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Information About Estuaries and Near Coastal Waters
August 2000 - Issue 10.4

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Lobster Mortalities Lead to Fisheries Disaster in Long Island Sound

A Fishery Disaster

Lobster fishermen and dealers began reporting significant numbers of dead and dying lobsters in their lobster pot gear in the western half of Long Island Sound in mid-September of 1999. Affected lobsters appeared normal, but were limp or dead. The Connecticut Department of Environmental Protection (CTDEP) Long Island Sound trawl survey recorded a drop off of lobster catch in September and a more noticeable decline in abundance and an increase in sick lobsters in October. While autumn die-offs have occurred in other years since the late 1980s, the event in 1999 was more severe and occurred over a much larger area of the Sound (more than half of the Sound) than in previous years. By November it was clear that the die-off was unprecedented in scope and catastrophic to the lobster fishery. To make matters worse, the incidence of shell disease, in which bacteria (Bacteria is plural, bacterium singular, so bacteria form would be correct) forms a black mass that rots through the carapace (shell), has increased in lobsters from eastern Long Island Sound over the past few years.

In January, 2000, at the request of the Governors of New York and Connecticut, Long Island Sound was declared a federal fishery disaster area. On February 29, President Clinton asked Congress for $10 million; $6.6 million for research to determine the cause of the die-off and another $3.4 million for economic assistance and development initiatives. What happened to Long Island Sound lobsters? And what are the potential causes of the die-off? Before discussing research done to date to understand the cause of the die-off, some background on the fishery is warranted.

The Lobster Fishery in Long Island Sound

The American lobster fishery is the most highly valued commercial fishery in New York and Connecticut (around 1,300 fishers landed 11 million pounds in 1998). New York is at the southern end of the geographic range of inshore abundance of American lobsters.

In Long Island Sound, lobsters take about seven years to grow to legal size. Nearly all females have borne eggs at least once before they grow to legal size. Egg-bearing females may not be taken. Lobsters grow only when they molt and tend to molt en-masse. In Long Island Sound, molting takes place in the summer and fall. Following molting, lobsters tend to feed actively and readily enter traps. The fishermen call these periods the summer and fall "runs." Landings are concentrated in the periods following the molts; July and August account for at least half of recent landings, and November and December about a third.

Long Island Sound lobsters are very heavily exploited. More than 90 percent of lobsters are harvested following their initial molt to legal size. Despite extremely high exploitation rates, lobster populations and fisheries have increased in yield because of reproductive success and survival and growth of young lobsters to legal size. Commercial lobster landings increased from 2 to 12 million pounds from 1982 to 1998. Scientists are not in agreement on whether lobsters are overfished and in need of increased regulatory protection. However, there is agreement that lobster fisheries are at significant risk if there are episodes of reduced reproductive success. The truncated size structure of the population and high exploitation rates provide virtually no protection against such events.

Understanding What Happened

In response to the die-off, state agencies mobilized to investigate potential causes. Water and sediment samples were collected and analyzed but showed no signs of unusual contaminant events. Researchers in Connecticut, Maine, and Arizona tested the western Sound lobsters for bacteria and viruses, but found nothing to indicate the cause of the huge die-off. Then, Dr. Richard French, a pathologist at the University of Connecticut, found a potential killer--a parasitic paramoeba known to cause death in lobsters, crabs, and sea urchins. The paramoeba enters the lobster's nervous system and destroys nerve tissue. "Limp lobster syndrome" may result, with death usually following within 24 hours.

But many questions remain. Is parameoba the cause of the die-off or just an opportunistic parasite

invading stressed lobsters? What are the possible contributing environmental factors, both human-caused and natural?

Exploring these and other questions was the focus of an April 17-18, 2000 symposium sponsored by Sea Grant College Programs in New York (NYSG) and Connecticut (CTSG). The purpose of the symposium was to interpret and evaluate the results of existing assessment, monitoring, and research activities and to develop a working hypothesis on the cause of the lobster mortalities in Long Island Sound.

The symposium reviewed potential factors, environmental as well as pathogenic, contributing to the recent massive lobster die-off in Long Island Sound. Industry representatives participated to voice their concerns. The targeted audiences included both fishers with anecdotal observations and scientists with water quality data, information on trace contaminants in lobster tissue or information on various parasites and pathogens.

