THIRD BIENNIAL STATE OF TOMALES BAY CONFERENCE, 1992
AGENDA

October 24, 1992
9:00 AM to 4:40 PM

9:00	Registration
9:30	Welcome: John Grissim, Environmental Action Committee of West Marin
9:35	Keynote: Skip Schwartz, Audubon Canyon Ranch
9:50	Summation of First Two Conferences: Bruce Wyatt, U.C. Cooperative Extension Sea Grant Program
10:10	Current Issues Facing Tomales Bay: Richard Plant
10:30	State Government & Bay Protection: Senator Milton Marks
10:40	The Role of County Government and the Coastal Commission: Supervisor Gary Giacomini
10:50	My Front Yard: Clayton Lewis
11:00	Break: Refreshments
11:15	Water Quality Panel: Guest Moderator, Steve Eabry
12:35	Poetry: Dr. Michael Whitt
12:45	Lunch (provided)
1:45	Citizen Stewardship for Tomales Bay: Michael Herz, San Francisco Baykeeper
2:15	Research Panel: Guest Moderator, Jules Evens
3:35	Break: Refreshments
3:50	Tomales Bay Poetry/Song: Rhiannon
4:00	Herding Fleas: Steve Eabry, Coordinator Morro Bay Task Force
4:30	Concluding Remarks: Suzanne d'Coney, Conference Coordinator

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1992

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A Summary of the Past Two Conferences

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I have found that trying to summarize the work of the past two conferences is an impossible task. I want to share some of the responsibility of summary with each of you here today and with some who are not here. Let me explain. The proceedings that you received this morning were financed by the County of Marin through its Wildlife and Fisheries and Advisory Committee. There was a little money left over in the grant and I arranged for about twenty-five copies of each of the past two proceedings to be made. These copies are available, at our cost, at the back of the room so, that you may have a record of the happenings and plans of the past two conferences. A few free copies are available for teachers, to encourage elementary, high school, and college students to submit papers for the 1994 proceedings. We would also like to have a volunteer teacher from an elementary school or high school serve on the conference steering committee.

I want to get back on task to summarize the past proceedings. The theme of this year's conference is "Stewardship." The first conference also had a theme. I am going to read it, because it is several lines long. "TOMALES BAY IS RECOGNIZED AS ONE OF THE MOST PRISTINE ESTUARIES REMAINING IN THE UNITED STATES. HOWEVER, THE -BAY AND ITS WATERSHED ARE INCREASINGLY SUBJECT TO THE PRESSURES OF RESIDENTIAL AND TOURIST GROWTH, AND THE RESULTING EXPANSION OF COMMERCIAL ACMVITY. HOW CAN WE ENSURE THAT THIS UNIQUE BAY WILL BE PRESERVED? THIS CONFERENCE WILL CONSIDER THE BAY'S VARIED RESOURCES AND CONCLUDE WITH A PANEL DISCUSSION OFFERING RECOMMENDATIONS FOR DEVELOPING A PROGRAM OF COOPERATIVE RESEARCH AND EDUCATION TO PROMOTE THE HEALTH AND PRODUC71VITY OF TOMALES BAY.

I notice that the statement of theme has a goal in it -- developing a program of cooperative research. This goal is being accomplished. The backbone of this cooperative research is the Land Margin Ecosystem Research Program being funded by the National Science Foundation and managed by the San Francisco State University Romberg Center and the University of Hawaii. Many other universities are involved: Sonoma State, UC Bodega Marine Laboratory, and the University of Maryland to name only a few. We hope that elementary schools and high schools can also be involved. The UC Cooperative Extension, a source of information on research and community involvement, also has helped the schools with projects such as "Ag. in the Classroom," and "Salmon in the Classroom." An accomplishment of the first State of Tomales Bay conference was the birth of the Tomales Bay Advisory Committee, chaired by the Honorable Peter Behr. The committee hears, discusses, and reacts to Tomales Bay problems. Peter Behr gives a detailed description of the Committee in the 1990 State of Tomales Bay proceedings, and names of current participants are given in this years proceedings.

I want to stay on task by highlighting some of the research presented at the first two conferences. The fisheries including the Pacific herring fishery, have been a major focus

from the beginning. The concern for herring and the apparent decline in herring populations was a rallying point for many bay people. Tom Moore discussed herring in the 1990 proceedings and he felt that the population decline was associated with the drought. Pacific herring like to spawn in estuaries with some fresh water inflow; Tomales Bay has not had much fresh water the past few years.

Another rallying point has been the rapid sediment deposition occurring in Tomales Bay.Every estuary in California is filling. Sedimentation and water quality are major problems throughout the United States. Tomales Bay has its share of these problems. Steve Chatham at the 1990 Conference talked about repairing gullies and erosion control in the watersheds. Phil Williams spoke about freshwater inflow and sedimentation in Tomales By and San Francisco Bay. 'Me 1990 proceeding contained a lot of basic background data. Michael Martin talked about toxic materials and heavy metals. The shellfish industry was described, and the role of California Public Health Department was discussed. Some results were also presented about the "Land Margin Research Project." Studies were reported on the nutrient budget, the pathways of nitrates and phosphates, and how this relates to productivity of the bay and its animal and plant populations. The work of detailing the circulation patterns was also considered to be important. This is all of the summary I plan to present.

In the remaining time, I want to talk about the theme of this year's conference, "Stewardship." The dictionary definition of a steward is " a person entrusted with the management of estates or affairs not his/her own." In Tomales Bay, both individuals and groups practice stewardship or management. I believe we need to keep improving our management skills in Tomales Bay. Simple things like holding effective meetings about the bay can enhance our management skills. Meetings that can develop consensus are very helpful in giving everyone a chance to participate.

Suntan Lotion and Other Impacts Affecting Tomales Bay

Richard Plant
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In the 1972 Tomales Bay Environmental Study by the Conservation Foundation, Dr. Robert Cooper stated that "... the existence of an unspoiled estuary is a rare phenomenon" and that "Tomales Bay is such a rarity". He said that "all efforts should be made in the course of the area's development to preserve the estuary in its relatively pristine condition". At the 1988 State of Tomales Bay Conference, Dr. Michael Josselyn of San Francisco State University described Tomales Bay as the " jewel on the beautiful coastline of Marin County". After living near Tomales Bay for many years in the town of Inverness, I enthusiastically endorse both of these remarks. I find the bay to be a place of astounding beauty with clean water suitable for swimming, sailing and fishing.

Tomales Bay currently supports an oyster farming industry and until recently it supported a vigorous herring roe fishery. To a lesser degree than in the past, Tomales Bay also provides a sport-fishery for clams, crabs, striped bass, flounder, halibut and perch. In the early fifties, fishermen would catch about 400 salmon each year offshore from Inverness. Unfortunately, the runs of these fish have diminished to the point where fishermen no longer bother to fish for them in the bay, although it is still legal to do so.

When first asked to give a talk at this conference, I worried about my qualifications. I am a carpenter and building contractor by profession. I think that my highest level of expertise all of these years has been in enjoying Tomales Bay: swimming, fishing, sailing, rowing, sunbathing-many, many hours of intimacy with and pleasure on the bay. I have also written two short scientific papers on fish and have been active with others in groups whose purposes are to protect Tomales Bay. Perhaps these experiences afford me a useful perspective.

I have been asked to list the critical issues which I think are, or might, affect Tomales Bay. The general problem is that there are too many of us making too many demands on the bay and its surrounding hillsides. Each one of us who puts on suntan lotion, walks down a trail, and then swims in the bay has an impact. If you have ever looked in the water that you rinse your outboard motor in, you will see an oily scum on the surface that we all prefer not to think about when we are out motor boating. If you have been on your boat for a long time and feel the call of nature and head toward a beach and the bushes beyond, it is likely that you will discover that someone has been there before you. If you go clamming, you will also discover that someone has been digging there before you. Sometimes just too much viewing has had harmful consequences such as when eager sight seers disturb harbor seals.

I wish to preface my remarks this way because it is easier to find fault with others than to analyze one's own practices. If we wish to use and enjoy Tomales Bay, we should consider our own impacts. There may be some relatively easy ways to reduce these impacts that do not now occur to us, perhaps in the same fashion that solid waste

recycling did not occur to many of us until a few years ago.

There are activities affecting Tomales Bay, other than my own, that merit attention. The June 25, 1992 Point Reyes Light describes a projected waterfront development for Marshall that will include a marina, restaurant, retail stores, ten unit inn, ten cottages and nine houses. A short distance to the south a similar development has been considered for Marconi. Across the bay from Inverness and adjacent to Millerton Creek, a greatly expanded quarry operation is proposed, raising concerns about siltation (Point Reyes Light, July 16,1992). And at the head of Tomales Bay at Tomasini Creek, a sevenfold expansion of the West Marin Sanitary Landfill is being planned. It would accept industrial and other waste from the San Francisco Bay Area.

Agriculture, a benign industry compared to the types of industry affecting other waterways, has had its impacts of nutrient and sediment runoff. Good grazing and management practices, which are being adopted by a number of ranchers, can yield large benefits both to their land and to the bay. But even in agriculture there are changes. The shift on some ranches from grazing to the raising of crops or vineyards may eventually result in more chemicals and sediments reaching the bay.

Currently the State Water Resources Control Board is considering the fresh water release schedule that Marin Municipal Water District should adhere to in order to protect the resources of Lagunitas Creek and Tomales Bay. Local groups have participated heavily in these deliberations and now await with anxiety the decision of the State Board.

Those of us who live in the area and value Tomales Bay are being challenged and sometimes overwhelmed in our efforts to keep track of these and other proposed changes. But we should be encouraged by the knowledge that Tomales Bay, unlike many other estuaries, still has water of remarkably good quality. This is reason enough for us all to become baykeepers.

It is often assumed that the various county, federal and state agencies should do this job for us. But the people who staff these agencies are a lot like the rest of us- of varying talents, often overworked or under funded, driven sometimes by political considerations, and on rare occasions, too lazy or too tired to do their jobs properly. Sometimes obvious but important protective or enforcement measures are overlooked.

For instance, most of us in this area have septic systems attached to our houses. But do we know how often they should be inspected and pumped? If we knew, it might save repair money in the long run, and it would reduce the flow of unnecessary nutrients especially during wet weather. I confess to being sadly ignorant as to the answer to this question. I think that the County Department of Health could help us by annually publishing advisory information on this topic in the local newspaper.

I have learned that the agencies responsible for safeguarding the water quality of Tomales Bay do not always have clearly established lines of authority amongst themselves when it comes time to deal with a pollution problem. And of course, the members of the public often have an even less clear idea.

We have observed that the Fish and Game Department will take decisive action regarding some agricultural waste water runoff problems. The State Department of Health monitors the safety of shellfish. But it is not clear to me how these and other agencies coordinate to take action when pollution of the bay is more directly initiated by an individual or a business.

Several years ago I saw a man drain his auto radiator containing antifreeze onto a boat ramp which then ran down into Tomales Bay. I know of bay side buildings that dump washing machine or washbasin water directly into the bay. I know of one building that has electricity, beds and a toilet without proper plumbing -- how the waste is taken care of is anyone's guess. Twice it has been reported to me that a place of business has pumped out its septic tank directly into Tomales Bay.

The consequences of such actions to the perpetrators, and the way that various agencies might coordinate to discourage these activities are unknown to me. I think that a public education and publicity program would be of value. For instance, signs could be placed at boat launching ramps informing the public about their responsibility in keeping the waters clean.

Perhaps a clearer, coordinated program of presenting evidence, along with appropriate agency response and enforcement is required. If you agree that this issue should be recommended to the Tomales Bay Advisory Committee as being of highest priority, I hope that you will support the resolution attached to the questionnaire being distributed at this conference.

I thank you for your attention, and I suggest that you keep wearing suntan lotion when you go to the beach. But try to get the kind that doesn't easily wash off. Its cheaper in the long run.

SUGGESTED WATER QUALITY RESOLUTION

Whereas Tomales Bay water is generally acknowledged to be of unusually fine quality,

Whereas this high water quality is beneficial to wildlife, oyster growers, sports fishermen and other recreational users,

Whereas there are a number of agencies at the state, county and federal levels that can be expected to take an active role in protecting the high quality of Tomales Bay water,

Therefore, we as attendees of the 1992 State of Tomales Bay Conference urge:

1. That the Tomales Bay Advisory Committee accept as the highest order of priority the protection of Tomales Bay water quality.

2. That the lines of authority and coordination amongst the various government agencies in abating water quality problems of different types be clearly established

3. That the evidence required for an agency to respond to a water quality problem as a valid problem meriting investigation be create; delineated

4. That the nature o the response of each agency to a valid problem be clearly specified.

5. That the legal and enforcement consequences to someone or a place of business who knowingly causes pollution in Tomales Bay be made unambiguous,

6. That the various government agencies support public information and educational efforts to discourage actions which cause pollution of Tomales Bay.

