DUELING WITH BOAT OARS, DRAGGING THROUGH MOORING LINES: TIME FOR MORE FORMAL RESOLUTION OF USE CONFLICTS IN STATE COASTAL WATERS?

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Growing Marine Use Conflicts

Many states are experiencing greatly increased demand for use of their coastal waters. Not only are more people engaging in traditional recreational and commercial activities like boating and fishing, but emerging variations are posing new challenges. Sea kayakers, operators of high-speed personal watercraft, oil tankers, and live-aboard boaters all assert their right to use public waters. Aquaculture, based on state-granted rights of exclusive control over particular waters and marine resources, is a fast-growing industry in some areas. Concurrently, environmentalists, resource harvesters, and others make a strong case for the need to maintain coastal water quality and habitat values.

The increased demand to use coastal waters has spawned many conflicts over space allocation, resource allocation, and allowable resource degradation. The popular press is replete with reports of resource users attempting to settle disputes by dueling with boat oars, dragging through aquaculture mooring lines, or using other "self help" methods.

In the past, coastal waters were generally available to private users on a first-come basis, without state or local policies on use priorities. However, as conflicts escalate and it is increasingly clear that not all demand can be accommodated, that approach is increasingly untenable.

Justification for Increased State Involvement

State governments should take the lead in developing comprehensive conflict resolution strategies for application in coastal waters for at least four reasons:

(1) Coastal waters are a public resource of the state; the state has a fiduciary responsibility to hold and manage these lands for the benefit of the public.

(2) Not all uses can be accommodated; hard choices have to be made to minimize the costs of continued, unresolved conflict.

(3) There are inherent difficulties in managing common property resources, particularly where there are ongoing disputes among user groups who value
disparate resource functions and values. While self-regulation by stakeholders or privatization may eventually play a role, the critical first step requires strengthened governmental leadership in coastal waters to adopt and implement a comprehensive management program.

(4) The multiple single-focus agencies and narrow purpose laws which currently regulate marine waters are not designed to resolve conflicts among uses. The focus has to be shifted from the details of managing a particular resource to a broader ecosystem perspective. State governments may have greater flexibility to embrace this new focus.

In developing a marine conflict resolution strategy, policy makers will have to consider: (1) whether the state already has a policy designating marine use priorities, (2) how the state/local division of authority will affect decision making for coastal waters, and (3) whether state mechanisms and institutions exist which are capable of resolving conflicts and implementing decisions about use priorities for coastal waters.

Use Conflict Resolution Mechanisms for State Coastal Waters

Many states are at the point where they have identified the need for increased planning and management of their coastal waters, but have not yet taken concrete steps to address the problem. In these states, decisions about use of coastal waters are too frequently made by using less than optimal methods: by default to the first user, by litigation of narrow questions, or by ad hoc legislative actions supported by those with the greatest financial stake in a particular resource. The public trustees have no comprehensive plan, goals, or priorities for the marine environment, so there is no overarching context for decision making.

Maine is probably typical of these states. A 1991 study concluded Maine has no comprehensive planning and no comprehensive policy for the use of its coastal waters. It is hampered in resolving conflicts because it lacks priority-setting criteria. There is little coordination among local, state and federal agencies, each responsible for managing discrete aspects affecting the use of marine waters (Catena, 1991). The state/local division of authority over coastal waters is unclear.

However, several states have begun the process of formulating more detailed plans and priority systems to manage their coastal waters. Some of the more promising mechanisms include: (1) clarification of authority between state and local governments; (2) promotion of collaborative decision-making and implementation; and (3) development of space and resource allocation systems.
Clarification of State/local Authority

Municipalities in some states are reluctant to manage coastal waters within their boundaries because they are uncertain about the extent of local control over harbors and adjacent waters. At the same time, states are often concerned that giving control to local governments may result in decisions inconsistent with the state-wide public trust interest. Some states have successfully clarified local authority while maintaining state oversight.

For example, Connecticut’s Harbor Management Act allows municipalities to establish a local harbor management commission to prepare a detailed management plan for the most desirable use of the harbor; the plan is to encompass the water area and land-side uses that will impact the water. The Act clarifies the relationship of the commission to other state and local entities, and requires U.S. Army Corps review of proposed plans. The plan must be approved by the state and must be in compliance with state-wide resource goals.

Similarly, New York amended its waterfront revitalization program to expand and standardize the authority of local governments to regulate the use of surface waters and underwater lands. Local governments have the authority to adopt comprehensive harbor management plans and implementing ordinances. The plans must address problems of conflict, congestion and competition for space in the use of harbors, surface waters and underwater lands. The plan and ordinances must be approved by the state; once approved, all state agency actions must be consistent with the approved local plan to the maximum extent practicable, and the municipality may regulate everything "abounding" the municipality to a distance of 1,500 feet from its shore, even if that exceeds the town’s historic legal boundaries.

Important innovations include: a state approval process to ensure consistency with state-wide goals and priorities for public trust lands, integrated federal review for early identification of obvious conflicts, incentives for local planning to gain consistency of state agency action, and equal local authority with simplified geographic boundaries regardless of historic town boundaries.

Collaborative Decision-making and Implementation

As many agencies in different levels of government currently each have some jurisdiction over the use of coastal waters, the state’s capacity to manage its coastal waters should be enhanced by improving the capacity for multiple-agency collaboration on cross-cutting decisions. These efforts can include informal collaboration, formal intergovernmental agreements, and creation of special districts, authorities, or management entities.
Most states engaged in planning for coastal and ocean waters have identified the need to create coordinating councils which are, at a minimum, composed of representatives from all state agencies with some marine authority. Some councils, such as Oregon’s Policy Advisory Council, are more broadly representative. California and Oregon have also made use of multi-agency, coordinated project review panels to review and make recommendations on specific project applications.

If the goals of federal agencies with concurrent regulatory jurisdiction are compatible with state goals, state-initiated informal collaboration may include federal agencies as well. States may also benefit from participating in federally established processes. While currently focused primarily on water quality, the National Estuary Program is a model of a collaborative approach which could become a vehicle for use conflict resolution. Similarly, regional fishery management councils may expand their focus to address foreseeable use conflicts, particularly between capture and aquaculture fisheries.

Occasionally this state/federal collaboration may extend to a more formal sharing of authority between federal and state entities to further integrated management of coastal waters. For example, the U.S. Fish and Wildlife Service (USFWS), administrator of uplands composing four National Wildlife Refuges in the Florida Keys, and various Florida agencies which own the surrounding submerged lands, troubled by conflicting water uses of the Lower Florida Keys, developed an innovative Management Agreement to overcome jurisdictional constraints. The parties negotiated a Management Agreement, effective in 1993, which uses state authority to limit public use of particular waters and allows USFWS enforcement officers to patrol state waters (Cuthbert and Suman, 1995).

Space and Resource Allocation Systems

Among the more promising allocation techniques are submerged lands leasing programs, marine zoning, special area management plans, performance standards, and ocean management plans.

Submerged Lands Leasing Programs: Submerged lands leasing programs can help minimize use conflicts in coastal waters by requiring users who propose permanent occupancy of state coastal waters to first obtain a lease or other conveyance from the state. However, these programs typically control only built infrastructure or physical changes in, on or over submerged lands such as structures or dredging, and are not designed to control temporary or transient uses such as seasonal docks, recreational use, or capture fisheries. If the state has not engaged in comprehensive planning, the decisions may be ad hoc, based purely on space allocation criteria.
Comprehensive Marine Zoning: Some states utilize traditional comprehensive zoning applied to the marine environment. Rhode Island, has successfully used marine zoning as a component of its comprehensive land and water management system since 1971. In a state-administered system, it divides all coastal waters of the state into water use categories which determine permissible uses. Similarly, Washington's shoreline management program, also adopted in 1971, utilizes similar water classification techniques but allocates more responsibility to local government. A more recent variation, recommended for adoption in North Carolina recommends employing water use zoning maps, which while not regulatory per se, would illustrate where particular use policies should be considered (Clark, 1993).

These examples illustrate that zoning can be used to comprehensively divide coastal waters into use and intensity classifications. However, as with traditional land-based zoning, this tool regulates major new developments and major changes in use. It can minimize future use conflicts through geographic separation and redirection to least sensitive areas, but it is not designed to facilitate resolution of conflicts among temporary or transient uses.

Special Management Areas: Special area management plans generally allow for more detailed regulation; they can control temporary or transient uses in addition to permanent development. However, due to the intensive effort and cost of developing such a plan, SAMPs are likely to be used only in the most intensely used or particularly sensitive areas. A comprehensive special area management plan is under development for the Florida Keys National Marine Sanctuary. The draft management plan, developed by NOAA in partnership with Florida, identifies 98 "strategies" that together form an integrated management plan. As one strategy, the plan includes the creation of four new marine zoning categories within the special management area to regulate temporary user activities by controlling type and amount of access.

Performance Standards: Performance standards allow states to establish advanced criteria to guide decision makers. For example, in 1991, Hawaii developed guidelines for private marina development to protect public interests and allocate valuable ocean space in a fair and equitable manner. Similarly, through its Coastal Management Act (CCMA), Connecticut established extensive goals and policies for coastal lands and resources. Local actions must be in accordance with the CCMA, and the statutory policies of the CCMA override any less restrictive state or local regulatory standards. These very detailed performance standards allow the state to establish policies for local implementation without the state itself engaging in zoning or other specific space allocation decisions.
Ocean Management Plans: In the last ten years, more comprehensive ocean management planning has emerged which has begun to shift the focus from mere physical space allocation systems to more comprehensive resource allocation systems. They embrace a more holistic, integrated, ecosystem perspective. Examples include the NOAA-led Florida Keys National Marine Sanctuary stewardship strategy and state-initiated ocean management studies or plans in states such as Oregon, California, North Carolina, Mississippi, and Florida. State ocean plans typically study an area out to the 200-mile exclusive economic zone limit and tend to be developed to prepare the state to defend itself against outside development interests in federal waters. In theory, multiple-use ocean management should advance use conflict resolution throughout the stewardship area by establishing priorities for valued uses and establishing a framework within which to make decisions about space and resource allocation. However, in actuality, the geographic scope and activity emphases of most first generation ocean plans are not intended to address competition for space and resources on a scale relevant to resolving coastal use conflicts. However, Oregon's Territorial Sea Plan, a component of its Ocean Plan, suggests that refinement of successive components of ocean plans may eventually produce concrete guidance on conflict resolution in coastal waters.

