et al., 2004). Generally, the water quality of upland rangelands is very important for an entire watershed because these areas are often the headwater tributaries for larger rivers (Lewis et al., 2002). Several factors contribute to the rate and amount of runoff received by a water body. These factors include but are not limited to slope, soil type, rainfall intensity and duration, type of pollutant, and the total size of the drainage area (Castelle et al., 1994; Schmitt et al., 1999; Bharati et al., 2002; Tate et al., 2000).

#### *Nutrient runoff*

Another concern is the runoff of nutrients into rangeland surface waters. Nutrient runoff can be detrimental to both humans and aquatic species (Hubbard et al., 2004) and it can be reduced by adopting appropriate nutrient management practices. A study by Edwards et al. (1996) found that the implementation of several BMPs including nutrient management (amount, timing and placement of plant nutrient applications), waste utilization, pasture and hay land management, significantly

reduced the instream concentrations of ammonia, total Kjeldahl nitrogen and chemical oxygen demand in streams in Northwestern Arkansas.

Vegetative buffers reduce nitrogen runoff through the process of denitrification, infiltration, and plant uptake (Hill, 1996 cited in Berard-Haughn et al., 2004). According to Berard-Haughn, et al. (2004), runoff was effectively cut by the use of buffers. In an 8-meter buffer, for example, nitrogen loads decreased by 28%, ammonium by 34%, and dissolved organic nitrogen by 21%.

#### *Pathogen contamination*

Vegetated riparian buffers on rangelands have been shown to filter pathogens. Pathogenic contaminants are the most common surface water impairment in California posing a significant public health concern (Knox et al., 2007). They are not only dangerous to human end-users, but also to downstream wildlife and livestock (Tate et al., 2004). Vegetated buffers can minimize water contamination of pathogenic materials (Tate et al., 2006; Tate et al., 2004). Studies have shown that buffers ranging in size from 0.1 to 1.8 meters can filter pathogens by 90-100% (Knox et al., 2007; Tate et al., 2006).

Buffer width is an important factor for maximizing filtration and uptake effectiveness. One study (Tate et al., 2006) found that a 1-meter buffer had a 95-100% effectiveness rate on preventing *E. coli* runoff into a waterway. Another study (Fleming et al., 2001) proposed that 18.3 meters is an appropriate width for vegetative buffers under otherwise healthy range conditions, and more width would be necessary for areas of large slope or heavy fertilization. A third study found that a 0.9-1.8 meter buffer reduced pathogen contamination by 90-99% under heavy rainfall conditions (Knox et al., 2007).

#### *Water temperature improvements*

Water temperature is a particularly important habitat feature that impacts wildlife species in arid rangeland basins of the western United States. Riparian vegetation can lower water temperatures of streams and rivers, which benefits aquatic species such as salmon and trout, both of which are listed as endangered species in certain areas of California. However, Larson and Larson (1996) argue that although stream shading may have some value for in-stream water temperature attenuation, there are too many factors that can diminish the effectiveness of buffers. For instance, vegetation must be tall and abundant enough to cover the stream during peak direct sunlight hours. Additionally, the stream would need to be fairly narrow in order to be significantly covered. Using riparian buffers for stream temperature attenuation is either too unrealistic or will yield limited benefits (Larson and Larson, 1996). This argument is countered by Beschta (1997) who suggests that riparian vegetation is like a 'hat' that prevents light and heat from impacting the surface waters. Additionally, there is a proportional increase in stream temperature when solar radiation reaches water, so it is critical to take advantage of all the shading possible. In addition Maloney and collaborators (1999) in a study of 12 forested Oregon watersheds found that streams with 75% stream shade maintained acceptable temperatures for rainbow trout and Chinook salmon. However, ungrazed watersheds had the lowest temperatures while the most intensively grazed watersheds had the highest temperatures. While

there are beneficial impacts from stream shading, grazing management can also have an impact on the level of temperature benefits attained in the watershed.

The scientific literature supports the assertion that riparian management to enhance and sustain riparian woody plants can be effective in moderating stream temperatures (George et al. 2011). However woody plant canopy cover is among the many factors, in determining stream temperature and its role in affecting stream temperatures varies across ecosystems, watersheds, streams, and stream reaches (George et al. 2011).