Programs and Practices for the Protection of Tomales Bay

Richard H. Bennett Ph.D.
University of California Cooperative Extension
Food and Water Quality Advisor
North Bay Region

The Tomales Bay watershed is a unique resource. It lies well within the influence of the San Francisco Bay Area, yet remains mostly undeveloped and sheltered from the effects of urbanization. The harvest of timber and the production of food to meet the needs of San Francisco caused great changes in the landscape and the nature of Tomales Bay, but at the same time, much of its unique quality has been preserved and protected. This is due, in part, to land uses that have prevailed since the turn of the century.

Today, agricultural and rural residential land use around the bay provides a hope and a threat. The hope is that traditional land use will persist. Moderate to high density housing and business development would create environmental changes incompatible with sustaining a healthy and estuary. 'Me threat is that even the current population and the moderate agricultural land use of the watershed may create changes in the system that are deleterious and threaten the long-term sustainability of the land and marine resources.

Recognizing this delicate balance, the people of the region adopted land use policies to reduce the potential of large urban populations in West Marin County. These present polices remain somewhat effective, but a less conservative policy could result at any time, particularly in this era of economic recession, when some argue for relaxation of environmental protection. Even with West Marin's pro-agriculture policies, some residents criticize agriculture as one of the main threats to Tomales Bay. Others have the position that agriculture is more compatible with the resources of the Tomales Bay region than intense urban economic uses of the land would be. Finding the balance remains the challenge for the people and policy makers of the region. Agricultural practices can be improved for the betterment of Tomales Bay. Many of these improvements, however, will require investments that will become profitable only in the long-term. In the near-term, mechanisms for cost-sharing and improving the cash position of the farms will be needed to implement these enhancements.

Many years ago, it became clear to those of us in the University of California Cooperative Extension program, that the Tomales Bay area provided a unique opportunity to provide technical and public policy assistance for those grappling with the dilemma of finding the balance needed to protect the unique assets of the region. For example, UC conducted the Farm Family Tours, a first-hand experience of farms in the western region. Farmers and environmentalists were provided opportunities to hear, see, and yes, smell the issues and begin a face-to-face dialog. Perhaps for the first time in California, former agricultural and environmental adversaries were talking with each other rather than at each other.

Also, the local UC office conducted the first-ever livestock waste inventory of the Tomales Bay watershed, the findings of which were discussed and published at the previous Tomales Bay Conference. That study determined that the livestock resources of the region were significant, and that the manure created by the dairy, beef, and sheep

operations was equally significant. If not properly managed to keep the nutrients and organic materials out of the bay, the wastes could pose a specific, localized, or even a bay-wide threat. We postulated that from 5,000 to 15,000 acres of range and farmland are needed in the region for the land-based recycling of the animal waste nutrients. This finding has profound implications for land use planning of the region. The technology to capture and reuse the animal waste resource exists, and the use of animal wastes as a resource is an ongoing program of UC in this region. The program examines the current public policy of water quality and environmental protection and conveys it in terms that are meaningful and understood by the agricultural community.

In July, 1992, the Fourth Annual Animal Waste Conference was held in Cotati. Subjects ranged from an in-depth discussion of the current regulatory programs to concepts such as the integrated pond system for the biological treatment of dairy wastes. In 1993, the Dairy Waste program will include a tour of model farms and successful projects in the Stemple Creek and Estero Americano watersheds. The purpose of these programs is to provide producers with first-hand information on waste management and on using wastes as resources, while complying with waste management regulations.

The conferences are an outgrowth of an ongoing leadership role UC has in a group called the Sonoma Marin Dairy Waste Committee. This group of farmers, regulators, engineers, and scientists meets monthly to discuss issues, develop procedures, and offer a first-line industry response to complaints of dairy waste violations. It is the hope of this committee that education and prompt attention to problems will enable the industry to be self-regulated. Close working relationships with the region's regulators have already provided for prompt resolution of farm problems. The committee will soon be publishing a set of manure-management goals and recommended practices. This set of goals and management recommendations will provide a clear, concise objective for effective farm waste management.

A part of the dairy waste issue is connected with another food producing industry in Tomales Bay. The oyster producers of the bay are prohibited by statute from selling oysters after heavy rainfall. The statute assumes that after a rainfall, oysters will be contaminated with sewage bacteria. Coliform bacteria in sea water are used as an indicator of human sewage contamination. Foodstuffs and water that contain an excess of coliform bacteria are presumed to be contaminated with sewage, and therefore unsafe for human consumption. Dairy waste is laden with coliforms and, possibly, other disease producing organisms. The presence of coliforms from animal waste is not a valid indicator of human sewage, but unfortunately, the scientific methods used to discriminate between human coliforms and animal coliforms are very costly, and not available for routine public health laboratory use. Research demonstrates that during a heavy rain, manure can be washed into the bay. Although it is prudent to err on the side of caution, it is not clear to what "tent animal manure represents a health risk to consumers of raw shellfish. Further research is recommended by the EPA in order that protection from disease can be provided, without unnecessary restrictions on shellfish-growing areas adjacent to farm animal production lands or wildlife areas.

Working with UC marine advisor Bruce Wyatt, we assisted the oyster growers by using our problem-solving model to define the specific sanitation problems they confronted, and how these problems might be addressed. As a result of the problem-solving sessions, the participants recommended that a sanitary survey of bay waters be performed this

winter. If "typical" rainfall occurs, the data may determine whether the quality of the bay waters has improved since the advent of more stringent animal waste control regulations.

The new interest in animal waste control will emphasize non-point sources of animal waste. Non-point sources include pasture animals that congregate in drainages to graze and seek shade. Non-point pollution controls will also address field and pasture applications of manures, in order to assure that over-application will not result in immediate or long-term transfer of excessive nutrients to the bay drainages. The success of this program will be determined, in part, by the ability of the food producers to pass these added costs of non-point source nutrient management along to the consumer.

These external costs of food production have remained insulated from the retail cost of food for far too long, and resulted in artificially inexpensive food. This avoided cost will continue to be paid at the expense of the environment until the true cost of food production is paid for through tax based mitigation programs or at the check out stand.

In conclusion, we of the local UC program are committed to working with the people and issues of Tomales Bay. We have a unique resource and a unique opportunity to demonstrate that the beneficial uses of land and water resources can be sustained, while protecting the local economy. Failure to accomplish both may result in land and resource use changes that are more deleterious in the long run.

California Department of Fish & Game: Activities and Plans

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ANIMAL WASTES ARE MORE THAN JUST SMELLY -- THEY'RE LETHAL

You are undoubtedly aware of the Department of Fish and Game --- that agency of sleep- deprived wardens who lurk behind trees, bushes, and shrubs, usually in the middle of the night, to pounce upon the occasional misguided "conservationist." Right! Well, I'm one of them -- not a midnight lurker, but rather the guy they send out when everything either smells so bad no one else will go, or something has spilled or is about to spill that no one else can pronounce. I've worked in this capacity for the past twenty-two years within about a third of the state, including Marin and Sonoma Counties, and I find my job fascinating!

I have worked with game wardens, sheriffs, police, fire departments, district attorneys, and other law enforcement agencies, as well as the dedicated staffs of regulatory agencies, to resolve a variety of pollution problems. I have responded to every major oil or hazardous material spill within the fifteen central coast counties of the state, as well as the seemingly innocuous spills of molasses, milk, soap, or wine which can have their own lethal effects on fish and aquatic life. I have been deeply involved in evaluating the risks to fish and aquatic life of major municipal waste discharges, cleaning up contaminated soils and wetlands at superfund sites, investigating acid mine drainage, and the effects of urban runoff.

During this period, I have seen dramatic changes in the regulation of polluters, and, commensurate with that added attention, dramatic improvements in water quality. There is one notable exception, however, and that involves the lack of regulatory attention to agricultural operations, especially large confined animal facilities like dairies. Today, some of the most polluted streams in the state drain these agricultural areas. Streams that once supported abundant populations of salmon and steelhead now contain remnant populations which are struggling to survive.

I first became involved with the dairy industry in the early 1970s, as a member of both the Marin and Sonoma Dairy Waste Committees. These committees were composed of dairy operators as well as representatives of the Farm Bureau, the University of California Cooperative Extension, the Department of Fish and Game, and the Regional Water Quality Control Boards. The stimulus for creating these committees was an abrupt increase in regulatory attention, principally by the State of California Water Resources Control Board, which adopted a set of minimum guidelines for animal confinement facilities. These guidelines were actually no more than what we might today consider to be common sense recycling. These "guidelines" required that all animal wastes and contaminated storm water be contained on-site without overflow to streams or other watercourses except during major 25-year storms. In response, the dairy waste committees encouraged dairymen to construct waste collection and disposal systems that would put wastes back on the land and keep it out of the creeks. To sweeten the program, federal funds were available to assist in constructing ponds. The San Francisco Bay Regional Water Quality Control Board even adopted some fairly specific waste discharge requirements for a small number of dairies so that the dairymen would know what was expected of them. The Boards hoped that the non-

regulated dairies would sense their obligations and clean up their waste handling problems on voluntarily.

Considering the sad state of dairy waste handling practices at that time, this program had some initial success. Most dairies constructed ponds and the collected wastes were frequently spread on adjacent fields, some only occasionally. Some systems were well managed, but many were not. More important, all dairies increased their herd sizes but many did not increase their capacity to handle the additional wastes. This situation should have evoked renewed regulatory attention, but higher priority state and federal water quality programs within metropolitan areas distracted the regulators. As a result, the dramatic improvement in water quality of our major bays, streams, and watercourses in urbanized and industrialized areas, realized through intensive regulatory programs, have not materialized in rural agricultural areas.

Confined animal operations create problems in local watersheds. In the past, we thought that the effects of animal wastes were limited principally to the addition of solids, bacterial contaminants, and oxygen-demanding materials. By their sheer volume, these could result in fish kills, impaired spawning of anadromous fish, and fecal contamination of shellfish in Tomales Bay, long recognized as bringing about increased regulatory control of commercial shellfish harvesters, rather than the generators of the contamination. Now, however, recent responses to several dairy waste pond failures within the tributary watersheds and other streams of the area, have led to the discovery that soluble organics, principally ammonia, are of even greater importance, because their migration into the stream kills stream biota. Ammonia is extremely lethal at concentrations considerably less than one part per million, and its toxicity in the receiving waters is exacerbated by other extremely soluble nutrients commonly associated with it. We did not know that ammonia is not limited to fresh animal wastes, but is also leachable from dried animal waste stockpiled, applied to fields, or held in disposal areas, and thus potentially mobile. Thus, the management of animal wastes and compliance with regulatory standards should be worthy of much greater regulatory attention today.

The Department of Fish and Game is not a regulatory agency, but rather a law enforcement agency. For the past two years, we have been involved in a program of investigation within Marin and Sonoma Counties involving the collection of water quality data to document and identify sources of ammonia, salts, and other constituents which limit the area's aquatic resources. Our program, termed the Marin Sonoma County Agricultural Runoff Influence Investigation (MSCARU) has been successful in identifying dairies, feed lots, and even a duck farm which were discharging toxic wastes. Criminal enforcement of Fish and Game Code violations was sought by the District Attorneys when the evidence warranted it. Our principal objective, however, was to develop a data base on the quality of our local streams that would stimulate renewed regulatory attention. We also hope that our program can assist the animal husbandry industry in identifying management options which are effective in keeping our local streams and watercourses clean, productive, and a place that a respectable fish might want to call home.

I will not present any data here. During the past two wet seasons we sampled at twenty sites, principally in Sonoma County. Two intermittently sampled stations were located within the Tomales Bay watershed. The data are available in a dbase IV program to anyone interested.

California Regional Water Quality Control Board
Activities and Plans

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The San Francisco Bay Regional Water Quality Control Board (RWQCB) is one of nine regional boards in California, operating under the direction of the State Water Resources Control Board, which in turn is part of the new Cal/EPA. The overall purpose of the RWQCB is to protect the surface and ground waters of the San Francisco Bay Basin. The San Francisco Bay Region includes the area from the southern boundary of the watershed of the Estero de San Antonio in Marin County (south of the Stemple Creek drainage) to the southern boundary of the Pescadero Creek watershed in San Mateo and Santa Cruz Counties. The goals of the RWQCB are to protect beneficial uses of water, to preserve existing water quality, and to implement state and federal laws. The primary policy document the RWQCB uses to carry out these functions is the Water Quality Control Plan for the San Francisco Bay Basin. The Basin Plan defines and delineates beneficial uses for water bodies within the region, sets water quality objectives (based on EPA criteria and public health guidelines), and details an implementation plan for protecting water quality through a variety of requirements and prohibitions. The legal basis underlying the Basin Plan comes from two primary sources: the Porter-Cologne Water Quality Control Act (California Water Code) and the federal Clean Water Act (administered in California by the Regional Boards with EPA oversight).