Conclusion

Conflict resolution strategies for use in states' coastal waters are still in the initial stages of development. More empirical evidence will be required to determine if these particular approaches will successfully protect the public interest and reduce use conflicts. It is clear, however, that as conflicts escalate, states must more forcefully assert their role as public trustee by developing a comprehensive plan, establishing priorities and mediating among user groups. In the absence of state leadership, resource allocation may be made by self-help appropriation, citizen-initiated referenda, special interest legislation, or other ad hoc methods which offer less than optimal protection for the broad public interest in this valuable resource.

References


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This presentation describes an increasingly common land use conflict between the preservation of natural resources — in this case seasonal and tidal wetlands — and urban development. The project at issue is the upgrading of a long-established levee. The real story behind this project is one of impasse, followed by challenge, negotiation, and compromise. Five years have gone by since the project was first conceived; a solution appears to be imminent.

The project levee is part of a five-mile levee system that generally surrounds on three sides the Redwood Shores Peninsula, an area of about 1,500 acres located in Redwood City, San Mateo County, California (Figure 1). The levee separates the peninsula from the tidal waters of San Francisco Bay itself and from two wide, shallow tidal sloughs that enter the Bay on either side of the peninsula. Redwood Shores is primarily a low- to medium-density residential area. A population of 6,000 currently occupies a series of waterfront residential communities that front either directly on the Bay or on a system of internal lagoons. The Peninsula also contains 2.5 million square feet of low- to mid-rise office and commercial space.

The Redwood Shores Peninsula was created as a land form in the early 1900s by diking about 1,500 acres of San Francisco Bay tidelands to create shallow ponds for the production of salt. From the early 1960s, the ponds were drained and/or filled with bay mud dredged to create internal lagoons; additional soil was imported to surcharge the semiconsolidated substrate, and the area was gradually prepared for development. Two-thirds of the peninsula are now fully developed, and the City General Plan calls for developing much of the remaining land.

The remaining undeveloped areas of Redwood Shores have been diked and partially filled but are not yet developed; other diked areas have never been filled. Especially these latter areas, which are of low elevation and frequently pond throughout the rainy season, retain many of the characteristics of the Bay shoreline except for tides that are excluded by the levee. The meanders of former small sloughs are still evident, and salt marsh vegetation covers in varying degree most of these unfilled lands. The combination of tidal salt marsh and mudflats outside the levee, seasonal wetlands and salt flats in unfilled areas inside the levee, and ruderal/upland vegetation on higher, filled lands of the peninsula, creates a complex of habitats that support a variety of wildlife species. At a minimum these
include numerous waterfowl and wading birds, shorebirds, raptors and
passerines, as well as populations of small mammals and larger mammals
such as red fox, raccoon, striped skunk and ground squirrel. Two federal
and state-listed endangered animal species also share some of these habitats,
both inboard and outboard of the levee.

Although most of the undeveloped lands of the peninsula are owned by one
land owner (slated for eventual development), several parcels around the
periphery of the peninsula are owned by others. A wastewater treatment
plant is situated in one small corner of the peninsula. Both inboard and
outboard of the levee are several parcels owned by California. Much of
this public land, including waters bayward of the state-owned intertidal
areas, could someday become part of the San Francisco Bay National
Wildlife Refuge (SFBNWR). Bayward of the peninsula are tidal areas
indicated on a 1990 map of the SFBNWR as "Approved Areas," that is,
approved by Congress for acquisition. Within the peninsula is a privately-
owned, unfilled 120-acre parcel that is on the SFBNWR "wish list."

The Levee Project

Approximately five miles of levee surround the bayward and slough sides
of the peninsula. In addition to providing flood control for the entire
Redwood Shores community, the levee is used for incidental recreational
purposes -- walking, jogging, biking -- by residents of Redwood Shores and
others. Four miles of the existing levee are of insufficient height and cross-
section to meet current federal (U. S. Corps of Engineers [Corps] and
Federal Emergency Management Agency [FEMA]) and local (City) flood-
control and flood hazard insurance standards. In 1991, to protect present
and future development on the peninsula, the City proposed to upgrade the
levee system to meet the standards that they felt were appropriate. They
explored a number of design concepts for rehabilitating and strengthening
the levee, including constructing a partial floodwall. The City was sensitive
to the need to avoid wetlands on the peninsula and thus modified their
preferred design, which called for a relatively massive cross section and
conservative free-board elevation, to accommodate a three-foot seawall in
several places. While more expensive than a standard levee, the seawall
(floodwall) theoretically would result in a much smaller levee base
"footprint" and thus have less impact on wetlands. The seawall concept
later proved to create its own unacceptable impacts (see below).

Permits

The City was aware that the levee upgrade project would require a permit
to place fill in wetlands under the Corps Section 404 Permit Program (Clean
Water Act), and a permit to build within the 100-foot shoreline jurisdiction
of the San Francisco Bay Conservation and Development Commission
(BCDC). BCDC is the equivalent state coastal zone management agency for
San Francisco Bay. As such, it has two primary goals: to prevent the unnecessary filling of San Francisco Bay, including wetlands, and to increase public access to and along the Bay shoreline.

Initially, the City expected that regulatory compliance would be relatively uncomplicated and that it could be completed under streamlined permit options at both the Corps and BCDC. Initial consultation with the key agencies revealed that this would not be possible. That position was confirmed by the discovery by consultants (ESA) in 1992 that the levee project area provided habitat for the endangered salt marsh harvest mouse (SMHM), and that tidal marshes external and adjacent to the levee were inhabited by both the SMHM and the endangered California clapper rail (CCR). The presence of SMHM (*Reithrodontomys raviventris*) in the project areas was determined through live trappings conducted as part of a biological assessment (ESA, 1992). It could be readily assumed that the SMHM also inhabited the undisturbed, unfilled, diked marshlands in the project area. The CCR (*Rallus longirostris obsoletus*) is listed as endangered by both federal and state governments, is known to inhabit offshore islands near the peninsula, and has been reported in tidal marshes along the Bay shoreline and sloughs bordering Redwood Shores. The presence of these two species in the project area guaranteed that the U. S. Fish and Wildlife Service (USFWS) would be a key player in the permit process.

The City had approached the activity as routine maintenance of an existing facility (the levee) that was necessary to maintain protection of private lands and the safety and welfare of existing City residents from flooding. The regulatory agencies, including those that normally comment on Corps and/or BCDC permit actions (USFWS, Environmental Protection Agency [EPA], California Department of Fish and Game [CDFG], Regional Water Quality Control Board [RWQCB], among others), took a fundamentally different view of the project: they looked at the levee upgrade as enabling private development investment on the remaining undeveloped lands behind the levee, and as a major threat to the continued existence of the two endangered species. Thus the process of designing, mitigating impacts, and gaining regulatory approval for this levee upgrade project has involved almost five years, consultation under Section 7 of the federal Endangered Species Act, a draft "Jeopardy Opinion," and considerable efforts in creative engineering and compromise to find alternatives that would achieve the goals of both the City and the relevant regulatory agencies.

**Issues of Public and Agency Concern**

An EIR produced by City consultants under the California Environmental Quality Act (CEQA) brought to the surface the principal issues of public, resource agency, City, and property-owner concern. These were later expanded or supplemented through the Corps' permit process and
endangered species consultation. The issues fall into four main categories. These are summarized below.

1. Levee alignment - The City assumed that the existing levee following the shoreline would dictate the alignment of the rehabilitated structure. An underlying position of the resource agencies turned the alignment into a controversial issue. At issue was the 120-acre parcel immediately within the levee, which has never been filled, supports salt marsh vegetation; and is presumed to be habitat for the SMHM. It was the agencies’ position that, in the long-term, the upgraded levee would not only enable planned development in areas of the peninsula that currently serve as open space and wildlife habitat, but that it would preclude future opportunities to restore this particular parcel to tidal action, notwithstanding its private ownership status. As part of the 404(b)(1) alternatives analysis required for Corps permit, the agencies requested that the City analyze the feasibility of converting a temporary berm along an interior alignment into the primary levee; that would effectively place the 120-acre parcel outside the peninsula’s primary flood control system.

The City took an opposite position. They maintained, first, that this alternative constituted a new levee, not a maintenance project. The new project would not be practicable due to costs of construction and land acquisition, and also due to impacts associated with importing the required fill material. Second, the City contended that an interior levee would not meet the project purposes of upgrading an existing facility whose basic purpose was the protection of private property. Third, the City cited the risk of severing private lands and nullifying existing landowner development entitlements, general plan designations and zoning classifications. Basically, the City contended that an upgrade project along the existing levee alignment would not in itself encourage further residential development nor preclude restoration of lands in the future, were they to be acquired eventually as part of the SFBNWR. After considerable negotiation, the City and agencies agreed to a compromise: the City would make only minor improvements to that segment of the levee that bordered the 120-acre parcel, and would not construct a new levee along the interior alignment. This had the effect of removing that levee segment from the project.

One other resource issue was more easily solved. Between the wastewater treatment plant and the Bay is a row of trees used throughout the spring and summer as a rookery. Snowy egret, black-crowned night heron, great blue heron, and great egret nest in the trees and forage in the nearby freshwater marsh, shallow Bay waters, and mudflats. To avoid the rookery, the City was able to realign and redesign this segment of the levee as a narrow sheetpile floodwall, skirting the rookery inland and removed from areas of potential habitat fragmentation.
2. Levee design - Initially the levee was conceived as a conservative, "over-engineered" earthfill structure. The design was subsequently modified to reduce the cross-section and amount of fill in wetlands by replacing the top three feet with a block floodwall to reach the desired finished elevation. From a biological perspective, the wall posed several problems. It would fragment the saltmarsh habitat, interfering with SMHM movements between the inboard and outboard sides of the levee. It would prevent dispersal of SMHM populations and impede gene flow between inboard and outboard populations. It also would interfere with access to higher levee vegetation used by both SMHM and CCR as refuge during extreme high tides. From a human perspective, local residents whose homes fronted on the Bay and sloughs felt that the proposed flood wall would obstruct their waterfront views, that it would be visually unattractive, and furthermore would attract graffiti; in this manner, the wall would diminish property values.

On this issue, the biological and human perspectives were in general agreement, and the wall was removed from consideration except at the wastewater treatment plant. During subsequent negotiations, the City redesigned the levee, reducing the top elevation by one foot and narrowing the cross-section, apparently without losing the necessary security of flood protection.