#### *Wildlife benefits of improved riparian conditions*

Even though riparian zones only represent 1-2% of western forest and rangeland landscapes, they are considered hot-spots for the provision of ecosystem services such as biodiversity, wildlife habitat and water quality (Kauffman and Kruger, 1984; Kauffman et al., 2004; Gregory et al., 1991; Naiman and Decamps, 1997). It is well known that riparian vegetation plays an essential role in the provision of ecosystem services by regulating light and temperature regimes, providing nutrients and energy and maintaining biodiversity (Naiman and Decamps, 1990). Research suggests that plant community structure and composition determines the density and diversity of the wildlife community (Johnston and Anthony, 2008; Nur et al., 2008). Riparian buffer zones can provide valuable refuge areas for wildlife in otherwise homogeneous agricultural landscapes (Triquet et al., 1990).

Riparian buffers offer generally undisturbed land for nest sites, den locations, and bedding areas in habitats exposed to periodic disturbance by farming machinery (Best et al., 1995). Buffers harbor a variety of foods including plant seeds, vegetative material, and arthropods. Finally, buffers can serve as travel corridors between fragmented habitats, thus facilitating gene flow among otherwise isolated wildlife communities (Dickson et al., 1995; Haas, 1997; Jobin et al., 2001). These corridors will increase wildlife's ability to adapt to climate change impacts.

In California, over 225 species of birds, mammals, reptiles and amphibians depend on riparian habitat (Knopf et al., 1988; Dobking, 1994 citing Vaghti and Greco, p. 426). California riparian ecosystems provide habitat for 83% of the amphibians and 40% of the reptiles known in the state (Brode and Bury, 1984).

Riparian vegetation experiences a rapid recovery after the removal of livestock (Kondolf, 1993; Platts and Wagstaff, 1984; Popotnik and Giuliano, 2000). Willow (*Salix spp*) or cottonwood (*Populus spp*) densities and/or cover increases with livestock exclusion (Case and Kauffman, 1997; Green and Kauffman, 1995; Sarr, 1995). In turn, water quality improves as stream banks stabilize, excess nutrients are trapped by riparian vegetation, and the stream is shaded (Kauffman and Kruger, 1984; Belding et al., 2000).

The recovery of riparian vegetation after livestock exclusion often results in an increase in the abundance and diversity of wildlife populations. Research has shown that birds (Popotnik and Giuliano, 2000), fish (Platts and Wagstaff, 1984) and small mammals (Hayward et al., 1997) benefit from the exclusion of livestock from stream zones. Warren and Schwalbe (1985) found that

improved vegetation structure in riparian plant communities supported larger insect fauna and greater lizard density. Some herpetofauna (northern queen snake, eastern garter snake, and tadpoles) exhibit positive responses to the improved conditions provided by stream bank fencing (Kauffman et al., 2004). Fenced areas, with increased vegetative diversity and structure, can support a more abundant and diverse reptile and amphibian community, as suggested by Busack and Bury (1974), Szaro et al. (1985), and Bock et al. (1990).

Different species respond differently to livestock fencing in riparian areas. Homyack and Giuliano (2002) reported no differences in the abundance of reptile and amphibian communities after livestock exclusion. In a similar study, Rinne (1988a) also found few differences in the macro-invertebrate community between grazed and un-grazed stream sections. Fenced riparian areas may attract predators, thereby reducing reptile and amphibian numbers. For example, great blue herons, green herons, and belted kingfishers occur more commonly in areas with stream bank fencing than in unfenced areas (Popotnik and Giuliano, 2000). More research is needed to determine the different responses of species to livestock exclusion (Homyack and Giuliano, 2002).

Differences in the responses of native fishes and their habitat to livestock fencing have been noted as well. Some studies indicate a rapid recovery of aquatic and fisheries habitat, such as decreased stream bank angles, increases in shading, water column depth, and substrate quality for salmonids (Rinne, 1988a, b; Knapp and Matthews, 1996). Numerous studies have documented greater biomass and abundance of trout in livestock exclosures (Keller and Burnham, 1982; Knapp and Matthews, 1996), but others have shown little or no difference (Rinne 1988b; Rinne and LaFayette, 1991). In California, fencing riparian areas can improve fish habitat for species like steelhead by shading, improving large woody debris and creating narrower, deeper and more complex channel morphology (Opperman and Merenlender, 2004).

#### ***4.2.4 Other practices***

##### *Livestock distribution practices*

There are several BMPs that aim to reduce the time cattle spend in riparian zones and, therefore reduce grazing pressure on riparian vegetation and at the same time reducing potential contamination from livestock waste (George et al. 2011). The two main ones are the provision of an alternate shade source and the placement of supplemental feeding

##### a) Alternate Shade Source

Reducing the amount of solar radiation that an animal receives is one of the best methods for keeping an animal cool (Bond et al., 1954; Mitloehner et al., 2001). Steers without shade spent more time around water (Mc Ivan and Shoop, 1971). Providing alternate sources of shade reduces the amount of time that the cattle spend in riparian areas. However, the potential effects of providing shade sources to cattle on stream quality has not been researched.