A number of possible stressors were reviewed, including point source loadings, side effects of chlorination, dredge material disposal, and pesticides. These were concluded to have a low probability of causation. Hypoxia, through low dissolved oxygen and hydrogen sulfide release, was cited as having a moderate probability of causation. Two factors were concluded to have a high probability of causation. First, anomalously high bottom water temperatures in 1998 and 1999 approaching 2º C above the 10-year mean bottom water temperatures could have stressed the lobsters, already at the southern end of the geographic range of inshore abundance of American lobsters. Second, commercial lobster landings and trap concentrations were at an historic high. The high population densities of lobsters could have made them more susceptible to disease.

If there is a positive side to the lobster mortalities, it is that the discussion has spurred interest on how to strengthen the region's capability to study, understand, and respond to the array of marine diseases that can devastate living resources and the livelihood of people that harvest them. It is an investment that seems especially wise after the events of the past three years where oysters, hard clams, soft clams and now lobsters in Long Island Sound have been struck by various diseases.

Responding to the die-off of lobsters in Long Island Sound, New York, lawmakers have set aside $1 million to establish a Long Island Marine Disease and Pathology Research Consortium. The center, to be opened as part of the Marine Sciences Research Center at the State University at Stony Brook, will also provide animal disease research on fish and shellfish. The money for the center has been secured and is expected to be signed into law soon.

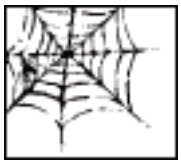
The consortium would work closely with the state Department of Environmental Conservation, which oversees permits for commercial fishermen and which has been coordinating the state's response so far to the lobster deaths. The $1 million is expected to be used to buy laboratory equipment and to hire marine disease pathologists. The consortium hopes to bring together talent from a variety of local institutions.

More immediately, the US EPA has set aside funds to support state efforts to monitor conditions this

summer and has joined with Connecticut and New York Sea Grant to fund additional research on paramoeba. More comprehensive research efforts got a big boost when, in early July, Congress approved $13.9 million in aid as part of a supplementary appropriations bill, $6.6 million for research to determine the cause of the die-off and another $3.65 million to each state for economic assistance and development initiatives. Efforts are underway to develop a research agenda. In the meantime, as one old-timer on the Sound has said, "the only two people who know for sure what will happen are Father Time and Mother Nature."

For further information, contact Mark Tedesco, Director, EPA Long Island Sound Office; Phone: (203) 977-1541; FAX: (203) 977-1546; E-mail: tedesco.mark@epa.gov or Peg Van Patten, Communications Director, Connecticut Sea Grant College Program, University of Connecticut; Phone: (860) 405-9141; FAX: (860) 405-9109; E-mail: vanpatte@uconnvm.uconn.edu

For the latest information on the situation, visit:
http://www.seagrant.sunysb.edu/LILobsters/LILobsters.htm EXIT disclaimer



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Preview of a New Air Deposition Resource for Coastal Managers

Across the coastal U.S. and in the Great Lakes region, air deposition of one or more threatens coastal ecosystems. A wide variety of pollutants can reach coastal areas through deposition, including nitrogen, sulfur, mercury, polycyclic aromatic hydrocarbons (PAHs), lead, cadmium, PCBs, dioxin and other toxic chemicals. In some cases, such as for nitrogen deposition, the threat is relatively well known, but in others it is just beginning to be defined. In some places atmospheric deposition is known to be a significant portion of the total pollutant load to coastal waters, in others it is a minor component, while in many its significance is simply unknown.

The air is a pathway for pollutants emitted from both natural and anthropogenic sources. Winds transport these pollutants over distances ranging from a few yards to a few thousand miles before they are deposited on our land and in our water. While some air pollution originates from natural sources (fires and volcanic eruptions), most emissions come from human activities: industrial processes, agricultural activities, and perhaps most significantly, the combustion of fossil fuels. Fossil fuel burning produces large amounts of nitrogen compounds as well as various toxic chemicals, including mercury. These pollutants are deposited across the landscape and directly into freshwater, estuarine and coastal waters.

