WATER QUALITY IN THE TOMALES BAY WATERSHED:

Conflict and Response to On-farm Water Quality Management

Final Report

of the

University of California Tomales Bay Water Quality Project

to the

Marin Community Foundation

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WATER QUALITY IN THE TOMALES BAY WATERSHED:

Conflict and Response to On-farm Water Quality Management

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EXECUTIVE SUMMARY

Water quality and watershed management are critical issues to address in protecting the health of local residents and the watershed, as well as insuring the continued economic viability of agriculture and shellfish culture in the Tomales Bay Watershed. This final report presents project accomplishments and future steps of the University of California Tomales Bay Water Quality Project (UCTBWQP) funded by the Marin Community Foundation(MCF) and others from 1999-2004.

The Tomales Bay Shellfish Technical Advisory Committee (TBSTAC) confirmed that winter fecal coliform bacteria levels within Tomales Bay are above water quality standards for shellfish harvesting areas (O'Connell et al., 2000). Bay agricultural lands were identified as a source for this bacteria loading, as well as, onsite sewage disposal systems and recreational boating and camping activities. The project was developed and implemented to answer three questions:

1) Is there a science-based link between coliform inputs to the Bay and agricultural practices within the watershed? And, if yes,
2) What animal waste management practices could be modified to reduce pollution?
3) What resource management plans for waste management could operators use that would reduce pollutant loading to bay waters?

The UCTBWQP conducted storm runoff sampling on cooperating Bay ranches during the 1999-2000, 2000-2001, and 2001-2002 winters. This work was conducted to achieve the first project goal. Results indicate that fecal coliform loading in control watersheds is less than loading in watersheds with active animal agriculture operations. Sites of potential loading within the cooperating dairy and beef ranches include dry lots and corrals and pastures that are irrigated and fertilized with manure. Having generated results that illustrate the link between pollutant inputs to Tomales Bay and agriculture practices in the watershed, the Project initiated an evaluation of animal waste management practices to reduce pollution to surface waters. This work started in 2001 and was completed in the 2003-2004 field season. Specifically, we investigated the effectiveness or vegetative buffers, dry lot and corral management, and improved pasture management to reduce pollutant loads.

Storm runoff from corrals and pastures was sampled and analyzed with randomly assigned management practices. Management practices include scrapping, mulching, and seeding for corrals and altering the quantity and timing of field-applied manure to pastures. Water samples were analyzed for bacteria and pathogens, nutrients, and general chemistry. Results were extended to cooperating ranches through project meetings and farm visits, and to coastal livestock operations in general through community meetings, newsletter articles, and peer-reviewed articles.

The report includes a summary of on-farm water quality research, outreach and education activities, collaborative alliances, project outcomes and impacts, and a budget account.

BACKGROUND

Conflicts over natural resources have the potential to tear communities apart by pitting different stakeholders against each other. This is particularly true for a resource as precious as water. Such has been the situation in the Tomales Bay Watershed throughout the last ten years.

Both residents and visitors alike characterize Tomales Bay as a unique place. The open grasslands and pastures are part and parcel of a functional, working landscape for grazing livestock and dairy operations. The Bay's winding creeks and streams are critical habitat for salmon, steelhead trout, and other flora and fauna. This habitat function is continued into the Bay itself, where in addition to the estuarine ecosystem, a burgeoning shellfish industry exists. Conflict has resulted from the debate on the compatibility of this riparian and estuarine habitat with the viability of local ranches and shellfish operations.

The San Francisco Regional Water Quality Control Board (RWQCB) and California Department of Health Services (DHS) have confirmed that winter fecal bacteria levels within Tomales Bay are above water quality standards for shellfish harvesting areas during storms (TBSTAC, 2001). Agricultural lands were identified as one of the sources for this bacteria loading, as well as, onsite sewage disposal systems and recreational boating and camping activities. Shellfish growing areas are closed for harvest for 60 to 100 days each winter as result of these elevated levels. Such closures present a significant economic impact to shellfish growers. In response, growers have pursued and applied the options available to them to meet consumer demand, improve water quality, and reduce closures. These options have included installation of tanks to hold product during closures and the threat of legal action against their neighbors and community members, the local dairy and ranch operators. Alternatively, the growers and producers have participated in a third option to resolve the conflict over water quality in Tomales Bay. The Tomales Bay Agriculture Group (TBAG) and the University of California Cooperative Extension (UCCE) have directed this option, referred to as the University of California Tomales Bay Water Quality Project (UCTBWQP). This project is an on-farm research and education program with the specific goals to:

1. Provide a science-based link between coliform inputs to the Bay and agricultural practices within the watershed;
2. Evaluate animal waste management practices to reduce pollution; and
3. Develop resource management policies and a Hazard Analysis and Critical Control Points (HACCP) plan for waste management that would reduce coliform contamination of shellfish growing waters by tracking potential pathogens in the environment and identifying critical points where they can be eliminated or where management practices can be implemented to reduce exposure.

To achieve these goals and resolve the ongoing conflict, we have focused on agricultural practices and not individual farms.

Project Team Qualifications

The project team is multi-disciplinary and has strong experience in applied research and extension with animal agriculture in California. David Lewis, the UCCE Watershed Management Advisor, is the lead principal investigator for the project. He supervised and coordinated all field activities with Michael Lennox, the projects research assistant. Michael is a full-time postgraduate researcher with strong skills in water quality monitoring and riparian plant species propagation. David and Michael work closely with UCCE Livestock and Natural Resource Advisor, Stephanie Larson, UCCE Sea Grant Marine Advisor, Dr. Paul Olin, especially during the initial storm runoff investigations and management practice evaluation period to build the data set and cooperator relationships for the management practice evaluation phase. UCCE Environmental Animal Health Specialist, E. Robert Atwill, and Rangeland Watershed Specialist, Kenneth W. Tate provided technical assistance for field sampling and analytical laboratory methods as well as statistical analysis. Ellen Rilla, Marin County UCCE Director, provided administrative oversight.