#### b) Supplemental Feeding

The peer-reviewed literature generally supports the effectiveness of strategic placement of cattle feed supplement for reducing the amount of time that cattle spend in riparian areas. Bailey (2004, 2005) and George et al. (2007) have reviewed practices that attract livestock into underused areas. Abiotic and biotic characteristics of the landscape influence the effectiveness of these practices (Tate et al., 2003; Bailey et al., 2008). McInnis and McIver (2001) found that placement of off-stream water and trace mineralized salt under a moderate grazing regime was effective at reducing the impacts on vegetation cover and stability on streambanks. In a similar study, Porath et al. (2002) examined the distribution patterns of cattle with and without access to off-stream water and supplement and found that early in the season cattle without access to off-stream water spent more time within the riparian area as compared to cattle supplied with off-stream water and supplements. However, during the latter portions of the grazing season both groups of cattle spent more time grazing in the riparian areas. Porath et al. (2002) noted no significant difference in the amount of manure deposited within the riparian areas between the two groups of cattle.

The peer-reviewed literature supports the effectiveness of practices that reduce livestock densities, residence time, and fecal/urine deposition in riparian areas can reduce nutrient and pathogen loading of surface waters (George et al. 2011). In addition to reducing livestock fecal/urine loading in riparian areas, livestock distribution management improves riparian vegetation and soil hydrology (Gifford and Hawkins, 1978; Tate et al., 2004).

#### *Oak restoration*

Planting oak trees on rangelands increases ground cover and root structures, both of which are beneficial to water quality of surrounding surface waters. The root structure of mature blue oaks can decrease soil erosion on rangelands by binding together the soils of watersheds (Burns et al. 1990, cited in Sacramento Valley Conservancy [no date]). Similarly, the practice of oak removal has been shown to negatively impact soil stability, with clearing of oak trees from California oak savannas leading to excessive soil erosion (Bartolome et al., 1994; IHRMP, 1998). One study reported that removal of oaks led to a 59% increase in water runoff (Pitt et al., 1978).

A further beneficial effect of the oak canopy on nutrient cycling occurs through reduced leaching and erosion, which results in more nutrients being retained in the upper soil layers (Dahlgren and Singer, 1994; Dahlgren et al., 1997). Reduced leaching of nutrients and erosion of soil materials have a beneficial effect on water quality in streams draining these watersheds. In a study conducted in California rangelands (Dahlgren et al., 2003), evapotranspiration (loss of water vapor from soil and plant surfaces and through plant stomata) is approximately 30% greater in the oak system as compared with the open grasslands. This loss of water reduces the leaching intensity beneath the oak canopy more than in the grassland sites. In addition, higher organic matter concentrations under oak trees lead to lower soil bulk density and increased infiltration rates, which reduce surface runoff and loss of nutrients through erosion (Dahlgren et al., 2003).

There are co-benefits or additional ecosystems services provided by oak afforestation, including increases in forage production, carbon sequestration, water quality and wildlife habitat (Kroeger et

al., 2009). Research indicates that many rangeland owners appear to be aware of the beneficial impacts of oaks on water quality. A survey conducted in 1985 indicated that 64% of owners of parcels under 5,000 acres thought that blue oaks had value for erosion control on their land (Huntsinger and Fortmann, 1990). However, the relationship between woody plant cover and hydrology is complex and therefore definitive statements regarding outcomes of this interaction are not possible (Newman et al., 2006).

#### ***4.2.5 Multiple Best Management Practices***

Often times water quality management plans recommend implementing several practices at the same time and their effectiveness in improving water quality is therefore evaluated in combination. Brannan et al. (2000) identified reductions in both loads and concentrations for several water quality constituents following the installation of multiple BMPs in a Virginia watershed.

The animal waste BMP system consisted of waste storage facilities, nutrient management, riparian fencing along streams, water development and stream crossings. Reductions were detected for total suspended solids concentrations (35%), soluble organic nitrogen concentrations (62%), nitrate nitrogen concentrations (35%), particulate phosphorus concentrations (78%), and soluble phosphorus concentrations (39%). However, orthophosphate concentrations increased by 7%.