Many coastal managers are already dealing with atmospheric deposition in a monitoring or management context. Many more do not yet know whether air deposition is important in their watersheds. In order to help both groups, the US EPA is developing a handbook that answers some of the most frequently asked questions about air deposition. It also summarizes some of the most important details about air deposition monitoring and modeling for water resource managers. The following is an excerpt from the draft

handbook; the final version will be available in the fall of 2000.

How Do I Know If I Have an Air Deposition Problem?

There are several signs that suggest atmospheric deposition may be a problem:

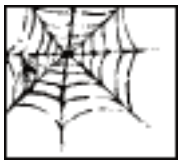
- There are large sources of atmospheric pollutants upwind
- Known sources of pollution do not explain the amount or location of contaminants found in the watershed
- National or regional deposition modeling or monitoring maps indicate a large amount of deposition in your area. (These maps will be in the final handbook.)
- Air deposition has been identified as a significant source of pollution in a nearby or similar watershed
- There is broad-scale (often low-level) water or sediment contamination with toxic pollutants but no hotspots or known discharges

These signs do not necessarily mean air deposition is a large source of pollution, or that it must be controlled. It simply suggests that it would be a good idea to take a closer look at what amount of deposition might be falling in the watershed.

If you think air deposition may be a significant pollutant source in the watershed, go on to the next section. It will describe ways to better estimate the pollutant load from atmospheric deposition without investing resources into monitoring or modeling programs. If the answer to all the questions is no, it is unlikely there is significant atmospheric deposition taking place in your watershed or it is masked by higher loads from other sources.

The handbook goes on to describe a method of estimating how much deposition of pollutants is occurring in your watershed. If it appears at first glance that air deposition might be important in your area, the handbook explains what you need to know about monitoring, modeling, and source attribution. If studies show it is indeed an important pathway for pollutants in the watershed, there is a section on the implications and options available to managers. There is also a comprehensive list of information sources on a wide variety of air deposition topics and potential sources of funding.

This handbook will be available on the EPA air deposition webpage as well as in hard copy. For more information on EPA's Air-Water coordination initiative and EPA resources available for coastal managers on air deposition, contact Debora Martin; Phone: (202) 260-2729 or visit the website at http://www.epa.gov/owow/oceans/airdep/



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New Pfiesteria Species Among Findings Presented at Tasmania Conference

A new species of the toxic dinoflagellate Pfiesteria has been identified by Drs. Howard Glasgow and JoAnn Burkholder of North Carolina State University and their colleagues. The species, which was found in the Albemarle-Pamlico and Chesapeake estuaries of the eastern U.S., is morphologically and genetically distinct from its infamous cousin, Pfiesteria piscicida, which has caused massive fish kills and human illnesses in Maryland, Virginia and North Carolina, but displays identical behavior and life-cycle traits.

The report of the species discovery and description was just one of a number of papers presented at the Ninth International Conference on Algal Blooms, held in Hobart, Tasmania, February 6-11. Among the numerous other papers presented at the conference were studies that:

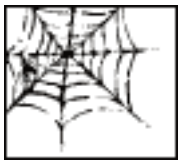
- Documented the key role of herbivorous copepods in transferring algal toxins through the marine food web,
- Addressed measures that can be taken to reduce the spread of harmful algal species as a result of ballast water discharge,
- Identified a new form of human shellfish poisoning in Europe, azaspiracid poisoning, or AZP -- caused by toxic phytoplankton,
- Considered whether blooms of certain harmful algal species could promote growth of tumors in at least some marine wildlife species, and

- Discussed the possible impact of salmon aquaculture on harmful algal blooms.

Harmful Algal Blooms (HABs) are natural phenomena and are commonly (although not always accurately) referred to as red tides. However, in recent years, there have been concerns that they may be spreading and becoming more frequent in many coastal environments around the world, due to human nutrient inputs and other causes.

For further information, all abstracts from the Conference are available at:
http://www.utas.edu.au/docs/plant_science/HAB2000/ EXIT disclaimer

Reprinted from SeaWeb Ocean Update March 1, 2000.



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Ethical Angler Aims to Hook Fishers on Conservation

Experienced anglers can pass on the ideals of responsible recreational fishing to newcomers to the sport under a program called The Ethical Angler(r), launched this April by Boat/U.S., the nation's largest organization of recreational boaters, and the National Marine Fisheries Service (NMFS). Current industry efforts to draw new people to the sport, coupled with the changing demographics of society, provided the perfect opportunity for responsible anglers to help newcomers learn to be responsible fishermen.