3. Development behind the levee - The most critical issue was not the physical presence of the levee itself but the impacts associated with development planned for lands behind the levee (in most instances already entitled by the City). In the long-term, the agencies believed that the levee upgrade would indirectly enable planned residential development in areas of the peninsula that currently serve as open space and wildlife habitat. In turn, the new residential areas would generate greater human activity along the levee, introduce domestic dogs and cats as predators and disturbers of wildlife habitat, and threaten the small resident population of CCR inhabiting the tidal marshes immediately outside the levee. Of particular concern was a filled area adjacent to the 120-acre parcel: Lido Homes. This development was already fully approved by the City for development and would place new homes within 100 feet of the high tide line outside the levee, and, in so doing, bring human activity within close range of CCR habitat. During Section 7 consultation (which produced a draft Biological Opinion, stating that the project as proposed would jeopardize the continued existence of the CCR and SMHM -- the equivalent of a "double jeopardy"), the USFWS recommended that an average 300-foot buffer be required by the City, between the outboard tidal marshes and any new residential development. This would severely reduce the number of homes that could be built within a project that had been approved for some time. The City countered that a 100-foot buffer was already included in the Lido development plans. A final buffer width of 150 feet was finally accepted by the City and landowner.
4. Cumulative impacts on endangered species - Consistent with their view that the levee would enable development, the agencies also viewed the levee as growth-inducing and, therefore, as contributing to cumulative impacts of development and population growth. During the course of negotiations, various recommendations and City concessions involving alignment, redesign, buffers, and controls (see below) were considered to reduce the significance of cumulative impacts to an acceptable level. The final details are still in process.

Summary

A final decision on this project has not been reached. However, at this point resolution seems more possible than it has since project initiation. Over the last few years, the Corps permit public notice generated extensive comment and the permit application was revised several times. After struggling to reach a compromise that would satisfy the resource agencies and fulfill the needs of the project (as viewed by the City), the City redesigned the overall project. Removing the levee segment surrounding the 120-acre parcel from the project also removed a major point of decision blockage. The compromise buffer zone of 150 feet was agreed upon along the Lido Homes shoreline (which reduced the development by a number of houses), and the City has made agreements with BCDC for special provisions for access along the levee to avoid compromising endangered species habitat.

How could this project have been accomplished in a more timely and less costly manner? It is generally impossible to foresee how a project such as this will proceed before the discovery and assessment process has begun. In this instance the discovery of endangered species in the area proved to be critical. A levee sounded innocent enough, but the resource agencies required that the future disposition of the area behind the levee be a decision factor in the project. Hindsight, they say is 20-20: Perhaps after studying alternatives and fully exploring the agencies’ legal responsibilities and specific concerns (both of which the City did), the approach might have been one of immediate mediation rather than confrontation and challenge through the regulatory process. Several lessons could be learned from this process. Resource agencies must appreciate a City’s immediate accountability to its constituents and its vulnerability to legal challenge. It is essential for a public agency such as a City to fulfill its responsibilities for protecting public health, safety, and welfare. However, how that obligation is implemented, requires creative study and solutions to accommodate important natural resources.
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Global, national, and local forces have been causing dramatic changes in the lives of fishing businesses and families and in the economic and social fabric of coastal communities. Increased competition for limited fisheries resources, restrictive management decisions, new federal laws, endangered species, changing markets, and unusual ocean conditions have combined to create a particularly stressful and uncertain climate in the commercial fishing industry in the Pacific Northwest. Many of these challenges, however, are not limited to the Pacific Northwest. In their description of Galilee, Rhode Island, Poggie and Gersuny (1974) could have easily been describing many fishing communities in the Pacific Northwest: proud, independent fishing operations made up of owners, skippers, crew, gear and service suppliers, and processing plant workers who deal with a wide variety of harvest, handling, and processing methods and species in a setting of suburban-rural communities. And when Snow (1990) describes the constantly changing environment that the commercial fishing industry in the Northeast has and will be operating in during the 1990s, many of his comments are hauntingly familiar.

Natural resource-based industries, such as fishing and timber, are an important source of income for coastal communities in the Pacific Northwest. A study in 1989 estimated that about 36% of the personal income received by residents in Oregon's coastal communities was generated by natural resource-based industries. In some areas, such as Newport and Astoria, Oregon, commercial fishing generates about 17% of the total personal income and about 26% of the earned income (Radke, 1993). What has happened in the salmon fishery is an example of the challenges facing fishing businesses, families, and communities. Personal income received from the salmon fisheries (sport and recreational) averaged around $42 million between 1976 and 1992 in Oregon. This declined to around $3 million in 1994. There were 2,061 vessels delivering salmon in 1988. There were 611 in 1993. The 90% decline in economic impacts and 70% decline
in vessel effort for salmon has meant changes for all involved: vessel owners, skippers and crew, workers and owners of related businesses (fish processing plants, gear stores), and, of course, family members.

The fishing industry, as with other natural resource-based industries, normally experiences cycles of good and bad years. Yet despite this, many have documented the personal commitment expressed by fishing businesses and families to the occupation (Poggie and Gersuny, 1974; Danowski, 1980; and Mederer, 1993). Terms like "it's in their blood" and "it's a way of life" are commonly heard and chronicled. However, in the Pacific Northwest, many segments of the industry have been in a general decline since 1990. The current decline is expected to be prolonged, with many businesses unable to survive economically.

This is particularly stressful to the families who are the backbone of these fishing businesses. Fishing families possess some unique qualities. Because the fisherman (most often the male) is frequently at sea, the responsibility of maintaining a comfortable and safe home life falls largely on the spouse's (most often the female) shoulders (Mederer, 1993). It's hard to have routine schedules or regular plans. Hobbies or social interactions that the spouse participates in when the fishermen is at sea often stop when he comes home (Danowski, 1980). And family members often comment about the danger involved in commercial fishing and the additional stress this can put on a family.

All in the industry agree that the entire industry is being confronted with enormous change and a painful period of transition. This situation is similar to the economic uncertainty that faced farm families in the 1980s, and timber families in the late 1980s and early 1990s (Conway and Wells, 1993). Those who make it through the current crisis will find themselves part of a much smaller and more restricted fishing fleet. Many will not make it through the transition and their families will be in financial crisis. Four factors often contribute to financial pressure: low family income, unstable work, income loss, and high debt-to-asset ratio. Boat owners certainly are facing income loss and the resulting high debt-to-asset ratio. Skippers, crew, processing workers, gear and service suppliers, and family members are facing all or part of the factors listed above. Anger, frustration, fear, and stress resulting from visions of an uncertain future are challenging the stability and security of fishing businesses, families, and communities.

In November 1993, it seemed timely to develop an experimental outreach program for fishing families in Oregon. Acting as a team, the authors developed a proposal for National Sea Grant funding for a pilot-scale educational outreach program. In January 1994, the team received notice that they had received a small grant for an 18-month effort. They began immediately establishing a project steering committee for guidance and
networking support. The next 18 months were filled with needs assessment, networking, and educational outreach activities to meet project objectives and ultimately the needs of the audience: fishermen and their families, workers of processing plants, equipment suppliers and service providers living or working in coastal communities. Our methodology was to assess their needs and then to provide appropriate educational resources to help families cope with the ups and downs of a natural resource-based industry in transition. We would furnish practical information on techniques and attitudes effective in managing community and personal change, tools and methods on surviving transition periods, diversifying employment/income options, and family stress precipitated by economic and social pressures.

The pilot project was an experimental outreach effort; a practical attempt at empowering fishing businesses and families to manage change and maneuver the subsequent transition in a way that provides the most business security and family stability. Through conducting close-to-the-industry needs assessment, we identified some of the unique personal and business challenges facing fishing businesses and families. We also assessed the existing "networks;" the communication/support links that exist within the industry (between fishing businesses or families) and between the industry and community and business agencies. Danowski (1980) reported the importance of networks such as Fishermen’s Wives Organizations in helping family members to cope with the fishing marriage. Fishermen have historically operated in the margins of society, and are feeling marginalized and disenfranchised from society in general and the communities where they live (Hall-Arber, 1993). Networks between the industry and community and business agencies will be critical in addressing this issue. During our pilot project, we asked, and encouraged them to ask themselves and each other, "What is your ability to respond to the fishing industry crisis?" We began to recognize the number of community and business agencies that are ill-prepared to respond or lack the understanding of how they might better serve fishing businesses and families in transition. We became aware of the research opportunities that matched these needs and issues. And we learned how an effective community-based outreach project could help fishing businesses and families in transition. In short, on a small scale, we learned about the real needs and issues facing fishing businesses and families and how outreach education can make a difference on these issues.

Improving on Success with Expanded Outreach and Increased Networking

The strategy we are using in the 1995-97 program, what we now call the OSU Fishing Families Project (FFP), is to actualize a vision of "fishing business and family support centers without walls" in each of three regions of the Pacific Northwest coastline:
1) The north coast (serving the ports of Lower Columbia River [Astoria, Hammond, Warrenton, Ilwaco], Tillamook Bay [Garibaldi, Bay City], Pacific City, Willapa Bay [Tokeland, South Bend, Raymond], and Gray's Harbor [Westport, Hoquiam])

2) The central coast (serving the ports of Lincoln City, Depoe Bay, Newport, Florence, Reedsport, Winchester Bay, and Coos Bay)

3) The south coast (serving the ports of Bandon, Port Orford, Gold Beach, Brookings, and Crescent City).

Our objectives are:

1) To implement successful educational outreach programs that help fishing businesses and families manage change.

2) To create or strengthen industry/community/agency networks to support this industry’s transition.

3) To regionalize the effort by extending it to fishing businesses and families to the south (northern California) and the north (southwest Washington).

4) To compare and share our research and outreach experience with other areas of the U.S. where similar challenges are being faced.

To do this we deliver, on a regional basis, locally-tailored, community-based, educational outreach activities. We use the support of regional- and port-based advisory groups in the design and delivery of effective educational materials and outreach activities, and in the creation or strengthening of networks. Our challenge is to work with the audience in implementing strategies and networks that make a significant difference in the lives of individuals, businesses, and community organizations.

But How? What Are the Nuts and Bolts/Hooks and Lines?

We take a 3-pronged approach to educational outreach and networking:

1) Personalized, community-based contact

2) Practical, educational materials and activities

3) Encouraging network creation or strengthening

The key to reaching this independent and proud audience is through the personalized contact of peers and we’re doing this via Fishing Family Coordinators (FFCs). FFCs are members of fishing families or businesses managing a major transition, and, like their peers, they are working to
make ends meet and keep their families strong. They are often "rich" with connections and credibility with the audience, and "poor" with spare time and cash. In the pilot project, the FFCs served as volunteers, receiving a small stipend plus travel and communication expenses. Unfortunately, the pilot experience showed this funding level to be inadequate. In the FFP we provide adequate time, communication, and travel support to the FFCs, assuring that they'll be able to:

1) Reach more peers within Oregon and throughout their region in a high-quality, timely way, and

2) increase their ability to serve as the center of the link between fishing businesses and families, and between these families and businesses and the industry/community/agency networks in the region.