Edwards et al. (1997) evaluated the effects of several practices including pasture and hayland management on storm flow stream quality in a northwest Arkansas watershed consisting predominantly of pasture and forest land. Reductions in concentrations of several nutrients were noted after the implementation of BMPs.

A study in Wyoming (Ellison et al., 2009) showed water quality improvements after 10 years of implementing water quality BMPs in Bureau of Land Management grazing allotments. The primary focus of BMPs was to address bank stability problems associated with riparian grazing and accelerated upland erosion related to season-long grazing practices. Planned grazing systems, cross fencing, off-stream water development, road and stream-crossing improvements, vegetation manipulation, and prescribed burns were implemented throughout the upper basin to achieve better distribution of livestock for both season and duration of use. Reductions of 13% for Total Dissolved Solids (TDS) and a 30% increase in macroinvertebrate total taxa occurred across years, strongly suggesting that improvements in water quality were correlated to BMPs that stabilized stream channels and improved the condition of riparian areas.

A literature review by Agouridis and collaborators (2005) suggests that more research needs to be done to evaluate the effectiveness of the implementation of multiple BMPs for water quality on rangelands.

Several conservation practices to improve water quality are available to ranchers and could become the basis for a payment for ecosystem services program. Most of the literature provides evidence

that exclusion fencing and riparian buffers are effective in improving riparian health and water quality. Evidence for some other practices such as alternate water sources is scarce (Agouridis, 2005). The USDA has evaluated the effectiveness of the rangeland conservation practices on various natural resources implemented through Farm Bill programs. The Conservation Effectiveness Assessment Program (CEAP) summarizes the results of peer-reviewed articles that provide experimental data associated with the effects of selected rangeland conservation practices (Briske, 2011). In addition, the USDA has compiled a bibliography developed by the water Quality Information Center at the National Agricultural Library. “Environmental Effects of Conservation Practices on Grazing Lands,” is a guide to recent scientific literature covering environmental effects of conservation practices on grazing lands. This information is useful in designing both policies and on-the-land conservation systems that foster practical and environmentally sound grazing practices, as well as serving as a baseline for a potential trading program.

The relationship between rangeland conservation practices and water quality is mediated by several biotic and abiotic factors and complex interactions among them. The effectiveness of BMPs to improve water quality is dependent on very site-specific conditions. The emerging field of rangeland ecohydrology offers a framework to understand how these interactions affect the water cycle and how to design effective BMPs to improve water quality. To develop payment programs for ecosystems services (such as water quality improvements), stakeholders will need answers to questions regarding which BMP or combination of BMPs is best for their specific situation and stream.

## 5.0 Conclusions

Rangelands play a key role in ensuring healthy watershed function in the Central Valley, and ranchers can contribute to improved water quality in streams and rivers through adoption of various best management practices. Benefits of those practices are not restricted to water quality, but extend to wildlife habitat co-benefits that improve biodiversity and agricultural productivity. Ranchers in the Central Valley are interested in participating in programs that compensate them for the provision of ecosystem services such as water quality and wildlife habitat (Cheatum et al., 2011). By creating programs to incentivize the adoption of best management practices to improve water quality ranchers can potentially diversify their income while achieving water quality in a cost-effective manner.

The policy framework provided by the US EPA water quality trading policy and the state's point source and nonpoint source pollution control policy provides an opportunity to explore options beyond the traditional command-and-control approaches and incorporate non-point sources as part of the solution to water pollution problems. There are a variety of water quality trading programs in the United States that can serve as models for water trading or source water protection in California. Programs that have successfully attained a high level of landowner participation, secured buyers or executed multiple trades of water quality credits provide some valuable lessons as to what factors make water quality markets work. These factors include motivating buyers to engage in trading, supplying ecosystem services, the type of pollutant to be reduced, the general trading environment, and the availability of effective practices for delivering water quality improvements.

### 5.1 Market Structure and Viability

- Rangelands are best suited to point source-to-nonpoint source trading where regulated entities such as private and public utilities realize that ranchers can supply water quality credits at a lower cost than constructed water treatment plants. Although regulation remains the main driver that motivates point sources to comply by funding or implementing BMPs on private lands, voluntary programs that provide education and technical assistance can be effective in achieving water quality goals if there are incentives in place.
- Any market structure for achieving water quality in the Central Valley needs to be oriented towards engaging landowners, such as farmers and ranchers. Rangelands in the Central Valley are mostly privately owned and any attempt at creating water quality markets must entice private land owners to participate in sufficient numbers to yield meaningful reductions in discharges.
- Programs need to engage all stakeholders from the start, including regulators, buyers, ranchers and third party negotiators/aggregators, credit verifiers. This ensures transparency, builds trust in the credits and trading system, and increases innovative and flexible solutions. Already existing partnerships such as the Integrated Regional Water Management Program and the California Rangeland Conservation Coalition provide the platform for the establishment of successful programs.