In the past, the RWQCB has focused most of its efforts on regulating point sources (for example, the West Marin Landfill and the Borello sewage ponds in the Tomales Bay watershed), through the NPDES (National Pollutant Discharge Elimination System) permit program or by issuing waste discharge requirements (WDRS) to specific facilities. At the same time, urban and agricultural runoff have continued to be mostly unregulated and unchecked, and now contribute much of the pollutant loading to rivers, streams, bays, lakes, and lagoons in the San Francisco Bay Basin. Therefore, the RWQCB has begun to focus more attention on controlling pollution from these sources, with an emphasis on preventing pollution before it happens rather than cleaning up "after the fact".

The RWQCB's new priorities are reflected in the reorganization of the staff to include a Watershed Management Division. This Division focuses on storm water runoff, other non- point source issues, and watershed management planning in watersheds impacted or threatened from point and/or non-point sources of pollution. We are also working with each county and incorporated city in this region to develop storm water management programs. Marin County will be required to develop a baseline program that includes operation and maintenance programs, ordinances to control runoff from new development during and after construction, and public and industry education programs.

The Regional Board's Basin Plan lists the beneficial uses of Tomales Bay as water contact recreation (swimming, boating, etc.), non-water contact recreation (hiking, bird-watching, picnicking), commercial and sport fishing, wildlife habitat, preservation of rare and

endangered species, marine habitat, fish migration, fish spawning, and shellfish harvesting. From our perspective as a water quality agency, our role in helping to protect Tomales Bay is focused on protecting these beneficial uses by implementing our stated policies to regulate the major point sources (treatment plants, septic systems, landfills) and the major non-point sources (including sedimentation from mines and quarries and impacts of dairy and other animal wastes discharged to the creeks feeding into the bay).

In line with the RWQCB's goal of reducing and preventing accelerated (human-caused) erosion to restore and protect beneficial uses of water bodies, we are actively working to develop erosion control policies in this region. We have a memorandum of understanding (MOU) with the Council of Bay Area Resource Conservation Districts to assess existing problems and to monitor local government progress on adopting and implementing erosion and sediment control ordinances. Our guidelines call for local government agencies to be the lead on erosion control, for use of best management practices, and for potential use of WDRs and enforcement actions. We are also working with several mines and quarries in the area to develop management plans for discharges from these facilities.

Recognizing that septic system discharges may have an important impact on surface and ground water quality in rural areas such as the Tomales Bay drainage, the Board staff are also working on a revised and expanded septic policy in the Basin Plan. The RWQCB has a waiver resolution with each county in the region, acknowledging that the county ordinances are in compliance with Regional Board guidelines and waiving requirements for filing waste discharge reports for conventional septic systems. Innovative (alternative or experimental) systems will be allowed through MOUs with individual local agencies. In order to qualify for approval under the MOU, the local agency program will be required to develop and implement monitoring and inspection programs, reporting procedures, site evaluations, and minimum site and design criteria.

We are also currently working with the Dairy Waste Committee of Marin and Sonoma Counties, the Farm Bureaus, and Resource Conservation Districts (RCDS) in a cooperative effort to develop best management practices for control of dairy wastes. Such practices include proper maintenance of waste ponds (cleaning them out before the rainy season begins), land application of pond water and manure at safe distances from creek beds, diversion of rainwater away from barns and stalls by gutters, and fencing creeks to keep livestock out. Our authority to regulate dairies and other confined animal facilities (such as stables, chicken farms, and so on) is contained in the California Code of Regulations Article 23, Chapter 15, which sets out specific requirements for containing animal wastes. At this time we do not plan to issue waste discharge requirements as long as dairies voluntarily comply with the Chapter 15 regulations; however, we are prepared to issue WDRs and/or to take enforcement action where water quality goals are consistently being exceeded (e.g., we have recently levied a $3000 fine on a dairy in Sonoma County). We are currently visiting dairies in Marin and Sonoma counties to check on their progress during the dry season, and we definitely intend to have a presence in the area once the rains begin.

As noted above, we are putting a great deal more emphasis on watershed planning and management, and we are now reviewing EIRs and environmental assessments with this in mind. The Basin Plan policy on wetland fill is that there is to be no net loss of habitat acreage or value. The Board has the authority to waive or deny water quality certification on all wetland dredge or fill projects, and we expect to use this authority to protect riparian

vegetation to the maximum extent possible. We are continuing to work with the Department of Fish and Game, the State Parks Department, the Department of Toxic Substances Control, the RCDS, Soil Conservation Service, and the Marin County Planning Department on point and non-point source impacts in the Tomales Bay watershed.

Finally, we have been doing water quality sampling of Tomales Bay as part of the RWQCB's work to develop sediment quality criteria. In 1991-92 sediment samples from eight sites in Tomales Bay were collected to serve as reference sites. Samples used for bioassay testing (i.e., testing for sediment toxicity using marine invertebrate species) showed some toxicity in samples taken from Tomales Bay, Drake's Estero and Bolinas Lagoon. The cause of the toxicity is not clear at this point since there were no high levels of metals, ammonia, or sulfides found in the samples. In 1992-93 the Board will be conducting a major study in Tomales Bay, Drake's Estero, Bolinas Lagoon, and San Pablo Bay to determine the cause of the toxicity and to try to develop region-wide protocols for testing marine sediments.

California Department of Health Services
Preharvest Shellfish Sanitation Program

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Seven existing commercial firms in Tomales Bay, operating on a total of 212 acres, are growing and harvesting oysters, mussels, and clams. In 1989 the California Fish and Game Commission offered eight new parcels in Tomales Bay for aquaculture leases. These new parcels have a combined area of approximately 480 acres. To date, only one of the eight companies holding new leases has applied for a Shellfish Growing Area Certificate from the California Department of Health Services (DHS).

The Environmental Health Division within DHS is the lead agency in the state Shellfish Sanitation Program (SSP), which certifies and regulates sanitary procedures followed in the harvesting, handling, processing, storage, and distribution of bivalve mollusk shellfish intended for sale for human consumption. Within the Division, the Environmental Management Branch (EMB) regulates shellfish sanitation in the growing waters while the Food and Drug Branch regulates shellfish sanitation after harvest. EMB is also responsible for the preparation and administration of a management plan for commercial shellfishing in Tomales Bay. This management plan establishes procedures for emergency notification and harvest closures in case of accidental sewage spills or toxic substance spills. Procedures are also established for temporary harvest closures based on rainfall measurements. A separate management plan exists for establishing quarantines and harvest closures when naturally-occurring biotoxins (e.g., paralytic shellfish poisoning toxins) are found at alert levels.

Tomales Bay is classified for commercial shellfish production in accordance with the National Shellfish Sanitation Program's (NSSP) Manual of Operations. All commercial shellfishing operations in Tomales Bay are in areas classified as conditionally approved. The purpose of the conditionally approved classification is to provide a mechanism for the declaration of harvest closures during predictable periods when the shellfish growing area does not meet NSSP standards for harvesting shellfish for direct marketing for human consumption. For Tomales Bay, these predictable periods of water quality degradation occur during significant rainfall events.

The SSP currently uses the fecal coliform (FC) standard, as established in the NSSP Manual of Operations, as the primary measure of water quality within the growing areas in Tomales Bay. Fecal coliform, used as an indicator for the presence of human pathogens, is currently the only indicator organism recognized by the NSSP. Water quality monitoring for FC densities is conducted at least monthly during open periods, and the growing area classifications and closure rules are reevaluated annually. Sixteen primary sampling stations are monitored monthly, and thirteen secondary stations are monitored on a less frequent basis. The primary stations represent the aquaculture leases currently under production, as well as four main tributaries to Tomales Bay. The secondary stations represent additional sites within current leases, new leases not yet under production, and areas of known or suspected water quality degradation. The SSP targets periods of adverse conditions for

sampling (e.g., on the first day of reopening following a rainfall closure). In addition, supplemental data for water and shellfish quality are collected during rainfall closures.

The subject of rainfall-related water quality degradation in Tomales Bay is a complex issue involving a matrix of environmental, biological, and chemical processes. Some of the variables involved include (i) the volume, rate, and duration of rainfall, (ii) the distance of various pollution sources from the bay (and the transport time involved from each of these sources to main tributaries or directly to the bay), (iii) flow rates for the major tributaries, (v) tidal influence, (vi) salinity, (vii) water temperature, (viii) dilution and mixing both in the tributaries and in the bay, (ix) flushing, and (x) bacterial die-off rates. In determining the length of a rainfall closure, two criteria must be met: (1) Water quality in the affected areas must return to acceptable levels, and (2) sufficient time must be provided for shellfish to depurate.

Rainfall closure rules for all conditionally approved growing areas in Tomales Bay are based on a joint study by DHS and the U.S. Food and Drug Administration conducted in the winter of 1980. This study concluded that rainfall-related runoff was the principal cause of observed elevated bacterial levels. Rainfall greater than 0.50 inches within a 24 hour period results in a closure of the commercial shellfishing areas to help mitigate the impact from the various non-point pollution sources. These non-point sources enter the bay via one of several main tributaries. Recent evaluation of water quality data confirm that these closures have been successful in keeping the certified shellfish growing areas within NSSP standards for water quality during the times the bay is open for shellfish harvesting.

National Marine Sanctuary Protection in the Area

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The Cordell Bank and Gulf of the Farallones National Marine Sanctuaries protect the second largest marine environment in the United States. This area is roughly encompassed by the 1000 fathom curve on the west, Bodega Head in the north, the mean high tide line in the east and Half moon Bay in the south. The gulf of the Farallones and Cordell Bank National Marine Sanctuaries celebrated their 12th and 4th anniversaries, respectively, this year.

The Gulf of the Farallones National Marine Sanctuary contains features unique to the west coast of the continental United States. These waters provide some of the West Coast's most bountiful catch of commercial and recreational seafood and support an unrivaled number and diversity of marine mammals and seabirds.

Estuarine marshes within the Sanctuary are double the acreage of all the West Coast estuarine reserves. Esteros Americano and San Antonio are the only known protected salt water estuaries of their kind in the world. Tomales Bay is considered by some to be the most pristine estuary in the continental United States. Bolinas Lagoon is another estuary within' the Gulf of the Farallones National Marine Sanctuary. These four estuaries constitute an important component of the environmental system and contribute greatly to the beauty and productivity of our area.

The Sanctuaries have community outreach programs which include, at no charge, slide programs available for loan to schools, guest speakers for elementary through high school classes, and programs for community fairs. The Sanctuary contracts for schools to participate in the Adopt-A-Beach program, and provides funding for the Tarlton Foundation's Whale Bus program.

The Sanctuary coordinates all marine research in the area and disseminates the information to the many groups which gather data on the marine environment. Monitoring studies of organisms provide data the staff uses to ensure that the environmental quality of the marine ecosystem is protected.

Marin-Sonoma Dairy Waste Committee
Joe Mendoza, Rancher
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I'm Joe Mendoza, Jr., a third generation dairy rancher. I am to be the chairman of the Marin County Dairy Waste Committee, and I'd like to explain a little about what that committee was formed for and what it tries to do. Initially, in the 1960s and early '70s, we became aware that water quality was going to be an issue. It was apparent that in order to stay in business and continue in the dairy industry, we would have to face this issue and try to educate ourselves and head off some of the problems.

Our Committee tries to act as a mediator between the dairies and the various water quality agencies, such as the Department of Fish and Game. When a complaint is made, I'm usually notified. One of the Committee members will then go out and speak to the individual concerned. One of the first things we try to do is get the engineers out to look at the situation to see what can be done to improve it. Normally, the individual involved is cooperative. The ranchers generally feel easier talking to someone they know and then we all try to solve these problems together.

We're very fortunate to have a fine Resource Conservation District staff. There's Rick Bennett and quite a few others who really try to help the ranchers remedy these problems. But we also try to head some of them off before they happen. So we've had various seminars, and mailers going out to inform about types of management practices. We're trying to educate our dairy ranchers and prevent some of these troubles as much as we can.

ne industry has changed somewhat. There aren't nearly as many dairies as there used to be when I was starting in this business. There are now only about 60 in Marin County and about 120 in Sonoma County. If you go back 20 years, you could probably double that. There are fewer dairies, but there are more animals per dairy. In addition, the animals are confined more for the purpose of getting more production. We've got a lower price today than we had eight years ago for our product. So we've been forced to get more efficient. The cows are confined more, milked three times a day, for example, to improve efficiency.