A project advisory committee composed of 13 federal, state, and local resource agency staff, an oyster company owner, two dairy operators, a MALT representative, and the program officer from the Marin Community Foundation met yearly to review progress and provide feedback on project direction.

A project calendar includes steps completed in the project years 1999-2004 as well as next steps to be completed by 2005.

TASK	1999 - 2000	2000 - 2001	2001 - 2002	2002 - 2003	2003 - 2004	2004 - 2005
On-farm research and trials						
Identifying Links and Sources						
Evaluation of Practices						
Lot treatment						
Buffer enhancement planting						
Manure Management						
Education/ Outreach						
TBAG meetings						
Advisory Committee meetings						
Tillamook Bay Exchange						
Speaker Series						
Community Forum						
Project Presentations						
Next Steps						
Complete Analysis of Results						
Produce Educational Publications						
Conduct Workshops in Humboldt Morro, and Tomales Bay						

ON-FARM RESEARCH AND TRIALS

Water quality sampling and analysis was a critical component of this project because it provided the needed data to form recommendations that were credible to the cooperating producers and the larger Bay community. We generated this data through on-farm research and trials to identify practices and locations within livestock agricultural operations that have greatest likelihood of impacting water quality, as well as test ways to reduce those impacts. We conducted water quality sampling analysis, for these two elements, on a number of potential pollutants including bacteria, nutrients, and sediment. To demonstrate the results from this research, findings for bacteria are presented because of the immediate relevance to the conflict over water quality in the Bay.

Identifying Links and Sources

Approach

Each dairy property is unique and comprised of a complex set of management units such as pastures, milking barns, loafing areas, dry lots, and manure storage facilities. The dairy manager's water quality data needs are generally at a scale that matches these units, which is smaller than that provided by earlier tributary scale investigations (Sharpe, 1974; Jarvis et al., 1978; Musselman, 1980; DHS, 1996; O'Connell et al., 2001). In order to assist these dairy owners in developing a water quality management plan, we developed and implemented an on-farm monitoring method that matches water quality data to these on-farm management units. Our approach generated water quality data that guided land owners as to which specific land use practices are contributing the greatest pollutant loads on their property and thereby help prioritize which management practices would need to be modified to reduce that loading.

Dairy farms are comprised of different management areas that likely discharge differing loads of fecal coliform due to different fecal loading and runoff amounts. We designed our monitoring strategy to be consistent with the different management units the cooperating dairies as illustrated in Figure 1 and described below:

- **Manure management system (MMS):** Retention lagoons and flush systems that capture and store barn manure. These systems are critical to dairy production systems as the primary management measure to prevent the direct release of pollutants to surface waters. Materials from these systems were sampled to provide a context of manure generated and managed within the studied facilities. They represent nascent materials, with little or no dilution from precipitation in contrast to the other loading units.
- **Pasture:** These units range in size from tens to hundreds of hectares on to which calves and adult animals are released to graze annual grasses. In some cases, these units are disked and seeded for the production of feed silage. Manure from the manure management systems is spread and irrigated on to these units during the spring, summer, and fall, for irrigation and fertilization of grasses and feed crops.

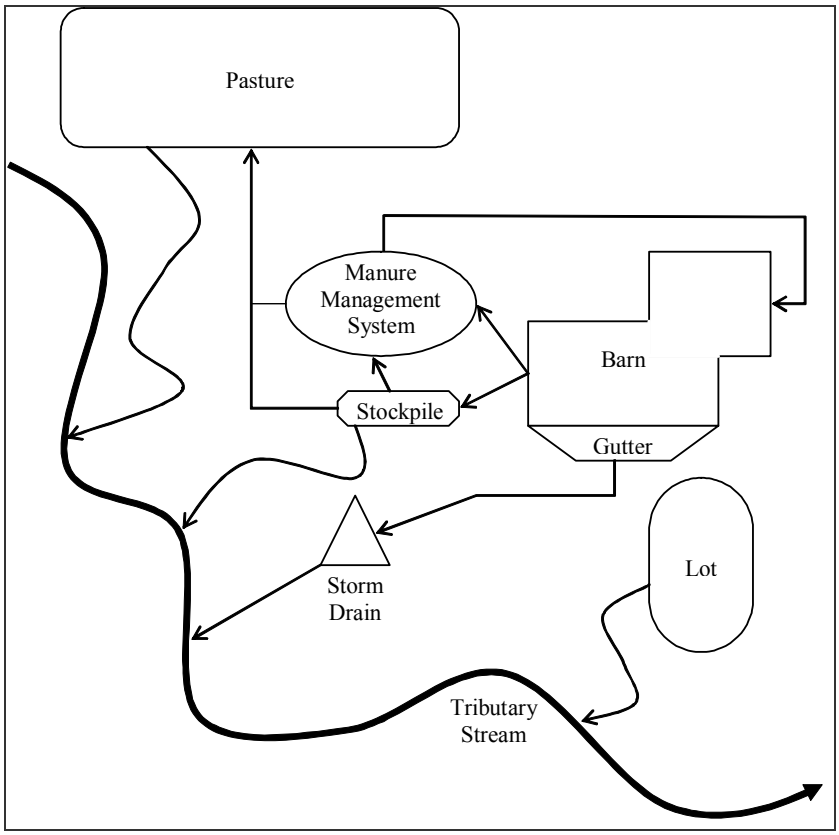

Figure 1: Loading unit schematic representing dairy barn and corresponding units. Bold line depicts tributary stream channel. Thin lines and arrows indicate general flow paths for barn wash water, manure, and sources of fecal coliform to the tributary stream.

- **Lot:** Typically positioned next to barns, these units range from several hectares to less than a hectare in size. These units are used to provide daily exercise to milking cows which are milked two or three times a day and do not move away from the barn and milking facilities. In general, these areas hold high densities of dairy cattle during the summer, are scraped of manure in the fall, and not used in the winter.
- **Manure stockpile:** Areas where solid manure is stored and composted. For example, manure scraped from lot units is stored at these stockpile locations. Stockpiled manure is spread and distributed to pastures during the spring, summer, and fall for fertilization
- **Gutter:** Drainage structures installed on dairy homes and barns to capture roof runoff before entering subsurface drains. The purpose of these gutters is to capture and separate water that has not been impacted by manure from other surface runoff that has, and then provide for its direct release to surface waters.
- **Drain:** These drains are a continuation of the stormwater system from the gutter units. Water that is separated by gutters is routed through these drains to streams.
- **Runoff:** Surface runoff along driveways and parking areas in and around dairy homes and barns.