- In addition to the technical characteristics, there must be political will in establishing markets including support and coordination of programs and policies at the federal, state, regional and local level.

## 5.2 Market Drivers

- There are a large number of water quality pollutant problems in the Central Valley watersheds, but there are few regulatory drivers that are in place for pollutants such as sediment, pathogens and temperature that can be linked to non-point sources. Several of the potential TMDLs are for pollutants that rangeland owners are well positioned to address. For example, future temperature TMDLs can be addressed through riparian shading which ranchers can undertake. These TMDLs are in development with expected completion dates in the next 10 years.
- In the face of weak regulatory drivers, opportunities for ranchers to access water quality trading programs in the Central Valley to abate non-point source water pollution are limited. Opportunities for abating point sources may be limited to a few instances in which the geographic location of private ranches lies near to a regulated point source.
- Source water protection and payment programs provide a voluntary and very promising alternative that may provide funding and ensure water supply and water quality in addition to other environmental co-benefits such as wildlife habitat that are achieved by the conservation of privately-owned rangelands.

## 5.3 Demand and Supply of Water Quality Credits

- Rangelands are a viable source for water quality credits. There are several BMPs for water quality available to ranchers in the Central Valley that greatly improve water quality. In addition, several BMPs, such as riparian buffers, can produce additional ecosystem co-benefits beyond water quality such as wildlife habitat for aquatic species and riparian species. Successful programs will likely focus on practices that address pervasive problems and provide very large pollutant reductions. For example, riparian buffers can reduce pathogen loads by 90 to 100%. However, the effectiveness of BMPs can be site specific and should be selected based on local conditions.
- Participation from several landowners is necessary to achieve measurable improvements in water quality for any large watershed. An aggregator or credit registry be used to reduce the cost and effort of marketing the credits and also to make it easier for buyers to access enough credits when they need them. Examples of existing credit registries are NutrientNet which provides a suite of web-based tools used to facilitate water quality trading; and The Willamette Partnership which has developed a Ecosystem Credit Accounting System which provides a package of protocols, tools, and resources that allow buyers and sellers to trade in multiple types of ecosystem credits.
- Ranchers can form consortiums that collectively supply water quality services; thereby, reducing the search costs associated with finding sellers and delivering sufficient quantity of water quality

services to meet buyer demand. The consortium would also enable suppliers to report to the administrating body as a group, rather than as individuals.

- Technical support in implementing conservation practices and navigating paperwork is necessary for ranchers. Technical assistance ensures that management practices are implemented correctly, the necessary water quality improvements are achieved, and the transaction costs for landowner participation are reduced. Simple, cost-effective and science-based monitoring programs are essential in the success of a water quality program for rangelands.
- Source water protection programs should leverage existing conservation practice programs in use by ranchers such as the Conservation Reserve Enhancement Program (CREP) and Environmental Quality Incentives Program (EQIP). Such programs provide technical assistance and cost-share options that help to ensure that environmental quality objectives are achieved through the use of established and scientifically sound conservation practices. In addition, the cost-share offered by some programs motivates participation by landowners to supply water quality improvements. Many ranchers have implemented conservation practices through agency programs. For this reason, source water protection programs should coordinate with existing agency efforts to avoid undermining any payment for ecosystem services framework.

#### **5.4 Policy Recommendations**

- Investment in cross-disciplinary research that studies the complex interactions that influence the role of rangelands in the water cycle is key to addressing water quality issues through market-based programs. In addition, applied site-specific research is needed to design and evaluate the effectiveness of BMPs to improve water quality. The emerging field of rangeland ecohydrology offers a potential framework for this type of research.
- There is a need to increase education and outreach to landowners, the private sector, and general public on the role of and value of rangelands as providers of ecosystem services. The link between the producers of ecosystem services and the beneficiaries is weak. Consumers are often unaware of the role of ecosystems in providing them with clean water; and private and public organizations may not be aware of how dependent they are on rangeland ecosystem services, or how private rangelands contribute to the health of watersheds. Outreach to educate consumers, as well as private and public sector agencies, on the role and value of rangelands as providers of ecosystem services is essential for the development and long-term sustainability of water quality trading programs.
- There is further need to identify and engage potential buyers of water quality services. For example, water districts or utilities supplying public drinking water are facing increased water scarcity and growing water demand. We recommend outreach to potential buyers to raise awareness of the role of ecosystem services and the importance of watershed stewardship in securing clean water supplies.