But this means that the dairies have to have better facilities for containing the waste, which has put added pressure on the industry. Engineers are designing waste containment systems but the costs bring about economic strain. However, we're encouraging our dairy ranchers to make these investments. We also have the Agricultural Conservation Stabilization office (which, we hope to keep open) in Santa Rosa, which helps fund some of these investments. They pay for part of the costs of installing new facilities, and I hope that people are interested in keeping Tomales Bay clean. We encourage legislators to get us in the budget to assist us in our goal of keeping the water clean.

BLACK BRANT

Brant nigficans

for Tupper Blake

From far out
across the bar,
from the sea haze
and the banked fog,
from the ocean's roar
the wavy line
of geese appear,
undulant,
rising and falling
with the rhythm of the sea swell,
climbing
in a long file
against the green hill,
like a squadron
of elegant ships
with jet prows
and snow-white sterns,
their eloquent gabble
carried to us
in snatches
on the seawind,
their powerful flight
driving them toward
us as we crouch low
in the blowing sand.

From above the Arctic Circle,
from the tundra of Alaska
and Siberia they come,
from their great rendezvous
at Izembek Bay they come
over the route of the gray whale,
sweeping down on powerful wings
over the ocean barrens,
skirting headlands as some evil,
flying aloft or in the wave trough,
from the polar regions
to the Tropic of Cancer
they come.

We summon them into our bays
we pray for their return,
we place our decoys as icons,
we await their arrival
on bent knee
in this drowned valley
in a crease of the great fault.
We offer them our eel grass,
our prayers, our devotion:
elegant argonauts,
give us the power
of your flight,
give us the strength
of your hearts,
give us your faith
in the providence
of the earth and the skies;
come to our icons,
yield to us
your downy breasts
reveal to us
your deep keel bones
that part the waves and cut the air,
provide us
with your stalwart spirit,
lead us
on our long journey.

Black brant!
Be our totem,
crown our dreams
with your beauty,
your power, your fidelity,
be our ancestors,
our source.

Paradise Grove, Fall 1982

Michael Whitt
from *Coho*.
La Ventana (1988)

Bird Populations on Tomales Bay

John Kelly
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INTRODUCTION

As many of us here today know quite well, Tomales Bay is a very good place for birds. This is true both for numbers of species that occur here (over 100 species of water birds and shorebirds alone) and the abundances supported by Tomales Bay. However, because most of the work conducted here has been limited to censuses, I am unable at this time to make any profound statements about the processes or mechanisms that promote or limit bird life here -- that is, we do not yet know exactly why this is such a good place for birds. Nevertheless, 'we can make some fairly clear assessments of Tomales Bay bird populations, and we have established some simple long-term monitoring studies that may in time become quite valuable in addressing questions about the ecology of Tomales Bay birds. Today I want to provide a brief account of some of the biomontoring studies being conducted by Audubon Canyon Ranch.

As part of my role in all of this, I work at Cypress Grove Preserve (CGP) near Marshall. Cypress Grove is the center of about 410 acres of Audubon Canyon Ranch properties around Tomales Bay, including Tom's Point, Hog Island, Walker Creek Delta, Olema Marsh, and nine other smaller sections of shoreline.

OLEMA AND LIVERMORE MARSHES

We have been monitoring breeding bird populations and vegetation changes at Olema Marsh and Livermore Marsh (CGP) since 1985. We are currently studying the local habitat use and foraging niche of Common Yellowthroats. Yellowthroats here are called "Salt Marsh Common Yellowthroats," the San Francisco Bay Area subspecies, which is a Category 2 candidate for federal listing under the Endangered Species Act. During dry years with reduced water levels, these and other wetland breeders become more vulnerable to nest predation by terrestrial predators, and may suffer reduced availability of insect prey. Our aim is to eventually complete studies of local habitat preferences of other key wetland species, including Virginia Rails, and Tricolored Blackbirds (currently being considered for federal listing).

Since the late 70's, vegetation in both marshes has changed dramatically producing a more complex and productive habitat. A major determinant of the long-term character of these habitats is of course, sediment. Livermore Marsh has been accreting at a rate of about 11 mm per year since 1988, but this rate reflects a period of drought and most sedimentation probably occurs during episodic events associated with heavy rainfall. So the expected rate is much greater.

SHOREBIRDS

In November 1989, Audubon Canyon Ranch (ACR) began conducting seasonal censuses of shorebirds (Scolopacidae and Charadriidae) on Tomales Bay. The bay is divided into nine count areas that are covered simultaneously by teams of qualified volunteer field observers. Three bay-wide counts are completed within each of four census periods. We estimate early winter (November-December) and late winter (January-February) population levels, and attempt to record peak numbers of fall (August-September) and spring (April) migrants.

Tomales Bay supports about a third of the shorebirds that winter along coastal Marin and Sonoma Counties, reaching 17,000 to 20,000 shorebirds in early winter. The most abundant shorebird species concentrate on the large tidal flats at the north and south ends of Tomales Bay. By conducting all-day watches, we have found some evidence of restricted movements of winter flocks between north and south Tomales Bay. Seasonal abundance patterns also appear to differ between the north and south bay, with late-winter numbers of shorebirds, especially Dunlin, decreasing more dramatically in the south than in the north. Although this pattern cannot yet be explained, it could result from movements to seasonally available wetlands, either locally or in the San Francisco Bay or Delta areas, when winter rainfall of runoff reaches a particular threshold, or from adverse feeding conditions in the south bay if freshwater runoff from Lagunitas Creek results in reduced availability (greater depth) of marine invertebrate prey. At this point, however, such explanations are speculative. During winter storms and high water, shorebirds in the south bay sometimes, but not always, use the seasonal habitat near the mouth of Tomasini Creek.

AQUACULTURE AND SHOREBIRDS

As a precondition for issuing permits for the 1989 aquaculture leases in Tomales Bay, the California Department of Fish and Game agreed to fund a five-year study of the possible effects of aquaculture on winter shorebird use of intertidal habitat. This winter, we will begin the fourth year of this study.

For most species, preliminary analyses based on the first three years of study do not detect aquaculture effects that are significantly greater than the underlying variation found within the plots. Preliminary results do indicate that aquaculture plots support more Willets and fewer Dunlin than non-aquaculture areas; however, the possibility that these differences result from aquaculture impacts must be substantiated by continuing study and the planned development of aquaculture on two of the control plots.

WATERBIRDS

Tomales Bay differs from other, generally shallower, coastal estuaries and lagoons along our coast in having a much greater area of open water at low tide. Consequently, the bay provides more waterbird habitat through the tidal cycle and supports more diving ducks, loons, and other divers, than most other coastal estuaries. Each winter since 1989-90, we have been conducting waterbird censuses of all loons, grebes, pelicans, cormorants, ducks, geese, Bonaparte's Gulls, terns, and alcids. We attempt to complete three or four waterbird counts during each December-February period. Observers count waterbirds simultaneously

from three boats in formation using radio communications along parallel 20-km transacts. The count data are partitioned into four subsets corresponding to estuarine intervals in Tomales Bay: (1) south of Tomasini Point, (2) Tomasini Point to Pelican Point, (3) Pelican Point to Tom's Point, and (4) Tom's Point to Sand Point.

Waterbird distributions on the bay reflect differences in habitat preferences and gradients of food availability for particular species. Ruddy Ducks, for example, concentrate in the shallow water at the south end of the bay. Homed, Eared, Western, and Clark's Grebes, and Red-throated, Common, and Pacific Loons concentrate in the deeper water between Cypress Point and Pelican Point, loons and grebes alone totalling up to 2,500 birds. Red- necked Grebes, which are uncommon to rare in the state, occur regularly north of White Gulch numbering from a few to over a hundred. Black Scoters are irregular and uncommon elsewhere on the California coast, but their haunting whistles mark a regular wintering population of 50-100 Black Scoters just north of Tomasini Point.

Wintering Black Brant have been increasing in the last few years. These small marine geese, about the size of mallards, depend on the lush eel grass meadows surrounding Hog Island for their food. Migrating Brant stop here during flights northward from Baia California and can reach 5,000 in early April, creating a beautiful spectacle of loud honking and aerial lacework. However, wintering individuals have been scarce until two years ago. December counts, normally ranging from 0 to less than 50, were 377 in 1990 and 986 in 1991. Several thousand brant wintered on Tomales Bay in the thirties and early forties.

Since 1989, total winter waterbird abundances on Tomales Bay have averaged between 21,000 and 25,000 birds, not including gulls or shorebirds. Unfortunately earlier records before the 1988 collapse of Pacific Herring spawning activity are not comparable, and are quite variable -- this is understandable since they were collected either from quick fly-over estimates or from a single Christmas Bird Count boat. Can you imagine counting over 2,000 waterbirds per square mile of water from one boat, rain or shine, calm or windy, in a bay averaging almost a mile wide? We are just now establishing a baseline capable of detecting population changes of 15 to 25 percent.

Surf Scoters are one of the more important waterbirds in the bay, known to heavily exploit herring roe in winter, have declined in the last three years. But we have no comparable data before the herring crash. It is possible that we will find no continuing pattern if birds are able to shift preferences to other available prey in the bay. Scoters also feed on molluscs and crustaceans in and around the eel grass, and in other bottom substrates. If waterbird numbers in Tomales Bay are dependent on the herring, we might expect to count greater numbers in the future if the herring continue to recover; or, perhaps a delayed decline in waterbirds as site faithfulness of individuals that wintered here before the herring crash abates, as suggested by the recent decline in Surf Scoters. Other species, such as horned grebes, have shown some increases. The possibility that overall populations of waterbirds have not changed appreciably four years after the loss of herring suggests an important aspect of adaptive behavior in birds: that waiting can be adaptive if evolution has encoded some measure of certainty for overriding short-term fluctuations in food supply.

HERONS AND EGRETS

I should add that Tomales Bay supports two very important Great Blue Heron and Great Egret nesting colonies: one at Brazil Beach with 22 active heron nests and 45 Great Egret nests this year, and one at Inverness Park with 21 heron nests and four Great Egret nests. With the assistance of about 75 trained volunteers, I am monitoring nesting activity at all the known heron and egret colonies in five northern San Francisco Bay Area counties, and I can say that the colonies on Tomales Bay are very important in the region. They represent two of the seven largest Great Blue Heron colonies in the region and two of the three largest in Marin County. Tomales Bay also supports herons and egrets nesting in other areas. In spring, herons and egrets can occasionally be seen flying up the Olema Valley to Tomales Bay, probably from the colony at Audubon Canyon Ranch on Bolinas Lagoon, or from the colony in downtown Bolinas that we have begun to call "Smiley's Preserve."

OTHER PROJECTS

Although I am here to talk about birds, there are other biomonitoring programs in place at Cypress Grove Preserve (see Appendix), including an annual inventory of rare plants in the Tomales Bay area. I will end with a photo of a rare salt marsh annual we found this year in Tomales Bay, *Castelleja ambigua humboldtensis.*

APPENDIX: CURRENT AUDUBON CANYON RANCH RESEARCH ON TOMALES BAY

1. Tomales Bay Shorebird Project: three bay-wide counts within each of four shorebird seasons, since 1989

2. The use of aquaculture areas by wintering shorebirds at Walker Creek Delta, Tomales Bay; 5-year study began in 1989-90

3. Tomales Bay Water bird Census: winter counts of all water bird species, conducted from boats, began in 1989-90

4. North Bay Counties Heron/Egret Project: annual monitoring of all known breeding colonies in Marin, Sonoma, Napa, Solano, and Contra Costa; since 1990

5. Disturbance behaviors of harbor seals (*Phoca vitulina*) in Tomales Bay (Sarah Allen and Mary Ellen King, associates)

6. Cultural resource assessment of pre-European land use on ACR properties (Faith Duncan, associate)

7. Tomales Bay Plant Species Inventory: relational data base of field records, also monitors rare species, dominant vegetation, and phenotogy; began in 1984

8. Vegetation photopoints: standardized photos taken twice annually at Cypress Grove Preserve, Tom's Point, Olema Marsh, and Shields Marsh; since 1988

9. Ecology and distribution of Point Reyes Bird's Beak, *Cordylanthus matitimuv* ssp. *palustris*, in Tomales Bay; 1989-1992

10. Test plots on the effects of mowing on Italian thistle, bull thistle, and poison hemlock; since 1990

11. Breeding bird censuses, Livermore and Olema Marshes; since 1985

12. Winter bird population studies, Livermore Marsh since 1985, Olema Marsh; 1985-91

13. Coastal Freshwater Marsh vegetation analysis, Livermore and Olema Marshes; since 1988

14. Common Yellowthroat habitat use, breeding and foraging niche, Livermore and Olema Marshes; 1989-93

15. Tricolored Blackbird breeding biology, Livermore Marsh; 1988, 1989, 1992

16. Vocal repertoire of the Black Rail, since 1992 (Chris Wood, associate)

17. Water level monitoring, Livermore Marsh; since 1988

18. Annual sedimentation, Livermore Marsh; since 1988

19. Semi-annual population index of California votes, *Microtus californicus*, Cypress Grove Preserve, November and May; since 1988

20. Coastal Prairie vegetation analysis May-June; since 1988

21. Reintroduction of native grasses, includes vegetation and *Microtus* plots (above) to monitor effects of Coastal Prairie restoration; annually since 1990

22. Coastal Prairie breeding bird census, Cypress Grove Preserve; since 1988

Tomales Bay Harbor Seals: A Colony at Risk?