The Ethical Angler(r) program is intended to educate anglers using a personal message that will help protect fish stocks, their habitat and the future of sport fishing. Rather than a list of "dos and don'ts", this code of ethics engages the angler through a set of personal statements of principle. In a nutshell, the code conveys the message to respect fish, by protecting habitat and preserving the natural resources that sustain both the fish and the sport of fishing. To make the principles memorable and eye-catching for publications, teaching situations and public service advertising, the seven-point code is based on the letters in the word "ANGLERS."

I'm an Ethical Angler. I:

A Avoid spilling and never dump gasoline, oil or other pollutants on land or in the water.

N Never leave trash behind, including worn line, old hooks and bait, and practice recycling.

G Gain knowledge about Aquatic Nuisance Species and how to help prevent their spread.

L Learn and abide by all fishing regulations and boating laws.

The partnership between Boat/U.S. (Boat Owners Association of the United States) and NMFS, as well as the campaign itself, grew out of an article that appeared in BOAT/U.S. Magazine in July, 1999. That article described an effort by the National Marine Fisheries Service to revise and update a 20 year-old statement of recreational fishing ethics. To illustrate the article, Boat/U.S. recast the code to fit the word, "ANGLERS," so that each letter starts a sentence stating one of the principles.

E Educate fellow anglers and especially new participants about fishing ethics.

R Respect private property and the rights of other anglers and outdoor recreationists.

S Save fish for tomorrow by practicing conservation and learning proper catch-and-release techniques.

In addition to abiding by sportfishing regulations, the code encourages fish conservation and emphasizes keeping only fish an angler can consume or using catch-and-release techniques that help ensure survival. The code advocates respect for private property and the rights of other recreational users while encouraging environmental stewardship.

The code puts the focus on the individual angler by stating the principles in the first person. That approach reinforces personal commitment while emphasizing the role anglers can play in maintaining the health of fisheries habitat, the quality of the marine and aquatic ecosystems and the stocks of fish that they pursue.

Almost immediately after the article ran in the magazine, a saltwater fishing club in Florida requested permission to reprint the code in its newsletter. Shortly afterward a yacht club on Lake Michigan made a similar request, and it became apparent that the code had become a tool that responsible anglers wanted to use in order to spread the conservation message. The Ethical Angler(r) principles apply equally to freshwater fishing and in fact, once Boat/U.S. announced the formal campaign, a bass fishing club in Oklahoma became the first fresh water group to adopt the code.

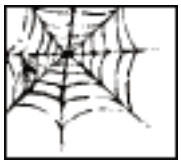
Boat/U.S., with over 500,000 members, provides a wide variety of services to recreational boaters nationwide and member surveys have shown that well over 60 percent engage in saltwater and/or freshwater fishing. Thus, the association revamped the code that had appeared as the magazine illustration and designed a companion Ethical Angler(r) emblem for use as an affinity sticker by individual anglers.

As a further step in the partnership, Boat/U.S. and NMFS designed an Internet-based survey to provide useful demographic information. Anglers answering the survey on the Boat/U.S. Web site (www.boatus.com) or at one of the 54 Boat/U.S. retail Marine Centers receive an Ethical Angler(r) sticker. By early June, nearly 200 anglers had participated in the survey.

The Ethical Angler(r) code is available at no cost in camera-ready format for use by fishing clubs, conservation organizations and youth groups that want to promote responsible angling. In addition, natural resource managers and public agencies that wish to convey this positive message may adopt The

Ethical Angler(r) code in their newsletters and education materials. Individual anglers can obtain an Ethical Angler(r) sticker to display on their boat, trailer or vehicle as a reminder to the public that anglers care about conservation and responsible fishing practices.

For more information about The Ethical Angler(r) and organizational partnerships, E-mail: eangler@boatus.com or write Ryck Lydecker, Boat/U.S. Public Affairs, 880 Pickett Street, Alexandria, VA 22304. To take The Ethical Angler(r) survey, visit http://www.boatus.com/ EXIT disclaimer and click on "Angler's Alley."