In addition to sampling the different fecal coliform loading units described above, tributary-scale and above-and-below sampling was conducted to establish additional metrics of water quality. These sampling units included:

- **Control:** Watersheds with little to no intensive animal agriculture facilities, substantial human development, and minimal rangeland usage by cattle.
- **Upstream:** Represents tributary streams before entering areas of dairy facility infrastructure. These sample locations receive runoff from a variety of land uses including pastures, grasslands, and woodlands.
- **Downstream:** Encompasses tributaries at various locations below dairy facilities including streams on the Eastern Shore, and in the Nicasio, Olema, and Chileno Creek watersheds.

Results

Results from within the dairy operations identify patterns of fecal coliform concentration, storm runoff volumes, and potential loading amounts that are useful to prioritize remediation actions. A complete description and account of these results will be available in a journal article entitled *Linking on-farm dairy management practices to storm-flow fecal coliform loading for California coastal watershed* to be published in the Journal of Environmental Monitoring and Assessment in 2005. As an example of these results, fecal coliform concentrations ranged for pastures between 206 and 2,288,888 cfu/100mL; gutters between 0 and 2,378 cfu/100mL; drains between 1.5 and 1,975,309 cfu/100mL; facility runoff from 898 to 740,741 cfu/100mL; stockpiles between 3,333 and 44,893,400 cfu/100mL; lots between 1,933 and 166,105,000 cfu/100mL; and manure management systems from 2,708 to 219,978,000 cfu/100mL (Figure 2). Gutters had significantly lower mean fecal coliform concentration than all other loading units except control. On the other end of the scale, runoff from stockpiles had similar mean fecal coliform concentrations to manure management systems and both were significantly greater than all other loading units. Mean fecal coliform concentration from lots was significantly greater than pastures and drains while neither were significantly different than facility runoff.

The operator can weigh the options for where and what to implement in partnership with technical and financial assistance, based on the area of a given unit, the runoff that will be generated from it, and the concentration of fecal coliform in that runoff. The high concentrations and loads for the material within the manure management system emphasizes the value and importance of a functioning system to capture and store the material with the greatest potential to load fecal coliform to surface waters. Outside of those systems, dairy managers would get the greatest reduction in fecal coliform loading through reduction of concentrations and runoff generated from lots and stockpiles. Following lots and stockpiles, attention should be given to pastures. Concentration and load values from gutters are similar to those identified in upstream and control units indicating that, if this water can be kept separate from manure sources, it can be directed back into surface waterways. Results from storm drains and surface runoff identify that mixing of stormwater and manure sources may be occurring and that attention to the maintenance of storm drains will help to reduce and prevent this mixing and resulting deliver of bacteria to surface waters.

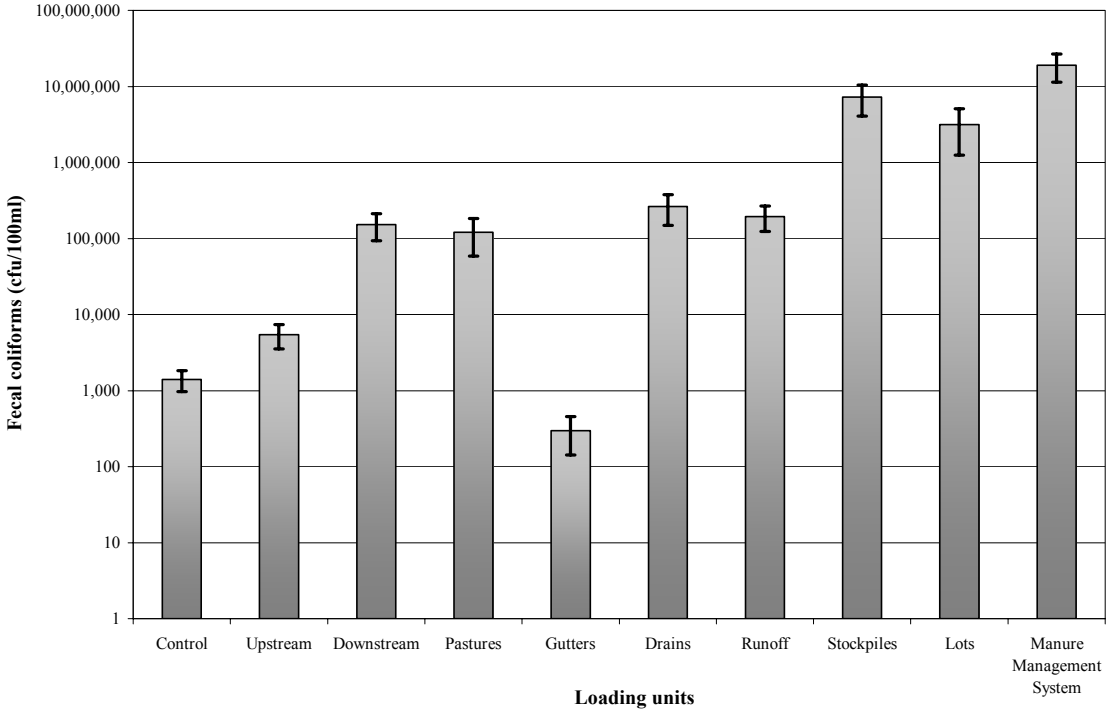

Figure 2: Concentration of fecal coliforms in runoff from respective loading units within participating dairies.