- A multi-stakeholder group including state and federal agencies, ranchers, universities, NGO's, and private sector business should develop a coherent system of acceptable protocols and measures of water quality improvements and enhanced ecosystem services. Existing metrics and protocols from the Willamette Partnership can serve as a model to create a system that delivers measurable ecosystem services and guarantees accountability.
- California should seek to implement a state-wide policy that recognizes the importance of ecosystem services provided by privately-owned rangelands in state planning. Formal recognition can help facilitate the coordination of efforts among federal, state, regional and local agencies; improve the ability to leverage existing funding mechanisms; the provision of technical assistance; and encourage the incorporation of ecosystem services into watershed and habitat management plans. Recognizing the cost-effectiveness of investing in “green infrastructure,” such as rangeland BMPs and voluntary easement programs, to improve water quality, increases the likelihood that regulated point sources will use water quality credits generated by ranchers as a means to meet their regulatory permit requirement.

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## 7.0 Appendices



Appendix 1. List of Water Quality Limited Segments within the California Rangeland Conservation Coalition Area.

<i>Map ID</i>	<i>Region</i>	<i>Water Body Name</i>	<i>Size Affected</i>	<i>Pollutant</i>	<i>Pollutant Category</i>	<i>Source<sup>1</sup></i>	<i>TMDL status<sup>2</sup></i>
1	North Coast	Russian River HU, Lower Russian River HA, Guerneville HSA	195 miles	Indicator Bacteria, Sedimentation and Siltation, Temperature	Pathogens, Sediment, Miscellaneous	NP/PS	5A
2	North Coast	Russian River HU, Middle Russian River HA, Santa Rosa Creek	87 miles	Indicator Bacteria, Sedimentation and Siltation, Temperature	Pathogens, Sediment, Miscellaneous	NPS	5A
3	Central Valley	Sacramento Slough	2 miles	Chlorpyrifos, Mercury, Dissolved Oxygen, Unknown Toxicity, pH (low)	Pesticides, Metals/Metalloids, Nutrients, Toxicity, Miscellaneous	SU	5A
4	Central Valley	Feather River, Lower (Lake Oroville Dam to Confluence with Sacramento River)	42 miles	Chlorpyrifos, Group A Pesticides, Mercury, PCBs (Polychlorinated biphenyls)	Pesticides, Metals/Metalloids, Other Organics	SU	5A
5	Central Valley	Sacramento River ( Red Bluff to Knights Landing)	82 miles	DDT (Dichlorodiphenyltrichloroethane), Dieldrin, Mercury, PCBs (Polychlorinated biphenyls), Unknown Toxicity	Pesticides, Metals/Metalloids, Other Organics, Toxicity	SU	5A
6	Central Valley	Willow Creek (Madera County)	6 miles	Temperature, water	Miscellaneous	SU	5A

7	Central Valley	Cosumnes River	53 miles	Exotic Species, Escherichia coli (E. coli), Sediment Toxicity	Pathogens, Miscellaneous, Toxicity	SU	5A
8	Central Valley	Clover Creek	11 miles	Fecal Coliform	Pathogens	Agriculture-grazing	5A
9	Central Valley	Feather River, North Fork (below Lake Almanor)	54 miles	Mercury, PCBs, Temperature, Toxicity	Metals/Metalloids, Other Organics, Miscellaneous, Toxicity	SU	5A
10	Central Valley	Deer Creek (Sacramento County)	12 miles	Iron	Metals/Metalloids	SU	5A
11	Central Valley	Sacramento River (Cottonwood Creek to Red Bluff)	16 miles	Mercury, Unknown Toxicity	Metals/Metalloids, Toxicity	SU	5A
12	Central Valley	Carson Creek (from WWTP to Deer Creek)	12 miles	Aluminum, Manganese	Metals/Metalloids	SU	5A
13	Central Valley	San Joaquin River (Friant Dam to Mendota Pool)	70 miles	Exotic Species	Miscellaneous	SU	5A
14	Central Valley	Grayson Drain (at outfall)	0 miles	E. coli, Sediment Toxicity, Unknown Toxicity	Pathogens, Toxicity	SU	5A
15	Central Valley	Ingram Creek (from confluence with Hospital Creek to Hwy 33 crossing)	3 miles	Pyrethroids, Sediment Toxicity	Pesticides, Toxicity	SU	5A