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INTRODUCTION

Conservation, management, and protection of harbor seats come under the purview of the Marine Mammal Protection Act (MMPA) of 1972 (Public Law 92-522). A primary directive of the MMPA is to protect marine mammal stocks from declining below their optimum sustainable population. To fulfill this directive in California, the California Department of Fish and Game (CDFG), in cooperation with the National Marine Fisheries Service (NMFS), has been conducting annual, state-wide, aerial surveys of harbor seals to assess the status of the population. Harbor seal colonies along the Point Reyes coastline represent about 20% of the estimated breeding population of the state of California, and consequently, have received attention from CDFG and NMFS. In cooperation with these agencies and supported by the Point Reyes National Seashore and the Gulf of the Farallones National Marine Sanctuary, S. Allen has been monitoring harbor seals in Point Reyes since 1982. Audubon Canyon Ranch has supported surveys in Tomales Bay conducted by M. King and volunteers since 1991.

Tomales Bay is one of several locations along the Point Reyes Peninsula where harbor seals (*Phoca vitulina richardsi*) congregate onshore. Resting areas or "haul-out" sites in Point Reyes are found in remote areas on tidal sand bars, sandy pocket beaches, and offshore tidal ledges or islands (Figure 1). These haul out sites are critical habitat for seals because of their historical, physiological and reproductive significance. They have historical significance because seals congregate at the same site for years, perhaps centuries. Seals benefit physiologically from resting onshore after several hours of continuous diving for food. Seals rest onshore mostly during daylight hours for an average of 7 hr per day and retreat to the water to feed at night. The sites are important for reproduction because seals give birth and nurse their pups on land.

RESEARCH RESULTS

We conducted surveys of harbor seals in Tomales Bay during the periods 1982-1984 and 1992-1992 (Allen et al. 1984). In the 1982 survey we determined that harbor seals in Tomales Bay haul-out on the southeast side of Hog Island, on tidal mud flats extending from Toms Point to Sand Point, and on pocket beaches near Tomales Point along the west side of Tomales Bay (Figure 1). All three areas were used throughout the year, but in our surveys most seals were counted on tidal mud flats. Between 1982 and 1984, the monthly average number of seals was least during the height of the breeding season (March-May; $x = 156$, range = 85-275) and greatest during the winter (November- February; $x = 194$, range= 93-355). This pattern contrasts sharply with all other haul-out sites in Point Reyes where maximum counts occur during the breeding season and followed by the annual molt period (June-August). Winter seal usage corresponds to when the Pacific herring spawn in Tomales Bay and several seals radio-tagged in Drakes Bay migrated to Tomales Bay in the winter. The summer decline coincides with elevated

levels of human activities in Tomales Bay.
Maximum pup counts in 1982 (58), 1984 (45), 1991 (86) and 1992 (55) were similar, although higher in 1991. Pups represent about 16% of all seals counted by Tomales Bay. This percentage representation is lower than that derived at nearby Drakes Estero (20%) or Tomales Point (24%).

DISTURBANCE

Harbor seals, when hauled out on land, are sensitive to the presence of humans, and when approached to within 100-300 m, will characteristically retreat into the water en masse. There are short- and long-term effects from disturbance to seals. Short-term effects include reduced overall usage, reduced reproduction, or abandonment.

We measured several variables to determine the reactions of seals to human activities in Point Reyes and found that seals in Tomales Bay experienced the highest level of disturbance of all haul-out sites studies in the Point Reyes area (Table 1). Seals were disturbed during 49% of our surveys in 1983 compared to 29% at Drakes Estero. In 1992 the percentage was nearly double(81%). Disturbance levels were higher for all months of the year except winter.

Clam diggers and fisherman were the major source for disturbance (51%), followed by boats (30%), hikers (14%) and dogs (5%). In a single day several hundred people were observed digging for clams on the sand bars between Sand Point and Toms Point. The average number of people counted during surveys in 1991 was 350 with a maximum of 1225 seen in one day; on average, there were 4 disturbance per survey period. These months also coincide with the pupping season. More recently, kayaks and other boats launched at Nicks Cove likely are having a negative effect on seals at Hog Island, were seal numbers have dropped sharply in the past decade.

After being disturbed, seals in Tomales Bay were least likely to rehaul during the census time interval (seals rehauled 58% of time) compared to other haul-out areas (seals rehauled 85-100'Yo). Instead, Tomales Bay seals were more likely to use alternate sand bars on which to haul-out (28%) compared to other areas in Point Reyes (3%). In many instances, people in Tomales Bay remained for entire low tide cycles, thereby precluding the return of the seals. This contrasted with the behavior of seals at less disturbed areas where seals normally were able to rehaul within 30 min. The percent recovery (the proportion of the original herd to rehaul within I hour) was also least for Tomales Bay; only 36% of the original number of seals counted was likely to rehaul, whereas 75% rehauled after disturbances at Bird Rock.

The above information, along with the depressed pupping rate at Tomales Bay compared to other less disturbed areas, suggest that there may be a relationship between harbor seal reproductive success and human disturbance in Tomales 'Bay. Additionally, pup mortality rates were higher in Tomales Bay compared to other sites in Point Reyes (Table 1), and several pups were removed each year by people assuming them to be abandoned.

Despite chronic levels of disturbance, total numbers of seals in Tomales Bay have remained unchanged over the past decade. Nevertheless, the spatial usage of Tomales

Bay has changed. Since 1982, usage of Hog Island has dropped precipitously and presently seals occur there irregularly and in low numbers. In 1992 seals were noted on Hog Island on less than 10% of the surveys and only a maximum of 30 seals were counted compared to 1982 when 264 were documented. California Fish and Game annual surveys of harbor seals, graphically illustrate the steady decline (Table 2).

RECOMMENDATIONS FOR MANAGEMENT

- Post educational signs at boat access routes:
  Nick's Cove, Lawson's Unding, Millerton
- Point Educational brochures available at access routes
- Fence off areas with stakes where seals haul out on sand bars near Tom's Point
- Restrict water access with buoys on the east shore of Hog Island
- Increase supervision of MMPA by federal agencies

Table 1. Measures of the effect of disturbance on harbor seals in Point Reyes.

Measure	Tomales Bay	Other site*
Days disturbed	49%	29%
Vigilance (head alerts/min)	0.68	0.35
Alternate sites	28%	3%
Likelihood to rehaul	58%	85-100%
Reproduction	16%	24%
Pup mortality	22%	13%

* Other site refers to a more remote or relatively undisturbed one in Point Reyes.

Table 2. Results of the California Department of Fish and Game state-wide aerial surveys of harbor seals in June, 1982-89 (Hanan 1991).

Year	Hog Island	Toms Point
1982	136	196
1983	44	215
1984	47	0
1985	76	283
1986	35	280
1987	14	431
1988	17	289
1989	14	0
1990	0	347

References

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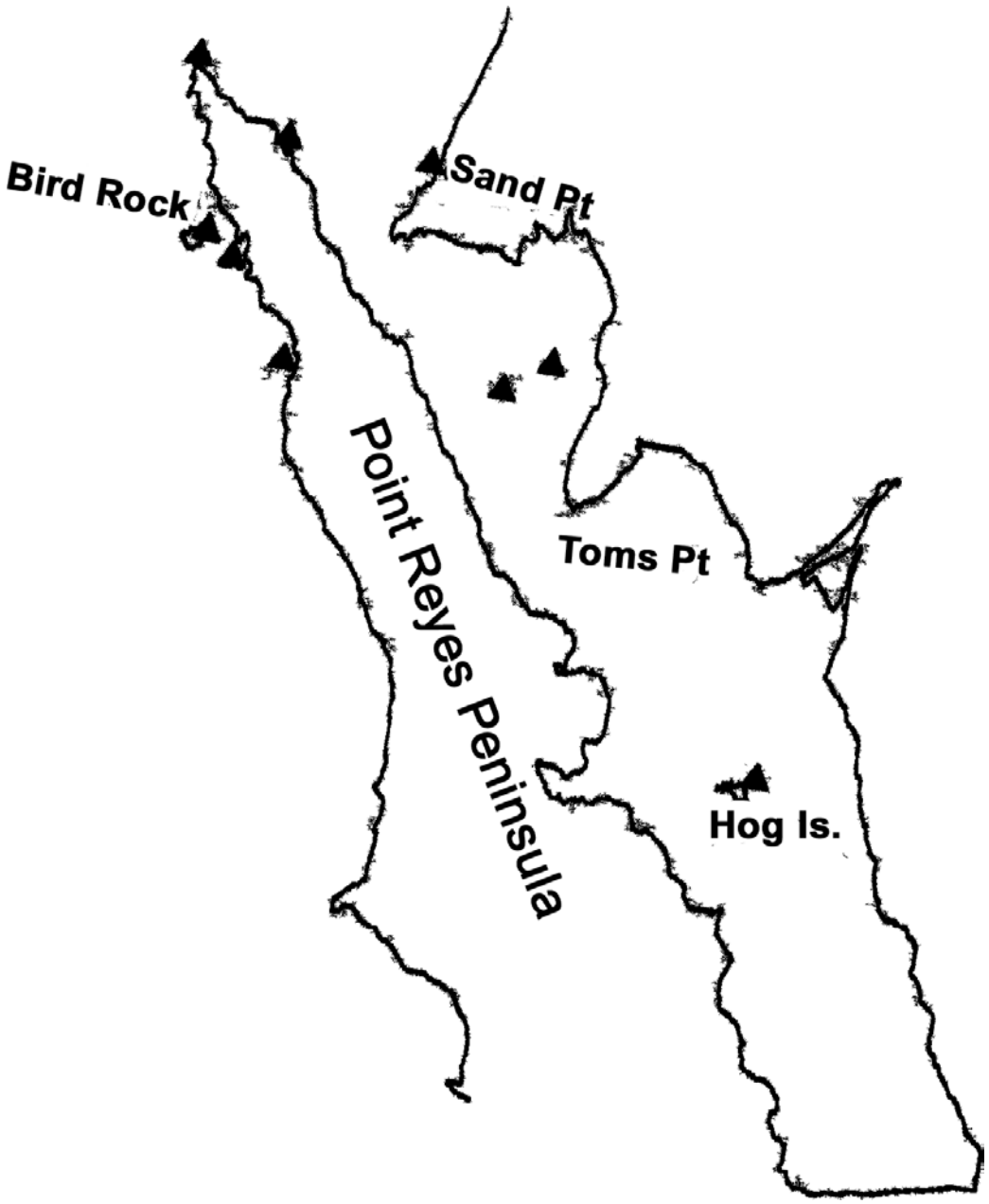
Hanan, D.A., 1990. Harbor seal, *Phoca vitulina richardsi* census in California, June 1989. Dept. Commerce, Natl. Marine Fish. Serv. Adm. Rpt. SER LJ-90-10.

Figure 1. Harbor seal haul out sites in the Tomales Bay area.



Plant Ecology of Walker Creek Marsh: Below-Ground Dynamics

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The intimate association between fungi and plant roots is a vital component of the below- ground dynamics in terrestrial ecosystems. Each partner in a mycorrhizal (Greek for "fungus-root") association benefits. The fungus enhances plant acquisition of soil resources through a network of tiny root-like structures termed "hyphae" which form an interface between the plant root and soil. The plant, in turn, provides energy in the form of sugar which is delivered to the fungus through the roots.

Vesicular arbuscular mycorrhizae (VAM) are by far the most commonplace type of mycorrhizae. The VAM fungus is related to the common bread mold but unlike the bread mold, it is obligately dependent on its plant partner--remove the plant and fungus dies. While the plant can usually live without the fungus, it generally suffers from poor nutrition unless fertilizers (particularly phosphorus) are applied. Consequently, VAM are important but seldom-seen components of natural vegetation systems.

Salt marshes have received little attention from mycorrhizal ecologist for several reasons. Since oxygen movement is impeded in waterlogged soils, microorganisms quickly consume what little oxygen is available and then turn to alternate compounds, sulfates for example, producing the familiar sulfurous odor associated with many marshes. The VAM fungus needs oxygen to metabolize the sugars it receives from the host plant and should, therefore, be excluded from waterlogged soils. Moreover, studies reveal that high moisture levels alone may inhibit fungal penetration of host roots. Finally, the highly saline soils common to salt marshes coupled with the presence of toxic compounds (like sulfur) are an added deterrent. How, then, can we explain the presence of VAM in salt marshes and other wetlands"?