The educational materials and activities that we provide are community-based and address identified needs and issues. For example, we offer workshops focusing on family and business financial management, industry trends and forecasts, business diversification (within the industry and to transition to other industries), individual and group communication/cop ing methods related to dealing with stress and change, how to access resources, develop and maintain effective networks, etc. One example of a successful educational outreach activity were the "Staying Afloat/Getting Ahead" workshops. Designed to assist fishing families manage their business and family finances, these workshops provided an interactive, educational forum where participants learned from presenters and each other practical strategies to keep records, do some financial planning, and prepare for tax time. Participants evaluated that these workshops were helpful and got many of them "back on track." In fact, a shrimper who attended one of the sessions said that his participation in this workshop "saved my family a very significant amount of money." What also resulted from these workshops were two new publications ("Tax Information for Crewmen on Commercial Fishing Boats" and "Family and Business Records Checklist for Fishing Families") and innovative ways to get them into the hands of those in need. Other examples of educational materials available through the FFP are the "Fishing Family & Business Resource Kit," "Helping Persons Cope With Change, Crisis, and Loss," and "Getting Unhooked From Anger and Conflict."

We create local and regional networking activities that bring all interested parties together, for example through regional conferences for local industry-related groups such as the Fishermen Wives Organizations, or through the regionally-based "Marine Fisheries Resource Fairs." The idea with these networking opportunities is to provide a "one-stop shop" for fishing families and businesses. At these fairs individuals and families access information related to industry- and family-related agencies/organizations, and become connected with opportunities for
support, information, and future possibilities. One of the most important aspects of these fairs are the interactive symposiums on topics such as fisheries management, family support networks, etc. Another example of community-based, networking efforts is the Fishermen's Referral Service program in the central coast region. This effort was created in cooperation with the Newport Fishermen's Wives Group and links available crewmen with boat owners/skippers in need of skilled crew. Although it is still young in its process, this may end up being a model for other regions.

Lessons Learned So Far

As OSU Forest Ecologist Steve Radosevich says, "Many of today's natural resource problems are 'wicked problems' — problems so complex and with so many interactions that no solution seems possible, only resolution." And, it could probably be argued that these "wicked problems" are not just related to natural resources. Issues facing families — parenting challenges, the lack of family-wage job opportunities for rural youth, increasing costs and lack of security in income, etc. — are "wicked problems" as well. Combine this with declining agency budgets and increasing impacts of resource management/policy decisions on communities, it obvious why a collaborative approach to resource issues has become so popular. However, most family, business, community, and agency partners have not had the experience or the skills to address these complex situations effectively and collaboratively. That is why we have, and continue to, put so much effort into creating or strengthening networks, both within the fishing industry and between the fishing industry and the community/agency support agencies. Workshops such as the "Fishing Families Networking" appear to be helpful with this. Through these and other workshops, fishing business and family members have and will learn how to build empathy for the kinds of emotional problems that people in changing natural resource-dependent communities face, and how to develop assessment and analytical skills and recognition of opportunities others have taken in similar situations.

We're learning that certain parts of the audience are especially hard to reach. Examples of this are charterboats (some differences of opinion on "if and how" these folks are really part of the commercial fishing industry), crewmen (due to their apparent lack of interest or trust in education, and their mobile lifestyle), and processing plant workers (often due to a language barrier and/or mobile lifestyle). One-on-one visits are hard on the FFCs; phone visits seem to be a more effective and efficient tool. Possibly more workshops like Coping with Loss, and Getting Unhooked from Anger and Conflict, as well as dealing with other types of skills related to change would be helpful. Through an increased awareness of educational materials and other resources, they begin to understand the stages of individual change and build skill in recognizing emotional states during individual change, and develop skills used to manage during transition periods.
We've learned that try as we might to "get the word out," we must be more creative and effective at marketing the FFP and the related materials and activities. There appears to be no "good time of year" or only short squatches of time to reach this audience, so we'll have to be more flexible and increase our ability to respond to needs on shorter notice. And, regardless of the form the materials or activities take, we recognize that fishing businesses and families are made up of independent, busy people with no tolerance for abstract information. We must continue to capture their attention with high interest, practically-oriented educational materials and activities.

References


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Urban youth and community youth leaders have been involved in a three-year pilot program in the New Haven, Connecticut metropolitan area which utilizes a collaborative community-based experiential learning approach to:

a) involving urban youth in learning how they are connected to marine and aquatic environments (natural and those created by society),

b) using scientific-based techniques and knowledge to assist youth in understanding and protecting those environments, and

c) exposing them to related employment and career opportunities available to those with appropriate educational backgrounds.

The program focuses on the ecosystem and geographic area of the Quinnipiac River watershed in Southern Connecticut. A marine and aquatic environmental issues curriculum was developed to be completed by middle-school-aged urban youth and community youth leaders. Included are: field trips to key watershed, river and harbor sites; scientific and management demonstrations and hands-on activities; and community outreach opportunities for youth to share their new knowledge and perspectives.

Cooperative Extension educators at the University of Connecticut identified a need for urban youth to develop an understanding of their relationships to nearby environments and how they can use science to understand and protect these environments. The project addresses Extension education priorities in the areas of youth-at-risk, environmental education, water quality, and marine resources.

Overview

The urban youth and the environment program was initiated in 1993 by Cooperative Extension System educators working in the 4-H Youth-at-Risk programs and Sea Grant Marine Advisory Programs.

Educational activities for 4-H youth and leaders in Connecticut have included an annual one-day 4-H Marine Science Day. Up to 150 youth and leaders have increased their awareness of marine environmental issues and
the use of scientific research methods to understand aquatic ecosystems. Youth from the City of New Haven have participated in annual Marine Science Days as well as other educational experiences aboard Project Oceanology's educational vessel studying the marine environment at the eastern end of Long Island Sound. Participation in these activities establishes interest in marine and aquatic environmental issues and related science activities. However, one-day educational events provide limited opportunities to develop their knowledge base and skills levels to a point where they can become involved in on-going marine and aquatic programs.

The Fund of the Community Foundation for Greater New Haven was established as part of a lawsuit settlement addressing water pollution from an Upjohn Company plant in North Haven, Connecticut. The lawsuit resulted in establishment of the Quinnipiac River Fund to be used "to improve the environmental quality of the Quinnipiac River and the New Haven Harbor and the watersheds of these water bodies, and otherwise to benefit the environment of these resources."

Among the purposes of grants from the fund are: "a) studying the ecology of the Quinnipiac River and the New Haven Harbor; b) studying pollution of these water bodies; ... and c) providing public education about these water bodies ..."

A proposal submitted to the Quinnipiac River Fund was approved for funding during 1993-94 and subsequent proposals have been funded during 1994-95 and 1995-96. Objectives for these proposals are:

1995-96 and 1994-95

a. To increase awareness of 30 middle-school-age, inner-city youth and 10 youth leaders about the aquatic and estuarine ecosystem and its relationship to their community including causes and impacts of water pollution.

b. To continue developing an integrated program relating science to life in urban communities using the Quinnipiac River Watershed as a focus involving a variety of pre-existing educational programs; and have students explore the possibility of careers in science, education, and industry relating to the aquatic environment.

1993-94

a. To increase awareness of 120 middle-school-age, inner-city youth leaders about the estuarine ecosystem and its relationship to their community; causes and impacts of water pollution.

b. To initiate an integrated program relating science to life in urban communities using the Quinnipiac River Watershed as a focus. Involve a
variety of pre-existing educational programs and have the students explore the possibility of careers in science, education and industry relating to the aquatic environment.

c. To identify 10 4-H leaders who will work with project coordinators and instructors in identifying marine environmental topics appropriate for on-going projects carried out by 4-H leaders and middle-school-age, 4-H youth.

Educational Activities

1995-96

A five-day series of educational activities occurred during July 1995. The first day involved studying fish population dynamics in Long Island Sound. Biologists at the National Marine Fisheries Service Laboratory in Milford covered: identifying common fish species, research methods, and a winter flounder study.

Thirty-three youth and leaders participated in hands-on activities measuring fish lengths, recording data, and plotting size distribution data on graphs. This was an opportunity for youth to become "immersed" in their work while also having fun.

Day two involved a tour of coastal sites and activities along New Haven Harbor. Twenty-five youth explored shore-side sites including: Tallmadge Brothers Oyster Company’s Mill River facility where thousands of tons of oyster shells are loaded aboard large shell-fishing vessels for transport to oyster beds in Long Island Sound, the U.S. Coast Guard Long Island Sound Station (Search and Rescue Unit), and Fort Nathan Hale and Black Rock Fort (restored historical sites).

Participants learned about oyster production (aquaculture) in nearby waters and the need for clean, unpolluted waters, Coast Guard activities relating to safe use of coastal waters for maritime transportation and recreational boating, and historical activities like harbor defense and shell fishing.

The third day involved a three-hour cruise aboard the educational sailing vessel Quinnipiak which included scientific demonstrations related to water quality, analyzing bottom sediments, identifying marine life, and sail training. Youth utilized fish identification information and size distribution analysis techniques learned at the Milford laboratory.

On the fourth day, participants explored harbor and shoreline habitats at Lighthouse Point Park. Marine scientists led a series of activities exploring a natural rocky shore area, a rock groin extending into the Sound, a sandy beach, and a tidal river.
The final session involved educational activities at two locations. A professor from the University of New Haven demonstrated how a geographic information system (G.I.S.) computer program is used to study the Quinnipiac River Watershed. Participants were able to identify where they live and its proximity to areas of environmental concern.

The second location offered activities covering: seafood safety and human health (including preparation of and sampling flounder), Long Island Sound public issues, and vocational aquaculture education opportunities available at the Sound School (a marine oriented high school).

Ten young people also participated in a week-long summer marine camp which provided additional opportunities to learn about the Quinnipiac River and have fun.

1994-95

The first day involved all participants learning about water safety, handling a canoe, and the water cycle and pollution. Participants discussed how water moves through the water cycle and a watershed, using the different parts of the Quinnipiac River Watershed as examples. They also discussed different uses of water within the watershed and ways water gets polluted. The session finished with a brief training period on how to test water quality using a simple field kit.

A cruise aboard the Quinnipiak allowed participants to: observe human activities within New Haven Harbor, use scientific instruments to examine bottom sediments and measure dissolved oxygen, water salinity and pH, and collect marine life. On-board activities also covered sail training and navigational principles and skills.

Canoes were used to explore a fresh-water section of the river where they were tested for dissolved oxygen, water salinity, and pH. They observed the upper river's topography, vegetation and aquatic animals and compared these to the conditions in the river's marshes in North Haven. Experiencing and navigating the upper river's rocks, fallen trees and shallow water areas provided opportunities to learn about these areas as well as to develop canoeing skills.