16	Central Valley	American River, South Fork (below Slab Creek Reservoir to Folsom Lake)	37 miles	Mercury	Metals/Metalloids	SU	5A
17	Central Coast	San Luis Obispo Creek	2 miles	Nitrate as Nitrate (NO3)	Nutrients	SU	5A
18	Central Coast	Pajaro River	32 miles	Boron, Chlordane, Chloride, Chlorpyrifos, DDD, Dieldrin, E. coli, Fecal Coliform, Low Dissolved Oxygen, Nitrate, Nutrients, PCBs, Sedimentation/Siltation, Sodium, Turbidity, pH	Metals/Metalloids, Pesticides, Salinity, Pathogens, Nutrients, Other Organics, Sediment, Salinity, Miscellaneous	SU	5A, 5B (Nitrate, Nutrients, Sediment)
19	Central Coast	Salinas Reclamation Canal	8 miles	Ammonia (Unionized), Chlorpyrifos, Copper, Diazinon, E. coli, Fecal Coliform, Low Dissolved Oxygen, Nitrate, Pesticides, Sediment Toxicity, Turbidity, Unknown Toxicity, pH	Nutrients, Pesticides, Metals/Metalloids, Pathogens, Nutrients, Other Organics, Toxicity, Sediment, Miscellaneous	SU	5A
20	Central Coast	San Benito River	86 miles	Boron, Electrical Conductivity, E. coli, Fecal Coliform, Sedimentation/Siltation, Unknown Toxicity, pH	Metals/Metalloids, Salinity, Pathogens, Sediment, Toxicity, Miscellaneous	SU	5A, 5B(Sediment)
21	Central Coast	Atascadero Creek (San Luis Obispo County)	5 miles	E. coli, Fecal Coliform, Low Dissolved Oxygen	Pathogens, Nutrients	SU	5A

22	Central Coast	Canada De La Gaviota	7 miles	Boron, Chloride, E. coli, Fecal Coliform, Sodium	Metals/Metalloids, Salinity, Pathogens	SU	5A
23	Central Coast	Cuyama River	134 miles	Boron	Metals/Metalloids	SU	5A
24	Central Coast	Bradley Canyon Creek	17 miles	Ammonia (Unionized), Fecal Coliform, Low Dissolved Oxygen, Nitrate, Turbidity, Unknown Toxicity, pH	Nutrients, Pathogens, Sediment, Toxicity, Miscellaneous	SU	5A
25	Central Coast	Cholame Creek	9 miles	Boron, Chloride, Electrical Conductivity, E. coli, Fecal Coliform, Low Dissolved Oxygen, Sodium	Metals/Metalloids, Salinity, Pathogens, Nutrients	SU	5A
26	Central Coast	Quail Creek	4 miles	Ammonia (Unionized), Chlorpyrifos, Diazinon, E. coli, Fecal Coliform, Low Dissolved Oxygen, Nitrate, Sediment Toxicity, Temperature, Turbidity, Unknown Toxicity	Nutrients, Pesticides, Pathogens, Toxicity, Miscellaneous, Sediment	SU	5A
27	Central Coast	Santa Maria River	51 miles	Chloride, Chlorpyrifos, DDT, Dieldrin, Endrin, E. coli, Fecal Coliform, Nitrate, Sediment Toxicity, Sodium, Toxaphene, Turbidity, Unknown Toxicity	Salinity, Pesticides, Pathogens, Nutrients, Toxicity, Sediment	SU	5A
28	Central Coast	San Lorenzo Creek	49 miles	Boron, Chloride, Chlorpyrifos, DDT, Dieldrin, Endrin, E. coli, Fecal Coliform, Nitrate, Sediment Toxicity, Sodium, Toxaphene,	Metals/Metalloids, Salinity, Pesticides, Pathogens, Nutrients, Toxicity, Sediment	SU	5A