Evaluation of Practices

With the identification of sources and links for bacteria, nutrients, and sediment identified, we turned our attention to evaluating practices that would break those links. During the 2001-2002, 2002-2003, and 2003-2004 winters we implemented practices to improve the quality runoff from lots and pastures on cooperating dairies. This included the implementation of lot mulching and seeding, testing of vegetative buffers to filter runoff, and evaluation of manure management and application on pastures. In addition to these efforts, we expanded the project to include sampling and analysis of cyrptosporidium parvum. This expansion provided useful information about actual pathogens that is complimentary to the information about the indicator bacteria.

Mulching and Seeding Lots

Because runoff from lots can be one of the highest sources of bacteria and other pollutant loading, we focused on practices that would reduce the amount and improve the quality of the water in that runoff. To do this, we mulched and seeded a selected number of lots, leaving others untreated for comparison. We seeded identified lots with annual barley at 100 lbs. per acre and annual rye at 25 lbs. per acre. Mulching was done using straw or old hay, at one bale per 800 ft^2, or two tons per acre (NRCS, 2000). These treatments were done in combination with the existing practices by dairy managers, to scrape the

lots clean of any residual lose manure prior to the rains and halt use of the lots by animals during the winter storm season (Figure 3).

Figure 3: Areas of loafing such as lots and corrals are important production components on dairies for herd health, providing ways to separate and exercise groups of animals (top left). Runoff from these lots during winter storms can be improved by treating these surfaces through seeding and mulching (top right). This results in areas protected from erosion during early storms by straw (bottom left) and by grass in late winter and early spring (bottom right).

Water quality results from treated and untreated lots indicate that reductions in fecal coliform concentration can be achieved through mulching and seeding, as well as continuing the practice of removing animals during the winter storm season (Figure 4).

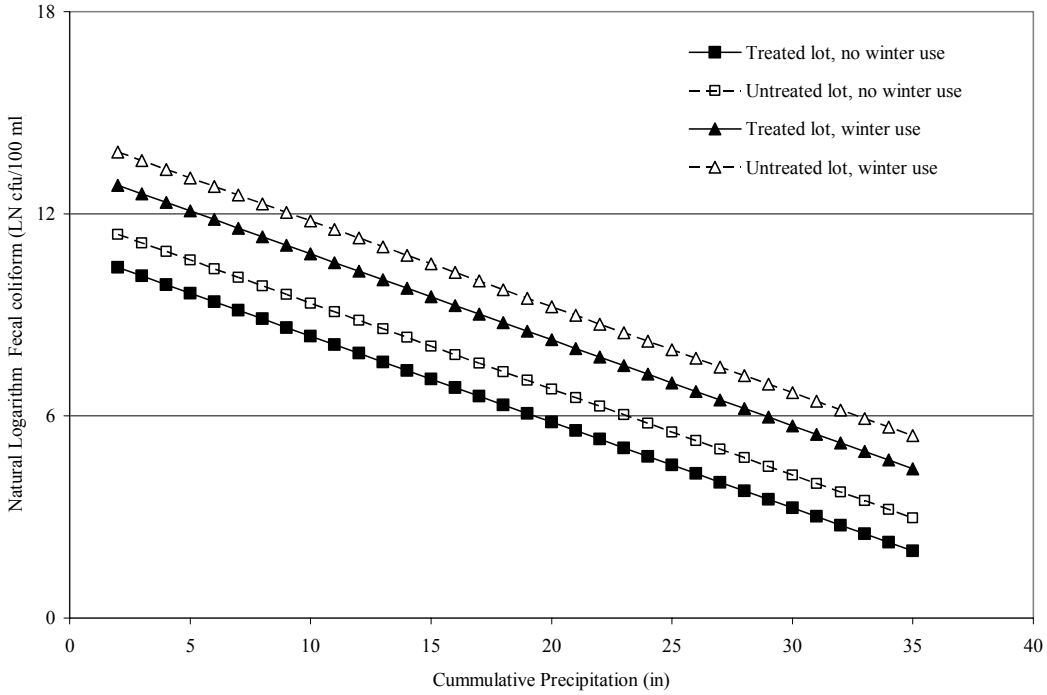

Figure 4: Modeled concentration of fecal coliform in runoff from lots with winter use (triangles) and without winter use (squares) that are both treated (closed triangles and squares) and untreated (open triangles and squares).

Vegetative Buffers

Vegetative buffers are designed to act as filters that slow runoff thus allowing sediment, such as manure, to settle and become trapped. We evaluated the benefits of this practice through construction of buffers and opportunistic sampling and analysis of runoff directed across resident grasses on cooperating dairies.

Active construction of buffers included the planting of *Carex barbarae* (Cyperaceae), *Juncus effusus* (Juncaceae) and *Leymus triticoides* (Poaceae). These were chosen for their tolerance to seasonal saturation and summer droughts, as well as their water quality functions (i.e. perennial, deep-rooted and dense groundcover). Regrettably these plantings were not successful. Their presence was not detectable one year after planting. It is most likely that they were out-competed by resident vegetation.

Opportunistic evaluation of buffers consisted of sampling above and below grassed areas through which runoff from lots and pastures was directed (Figure 5). Again using fecal coliform results to demonstrate the results, buffers provide reduction in concentration (Figure 6). It is important to keep in mind the performance of any buffer is dependent upon site conditions such as slope, soil type, and the quality of influent or water entering the buffer. The point is that buffers can serve as a beneficial component of a larger coordinated plan of practices for on-farm water quality management but should not be expected to provide total reduction of impacts by themselves.

Figure 5: Project researcher Michael Lennox evaluates the effect of a vegetative buffer to improve water quality in runoff from a lot above the fence.