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Burnett County Shoreline Incentive Program

Over the course of the last 40 years, shoreline development has surrounded two-thirds of Northern Wisconsin's larger lakes, and the diminishing supply of lakeshore property increasingly threatens smaller and smaller lakes. Not surprisingly, a doubling of the number of homes has substantially impacted the environment. Increased shoreline development has reduced critical wildlife habitat and increased the amount of sediments, nutrients and chemicals flowing into lakes, rivers and streams. Shorelines modeled after suburban subdivisions, with manicured lawns extending down to the waterline, contribute to accelerated stormwater run-off and erosion along waterways in Burnett County, located in northwest Wisconsin, along Lake Superior.

Because of these impacts, a coalition of organizations, including many county government agencies, have developed a program to address the natural resource concerns of the area. Agencies involved include the Burnett County Land and Water Conservation Department, Burnett County University of Wisconsin-Extension, the Wisconsin Department of Natural Resources, and Dragonfly Consulting. An innovative incentive program has been developed to enhance shoreline buffers (zones of natural vegetation that extend from the water inland) on private property.

Assessments of public opinion surveys and focus groups held in Burnett County revealed citizen concerns for water and shoreline integrity. Respondents and participants cited the need for more information on lakes and habitat, expressed an interest in a variety of incentives for preservation and restoration of shoreline, and indicated that they would welcome more communication with applicable government entities. However, landowners were not being motivated to follow environmentally-sound

land management practices. Although the State of Wisconsin had enacted shoreline protection statutes in the 1960s, unclear statute language resulted in poor enforcement. Landowners consequently often ignored the state and county initiatives that were designed to protect shoreline buffer zones. Burnett County's comprehensive plan, adopted in 1998, included significant shore-land zoning ordinance changes, but the county was also interested in exploring voluntary methods of shoreline restoration and preservation.

Accordingly, the need for an educational and motivational program became apparent to the official and unofficial water stewards of the northwest region of Wisconsin. In order to be effective, the program needed to increase awareness of the value of establishing buffer zones, provide technical advice and skills, and motivate individual landowners to adopt environmentally sound shoreline practices. Based on it's public surveys, the coalition designed a program that offers incentives for voluntary shoreline restoration and preservation. Through the efforts of many key individuals from lake organizations, county and state governments, and the private sector, the Burnett County Natural Shoreline Program is currently being implemented.

The program consists of providing technical and financial assistance for shoreline buffer restoration, monetary and other incentives for natural shoreline preservation, and educational and project evaluation programs. It offers two distinct approaches that help landowners restore or protect shoreline buffers.

For shoreline buffer restoration, Burnett County pays landowners up to 70 percent of the costs to replant native vegetation along lake and river shorelines, up to $1,200 per site. The county also provides information to landowners on site planning and preparation, plant selection and planting. To protect existing buffer zones, the county gives participants a one time payment of $250 and an annual $50 property tax credit in exchange for the landowner's agreement to maintain a minimum 35-foot vegetation buffer next to the water's edge. Participants are required to sign a deed covenant that guarantees the zone will continue to be protected with each new owner of the property and are asked to install a small sign indicating their participation. As an added bonus, landowners receive a logo shirt to announce their commitment.

The program is administered through the Burnett County Land and Water Conservation Department through cooperation with a local consultant. Sign-up procedures for both protection and restoration agreements were developed, including coordination with the Burnett County Register of Deeds and County Clerk offices. Site visits are made to verify compliance with the program.

Literature and sign-up information, including a Restore Your Shore Incentives Brochure, a Preserve Your Shore Incentives Brochure and a Landowner Guide are available at the Land and Water Conservation Department. Burnett County's website includes a description of the program and sign-up forms. A plant guide containing photos of acceptable plants and vegetation is also available. Multi-media demonstrations describing the program have been presented to many lake organizations and citizen groups, and natural shoreline workshops are being conducted for landscape professionals and landowners. Burnett County, in conjunction with other agencies, has produced two educational videos on

waterway protection. Instruments measuring the effectiveness of all aspects of the program are and have been utilized.

The ultimate value of this program's approach hinges in part on the fact that water quality, wildlife habitat, and waterway aesthetics are both valued by landowners and significantly improved with buffer zones. It is notably dependent on the cooperation between organizations from the private and public sector and public education efforts. The contributions of several county government agencies are integral to the success of this type of endeavor, and a core of leadership is instrumental in advancing program development and execution. Of course, operational funding is imperative. In the case of Burnett County, a grant from the Wisconsin Department of Natural Resources was critical to the establishment of this program.