Canoeing the estuarine North Haven marshes provided opportunities to conduct water tests and compare findings with those of the river's fresh-water section. Strong winds and a change in the tidal flow allowed youth and leaders to test their new knowledge navigating canoes.

There were two activities at Lighthouse Point Park. In the first, the park ranger conducted a workshop on compasses and navigating by compass bearings. The second was an exploration of a tidal creek.
There was discussion of the different sections of the Quinnipiac River Watershed that were visited during the project. Youth and leaders agreed that the upland canoe trip was their favorite activity.

1993-94

Two days of training were held for community program youth staff and volunteers. Topics covered were: 1) goals and requirements; 2) description of the boat trip, laboratory work, field trips, use of aquaria, and youth community projects; 3) orientation to the environment, Long Island Sound, Quinnipiac River Watershed and New Haven Harbor, and pollution; and 4) discussion of resource materials.

An educational vessel was utilized to explore New Haven Harbor focusing upon water quality, harbor sediments, and marine life. A field tour of the watershed provided opportunities to observe and learn about a variety of resources and human activities including food production (oystering, lobstering and fin fishing), waste disposal, power generation, a wildlife refuge, transportation facilities, and residential areas. There were also discussions about these activities' impacts upon the watershed and marine ecosystems.

The four community youth programs participating in the project were each provided with an aquarium representing the New Haven Harbor ecosystem. Youth at the community centers were able to observe estuarine animals and conduct several water-quality tests with their on-site aquaria.

Multi-agency Collaboration

Like many successful educational programs, the Quinnipiac River Urban Youth and the Environment project involves partnerships. The basic approach has been to develop collaborative educational efforts involving educational organizations, neighborhood youth centers, marine firms, and public agencies.

Three years of funding have been obtained from the Quinnipiac River Fund of the Community Foundation for Greater New Haven. Continuing support has been provided by the University of Connecticut Cooperative Extension System and Schooner, Inc. (a marine education program) while Sea Grant provided development fund support during the project’s first year.

Instructional activities have been contributed by Cooperative Extension, Schooner, Sea Grant, Tallmadge Brothers Oyster Company, Sound School Vocational Aquaculture Center, National Marine Fisheries Service, Fort Nathan Hale/Black Rock Fort Association, New Haven Parks and Recreation, University of New Haven, Environmental Science Program, and Project Oceanology.
A major partner in the continuing effort has been the 4-H SPACES Initiative and community youth programs. Seven youth programs which have involved youth staff and volunteers are: Newhallville Family Support Center, Students United for the Rebirth of Excellence, Farnum Neighborhood House, Church Street South Youth Diversion Program, The Natural Guard, Hill Cooperative Youth Service, and LEAP (Leadership, Education, and Athletics in Partnership). Several programs have participated for three years while others were involved for one to two years.

Summary

Multi-agency collaboration has been viewed as a major strength. Each cooperator continued a unique educational component to the project and most activities have been carried out by the respective programs as part of their on-going educational efforts.

Youth participants benefitted from exposure to different activities and perspectives provided by marine and aquatic educators, public agency researchers, marine and aquaculture firm representatives, high school teachers, Extension educators, and Coast Guard personnel. A combination of field exploration and experimentation, classroom instruction, and shore, canoe and boat trips contributed to achieving project objectives.

The multi-agency effort required a significant project coordination effort to ensure that all the activities were occurring on schedule. The number of participants per year was reduced to allow increased interaction with each participant. This resulted in a more effective educational situation.

The Quinnipiac River Urban Youth Project continues to develop through collaborative activities involving community youth programs, Schooner, Cooperative Extension, and Sea Grant. A Summer Science Camp with SPACES and Schooner will be implemented during 1996, funded by a National Science Foundation grant. Program collaborators are reviewing funding sources that could support a broader program providing continuing opportunities for urban youth to explore nearby environment, science and related careers.

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Tourism is now a $13 billion industry in South Carolina, with about $7 billion of that total generated in three of the state’s eight coastal counties. The industry’s growth represents both opportunities and challenges for natural resource conservation and rural economic development on the coast.

Tourism development on the South Carolina coast is clustered in three areas: Myrtle Beach on the north coast, Charleston on the central coast, and Hilton Head in the south. Between Myrtle Beach and Charleston lies the Santee River delta and the Francis Marion National Forest. Just south of Charleston, along U.S. Highway 17, is the ACE Basin, a 350,000 acre expanse defined by the basins of Ashepoo, Combahee, and Edisto Rivers.

A thriving tourism industry combined with abundant and relatively undeveloped natural resources and the state’s location within a day’s drive of almost half the population of the U.S., to make South Carolina an ideal domestic nature-based tourism destination. But for all its potential, nature-based tourism, if not carefully planned for and managed, could harm the resources it depends on. Therefore, the challenge is to engage all stakeholders in the development of a nature-based tourism industry to integrate, or balance, the need for economic development in rural coastal areas with the need to conserve our natural resources. This is a strategy of inclusion, consensus and optimization.

"Nature-based tourism is responsible travel to natural areas which conserves the environment and improves the welfare of people." This is the Ecotourism Society’s definition of "ecotourism" and also the definition adopted in S.C. by the S.C. Nature-based Tourism Association (SCNBTA) for "nature-based tourism." Why is this kind of tourism variously called ecotourism or nature-based tourism? Perception is reality. In South Carolina, nature-based tourism organizers feared that an "eco" label might cause the concept to be misperceived as a sign of exclusivity by more conservative or traditional natural resource users such as campers, hunters, and fishermen. Organizers also reasoned that because the key element of the definition of both eco- and nature-based tourism is conservation, then hunting and fishing (both well managed, and thus non-consumptive of total resources) could be considered a subset of nature-based tourism. Organizers decided to include the broad spectrum of activities under the umbrella of nature-based tourism so that it would not seem to be exclusive
or elitist in concept or practice, believing that the place from which to educate is from within the organization.

Achieving a balance of economic development and natural resource conservation through nature-based tourism requires good planning involving all stakeholders, including rural residents, public and private natural resource managers, tourism businesses, and tourists. The key to good planning for nature-based tourism lies in matching activities with the most appropriate natural resource areas. More sensitive natural resource areas might be appropriate for very low impact activities of small numbers of wilderness campers, for example. Less sensitive areas might be developed into nature and visitor centers with interpretative programs able to accommodate large groups, the disabled, elderly, and others requiring more infrastructure (parking lots, ramps, walk ways, etc.).

Ross Dowling outlined a process for such matching [Journal of Sustainable Tourism Vol. 1(1), 1993] in "An Environmentally-based Planning Model for Regional Tourism Development." Dowling's model is now being examined for its potential as the basis for a joint effort by the S.C. Department of Natural Resources, the S.C. Department of Parks, Recreation and Tourism, and the S.C. Sea Grant Consortium to create a nature-based tourism plan for the ACE Basin region.

Nature-based tourism became a focus of attention in South Carolina in 1990 when Margaret Davidson, S.C. Sea Grant Consortium director, and Robert Becker, director of the Strom Thurmond Institute at Clemson University, began to look at the changing fabric of the state's rural coastal communities. Davidson and Becker began to consider rural development alternatives which tended both to conserve cultural and natural resources and offer opportunities for economic growth. Nature-based tourism is one such alternative.

In partnership with the National Coastal Resources Research Institute (NCRI), Davidson and Becker began to explore nature-based tourism as a tool for rural economic development on South Carolina's coast. In their initial work investigators began to identify nature-based tourism businesses already in existence. They interviewed the operators and began to understand something of both the challenges they faced in operating their businesses and the things which made them successful. Investigators also attempted to draw a socio-economic profile of nature-based tourists with an interest in nature photography. The goal was to identify a segment of the nature travel market and help operators target that group in their marketing efforts.

Continuing the partnership with NCRI in 1992, Robert Bacon and Lorin Toepper, then director of Clemson University's Recreation, Travel and Tourism Institute created an outreach mechanism for previous and future
nature-based tourism information in South Carolina. Bacon and Toepper established a pilot Grand Strand nature-based tourism organization using the concept of "satellite" nature-based tourism development. The concept of satellite nature-based tourism development uses the existing tourism base in the Myrtle Beach area to draw visitors into adjacent rural areas for, at least, part of their visit. Nature-based tourism, as a niche market, enhances the existing tourism industry by expanding the available product mix, diversifying the kinds of activities offered and offering a product which is viable in the off-peak fall and winter seasons. Nature-based tourism benefits rural areas by providing a flow of visitors to local shops and restaurants, and creates business opportunities for residents with knowledge of local natural resources. Such nature-based tourism entrepreneurs, who may be the sons and daughters of farmers or fishermen, could use their familiarity with local streams, rivers, and marshes to start a canoe livery or wildlife guide service. Entrepreneurs might also establish bed and breakfast inns or "eco-lodge" accommodations.

Day-visits by nature tourists provides an initial flow of visitors into rural areas, stimulating an increased demand for products and services which can lead to the development, or expansion, of a variety of small local businesses. The emphasis on local businesses is important, because nature-based tourists enjoy experiencing both natural and cultural resources with the local flavor which helps to make these resources unique.

The success of the Grand Strand task force stimulated interest in creating a statewide organization. Bacon, Toepper, Kibler, and the members of the Grand Strand task force organized the state's first nature-based tourism conference in March 1993. The conference speakers addressed the potential impact of nature-based tourism on local businesses and communities, and extended much of the information gathered through Davidson and Becker's earlier project, including a socio-economic characterization of the nature-based tourist. The conference provided a first opportunity for existing nature-based business operators to meet and exchange ideas. It also drew participants from the established tourism industry, providing an opportunity for them to become acquainted with the potential benefits to them of nature-based tourism. The conference received wide press coverage in local newspapers and appeared in "USA Today's" Around the Nation section.

The S.C. Nature-Based Tourism Association (SCNBTA) was formally established at the second statewide nature-based tourism conference in March 1994. Officers were elected, and a constitution and by-laws adopted. The association was formed as primarily an educational organization to encourage and plan for sustainable nature-based tourism. Organizational objectives include the establishment of voluntary standards and practices; the development of interpretative quality control mechanisms; the development of in-service training for natural interpreters; the provision of
business assistance to members; the planned development of a nature-based tourism industry in S.C. including all stakeholders in the planning process; and enhanced industry impact through collective marketing and promotion activities.