The current hypothesis is that VAM can thrive in wetlands only during dry periods or in areas where surface water is not present'. The main objective of my research is to test this hypothesis by considering the spatial and temporal components of flooding on oxygen availability and VAM activity in the Walker Creek Delta marsh. In addition, I will also address the seasonality of VAM with respect to the host plant *Jaumea carnosa*, in terms of its growth patterns and nutrition.

The Walker Creek Delta marsh provides an ideal outdoor laboratory for assessing the importance of mycorrhizae in a land margin ecosystem. Situated 4.6 km southeast of the mouth of Tomales Bay, the marsh is characterized by a diverse assemblage of salt-tolerant vegetation dominated (in terms of % cover) by pickleweed (*Salicornia virginica*) at lower elevations, arrow grass (*Triglochin concinna*) at mid elevations, and gum plant (*Grindeli humilis*) at higher elevations along and stream and channel margins. The soils are continuously waterlogged deposits of stratified silt and clay. In addition, a gradient exists from the highly saline soils in the southwest marine zone to the more brackish soils in the northeast region of the marsh which are diluted by winter time precipitation and fresh water inflow from Walker Creek. During the long, dry season, evaporative moisture loss results in extremely saline conditions which are exaggerated in the northeast (upland) zone of the marsh (Fig. 1).

The Walker Creek Delta marsh is the first California wetland for which VAM have been described. Among the seven species surveyed in the spring of 1989, *Jaume carnosa* was consistently mycorrhizal exhibiting the highest levels of fungal colonization in the pioneer zone of the marsh. This perennial plant is an ideal candidate for testing the spatial and temporal aspects of flooding on VAM infection, as it can be found in areas of the marsh that are tidally submerged (sites 2 and 3), as well as areas that only become submerged with winter precipitation (Site 1). Moreover, it often forms pure stands as a consequence of its vegetative habit which simplifies collection and quantification of VAM roots.

Three permanent plots were established at upland, midland, and marine locations (Sites 1, 2, and 3, respectively) in the Walker Creek marsh. Soil moisture, redox potential (a measure of oxygen availability), and nitrogen were among the parameters measured at each location. The frequency of VAM and 10, 20, 30, and 40 cm depths was correlated to redox potential which was also measured at these depths. The redox measurement was repeated five to nine times over a 24 hour tidal cycle for an analysis of tidally-induced variance in oxygen availability.

Preliminary data suggest that VAM are not limited by waterlogged, oxygen deficient soils (Table 1), although it should be noted that there was a great deal of variance between the means reported in this table. Note also that VAM are absent in May at Site 1, where % moisture levels are comparatively lower and mean redox potentials higher than in other sites (the smaller the redox value, the greater the oxygen deficit in the soil). Figure 3 depicts the range in mean redox potentials over seasonal time: the trend is towards a more oxidized status as the soils become dryer in the summer months in the mid and upland locations. Typically, at redox values of 300 or less nitrate nitrogen (NO3-N) takes the place of oxygen in microbial metabolism. Thus, we predicted that nitrate would limit plant growth during periods of high demand. Indeed, vegetative and reproductive cover is greatest between May and July when nitrate levels decline (Fig. 2).

It is clear that VAM are a significant component of the Walker Creek marsh. What enables VAM to thrive in its waterlogged, oxygen deficient soils? What resources do the plants acquire from its fungal partner? Do VAM augment the aggregation of marine sediments, allowing plants to get a foothold in an unstable environments Salt marsh restoration efforts can only be enhanced with this sort of knowledge.

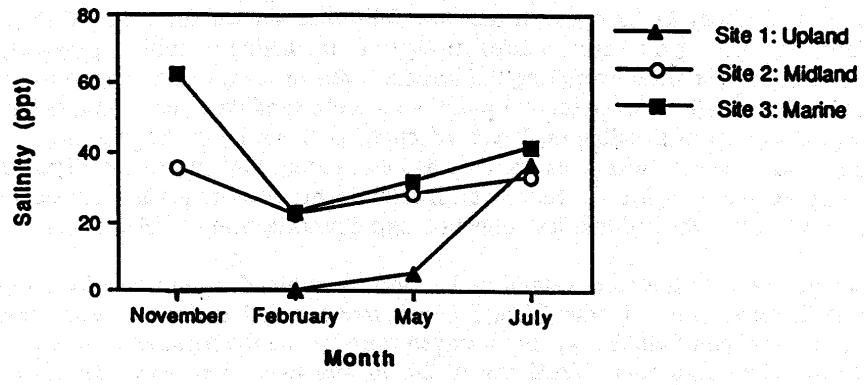

Fig. 1. Seasonal change in soil salinity for sites 1,2, and 3 in the Walker Creek Marsh

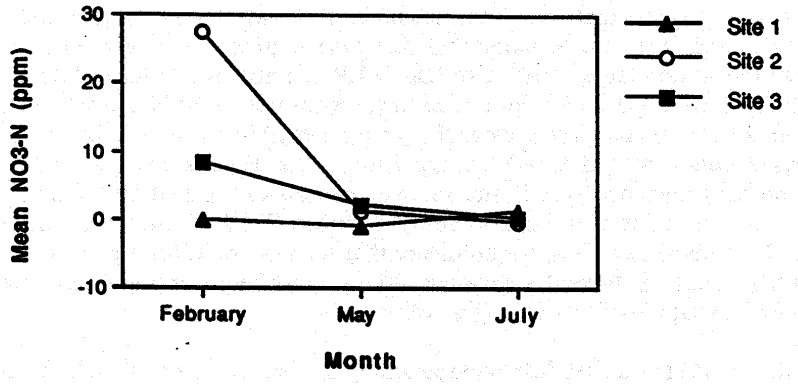

Fig. 2. Seasonal changes in soil nitrate levels

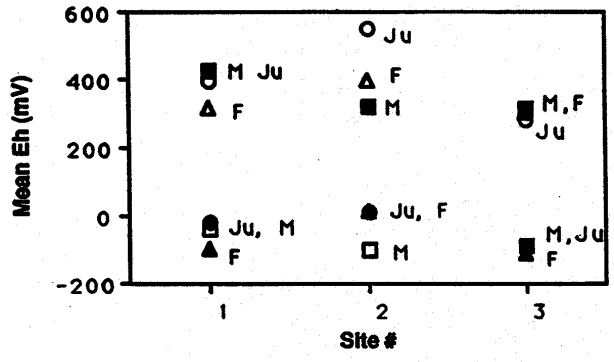

Fig. 3. Seasonal variation in minimum and maximum redox potentials (mean Eh) for February (F), May (M), and July (Ju), 1992.

Table 1. Summary of % Soil Moisture, Mean Redox, and %VAM

		February, 1992			May, 1992		
Site	Depth(cm)	%H2O	Redox (%)	% VAM	%H2O	Redox (%)	% VAM
1	10	*	166	4	120	382	0
	20	240	-43	15	70	31	0
	30	160	261	22	40	74	0
	40	*	*	*	40	233	0
2	10	88	111	67	150	254	40
	20	68	268	95	103	95	50
	30	69	156	100	71	174	30
	40	*	*	*	65	-50	40
3	10	69	255	7	225	238	40
	20	46	-20	20	185	206	40
	30	69	81	0	169	-5	0
	40	*	*	*	89	-8	.5

* Represents missing values

The Dispersal of Animals in Eelgrass Beds in Tomales Bay

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Eelgrass, Zostera marina, occurs in temperate estuaries and bays world-wide and provides a habitat for a wide variety of animals. Eelgrass is a true flowering plant that occurs in dense meadows along the shallow east shore of Tomales Bay.

Many species of animals live in eelgrass beds because of the cover the grass canopy provides relative to the bare mud flat regions nearby. Animals and plants of all sizes occur in eelgrass beds. For instance, the younger stages of Dungeness crabs and several flat fish occur in the grass beds. Bat rays commonly come into the grass beds to feed in Tomales Bay. There are also many small creatures like sea slugs, clams, tiny shrimp, and anemones.

Many of these animals spend their entire adult lives in eelgrass beds. When the young (or larvae) of these creatures disperse away from their parents to find a new "home", they may have to find a new eelgrass bed. Since most larvae are planktonic, that is they are carried at the whim of currents, dispersal to new grass beds is determined by water flow patterns in Tomales Bay. Dispersal is thus an important process because it allows for animals to colonize new areas of Tomales Bay. This is important in maintaining populations of animals in eelgrass beds in Tomales Bay and in nearby bays such as Bodega Bay.

To try to measure how animals travel from one grass bed to another, I worked with one of the smaller creatures in the eelgrass beds, a colonial tunicate or sea squirt. These are the orange and red gelatinous "blobs" that you find commonly attached to docks, boats and rocks as well as eelgrass. Although they look like slime molds, tunicates are actually closely related to you and 1. The larval stage of the tunicate has a spinal cord and a notochord (the rudiment of your backbone); these are some of the characteristics of organisms in our Phylum, the Chordata.

Tunicates have a biphasic life cycle in which the larval stage is a small planktonic creature and the adult stage is large sessile animal that remains permanently attached to one spot. I chose to work on this animal because the adults are brightly colored and easy to find and the larvae are (relatively) large, brightly colored, and easy to follow as they swim through the grass beds.

Although larval dispersal is most commonly studied in marine animals, there is another possible way in which animals in eelgrass beds can travel from one grass bed to another. That is they can raft on the leaves of eelgrass themselves. This is especially possible for the many small invertebrates that live attached to eelgrass leaves. Eelgrass grows rapidly in the summer and will shed its older leaves every 2-4 weeks, therefore, it is easily possible for animals to become detached and float away on these senesced leaves.

I am interested in understanding how animals are dispersed from one grass bed to another in Tomales Bay. I have been using the orange sheath tunicate to address a series of

questions such as: How do the grass beds affect the dispersal of larvae? What types of water flow patterns influence the dispersal of these larvae? Does rafting of animals on eelgrass leaves occur in Tomales Bay? If an animal rafts on a plant, how far can it go? If an animal rafts on a plant, can it survive a rafting trip?

I have had some interesting results during the several years that I have been working in Tomales Bay. I have found that animals can raft on plants and that they travel farther than larvae swim. I have also found that animals can survive a rafting trip provided that they land in water rather than being washed ashore. These results are interesting because rafting is not commonly thought to be a mode of dispersal for marine invertebrates. Rafting also appears to be relatively common in Tomales Bay, thus is probably important in maintaining animal populations throughout the bay.

Feasibility of Wetland Restoration at the Giacomini Ranch

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A study was undertaken under contract with the National Park Service to assess the benefits, impacts, and feasibility of restoring the 564 ac Giacomini Ranch located on former tidal marshes at the head of Tomales Bay. The Ranch was originally placed within the National Park Service's Golden Gate Recreational Area boundary in 1980 to preserve its rural open space values, but is still operated as a productive dairy ranch by the Giacomini family.

The study was undertaken to determine the ecological rationale for a restoration at the Ranch and to investigate possible restoration alternatives. The feasibility of restoration was assessed not only in terms of the physical and biological constraints affecting the site, but also the economic effects that such a restoration would have on the continued operations of the dairy industry in West Marin if the Giacomini Ranch production was curtailed or eliminated.

The conclusions from this study have been summarized in a draft report to the National Park Service.[1] The conclusions are as follows:

l.The restoration of the Giacomini Ranch as tidal wetlands would have a significant beneficial influence on the recovery of fish and wildlife resources of Tomales Bay. It would allow the re-establishment of a substantial contiguous habitat area with a gradually varying salinity gradient extending from intertidal mud flats through salt marsh to high marsh and riparian ecosystems. Restoration of natural habitat with this level of complexity will assist in protecting populations of endangered species such as the black rail. Restoration of tidal habitat will not only provide significant benefits for estuarine species, but also anadromous fish that use tidal wetlands channels in their life cycle.

2.Restoration of the Giacomini Ranch is physically feasible and its existing topography favors the rapid establishment of wetland vegetation without the need for extensive grading, filling or excavation.

3.At present, the Giacomini Ranch is a profitable efficiently run dairy. However, its long term viability is threatened by gradual and intermittent physical changes such as earthquakes, floods, subsidence, and sea level rise, all of which could make the ranch operation uneconomic unless public subsidies were provided.

4.Elimination of the Giacomini Ranch's milk production would constitute an incremental loss of about 4 percent of Marin County's current milk production. This loss is to be compared with increases in Marin's milk production of about 18 percent in the last 20 years. It is unlikely that this reduction would have a significant multiplier effect on West Marin's dairy economy.

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[1] This abstract and the materials presented at the Conference are the opinions of the authors and do not represent the off icial position of the National Park Service or the Golden Gate National Recreation Area. [1]

5.Four feasible restoration alternatives have been identified as well as the no action alternative.