For further information on the Natural Shoreline Program, contact Dave Ferris, Burnett County Land and Water Conservation Office, 7410 County Road K, #109 Siren, WI 54872; Phone: (715) 349-2186; or Email: bclwcd@win.bright.net or visit the website at http://www.mwd.com/burnett/. EXIT disclaimer Or contact Jim Bloms, Burnett County UW-Extension, 7410 County Road K, #107, Siren, WI 54872; Phone: (715) 349-2151; Fax: (715) 349-2102; or Email: jim.bloms@ces.uwex.edu

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Linking Science and Policy: The Relationship of Stream Channel Size to Nitrogen Inputs to the Gulf of Mexico

Nitrogen Delivery to the Gulf

Coastal zone managers have long suspected that much of the nitrogen pollution that enters the Gulf of Mexico via the Mississippi River comes from the northern Midwest and Ohio Valley states and is the result of high intensity agricultural activity in those regions. A recent analysis of

monitoring data by researchers at the U.S. Geological Survey (USGS) generally confirms those suspicions, but also suggests that another factor plays a large role in pinpointing where in the Mississippi Basin the largest quantities of river-borne nutrients come from.

Figure 1: *River Monitoring stations and major regional watersheds in the Mississippi river basin*

Researchers found that the amount of nitrogen reaching the Gulf from nutrient sources (agriculture and sewage treatment plants) in the Mississippi Basin depends heavily on the location of the nutrient sources relative to large rivers. The percentage of nitrogen that reaches the Gulf from interior watersheds was highest when nitrogen was carried quickly to larger rivers such as the Ohio and Missouri Rivers. In some cases, much higher proportions of nitrogen were delivered to the Gulf from pollution sources farther away (e.g., more than 1,500 miles away in Ohio and Minnesota), because the pollution sources are located near large rivers.

Conversely, the percentage of nitrogen reaching the Gulf was much lower when nitrogen was carried for extended periods of time by small streams, where the natural rate of nitrogen removal was found to be high (see Figure 2). Much lower proportions of nitrogen could be delivered to the Gulf from pollution sources closer to the Gulf (only a few hundred miles away in Mississippi and Arkansas) because those sources are not connected directly to large rivers but are located in smaller tributary streams.

Therefore, it appears that the percentage of nitrogen reaching the Gulf from all sources (point and nonpoint) in the Mississippi Basin is not simply a matter of its straight-line distance from the Gulf, but depends on proximity to large rivers.

Identifying the Sources of Nitrogen

Increases in nitrogen in the Mississippi River over the latter half of the twentieth century has been cited as the principal cause of eutrophication and chronic hypoxia in the coastal waters off Louisiana, creating the largest zone of oxygen-depleted waters in the western Atlantic Ocean. The seasonal inflow of nitrogen-enriched waters from the Mississippi River into the poorly mixed, shallow Gulf waters has caused excessive algal production, leading to mortality of bottom-dwelling