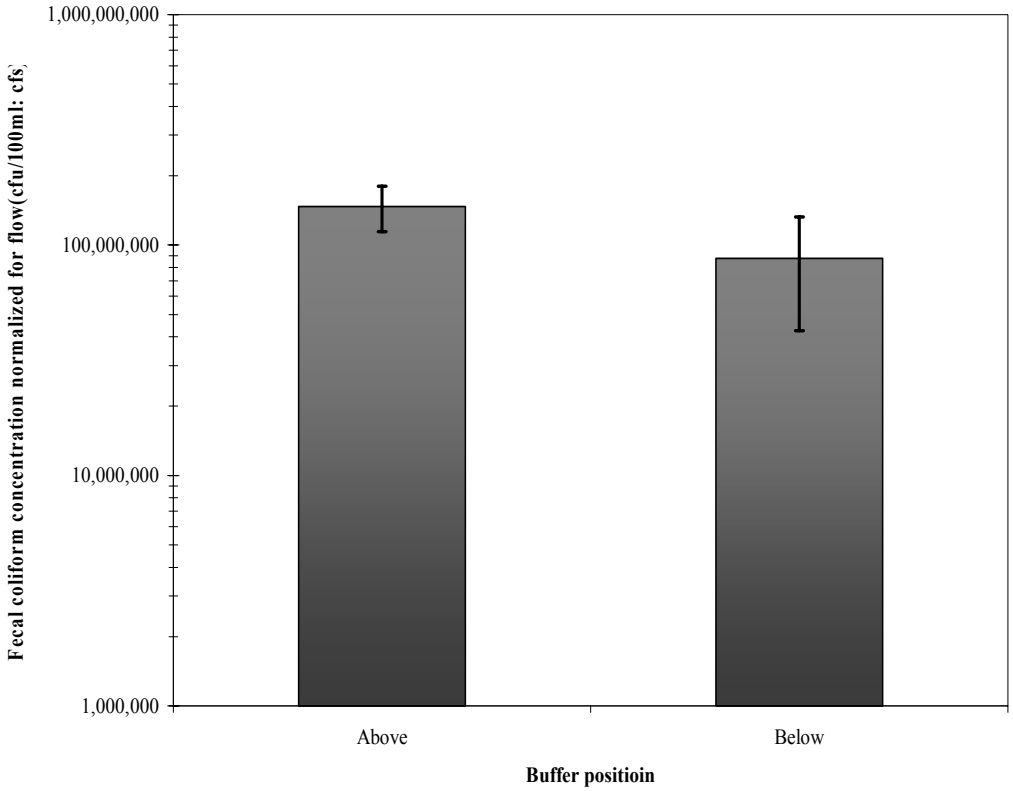

Figure 6: Fecal coliform concentration in runoff from above and below vegetative buffers.

Manure Management and Application

Dairy managers generally store dry and wet manure in a network of lagoons and stockpiles. This manure is stored during the winter storms and applied primarily late the following summer on fields and pastures. To provide direction on ways to reduce impacts to water quality from the manure storage and application we directed sampling and analysis toward two questions: 1) Does the duration of storage affect the quantity of bacteria in applied manure? 2) What is the rate of decay or die-off of bacteria in field-applied manure? While we have not fully completed our analysis, initial results provide direction for producers on how to reduce the bacteria levels available in the pasture and field where manure is applied. Firstly, the holding of manure approximately 150-200 days can result in a considerable reduction of bacteria in applied manure (Figure 7). In addition, bacteria concentrations in applied manure will be considerably less in approximately 20 to 30 days after application (Figure 8). These observations are seasonal and temperature-dependent and the influence of these dynamics on nutrients will differ from bacteria. However, they are a first step in providing recommendations to producers on how to manage manure to improve water quality.

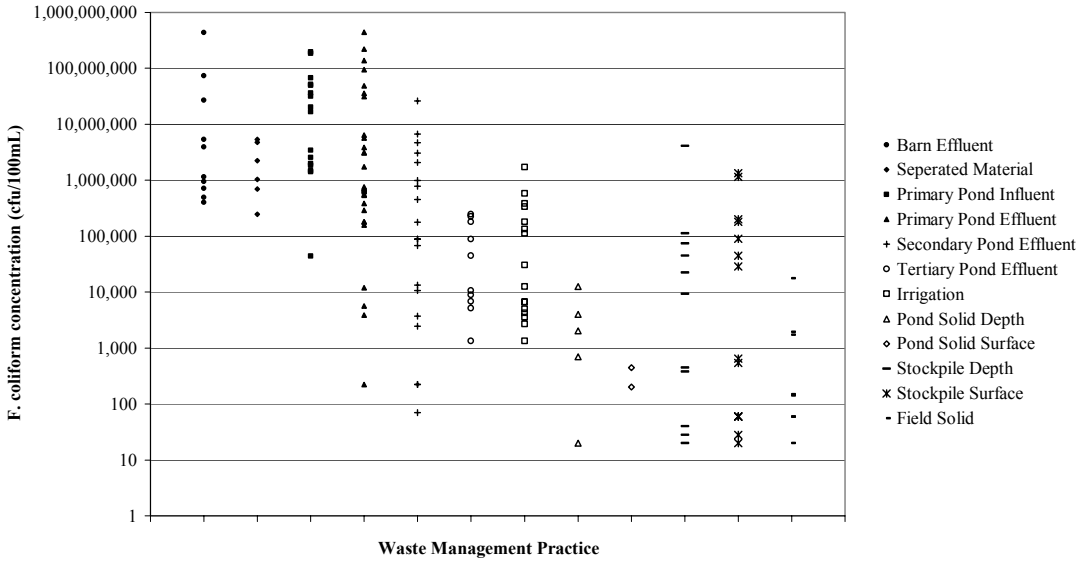

Figure 7: Concentration of fecal coliform in material at various stages of dairy manure management system. Each stage, moving from left to right across the graph and from top to bottom in the legend, represents an increase in the holding time for the material within the dairy manure management systems from one to 300 days.