Prior to the election of association officers, much of the leadership for nature-based tourism organization was undertaken by Bacon, Toepper, and Kibler in conjunction with their NCRI grant. Between the first and second conferences, Bacon, Toepper, and Kibler identified leaders to form the slate of nominees to head the association. The nominees included: for president, Charlie Sweat, the chair of the Edisto Canoe and Kayak Trail Commission; for vice president, Jim Koenig, the director of Camp St. Christopher, a barrier island environmental education program; for secretary, Tim Todd, the president of the S.C. Association of Tourism Regions; and for treasurer, Vicki Scott, an interpreter/guide from Capt'n Dick's Explorer Cruises, a nature tour operator in Murrell's Inlet. The slate of nominees became the association's first elected officers in March 1994. Bacon, Kibler, and Norman, Toepper's successor at RTTI, all now serve on an advisory board appointed by the president.

In 1994, based on the interest generated by the first nature-based tourism conference, Bacon and Toepper were able to secure a place for nature-based tourism on the program of the S.C. Governor's Conference on Travel and Tourism, the industry's largest and most prestigious event. Bacon and Toepper assembled an international panel from business and academia to address the audience on the nature-based tourism market and the issue of sustainability in tourism development.

Meanwhile, in 1993 Davidson and Bacon convened a group including academics, business people, and public and private agency representatives to consider how to plan for and manage sustainable nature-based tourism in South Carolina. The outcome of a series of meetings which took place over a year's time was "Guidelines and Recommendations for Nature-Based Tourism Planning and Practice in South Carolina." The guidelines were developed to address the roles of communities, resource managers, tourism businesses and tourists in contributing to a sustainable nature tourism industry.

The SCNBTA membership formally adopted the guidelines at the third nature-based tourism conference in 1995. The guidelines constitute the association's official set of standards and practices to guide the industry's planning activities and the member's sustainable business practices. The guidelines were published by the association with the assistance of NCRI and the S.C. Sea Grant Consortium and distributed to the membership, in response to mailed requests from around the country and at tourism industry gatherings, such as the 1996 S.C. Governor's Conference on Travel.
and Tourism. South Carolina’s fourth nature-based tourism conference will be held in November 1996 in Myrtle Beach.

In 1996, NCRI has again funded a joint two-year project of the SCNBTA, S.C. Sea Grant Extension and Clemson’s RTTI. The project is designed to create, market, and evaluate nature-based vacation packages and itineraries. Susan Reid, the S.C. Sea Grant Extension Community and Business Development Specialist, joined the project staff in planning this project. The goal of the project is to transform an unrelated series of nature-based tourism activities into coordinated nature vacations.

In order to enhance the attractiveness of S.C. to nature tourists and establish South Carolina as a nature tourism destination, the project planners reasoned that it was necessary to promote the entire industry and provide easy access to its individual businesses. The creation of a S.C. Nature-Based Tourism Business and Resource Directory will provide nature tourism businesses and nature travelers with the same benefits. In addition, the directory will serve as a membership tool for the SCNBTA. Again, the project is modeled after another successful publication, the "Bed and Breakfasts of South Carolina." This guide was published by the S.C. Bed and Breakfast Association with grant support from the S.C. Parks, Recreation and Tourism Department. Because it was produced with state money, the guide must list all bed and breakfast inns, not just association members. Members, however, receive enhanced listings which include promotional tag lines, the association logo and a designation of association approval. Non-members are simply listed by name address and phone. Nature-based project organizers are working with the staff person at SCPRT who assisted the bed and breakfast association with its guide.

Bacon, representing the SCNBTA, has applied for a 50/50 matching grant from SCPRT under its Tourism marketing Partnership Program to help support the development and marketing of the nature-based tourism guide. The guide will be produced in a standard rack compatible 4 x 9 inch format. The guide will also be created on-line for worldwide web access and facilitate updated listings between hard copy revisions. Norman is directing the data collection effort for the guide and is now supervising a pilot project to create a guide for the Grand Strand region. Kibler, working with a student from Coastal Carolina University, is testing data collection formats and methods in preparation for the statewide effort scheduled to begin this summer. The anticipated publication date for the guide is November 15, 1996, in conjunction with the annual SCNBTA conference. The back-up date is in early February 1997, in conjunction with the S.C. Governor’s Conference on Travel and Tourism.

The "SC Nature-Based Tourism Business and Resource Guide" will be distributed by the Association and SCPRT at travel industry trade shows; at S.C. Welcome Centers; by mail in response to individual inquiries; at
individual businesses; in state parks; and via the world-wide web through the linked home pages of the S.C. Sea Grant Consortium, the S.C. Parks, Recreation and Tourism Department and the State of South Carolina. The guide is also designed to be used by travel agents and receptive tour operators in assisting them and their clients with vacation and tour planning.

Finally, the SCNBTA has begun to address issues of quality control in the interpretation of natural resources through a series of educational seminars. These seminars are being conducted under the direction of SCNBTA Vice President Jim Koenig, director of Camp St. Christopher and environmental learning center on Seabrook Island, in collaboration with the education program staff of the SC Department of Natural Resources' Marine Division. At these seminars, natural resource scientists from the department and the state's universities will provide the state's public and private resource interpreters with in-service training to help ensure the accuracy of information provided to the traveling public. Eventually, the association would like to offer a certification program for interpreters, perhaps modeled after the one required by the City of Charleston for its historic tour guides.

In conclusion, over the past five years while many have contributed to setting the stage for the development of a sustainable nature-based tourism industry in South Carolina, much still remains to be done. Little has been done to address the issues of natural resource carrying capacity for nature travel. Although now being discussed by S.C. Sea Grant, the S.C. Parks, Recreation and Tourism Department, and the S.C. Department of Natural Resources, no regional planning process has yet begun. The SCNBTA is still a young, fragile organization which must engage and maintain the interest and participation of many more members to ensure its continued success. It must produce meaningful outcomes for its members and maintain an active voice within the tourism industry as a whole.

Today in South Carolina, economic development is paramount. The ultimate challenge in nature-based tourism development is, however, is to find and maintain a generally accepted and workable balance between economic development and the conservation of natural and cultural resources. If we can do that, we will have gone a long way toward preserving the things which have made our state an attractive and unique place in which to live, work visit and play.
WETLAND BUFFERS IN THE MONTEREY BAY REGION: A FIELD STUDY OF FUNCTION AND EFFECTIVENESS

Rosemary Dyste

Introduction

Wetland buffers are one way to protect wetlands from the potentially negative impact of introducing development adjacent to wetlands. In this study, wetland buffers are defined as a regulated strip of land or setback that provides open space between a development and a wetland.

Functions that buffers can provide include maintaining wetland water quality by reducing erosion and runoff and filtering toxics, a space for wildlife habitat, and a way to discourage easy human access to the wetland. The purpose of this study was to analyze the extent that buffer zones protect wetlands and to begin an investigation of the effectiveness of recommended buffer widths in the study region. This was accomplished by collecting data on buffer function indicators on 15 regulated wetland buffers in the Monterey Bay region.

The Monterey Bay region is located south of the San Francisco Bay area along California’s central coast. The region, including both Santa Cruz and Monterey Counties, is an ideal geographic area in which to study the effectiveness of and impacts to wetland buffers. The diversity and natural beauty of the landscape of both counties makes them a desirable place to live, leading to extensive development and regional growth. The Bay itself supports a large population of marine species and has the largest submarine canyon in North America. The national significance of the area was formally acknowledged in 1992 when the Monterey Bay area became a federally protected marine sanctuary (California Coastal Commission, 1994). While management plans and restoration projects have been prepared or are being prepared for many of the area’s diverse range of wetlands they are under the continuous pressure of development and human population growth. This combination of a desirable natural setting, development pressure, and the fairly high level of commitment that local governments show towards preserving their wetland resources makes the region ideal for studying the use and effectiveness of wetland buffer zones.

Most of the wetland buffer study sites were mostly chosen from a database of coastal zone wetland permits developed by the Santa Cruz office of the California Coastal Commission (CCC) for their 1995 Regional Cumulative Assessment Project (ReCAP). The remaining study sites were chosen from outside the coastal zone. Criteria for site selection included access to development permit information and site accessibility. The study sites
research was guided by two types of questions: those relating to buffer function effectiveness and those relating to effective buffer permitting.

The specific buffer function questions were: (1) how well do current buffers prevent human impacts from adjacent development, as measured by human presence, wildlife, vegetation, and erosion indicators; and (2) what features of buffers seem to limit human impacts?

Permitting questions included: (1) do buffer widths meet the regulatory requirements; (2) are wetland buffer goals established for each buffer; and (3) has the buffer changed over time and do the permits require monitoring or a postdevelopment analysis of success?

Methods

The data for this study were collected and evaluated in 1995. The parameters selected to assess the function and effectiveness of wetland buffer zones included the level and quantity of human use including both human caused disturbances and controlled public access features, wildlife habitat features, evidence of erosion, evidence of water ponding in the buffer, and buffer vegetation characteristics. Each site was walked and thoroughly examined in the months of January, February, and July. Indicators of the selected parameters were counted, measured, and recorded. Special features were noted on a map and the sites were photographed. When possible, a linear measurement was made at each site to determine if the measurements in the field match the regulated setback stated in the permit file.

Additional information was compiled for each site by reviewing permit files and other available reports to collect wetland area history, permit conditions and history, existing wetland evaluation results, and buffer goals. Aerial photographs were reviewed to determine the size of the buffer area in acres. After the field data was collected, statistical tests were conducted to determine if the width of the buffer and the level of human intrusion were correlated and to find if the average level of human intrusion was significantly different in fenced buffer sites versus unfenced ones.

Results and Evaluation

The primary objective of the field component of the study was to assess the characteristics of selected wetland buffers in the Monterey Bay area to determine the effectiveness of wetland buffer zones in protecting the wetland from disturbance. The results of the field study show that the buffers are generally effective in protecting the wetland from disturbance; however, there is a distinct lack of maintenance and control of human access.
Erosion indicators were found at 33% of the buffer sites. Erosion appeared to be associated with either incomplete or newly completed restoration efforts or stormwater outlets in the buffer. One site showed water ponding in the buffer area and no sites showed flooding of adjacent development which may indicate that the buffers are functioning to moderate water level fluctuations. Most sites had good cover for wildlife and many had snags and cavities available. The survey of vegetation characteristics showed that the buffers were dominated by herbaceous vegetation at 66% followed by 13% scrub-shrub, 1% forest, 9% plant litter, 9% bare earth, and 2% paved surface. Nine sites have been maintained in a natural condition (native or non-native vegetation unchanged since development took place), and six have been restored or will be restored with native species.