The recommendations from the report are:

l.The phased restoration alternative provides for the greatest certainty of achieving the desired ecologic benefits at least cost.

2.Prior to developing a detailed restoration design, a recent topographic survey is required for the site.

3.T'he design of the creation of replacement freshwater wetland habitat adjacent to Olema Creek would need to be incorporated as part of the detailed restoration design for Giacomini Ranch.

Geology of the Tomales Bay Region

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Introduction

Tomales Bay exists because of two natural phenomena: the San Andreas fault, and high sea level. The linear valley that extends from Bolinas Lagoon north to Tomales Bay coincides with the San Andreas fault, a 0.7 to 1.5 km-wide zone of concentrated geologic activity. The northern end of this valley has been inundated with sea water during the past 10,000 years, as glacial ice melted and sea level rose. We are studying the sedimentary layers and the land forms in the Tomales Bay valley in order to understand the recent geologic history of climatic changes and land deformation in this region.

San Andreas Fault Zone

The San Andreas fault is a major geologic feature. As the boundary between the North American and Pacific plates, it is the locus of motion as these immense crustal pieces slide past one another. The land adjacent to this great crack in the earth crumples and warps when the fault moves, producing earthquakes. A trenching study across the San Andreas fault near Olema (Niemi, 1992) showed that the land is offset an average of 2.4 cm/yr in a right-lateral motion. This means that the land west of Tomales Bay is moving toward the northwest relative to the land east of the bay. The slip rate of 2.4 cm/yr is somewhat misleading because this section of the San Andreas fault remains locked for long periods of time. There seems to be no motion for several hundred years, then there are several meters of motion that produces large-magnitude earthquakes, 1906 being the most recent example. The epicenter of the 1906 earthquake was north of San Francisco and the greatest offsets across the fault (4 to 5 meters) were measured near Olema (Lawson, 1908).

The persistence of the San Andreas fault is demonstrated by the different bedrock types that are found on either side of Tomales Bay (Figure 1). The granite bedrock that makes up Inverness Ridge (west of Tomales Bay), formed as molten rock cooled beneath earth's surface, similar to the rock that makes up Half Dome and much of the mountainous terrain in the Sierra Nevada. The Franciscan bedrock that makes up Bolinas Ridge (east of Tomales Bay) is a heterogenous assemblage of oceanic sediments and volcanic rocks that were accreted into the continent. By matching rock types across the fault, geologists have shown separations of over 300 km during the past 20 million years. The granite on Inverness Ridge probably originated somewhere in southern California, where it was separated from the southern Sierra Nevada.

Quaternary Climate Changes

During the past two million years (known as the Quaternary Period), our planet has been in the throes of an Ice Age, characterized by successive glacials and interglacials. During glacial times, world climate is colder and more water is held in ice caps at the poles and in glaciers at high elevations (for example, in the Sierra Nevada). As a result, sea level may lower to 150 meters below the present level. During interglacial times, some of the ice melts and sea level rises, producing levels similar to what we are experiencing today. 'ne most recent glacial period was about 18,000 years ago; since then, the climate has warmed and sea level has risen, drowning the north end of the fault valley to produce Tomales Bay. Sediments deposited during that sea level rise are -preserved beneath the surface of Tomales Bay (Daetwyler, 1966). When we look at Tomales Bay, we see an impersistant feature.

During glacials, the valley filled with streams and their deposits; when sea level rose, marine water intruded and formed estuaries. Tomales Bay has apparently come and gone many times during the Quaternary Period.

Our Research Project

I am interested in reconstructing the Quaternary history of Tomales Bay (and the surrounding region) by studying the preserved sedimentary record and the topography of the land surface. I and geology students at San Francisco State University have begun investigations of the Millerton and Olema Creek Formations and of terrace surfaces in the fault valley.

The Millerton Formation is exposed in the cliffs along the east side of Tomales Bay at Millerton, Tomasini, and Tom's Points. The Millerton Formation contains both river and estuarine deposits that formed as sea level rose and fell. We see sedimentary cycles that contain river gravels at the base and that grade upward into estuarine sands and muds, recording sea level rises. The erosional surfaces at the top of these cycles formed when sea level lowered and rivers again dominated the environment. We also see evidence of fault movements because the layers are tilted by deformation associated with earthquakes. The Millerton Formation, we believe, preserves deposits of ancient bays that were the precursors to Tomales Bay. Since their deposition, the sedimentary layers have been folded and uplifted to above-sea-level elevations.

The Olema Creek Formation is exposed in Olema Creek, south of Tomales Bay. This formation consists of sediments deposited in streams and in associated environments such as ponds and alluvial fans (like those coming out of the valleys along the east side of Inverness Ridge today). As movements occurred along the San Andreas fault, the land subsided and over 200 meters of sediments accumulated; since then the formation has been folded and uplifted. We think that the Millerton and Olema Creek Formations were deposited about 125,000 years old, but we hope to date them more precisely. Both formations contain small-scale features that show disruption of the layers during earthquakes.

Sedimentary deposits are also found on flat surfaces within the valley called terraces. For example, Point Reyes Station is sitting on one of these terrace surfaces. When sea level rose, river deposits filled in the valley to form a flat plain. When sea level lowered and/or the land was uplifted, a river incised into the flat surface, which was then elevated above the modern river bed. These terrace surfaces are most visible along the eastern side of the fault valley. A terrace is also visible on the Pacific coast side of the Point Reyes Peninsula; it is at or below sea level at Limantour Estero and rises in elevation to the south of the estero. The sloping elevation of this very young surface shows us that deformation is a currently active process. By studying the terrace surfaces and their deposits, we hope to improve our understanding of fault-related deformation, that is, the changes in shape that have occurred to rocks, sedimentary layers, and the land surface.

By clarifying past climatic conditions and past fault activities, we improve our ability to predict and to understand the global climatic changes and the earthquakes that have pootential to impact our lives.

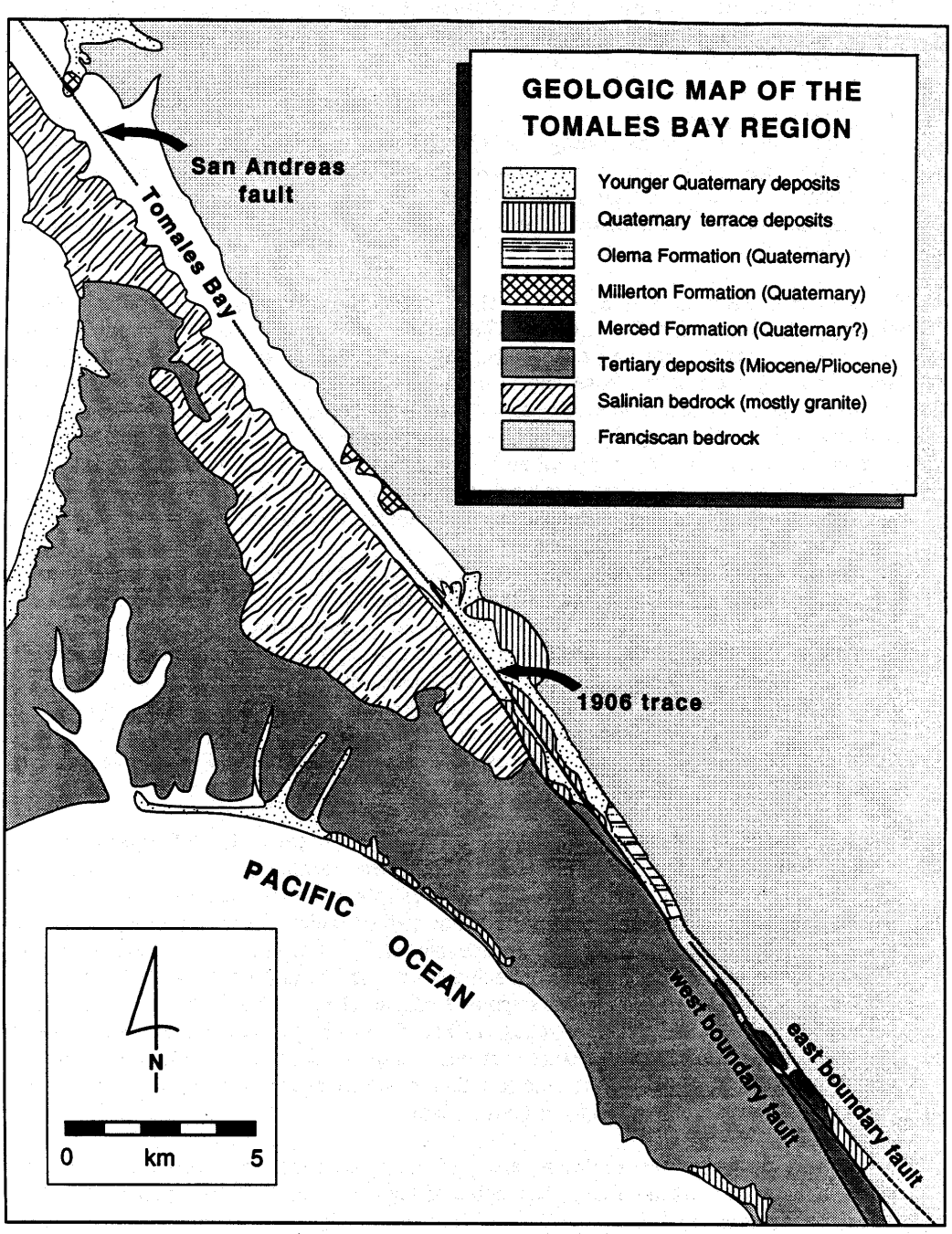

FIGURE 1. Geology adapted from Galloway (1977). This is a generalized map and Quaternary boundaries are somewhat different than shown.

Investigating the Linkages Between the Land and the Ocean:
The Tomales Bay LMER Program

James W. Fourqurean, Tiburon Center for Environmental Studies, San Francisco State University, PO Box 855, Tiburon. CA, 94920.

The importance of coastal systems in linking together the land and ocean domains has long been recognized, but direct assessments of the linkages between the land and ocean have not been commonly made. Recently the National Science Foundation, the arm of the federal government that oversees and funds much pure and applied scientific research in the United States, instituted a major initiative called "Land Margin Ecosystems Research", or LMER, to increase the understanding of coastal ecosystems and the linkages between the land and the ocean. Specifically, this initiative addresses questions concerning changes in the physical, sedimentological, chemical and biological inputs from the land to coastal systems, and the responses of biological communities to changes in the environmental variables. Tomales Bay was chosen as one of the few sites for research under this initiative. The first 5 years of LMER research in Tomales Bay was funded beginning in October, 1989.

The principal investigators on the Tomales Bay LMER are Dr. James T. Hollibaugh, from the Romberg Tiburon Center for Environmental Studies of San Francisco State University and Dr. Stephen V. Smith, from the Department of Oceanography, University of Hawaii. Collaborating with the principal investigators is a team of researchers from the Tiburon Center for Environmental Studies of SFSU, University of Hawaii, University of North Carolina, Virginia Institute of Marine Science, Scripps Institute of Oceanography, the U.S. Geological Survey, and Biosystems Analysis, Inc.

The purpose of this long-term program is to examine in detail a system that is ecologically typical of many bays and estuaries, yet is special in that it is very simple hydrographically. The simplicity of the water motion within Tomales Bay makes system-scale modelling and experiments practical. The LMER project was located at Tomales Bay based on this simplicity, and not to investigate problems unique to Tomales Bay. We hope, however, that the results of this project will be directly useful to those interested in the state of the Tomales Bay ecosystem. While the management implications of our research may be relevant to Tomales Bay, the goal of this project is to develop greater understanding of the functioning of all bays and estuaries. The primary question being addressed by the research in Tomales Bay is: What is the role of bays and estuaries in the exchange of nutrients and other materials between the land and the coastal ocean?

Besides the simplicity of the water motion in the bay, other features of the bay and the watershed make Tomales Bay amenable to our research. Much of the watershed lies within federal park land, and the entire bay below the tide line is part of the Gulf of the Farallones National Marine Sanctuary. The low human population density (about 11,000 people live in the watershed) means that many human-caused impacts are minimized. Less than 1% of the area of the watershed is occupied by towns and roads. In contrast, about 80% of the

watershed is used primarily for agriculture. By contrast with the human population, there are an estimated 30,000 cattle and 20,00 sheep in the watershed.

Streams provide the major linkage for materials between the watershed and the bay. Stream drainage is conveniently divided into three units. Walker Creek and its tributaries drain much of the eastern watershed and enter the bay towards the seaward end. Lagunitas Creek and some minor streams drain much of the area to the south of the bay. The remainder of the watershed is drained by small streams along the southwest and northeast shores of the bay. Much of the drainage of the watershed enters six reservoirs used by the Marin Municipal Water District, and that portion of the flow has been well characterized by the MMWD since 1955. This characterization provides essential information for investigating the Tomales Bay system.