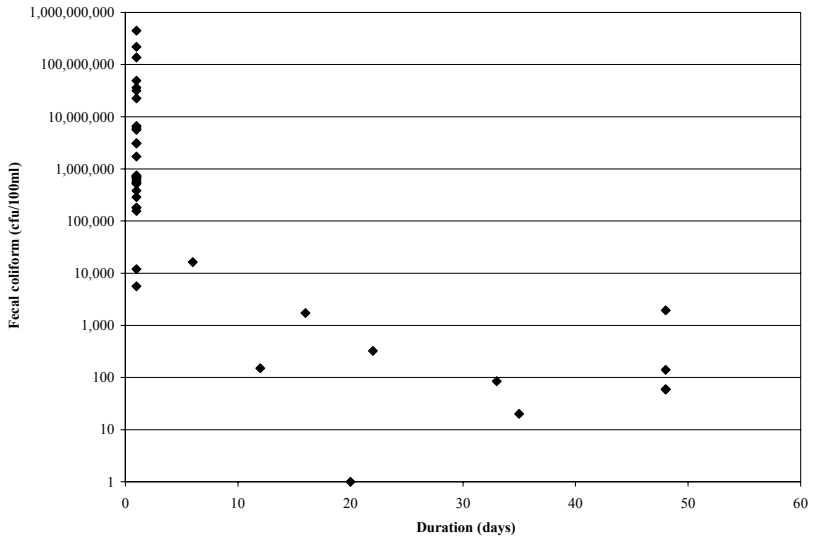

Figure 8: Reduction of fecal coliform concentration in field-applied manure from day of application.

EDUCATION AND OUTREACH

Our education and outreach activities were designed and delivered to compliment the on-farm research and trials component. These included one-on-one farm tours reviewing

results from the trials, and presentations of results and project progress to local groups and committees (Table 1). In doing these consultations and presentations, we were providing the producers with the information they needed to make on-farm changes. We were also demonstrating how focusing on practices, and not people, could lead to solutions for improving Bay water quality. Other education and outreach activities we conducted included traveling to Tillamook Bay, Oregon, to hear from dairy producers how they have implemented measures to improve water quality; organizing speaker series where invited researchers shared findings and recommendations for livestock management and water quality; and a community forum on water quality in Tomales Bay.

Tillamook Bay Exchange

Since its designation as an estuary of national significance and inclusion in the National Estuary project by the United States Environmental Protection Act in 1992, Tillamook Bay has undergone extensive study and management changes to improve water quality within its boundaries. These efforts include research and management prescriptions for non-point source pollution from animal confinement areas, water course areas, and field application of manure. To capitalize on Tillamook experiences, the project provided Tomales Bay agricultural managers and owners, as well as regulatory and resource agency staff, the opportunity to meet and share ideas with their Tillamook Bay counterparts. In the format of a farmer-to-farmer exchange this group met with their counterparts and toured project sites within the Tillamook Bay watershed on August 7 and 8, 2000. The exchange focused on management practices that have improved water quality and maintained the economic viability of agricultural production.

Real Poop Speaker Series

The project hosted three different community engagements in partnership with Marin Agricultural Land Trust and the Marin Resource Conservation District. These included presentations and discussions on livestock and water quality management by: Drs. Robert Atwill and Kenneth Tate, University of California Davis, on water borne pathogens in California rangeland watersheds; Dr. Jim Moore, Oregon State University, on dairy water quality management in Tillamook Bay, Oregon; and Dr. Christopher Kitts, California Polythenic University in San Luis Obispo, on determining sources of bacteria pollution in Morro Bay, California.

Drs. Robert Atwill and Kenneth Tate participated in a three-hour presentation and discussion of their research on the role of livestock in delivery and transport of water-borne pathogens in California rangeland watersheds. They provided an overview of water-borne pathogens and discussed recommendations on livestock herd distribution that would reduce water quality impacts.

Dr. Jim Moore visited from Oregon State University in November 2001. He toured the bay and farms, and gave two presentations on water quality research and management to the dairy and larger Tomales Bay communities. The tour provided Dr. Moore with an opportunity to become familiar with the bay and its tributaries, as well as visit watershed dairies to discuss differences and similarities in manure management. Dr. Moore's talk included:

- Discussion of dairy manure management methods in Tillamook Bay focused for a dairy owners and managers; and
- Presentation of results from bacteria source identification and water quality trend analysis. This presentation was also be open to the public but aimed at providing Bay community based resource management groups with useful water quality management information.

Research methods to identify specific sources of bacterial contamination have continued to be a popular topic of discussion. We co-hosted with the Tomales Bay Watershed Council, Dr. Christopher Kitts from Cal Polythenic University in San Luis Obispo. Dr. Kitts was specifically invited to share the results from his and his colleagues work on identifying sources of bacteria within the Morro Bay Watershed. He did this at two separate presentations, one for the Tomales Bay Shellfish Protection Technical Advisory Committee and one for the larger Tomales Bay community. These presentations were structured to facilitate a better understanding of how such a study is conducted and the benefits and drawbacks of the generated results.

Community Forum on Pathogens and Water Quality

Multiple agencies, with differing mandates and objectives, are charged with the management and regulation of Bay water quality for bacteria. This can prove to be confusing to the larger public as they seek information and direction on the topic. Recognizing this, we held a community forum on March 3, 2003, at the Point Reyes Station Dance Palace. Over 60 community members attended this third series of community forums held in conjunction with studies being conducted in Tomales Bay.

We co-organized and sponsored this event with the Tomales Bay Watershed Council, Marin County Environmental Health Services Department, and San Francisco Bay Regional Water Quality Control Board. The focus of the forum was pathogens and water quality in the Tomales Bay Watershed and we used a panel format comprised of agency and organization representatives. Each panel member provided a ten-minute overview of their respective organization and spoke about their efforts to improve water quality in the Bay. This was then followed by a question and answer session allowing panelists and forum participants the opportunity for lively exchange.

Table 1: List of presentations and educational workshops organized and provided through the University of California Tomales Bay Water Quality Project.