All of the buffer sites showed some level of human caused disturbances demonstrated by the amount of garbage deposited in the buffer or the wetland and other aspects such as unauthorized trails and vegetation trampling. A Pearson's Product-moment correlation was used to determine if the width of the buffer and the level of human intrusion were related. However, the coefficient of correlation ($r = -0.25$) implied that there was little or no linear relationship between the two factors. Very few of the wetlands in the study area had planned aesthetic development in the buffer that allows limited accessibility to the wetland. One site had plans for interpretive signs and a loop trail while two other sites had observation decks or benches facing the wetland. A Student's $t$-test was used to find if limiting access to the buffer with a fence had an impact on the average level of human intrusion. The results showed that the sample evidence was insufficient to indicate a statistically significant difference in intrusion levels at the $a = .05$ level of significance. Although the data in this sample did not provide sufficient evidence that the width and/or fencing of the buffer influenced the level of human intrusion, further studies are warranted.

While the field study portion of the thesis was designed to assess buffer function, the research was also guided by several questions to determine if the buffers met the regulations outlined for them in the permits. It was found that there were some discrepancies between the regulated setback requirements and the observed results. While 100 feet was the standard regulatory requirement for most of the buffers, the average width was 78.5 feet. Twelve out of 15 sites were fewer than 100 feet, 1 site was 100 feet, and 2 sites were over 100 feet. It was also found that accurate width measurements were difficult to make due to lack of standard maps in the permit file, ill-defined statements about where the buffer begins and ends, and physical barriers to making measurements.

The permit files, management plans, and restoration reports were searched to determine if wetland buffer goals statements were established for the buffer area. Clear, measurable goals were mostly lacking. Two sites had erosion prevention as a specific goal, enhancement or protection of natural
areas was a goal for seven sites, and controlling access was a goal for five sites. No goals were found for four sites. In addition to goal statements, the permits were examined to determine if monitoring or a postdevelopment analysis of success was required. It was found that monitoring and maintenance is not required at most of the study sites. Where monitoring is required (two sites) or recommended (two other sites) it is in conjunction with restoration efforts. One monitoring report contained measurable criteria for success of restoration of the buffer. Several sites are maintained by public works departments that mainly are responsible for clearing storm drains or detention ponds.

Conclusions

The conclusions based on the field study (Table 1) suggest that the wetland buffers in the study region are generally effective in preventing erosion, moderating water level fluctuations, and providing wildlife habitat. On the other hand, the wetland buffers are not preventing human intrusion and the opportunities for education, recreation, and aesthetic enjoyment of the wetlands are limited or not used to their best advantage. The regulatory process needs to be improved and more data is needed to make better judgments on buffer function and effectiveness. Direct observation showed that there was little evidence of erosion in the buffers that would lead to excess sedimentation in the wetlands. The vegetative cover at most of the sites is good and effective at preventing erosion. The buffers are used by birds, reptiles, and small mammals. Habitat features such as snags, cavities, brush, and cover are available. Due to the degree of urbanization surrounding these wetlands, they may be providing important wildlife habitat. Unfortunately, the important habitat features may be compromised by the lack of maintenance and control in these sites leading to garbage and yard waste dumping and unregulated trails. In addition, there was a lack of improvements that would channel human access and enhance human use.

Results from the permit evaluation showed that the permit files and the regulatory process by which buffer size is determined could be improved. Based on the permit file examination portion of the study, the research showed that there is not enough data in the files on baseline conditions and location maps are either missing or insufficient. The lack of predevelopment site information made it difficult to determine if introducing development adjacent to the wetland had a detrimental effect. Without a standard map demarcating the buffer it was difficult to determine the location and actual size of the buffer. In addition, the regulatory requirements for buffers are not explicit enough. There is no standard way of measuring buffers and the terms used to demarcate the buffers are not defined. Goals are not clearly stated and postdevelopment maintenance or monitoring is not required unless the buffer has been restored.
Recommendations

The following recommendations are suggestions to improve the effectiveness of wetland buffers in the Monterey Bay area. Responsibility for the suggested procedures can be divided among developers, regulators, the public, and the academic community. Implementation of the suggested recommendations is not exclusively the responsibility of one particular group; responsibility is best shared between the different stakeholders. The property developers can become responsible for improving water quality protection and wildlife habitat, and controlling human use. Regulators can improve the regulatory program, guide the developer's projects, and help educate the public. The public can become involved in education and maintenance through volunteer efforts and interest in their natural surroundings. Lastly, the academic community can educate the public and conduct further research to expand our knowledge of wetlands and their surrounding uplands.

Recommendations associated with the data findings include channeling human access, removing or improving the stormwater drain outlets in buffers, and improving the permitting procedure. Human access can be channeled with fences, carefully planned pathways, and observation platforms. Access features should be inspected periodically to ensure that the area is not damaged by public contact. Stormwater drain outlets can be improved with structural means to mitigate impacts such as sediment traps or in nonstructural manner such as planning the development to minimize runoff. The permitting procedures for wetland buffers could be improved with standard maps, statements of measurable goals, and more explicit definitions. Additional recommendations include encouraging restoration with native species, educating the public on the resource quality of wetlands and related uplands buffer area, maintaining the wetland buffers with a volunteer clean-up program, implementing variable buffer zones based on a minimum fixed width with the variability based on specific criteria, and improving practices in the watershed.

In summary, this study provided a portion of the information that is needed about wetland buffers. Effective, functional buffers are needed to protect environmentally sensitive areas. While size is an important criteria when designing wetland buffers, it is also important to consider impacts to the wetlands from beyond the buffer boundary. Goals for the buffer must be clearly stated with measurable criteria for success. Lastly, buffers themselves need to be valued for the functions they provide and as habitat for wetland-dependent species.
References


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Table 1—Data Findings Summary

<table>
<thead>
<tr>
<th>Function</th>
<th>Indicator Methods</th>
<th>Results</th>
<th>Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Erosion prevention</td>
<td>Count and measurement of rills and gullies</td>
<td>33% of sites showed some sign of erosion</td>
<td>-poor revegetation effort -stormwater outlets in buffer</td>
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<tr>
<td></td>
<td>Average vegetation cover estimation</td>
<td>Average cover for all sites is 89%</td>
<td>+good vegetative cover</td>
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<tr>
<td>Wildlife Habitat</td>
<td>Wildlife habitat features noted, single direct observation of species</td>
<td>Brush or cover present at 93% of sites, snags or cavities at 67%, burrows in 20%, and animal trails in 27%</td>
<td>+good habitat indicators -too much non-native vegetation</td>
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<tr>
<td>Human use (uncontrolled)</td>
<td>Indicators of human use counted</td>
<td>Garbage found in 80% of sites, yard waste in 27%, and human trails in 60%. No campfires found</td>
<td>-lack of maintenance and controls -lack of improvements</td>
</tr>
<tr>
<td>Human use (controlled)</td>
<td>Human access control features counted</td>
<td>Two sites have controlled access paths, 2 have signs, 5 sites are fenced and 5 have observation decks or benches</td>
<td>+good when present -could be improved</td>
</tr>
<tr>
<td>Moderation of water level fluctuation</td>
<td>Indicators of ponding or flooding observed</td>
<td>One site had water ponded in the buffer, no flooding observed</td>
<td>+occurs but not enough data available</td>
</tr>
</tbody>
</table>
Past studies have shown that the quality of some water bodies in the Snohomish River Watershed have violated water use standards. Bacteria, which are found in the intestinal tracts of certain warm-blooded species, have been identified as pollutants. Four river stations and five slough stations in the Snohomish River and adjoining Steamboat Slough were surveyed for existing levels of bacteria. Levels of total coliforms, fecal coliforms, and fecal streptococci were significantly higher in Steamboat Slough than in the Snohomish River. Fecal coliform levels in both water bodies were much lower than water quality standards. The data suggest that Ebey Slough may be a source of fecal coliform contamination to Steamboat Slough.

Introduction

In 1992, the Washington State Department of Ecology (DOE) assessed the existing water quality of various waterbodies (Washington State Department of Ecology, 1992), and concluded that the Snohomish River did not have sufficient water quality to support its designated uses of primary and secondary recreation or fish spawning, rearing, harvesting, or migration. Pollutants identified by DOE were bacteria, sediment, low oxygen, and metals. The bacterial standards state that the geometric mean value of fecal coliforms shall not exceed 100 org/100ml for class A waters, and that more than 10% of the samples shall not exceed 200 org/100ml (METRO, 1989).

Fecal coliform bacteria are found in the gut or feces of warm-blooded animals. Their presence in the environment is used as an indicator of recent contamination by sanitary wastes. While most species of the fecal coliform group are not pathogenic themselves, as the number of fecal coliforms increases, the probability of pathogenic organisms occurring also increases (Cirone-Storm, 1983). Point sources of bacteria to the Snohomish River, according to Cirone-Storm (1983), may include sewage treatment plans and combined sewer overflows (which collect urban storm runoff as well as sewage overflows). Non-point sources may include runoff from agricultural and urban lands, as well as industrial effluents.

Microbiological testing of water assesses the processes that regulate the distribution of bacteria in a water body. Standardized tests as described by the American Public Health Association (1975) have been created for this purpose. In the present study, the concentrations of Most Probable Numbers (MPNs) of fecal coliforms, total coliforms, and fecal streptococci are given for sampling stations along the Snohomish River Estuary as well
as Steamboat Slough. The ratios of fecal coliforms to fecal streptococci (FC/FS) were determined in order to indicate the source of the bacteria (they live in the intestinal tract of different warm-blooded animals in different concentrations). For example, the following FC/FS ratios are given by American Public Health Association (1975): humans 4.4; ducks 0.6; sheep, chicken, and pigs 0.4; cows 0.2; and turkeys 0.1. The obtained ratios will be interpreted loosely, however, because the American Public Health Association (1989) found that the method may not be reliable in determining fecal bacterial origin.

The study hypothesized that because total coliform, fecal coliform, and fecal streptococci distributions are primarily influenced by the hydrography as well as point and nonpoint sources, levels of these bacteria will be higher in the sloughs than in the Snohomish River Estuary (due to the surrounding land uses as well as extensive diking of the Snohomish River Estuary which inhibits nonpoint source contamination). Due to purposes of simplicity, the Snohomish River Estuary will be referred to as the mainstem in the remainder of the document. Furthermore, the FC/FS ratios were expected to be lower in Steamboat Slough due to the surrounding agricultural lands.

Methods

Surface water samples were taken at four stations along the mainstem of The Snohomish River on April 4, 1995, as well as five stations along Steamboat Slough on April 5, 1995. Sampling sites on the mainstem were chosen so as to sample through the salt wedge and obtain a survey of the river from a freshwater end-member (Station MI) to a station adjacent to the mouth of the Snohomish River Estuary (Station MIV). The sampling sites on Steamboat Slough were placed adjacent to strategic waterway junctions as well as other potential contamination sources. Duplicate samples were taken at each station.