The first three years of the LMER project has yielded a wealth of information about the Tomales Bay system, with over twenty-seven scholarly publications submitted to scientific journals. Much more work is in progress. The balance of this summary describes a sampling of the research results from both completed and in-progress studies.

Rapid sedimentation is occurring in Tomales Bay. Comparison of hydrographic charts prepared in 1860, 1926 and 1957 show that the bay has filled in at an average rate of 8 mm per year. This is equivalent to the inner bay (south of Hog Island) filling in with approximately 200,000 tons of sediment per year. Most of the sediment accumulated since 1860 was deposited between 1926 and 1957. We have just completed an updated survey of the water depths of the bay using sophisticated depth sounding and locating devices, to test whether the rapid sedimentation rates measured between 1860 and 1957 have continued to the present time. It is our plan to make the hydrographic chart that will result from our latest survey available to the public when it is completed.

We have demonstrated that nutrient dynamics in Tomales bay are driven largely by the decomposition of organic matter -- primarily the remains of oceanic phytoplankton and plants from the land deposited within the bay -- instead of input of inorganic nutrients from either the land or the open ocean. In the summer, when stream flow decreases, the bay becomes slightly more salty than seawater, since more water evaporates out of the bay than freshwater flows into it. Phosphorus concentrations rise in the bay in the summer, as a consequence of the decomposition of organic matter. Nitrogen is low in the summer in Tomales Bay, due to the rapid consumption of nitrogen by the microorganisms that inhabit the muds in the bottom of the bay. In the winter, this pattern reverses; phosphorus concentrations are low and nitrogen concentrations are high.

The weather determines much of the behavior of Tomales Bay. We have been fortunate, in terms of investigations of the bay, to have experienced some extreme climatic events, and we are examining the data to determine the effects of these events on the bay. One extreme event was the cold snap of the winter of 1990-1991. Water temperatures at the mouth of the bay were driven 3 degrees below normal during that time, and water temperatures at

the head of the bay were colder still. This past summer saw the occurrence of an El Nino event in the Pacific Ocean. During El Nino events, upwelling of cold bottom water ceases off of the mouth of Tomales Bay. Because of this phenomenon, water temperatures at the mouth of the bay were much warmer this spring than normal. Since upwelling is responsible for increasing nutrient concentrations in the coastal waters, El Nino may have also affected nutrient dynamics in Tomales Bay.

Since the project began, Tomales Bay and the surrounding watershed have been experiencing drought conditions. As yet, we have not been able to collect data to characterize a "normal" year in the bay. This project will continue for at least two more years. We hope, along with everyone else in the watershed of Tomales Bay, that at least one of the winters in the near future will have normal rainfall.

The Physiology and Ecology of Bat Rays in Tomales Bay

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We have been studying the distribution and abundance of sharks and rays (elasmobranch fishes) in Tomales Bay in relation to water temperature, salinity, and time of year. Monthly longline sets, at 2km intervals, produced bat rays (90% of catch), brown smoothhound sharks (6%), leopard sharks (3.9%), and others (0.1%). Bat rays were tagged with yellow ring tags through the spiracle flap, and all species were measured, sexed, and released. Sonic tags were implanted into five rays for location and movement data. Lack of fish caught on longlines and lack of signals from sonic-tagged fish indicated that all elasmobranchs left the bay during the late-November through late-February period when water temperatures were < 10 degrees C. Our model of bat ray abundance, incorporating temperature, salinity, and bay location, account for 77% of the variability in the catch data. High probable numbers of bat rays numbers in Tomales Bay (4 recaptures of 500 rays tagged) and their foraging- related bioturbation of sediments predicts significant resuspension of nutrients into the water, when rays are present in the Bay.

Herding Fleas

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My topic this afternoon is herding fleas -- whether sand fleas, dog fleas, individual fleas, government fleas, or community fleas -- the principle is all the same for all: collectively develop a basic framework and then turn the fleas out and let the individuals do what they are intersted in. We'll get back to that later.

We've listened to a number of local experts today, heard a lot of information on Tomales Bay, and heard some wisdom too about what's happening and what needs to happen. I'm the token out-of-town expert. In the consulting field, there are three primary criteria to judge an expert: business suit and tie (women too), a fancy brief case, and a distant address. Notice that none of these refer to knowledge or wisdom. By fulfilling only one of these criteria, I barely qualify as your token out-of-town expert. I don't own a tie and don't use a briefcase. But I do come from farther away than others on the agenda today.

Up here at Tomales Bay I can say things that your local experts can't get away with -- even those with much more knowledge and wisdom. Don't get too upset with me if I say some of those things this afternoon. About now you are beginning to realize that you are a captive audience. The oysters don't show till five o'clock, so you might as well humor me.

Part of my purpose is to tell you about Morro Bay. I'm coordinator of what we call the Morro Bay Task Force, composed of more than sixty local, state and federal agencies and commercial, industrial and environmental organizations with jurisdiction and interest in Morro Bay and its watershed. Two or three or more persons are involved from each of these organizations -- that's a lot of fleas.

Early on, we informally adopted the guiding philosophy: '.'Let us create a vision, and challenge the institutions to accomplish it." This has given the group freedom from the policies of individual organizations and allowed us collectively to go beyond our restrictions and work for the betterment of the bay.

Morro Bay is much more populated and developed than Tomales Bay, and has much greater pressures for further development. Morro Bay has some 2,300 acres of mud flats, tidal marshes, commercial harbor and marinas, and a watershed of about 48,000 acres. Where you have dairy farms, we have people (over 37,000) in the watershed. The Tomales Bay watershed is three times as large and has only one-third the population of Morro Bay, which has the highest population density of any functioning estuary on the coast. Morro Bay has a greater acreage in mariculture operations, but also a major prison, a college, and National Guard camp, i.e., an urban area of more than 10,000 persons, right in the middle of the watershed.

A fortunate characteristic that Morro and Tomales Bays share is that both still have options;

choices for our future. Many estuaries are already filled, or fully developed as marinas, or are so polluted the only option is to try to clean them up. Since our bays are relatively undisturbed, we can design their futures. The Morrow Bay Task Force has exchanged information with the Tomales Bay Advisory Committee and the Environmental Action Committee of West Marin -- to all of our benefits. You have had much success and so have we, and that is what I am here to talk about.

A wonderful piece of wisdom I heard from Peter Behr at a previous Tomales Bay conference has helped me often: "Persistence equals patience with a purpose." It is important to know where one is going and to hold the course. Since there really isn't very much new in this world, for the most part I'll be sharing old ideas. I've found that what I need and what comforts me has long since been learned, written, discussed and sadly, often forgotten. We must not forget to be aware of, to be cautious of, and critical of our adaptability. Our values change, individually and communally -- often without our conscious recognition.

I just saw the scary results of a study by Alan Hirsch, M.D. -- a survey of 1000 people in Chicago entitled WHAT SMELLS REMIND YOU OF YOUR CHILDHOOD?

NOSTALGIC ODORS FOR THE 1920's. 30's. & 40's

Burning Leaves	Attics	Hot Chocolate	Soap	Ocean Air
Baking Bread	Roses	Honeysuckle	Manure	Hay
Blueberries	Cinnamon	Fish	Clover	Petunias
Pine	Fresh Air	Meadows		

NOSTALGIC ODORS FOR THE 1960's & 70's

Motor Oil	Airplane Fuel	Baby Aspirin	Refineries	Mothballs
Mosquito Repellent	Suntan Oil	Nail Polish	Magic Markers	Chlorine
Tuna Casserole	Cocoa Puffs	Hair Spray	Play-Doh	Plastic
Burning Tires	Fabric Softener	Marijuana	Crayons	Exhaust

EABRY's Conclusion: We humans are very adaptable. We can come to enjoy and place positive values on degraded systems.

Each of you has a different feeling for Tomales Bay. Each vision was formed and influenced by when, and under what circumstances, you first saw the bay. By how you have used it, by your exposure to other estuaries, and by everything else in your life to date. Perhaps even past lives have contributed to your feelings.

What do you want for your bay? Do you want it to be like it was 50 years ago, 10 years ago, as it is today, or how it may be 10 years from now? Even if it were possible to stop all man-made pressures, you wouldn't be able to hold it as it is today. Even if we completely hold the line today, we are already behind! Remember the study of what makes us nostalgic. We can be conditioned to accept what we now would consider unacceptable. We must always be alert to this reality. To quote Paul Nitze, "One of the most dangerous forms of human error is forgetting what one is trying to achieve."

We tend to make decisions based on incomplete information and for short-term needs and goals. This is particularly true in these days of a failing economy and governmental chaos.

"As long as so many people accept this modern-day competition, willing to profit at the cost of others and believing it's a good thing; as long as we continue this habit of exploitation, using other people and other life, using nature in selfish, unnatural ways; [we won't progress].

> "The most basic principle of all is that of not harming others, and that includes all people and all life and all things."
>
> Rolling Thunder

We can accept no less than the standards of those who were the stewards before us:

> "In all our deliberations we must consider the impact of our decisions on the well-being of the seventh generation to follow us."
>
> from the great law of Haudenosaunee,
> the six nations, Iroquois confederation

Now it is time to talk about fleas. I look at what I do with our task force, and the various groups that have formed from it, as herding fleas. In the Morro Bay area, here on Tomales Bay, and throughout the country there is a tremendous amount of energy, expertise, love, and desire. All that is necessary is to turn it loose. Government has the unique ability to discourage, neutralize and antagonize this energy and love. Government is afraid to let "lay people" do things. I can say this because I've worked for government each of the past 34 years. When government is in charge, we get guaranteed mediocrity -- a McDonaldization. Government can't allow many people going in many directions because it is unpredictable - - there isn't a job description for a herder of fleas. But lay people, and individual agency people as well, can make great things happen. You have the opportunity, through the community here, to make great things happen.

> "The only thing that makes civilization go forward is the 'responsibility of individuals ... for the species ... for the culture ... for the larger thing outside themselves."
>
> Wallace Stegner

There is a tremendous resource here. This room is filled with enthusiastic people with ideas and energy. You have accomplished a lot, and can go much further. Don't be discouraged with present circumstances, just go to work. Don't wait for permission. Government's best role in this is to facilitate these efforts. The scary thing for government is to trust and give people and community groups their head. You have a very good organization in the Tomales Bay Advisory Committee. It could be your umbrella organization, or perhaps the Environmental Action Committee of West Marin, the Tomales Bay Association, or a county department such as our coordination effort. Which group takes the implementation lead is not important. But it is important that it welcome everyone with interest or responsibility in the bay and watershed. This larger group then needs to spend some time and work out - - with all the actors -- an agreed-upon set of goals and objectives. That will be a long list. We went through this exercise several years ago and our goals statements are eight pages

long. It is necessary to develop an organization wherein no single group dominates and wherein no group or agency can end the program. We almost had that happen early in our work; it was a convincing lesson.

When you have this basic framework, turn the fleas out and let the individuals do what they are interested in. You may have a high priority project, that is very important, but no one coming forward to carry it out. That's OK, don't force someone into that mold, or you'll get poor results. Put off that project and let people do their thing. The right person will come along in due time and give you a wonderful product! This has happened several times in our experience.

Again, it is necessary to include all. We are all one. The spider grandmother gave two rules to the Hopi and to all peoples:

> "Don't go around hurting each other, and try to understand things."

I believe that each of us is responsible for our present situation and that each of us needs to be part of the solution.

> "If you have a sense of opposition -- that is, if you feel contempt for others -- you're in a perfect position to receive their contempt...
>
> "You should be working with these people, not in opposition to them...
>
> "It's a mistake to think of any group or person as an opponent, because when you do, that's what the group or person will become. It's more useful to think of every other person as another you -- to think of every individual as a representative of the universe.
>
> "Every person is plugged into the whole works. Nobody is outside it or affects it any less than anyone else."
>
> Mad Bear

We tend to set up an "us" and -"them" conflict, when it is <u>always</u> a "WE." We the people. We can't afford to keep the oil companies, the dairymen, the military, the water district, the sewer system, the utilities, the "whomevers" out of the problem solving process. The problem isn't solvable by a part, only by the whole. The strength of our Morro Bay group and many of the important things we've accomplished have been due to wonderful volunteers from all parts of the community, who were encouraged and guided, but mostly just left alone to do their thing.

The greatest thing I have learned at Morro Bay is that I can't herd fleas. When I try, I waste considerable energy and the only result is an inhibiting of important accomplishments. Don't wait for government. Work with and within government, but turn the fleas loose now! Take a chance and trust. You will be rewarded. Things will be going in many directions at once. You'll often get the feeling that the fleas are out of control (true), and that you are going nowhere (false). From the chaos will come much beautiful work, and wisdom!