Date	Location/Event	Presenter	Presentation Title
08/25/00	Point Reyes Dance Hall	Drs. Kenneth Tate and Robert Atwill, U.C. Davis	Livestock Management to Improve Water Quality
10/08/00	State of Tomales Bay – Pt. Reyes Dance Hall	Robert Giacomini – TBAG	History and Role of Tomales Bay Agricultural Group
10/08/00	State of Tomales Bay – Pt. Reyes Dance Hall	David Lewis, UCCE	Improving Water Quality from Dairies
10/16/00	Tomales Bay Shellfish Protection Technical Advisory Committee	David Lewis, UCCE	Project Overview and Update
11/18/00	Tomales Bay Watershed Council	David Lewis, UCCE	Project Overview and Update
02/28/01	U.C. Berkeley Ecology Class Panel	David Lewis, UCCE	Surface Water Quality and Dairies
6/19/01	Tomales Bay Shellfish Protection Technical Advisory Committee	David Lewis, UCCE	Project Overview and Update
10/16/01	Tomales Bay Watershed Council	David Lewis, UCCE	Project Overview and Update
11/16/01	Two Rock Hall	Dr. Jim Moore, Oregon State University	Managing Dairy Manure
11/16/01	Point Reyes Dance Hall	Dr. Jim Moore, Oregon State University	Water Quality and Livestock Agriculture
12/04/01	U.C. Dairy Work Group Meeting	David Lewis, UCCE	Surface Water Quality and Dairies

2/28/02	Bodega Marine Laboratory Monthly Seminar	David Lewis, UCCE	Water Quality Management in California Coast Dairies
7/16/02	Tomales Bay Shellfish Protection Technical Advisory Committee	David Lewis, UCCE	Project Overview and Update
3/6/03	Sonoma/Marin Animal Resource Committee	David Lewis, UCCE	Measures to Improve Water Quality
3/10/03	Community Forum	Panel	Understanding and Managing Water Quality for Bacteria in Tomales Bay
03/28/03	Gulf of Farallones National Marine Sanctuary Water Quality Working Group	David Lewis, UCCE	Implementing Best Management Practices for the Marin and Sonoma County Livestock Industry
07/15/03	TBSTAC -PRNS Red Barn	Dr. Kitts, Cal Poly San Luis Obispo	Identifying Bacteria Sources in the Morro Bay Estuary
07/15/03	UCCE Sponsored Community Presentation	Dr. Kitts, Cal Poly San Luis Obispo	Identifying Bacteria Sources in the Morro Bay Estuary
10/30/03	CSREES Pacific Northwest Regional Water Quality Program	David Lewis, UCCE	Surface Water Fecal Coliform Load Within Coastal Dairy Watersheds
11/05/03	California Nonpoint Source Conference	David Lewis, UCCE	Making Water Quality Management Decisions on Dairies in the Tomales Bay Watershed
11/06/03	Sonoma/Marin Animal Resource Committee	Michael Lennox, UCCE	Managing Runoff from Lots
4/29/04	Redding, California	David Lewis and Dr. Paul Olin, UCCE and California Sea Grant	Balancing Beneficial Uses in Coastal Settings, Have Oysters, Got Milk?
09/12/04	UCCE Pasture Management Workshop	Stephanie Larson and David Lewis, UCCE	Improving Pasture Management by Implementing Riparian and Nutrient Practices

COLLABORATIVE ALLIANCES

A cooperative and collaborative approach is required in addressing a complex and contentious issue, such as water quality. This collaboration incorporates locally acceptable solutions and generates ownership of those solutions, leading to continuation and maintenance of those efforts. We carefully and purposefully formed collaborative alliances with the following groups and organizations to achieve this aspect of project management and sustainability.

- **Tomales Bay Agricultural Group (TBAG):** The dairy producers and ranchers of TBAG were the primary cooperators and clientele of our efforts. Each step of the project was reviewed by TBAG members to receive and incorporate their input and direction. Because of this role and function, the project itself is referred to by TBAG members and the general public as the "TBAG Project" rather than a University effort.
- **Marin Resource Conservation District (MRCD):** The District provides local ranches and dairy operators leadership and support in the implementation of practices to conserve natural resources and enhance wildlife habitat. It was a natural fit for our project team members to collaborate with the District through the sharing of our project findings and the incorporation of that information into efforts to secure funds for on-farm water quality improving projects. This has resulted in a successful grant application by the District to the California State Water Resources Control Board for $710,000 to implement and monitor management measures to improve water quality on Bay farms and ranches.
- **Natural Resources Conservation Service (NRCS):** The local NRCS office was instrumental in the selection, design, and implementation of on-farm management practices to improve water quality. This includes the development of methods to treat animal concentration areas, as well as the location of riparian fencing, buffer strips, and sediment retention basins.
- **Project Advisory Committee:** We formed an advisory committee consisting of representatives from federal, state, and local agencies, and other local organizations. Meeting once a year, committee members provided critical technical support and coordination with other organizations' educational, management, and regulatory efforts to improve Bay water quality.
- **Tomales Bay Shellfish Technical Advisory Committee (TBSTAC):** Project team members and cooperators have and continue to participate in TBSTAC meetings and subcommittee meetings to assist in the drafting of the TBSTAC final report. We continued to provide updates at committee meetings as an additional measure to keep regulatory agency staff informed of our efforts and progress.
- **Tomales Bay Watershed Council (TBWC):** The TBWC was started during the second year of this project, as the one organization intended to be representative of the diverse interests and stakeholders in the Bay Watershed. Project team members and cooperators have and continue to participate as council members including active roles on the Council's water quality committee. Through this

participation, we have been able to provide project updates as well as offer direction and leadership on the formation of a watershed wide water quality monitoring plan. In addition, we co-sponsored the March 2003 Community Forum on water quality management with the council.

- **Marin Agricultural Land Trust (MALT):** Collaboration with MALT has included the co-sponsoring of several educational forums and workshops, resulting in well publicized and attended events for the watershed community.
- **Other agency partners include**: CA Dept. of Health Services, US EPA, SF Regional Water Quality Control Board, Natural Resources Conservation Service, Pt. Reyes Nat'l Seashore, CA Dept of Fish & Game, and the County Health Dept.