Selective media for growing total coliforms, fecal coliforms, and fecal streptococci were purchased from Difco and diluted according to standards as described in American Public Health Association (1975). To determine the levels of total coliform, fecal coliform, and fecal streptococci bacteria, the Most Probable Number's were determined by the Multiple Tube Fermentation Test (American Public Health Association, 1975). Confirmed MPN's per 100 ml were calculated using tables found in American Public Health Association (1975). It is important to note that MPN's are an estimate based on probability formulas, and are not an actual enumeration of bacteria cells (Murphy, 1991).

Analysis of Variance was performed on log transformed bacterial data to determine if significant differences exist between bacterial levels: within the mainstem, within the slough, and between the mainstem and slough.
Results

Surface salinity in the mainstem ranged from 0.043 o/oo at station MI to 6.859 o/oo at station MIV. These measurements were taken during high tide. The surface water was well-mixed at stations MI-MIII because the surface water of these stations lay above the effects of the salt wedge during high tide (Figure 1). Station MIV had a higher salinity because it was situated in the salt wedge. Assuming no tidal influence, the average flow rate of water through the area sampled was approximately 404.3 m3/s during the time of sampling in the area sampled (M. Cook, pers. comm., 1995). This corresponds to a residence time estimate of around four hours for water in the area sampled between stations MI and MIV (Figure 1). The residence time of this water body including tidal influence could not be calculated due to a lack of data, however, it is thought to be on the order of less than one day, regardless of stage in the tidal cycle (M. Swapp, pers. comm, 1995).

The surface salinity values in Steamboat Slough ranged from 0 o/oo at station SII to 2.442 o/oo at station SV. The water between stations SI and SII remained fresh throughout the depth profile and appears unaffected by the tides. The circulation patterns between stations SII and SV are more complex. During ebb tides, a layer of fresh water flows seaward on the surface throughout the area sampled, but during flood tides, effects of the salt wedge travel up past station SIII into Ebey slough (M. Swapp, pers. comm., 1995). The residence time of water in Steamboat Slough between stations SII and SV ranges from 2-13 hours depending on the stage of the tide. The residence time between stations SI and SII is approximately 3-4 hours, independent of tidal effects (M. Swapp, pers. comm., 1995).

Levels of total coliforms, fecal coliforms, and fecal streptococci in MPNs/100 ml from the mainstem and Steamboat Slough can be seen in Figure 2. Results of Analysis of variance tests can be seen in Table 2.

Discussion

The lower stem of the Snohomish River is characterized by a strong salt wedge characteristic of a partially-mixed estuary which reaches up to 10 km upstream of the mouth of the river. The salt wedge affects surface circulation patterns which determine where impacts of fresh water runoff (potential bacteria sources) will occur. Stations MI-MIII lie in an area where the surface water is unaffected by the salt wedge even during high tide (Figure 1). Therefore, during high tide and low tide, bacteria found in the surface water at stations MI-MIII are most likely to have originated from sources either adjacent to the sampling sites, or upstream of the sampling sites. Bacteria levels at station MIV, however, may be affected by the tidal influence. Therefore, bacteria levels found at this station may originate from sources downstream in addition to the sources previously...
mentioned. During low tide, of course, all of the stations remain unaffected by the salt water intrusion. The area sampled flushes quickly (the residence time is thought to be less than one day) and may not allow a build-up of bacterial contaminants.

The circulation and hydrography of Steamboat Slough is more complex. The depth profiles of uniform salinity between stations SI and SII suggest that there is no tidal influence in this part of Steamboat Slough (Figure 1). Instead, during flood tides, the tidal influence appears to divert away from Steamboat Slough just downstream of station SII and travel up Ebey Slough (M. Swapp, pers. comm., 1995). Therefore, surface bacteria concentrations in the section between stations SI and SII are affected by surrounding land uses as well as sources upstream, regardless of the tidal cycle. Surface bacteria concentrations at stations SII-SV are influenced by sources along the upper parts of Steamboat and Ebey sloughs during ebb tides, and depending upon mixing, may be affected by sources near the mouth of Steamboat Slough during flood tides.

The geometric mean of fecal coliforms in the mainstem was 1.52 MPN/100 ml, which is well below the water quality standard of 100 org/100 ml for class A waters. Because there existed no significant differences within total coliform or fecal coliform MPN's between the mainstem stations, there appear to be no point sources of these bacterial contaminants to the mainstem in the area sampled. Curiously, levels of fecal streptococci were significantly higher (p=.05) at station MIV, the most saline downstream location. The viability of fecal bacteria generally decreases with increasing salinity. Assuming that the bacterial growth rate is matched by the rate of grazing on bacteria (Skinner, 1992), the bacteria are expected to act conservatively once they are in the river. The slightly higher levels of total coliforms, and significantly higher levels of fecal streptococci at station MIV, may be a result of concentrated man-made surface runoff features as well as industrial sites on the shore adjacent to station MIV (Tetra Tech, 1988). The mean FC/FS ratios in the mainstem ranged from 0.78 to 2.25. This range of values makes it difficult to pinpoint the biological sources of contamination. The existing FC/FS ratios are may be a result of a mixture of contaminant sources including livestock, water fowl, and humans.

The levels of total coliforms, fecal coliforms, and fecal streptococci were all significantly higher in Steamboat Slough than in the mainstem. This suggests that either sources of contamination to Steamboat slough are more prevalent or that the slough is more susceptible to contamination due to less effective diking. Much of Steamboat Slough is surrounded by agricultural land where livestock graze; surface runoff from these areas may provide significant non-point contamination to the slough. The mainstem, on the other hand, is bordered by the City of Everett, where chances of bacterial contamination are lower. Furthermore, weather may play a role in affecting the bacterial levels measured. It rained all day during April 4th,
which may have significantly increased the surface runoff on April 5th, which corresponds to the sampling date of Steamboat Slough. Therefore, the relatively higher levels of bacteria in Steamboat Slough may be attributed to relatively higher levels of surface runoff during the sampling time of Steamboat Slough. The FC/FS ratios in the slough were not significantly different than those in the river. Therefore, as in the mainstem, the bacteria are likely due to a mixture of biological contaminant sources.

There were no significant differences within total coliforms and fecal coliforms between the stations in the slough. This suggests that these bacteria stem from non-point sources. However, station SIII had significantly higher levels of fecal coliforms ($p = .10$), than did any of the other slough stations which suggests a more concentrated source that was not sampled. Station SIII is situated adjacent to an inlet connecting Ebey and Steamboat sloughs (Figure 1). Ebey Slough may be the source of high fecal coliform levels at this station. Ebey Slough is surrounded by agricultural land, and has been known in the past to violate water quality standards. Furthermore, both Quilceda and Allen creeks flow into Ebey Slough, and both of these water bodies have bacteria levels which consistently violate water quality standards (Kathy Thornburgh, pers. comm. 1995). The geometric mean of fecal coliforms in Steamboat Slough was 17 MPN/100 ml, well below the water quality standard of 100 org/100 ml. The mean FC/FS ratio of the replicates at this station was 17.9, which suggests that human waste may be somehow responsible for the contamination at station SIII.

References


METRO, Quality of Local Lakes and Streams. 1988-1989 Status Report.


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<table>
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<tr>
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<th>Total Coliforms</th>
<th>Fecal Coliforms</th>
<th>Fecal Streptococci</th>
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</tbody>
</table>

Table 1. Mean and standard error of Total Coliforms, Fecal Coliforms, Fecal Streptococci (MPN/100 ml), and FC/FS ratios.
| STATION                        | F CALCULATED | F TABLE (?,
|                               |             | .05)   | F TABLE (?,
|                               |             |        | .10)   |
| MAINSTEM: TOTAL COLIFORM      | 0.987       | F(3,4) | 6.59  | F(3,4) | 5.34  |
| MAINSTEM: FECAL COLIFORM      | 0.352       | F(3,4) | 6.59  | F(3,4) | 5.34  |
| MAINSTEM: FECAL STREPTOCCI    | 8.515       | F(3,4) | 6.59  | *      | F(3,4) | 5.34  |
| MAINSTEM FC/FS                | 0.855       | F(3,4) | 6.59  | F(3,4) | 5.34  |
| SLOUGH: TOTAL COLIFORM        | 0.757       | F(4,5) | 5.19  | F(4,5) | 3.52  |
| SLOUGH: FECAL COLIFORM        | 4.023       | F(4,5) | 5.19  | F(4,5) | 3.52  |
| SLOUGH: FECAL COLIFORM W/OUT SIII | 2.094   | F(3,4) | 6.59  | F(4,5) | 5.34  |
| SLOUGH: FECAL STREPTOCCI      | 1.276       | F(4,5) | 5.19  | F(4,5) | 3.52  |
| SLOUGH FC/FS                  | 2.861       | F(4,5) | 5.19  | F(4,5) | 3.52  |
| M VS S: TOTAL COLIFORM        | 6.214       | F(1,16)| 4.49  | *      | F(1,16)| 3.05  |
| M VS S: FECAL COLIFORM        | 8.956       | F(1,16)| 4.49  | *      | F(1,16)| 3.05  |
| M VS S: TOTAL COLIFORM W/OUT SIII | 5.955 | F(1,14)| 4.60  | *      | F(1,14)| 3.1   |
| M VS S: FECAL STREPTOCCI      | 10.746      | F(1,16)| 4.49  | *      | F(1,16)| 3.05  |
| M VS S: FC/FS                 | 1.41        | F(1,16)| 4.49  | F(1,16)| 3.05  |
| M VS S: FC/FS W/OUT SIII      | 0.092       | F(1,14)| 4.6   | F(1,14)| 3.1   |

Table 2. Summary of ANOVA Values: MAINSTEM: TOTAL COLIFORM = ANOVA of total coliform levels within the mainstem; SLOUGH: TOTAL COLIFORM = ANOVA of total coliform levels within Steamboat Slough; M VS S: TOTAL COLIFORM = ANOVA of total coliform levels between the mainstem and Steamboat Slough; * = a significant difference exists at this confidence interval (p = .05 or p = .10).
Figure 1. Sampling stations for Snohomish River and Steamboat Slough (after Shen, G.T., 1995)
Figure 2. Mean levels of bacteria (MPN/100ml) +/- one standard deviation for total coliform, fecal coliform, and fecal streptococci. Dashed line on fecal coliform plot represents the Washington State water quality standard of 100 organisms/100 ml (geometric mean value) for Class A waters (from Shen, G.T., 1995).