				Turbidity, Unknown Toxicity, pH			
29	Central Coast	Llagas Creek	16 miles	Chloride, Electrical Conductivity, E. coli, Fecal Coliform, Low Dissolved Oxygen, Sodium	Salinity, Pathogens, Nutrients	NPS	5A, 5B (Nutrients, Sediment).
30	Central Coast	Salinas River (middle, near Gonzales Rd crossing to confluence with Nacimiento River)	72 miles	E. coli, Fecal Coliform, Pesticides, Temperature, Turbidity, Unknown Toxicity, pH	Pathogens, Pesticides, Miscellaneous, Sediment, Toxicity	NPS	5A
31	Central Coast	Main Street Canal	5 miles	Ammonia (Unionized), Chlorpyrifos, Diazinon, Fecal Coliform, Nitrate, Turbidity, Unknown Toxicity, pH	Nutrients, Pesticides, Pathogens, Nutrients, Sediment, Toxicity, Miscellaneous	SU	5A
32	Central Coast	Bradley Channel	3 miles	Ammonia (Unionized), Chlorpyrifos, Fecal Coliform, Nitrate, Sediment Toxicity, Unknown Toxicity, pH	Nutrients, Pesticides, Pathogens, Nutrients, Toxicity, Miscellaneous	SU	5A
33	Central Coast	Natividad Creek	7 miles	Ammonia (Unionized), E. coli, Low Dissolved Oxygen, Nitrate, Sediment Toxicity, Temperature, Turbidity, Unknown Toxicity, pH	Nutrients, Pathogens, Toxicity, Miscellaneous, Sediment	SU	5A
34	Central Coast	Santa Rita Creek (Monterey County)	11 miles	Ammonia (Unionized), E. coli, Fecal Coliform, Low Dissolved Oxygen, Nitrate,	Nutrients, Pathogens, Salinity, Sediment	SU	5A

Sodium, Turbidity							
35	San Francisco Bay	San Pablo Bay	68349 acres	Chlordane, DDT, Dieldrin, Dioxin compounds, Furan compounds, Invasive Species, Mercury, PCBs, Selenium	Pesticides, Other Organics, Miscellaneous, Metals/Metalloids	NPS	A, B( Mercury)
36	San Francisco Bay	San Francisco Bay, Central	70992 acres	Chlordane, DDT, Dieldrin, Dioxin compounds, Furan compounds, Invasive Species, Mercury, PCBs, Selenium, Trash	Pesticides, Other Organics, Miscellaneous, Metals/Metalloids, Trash	NPS	A, B( Mercury)
37	San Francisco Bay	Suisun Bay	25335 acres	Chlordane, DDT, Dieldrin, Dioxin compounds, Furan compounds, Invasive Species, Mercury, PCBs, Selenium	Pesticides, Other Organics, Miscellaneous, Metals/Metalloids	NPS	A, B( Mercury)
38	San Francisco Bay	Carquinez Strait	5657 acres	Chlordane, DDT, Dieldrin, Dioxin compounds, Furan compounds, Invasive Species, Mercury, PCBs, Selenium	Pesticides, Other Organics, Miscellaneous, Metals/Metalloids	NPS	A, B( Mercury)
39	San Francisco Bay	Sacramento San Joaquin Delta	41736 acres	Chlordane, DDT, Dieldrin, Dioxin compounds, Furan compounds, Invasive Species, Mercury, PCBs, Selenium	Pesticides, Other Organics, Miscellaneous, Metals/Metalloids	NPS	A, B( Mercury)
40	San Francisco Bay	Castro Cove, Richmond (San Pablo Basin)	71 acres	Dieldrin , Mercury, PAHs (Polycyclic Aromatic Hydrocarbons), Selenium	Pesticides, Metals/Metalloids, Other Organics	PS	A
41	San Francisco	Anderson Reservoir	1013 acres	Mercury, PCBs	Metals/Metalloids,	SU	A

	Bay				Other Organics		
42	San Francisco Bay	San Pablo Reservoir	784 acres	Chlordane, Dieldrin, Heptachlor epoxide, Mercury, PCBs, Toxaphene	Pesticides, Metals/Metalloids, Other Organics	SU	A
43	San Francisco Bay	Del Valle Reservoir	1022 acres	Mercury, PCBs	Metals/Metalloids, Other Organics	SU	A
44	San Francisco Bay	Lafayette Reservoir	114 acres	Mercury, PCBs	Metals/Metalloids, Other Organics	SU	A
45	San Francisco Bay	Shadow Cliffs Reservoir	90 acres	Mercury, PCBs	Metals/Metalloids, Other Organics	SU	A
46	Central Coast	Soda Lake	2627 acres	Ammonia (Unionized)	Nutrients	SU	A
47	Central Valley	Kaweah Lake	1702 acres	Mercury	Metals/Metalloids	SU	A
48	Central Valley	Natoma, Lake	485 acres	Mercury	Metals/Metalloids	SU	A
<sup>1</sup> PS= point source, NPS=Nonpoint source, SU= Source Unknown <sup>2</sup> A= TMDL still required, B= being addressed by USEPA approved TMDL Source: SWRCB 2010 Integrated report (Clean Water Act Section 303(d) List / 305(b) Report, Category 5)							