OUTCOMES AND IMPACTS

Anecdotally, the impact of this project can be seen on the participating ranches. As part of the ongoing studies and educational programs, we are actively implementing management practices to improve surface water quality. Project-led implementation of practices is an indication of project success. However, more exciting and telling of real progress is the implementation of practices by producers themselves. These include exclusionary fencing, repositioning of feed troughs, and changes in animal distribution. Although it is not quantifiable, these actions speak to an understanding that has been achieved in objectives one and two on the part of the project cooperators. More extrinsic indications of outcomes and impacts include:

- The ability of project team to leverage $1,067,500 in additional funding and support for this project.
- Cooperating dairies successfully passing RWQCB regulatory inspection for water quality management.
- On 12/5/02 SFRWQCB presented certificates of recognition to 13 local dairies for their continued efforts in environmental stewardship. Over 1/2 were in this study area.
- Securing of $710,000 by MRCD to implement additional water quality improving practices on Bay dairies and ranches.
- Support of Bay agriculture and its efforts to improve water from the TBWC, TBSPTAC, and other organizations.
- Generation of peer-reviewed publications and invitations to speak at state and national conferences.

Figure 9. Dairy operator Albert Straus, RCD Director Nancy Scolari, and project leader Dave Lewis, in front of newly installed methane digester on Straus Ranch

By providing water quality results to area dairy and ranch operators, these producers have been able to prioritize and implement water quality improving management practices in collaboration with other technical and financial assistance agencies (Figure 9). State Water Resources Control Board approved a Proposition 13 funding request to support management practice implementation based on project results. Recently, four of the project cooperators were recognized by the San Francisco Bay Regional Water Quality Control Board for their efforts to implement appropriate practices and improve water quality on their ranches and dairies. These positive actions continue to stay threatened lawsuits against agriculture. The project research results and education efforts also serve as an example for others working on natural resource conservation and agricultural viability. As the Regional Water Quality Control Board TMDL standards are put into place, this project and the collaborative processes it has brokered serves as a statewide model of cooperation and problem solving.

BUDGET REPORT

Please see the attached financial report for details on MCF funded expenditures. The $112,000 MCF grant provided a base of support that extended from the original award period of 1999-2001 to December 2004. This allowed us to use the MCF funds as match for other grant sources.

Funds Leveraged

Since 2002 additional funds received allowed the expansion of the winter storm sampling for four seasons. This provided both researchers and producers with a stronger database for decisions.

Additional funding totaling $1,067,500 was secured from FY 1999 through FY 2004 to continue this project.

1999-2001

TBAG	$3,000 for water quality monitoring
RREA	$3,500 for water quality workshops
UCD	$25,000 for SRA salaries
Western United Dairy	$3,000 Tillamook producer trip
Dairy Workgroup	$4,000 lab expenses for one FY
Wildlife & Fisheries Committee	$5,000 for analytical lab work

2002-03

Sea Grant	$2,000 to bring OSU speaker on Tillamook experience to Pt Reyes
UC SAREP	$16,000 to supplement data collection/analysis
Prop. 13	$700,000 grant with MRCD staff to implement mgmt practices
Sea Grant	$300,000 cover salary and equip. expenses for field sampling and lab analysis for FY 2002-2004

2004

MMWD	$6,000 Willis Evans Watershed Habitat Improvement Grant

NEXT STEPS

Our project team is currently completing analysis of the water quality data. This includes determination of management practice effectiveness in reducing bacteria, nutrients, and sediment in runoff from dairies and ranches. We will use this analysis and results in publications that we are currently writing. These publications will include both peer reviewed journal articles and extension publications written to provide management directions to local ranchers and dairy producers. They provide an approach to evaluate and identify sources of on-farm pollution, direction on the implementation of on-farm practices to reduce water quality impacts including the distribution of animals, application of manure as fertilizer, and management of lots and corrals. We are also developing and will implement workshops in Humboldt, Morro, and Tomales Bay watersheds during the fall of 2005. These workshops will provide participants with the information and management directions developed through this project including the discussed publications.

It is not likely that the conflict over water quality in Tomales Bay will ever fully dissipate. We have, however, provided on-farm direction to ranchers and dairy operators who were under the threat of law suits and regulatory action. The cornerstone of this

effort was and continues to be a focus on agricultural practices instead of the agriculturalist. Because we have taken steps to provide concerned local community members and regulatory agency staff the results from our studies, those groups have adopted this cooperative "practice based" approach with livestock agriculturists to manage water quality. Our next steps, including the mentioned publications and workshops, are to continue providing tools for improving water quality on watershed farms and ranches. Our aim is to foster a cooperative community approach to resolving conflict, and assist groups in achieving their goals for water resources in the Bay.

REFERENCES

California State Senate: 1993. California Shellfish Act of 199 - Senate Bill No. 417. 4 pgs.

CRWQCB: 2004. Pathogens in Tomales Bay Total Maximum Daily Load: Final Project Report. California Regional Water Quality Control Board, San Francisco Bay Region, 78 pgs.

O'Connell, L., G. Langlois, D. Hopkins: 2001. Tomales Bay technical advisory committee final report: Investigation of nonpoint pollution sources impacting shellfish growing areas in Tomales Bay, 1995-1996. California State Water Resources Control Board, Department of Health Services and San Francisco Bay Regional Water Quality Control Board. 128 pgs.

DHS. 1996. Identification of Sources of Bacterial Indicators of Water Quality of Tomales Bay Shellfish beds, Pilot Monitoring Program, Winter 1994-95. California Department of Health Services, Environmental Microbial Diseases Laboratory.

Jarvis, F., C. Nokay, M. Amman, and M. Yee. 1978. Tomales bay and watershed water quality surveys during 1976-77 and 1977-78. San Francisco Bay Regional Water Quality Control Board. San Francisco, California. 22 pgs.

Lee, Kye-Han, T.M. Isenhart, R.C. Schultz, and S.K.Mickelson. 2000. Multispecies riparian buffers trap sediment and nutrients during rainfall simulations. Journal of Environmental Quality. 29: 1200-1205.

Musselman, J.F., 1980. Sanitary Survey of Shellfish Waters, Tomales Bay, California, February-March 1980, Department of Health and Human Services, Public Health Service, Food and Drug Administration, Shellfish Sanitation Branch, Davisville, RI.

NRCS Conservation Practice Specification 342A. 2000.

Sharpe, C.A., 1974. Tomales Bay Shellfish and Water Quality Survey, California State Department of Health, Water Sanitation Section.