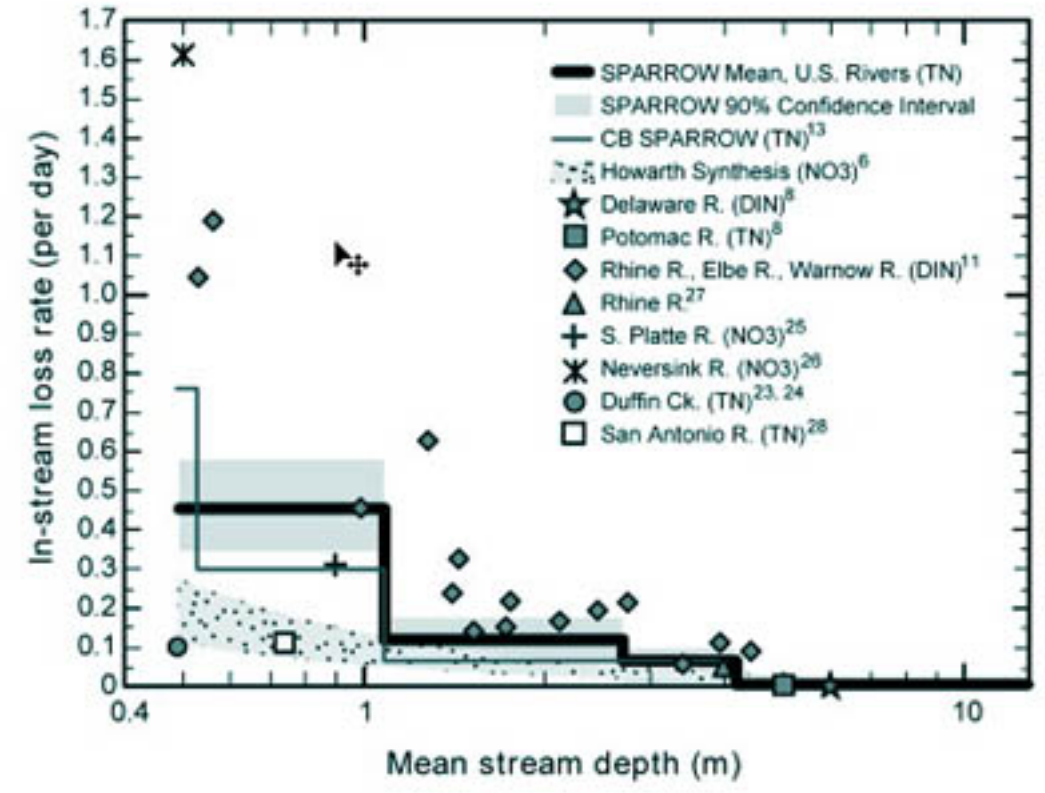

Figure 2: *Nitrogen-loss rate in relation to stream channel depth*

organisms and stresses on fishery resources.

The location of the major nitrogen sources has been difficult to accurately determine because of the lack of information on the rates at which nitrogen is naturally removed by denitrification and other processes in rivers. The USGS researchers used data from 374 monitoring stations on rivers and streams in the United States, including 123 stations in the Mississippi River basin, to quantify nitrogen loss rates in streams and rivers. These rates, together with information on the location of nitrogen inputs to the Mississippi basin, were combined through the use of a recently developed watershed model (SPARROW) to estimate the amounts of nitrogen reaching the Gulf from point and nonpoint sources.

Agriculture contributes an estimated 63% of the nitrogen delivered to the Gulf, with much of that nitrogen originating from the northeastern and north central portions of the Mississippi basin, areas containing large amounts of corn and soybean acreage. Livestock wastes account for about a quarter of the agricultural sources. Atmospheric deposition contributes about one half of the remaining fraction of nitrogen reaching the Gulf (18% of the total), with most of this nitrogen originating in the watersheds of the Ohio and Tennessee Rivers. Although municipal and industrial wastes account for the smallest quantities of nitrogen (6%) delivered to the Gulf, wastewater represents a dominant source of nitrogen within highly populated watersheds.

Previously, it had been unclear whether nitrogen loads released in different areas of large watersheds such as the Mississippi Basin had equal chances of reaching the sea. The percentage of nitrogen delivered to the Gulf of Mexico has generally been assumed to decrease gradually with increasing distance from the coast. However, because nitrogen is naturally removed more rapidly in small streams than in large rivers, large differences in the percentage delivered to the Gulf may occur among neighboring watersheds. On a map, the percentage delivered appears as a dendritic pattern (similar to the pattern displayed by the branches of a tree) that closely follows the rivers and streams of the Mississippi basin (see Figure 3).

The results of the USGS study have relevance to basic science as well as policy issues. The finding that nitrogen is naturally removed from small streams more quickly than from large rivers strongly supports

an existing theory that the amount of nitrogen loss in streams increases with the amount of water that comes in contact with bottom sediments where denitrification occurs (denitrification permanently removes nitrogen from streams through the biological conversion of dissolved nitrogen compounds to nitrogen gas, which is vented to the atmosphere). Theoretically, denitrification will be more effective in small, shallow streams because water in these streams has more contact with the bottom sediments than water in deep, large rivers. With respect to policy matters, the findings of the study suggest that a cost-effective strategy for reducing nutrient pollution in coastal watersheds may be to emphasize the control of nutrient sources near large rivers.

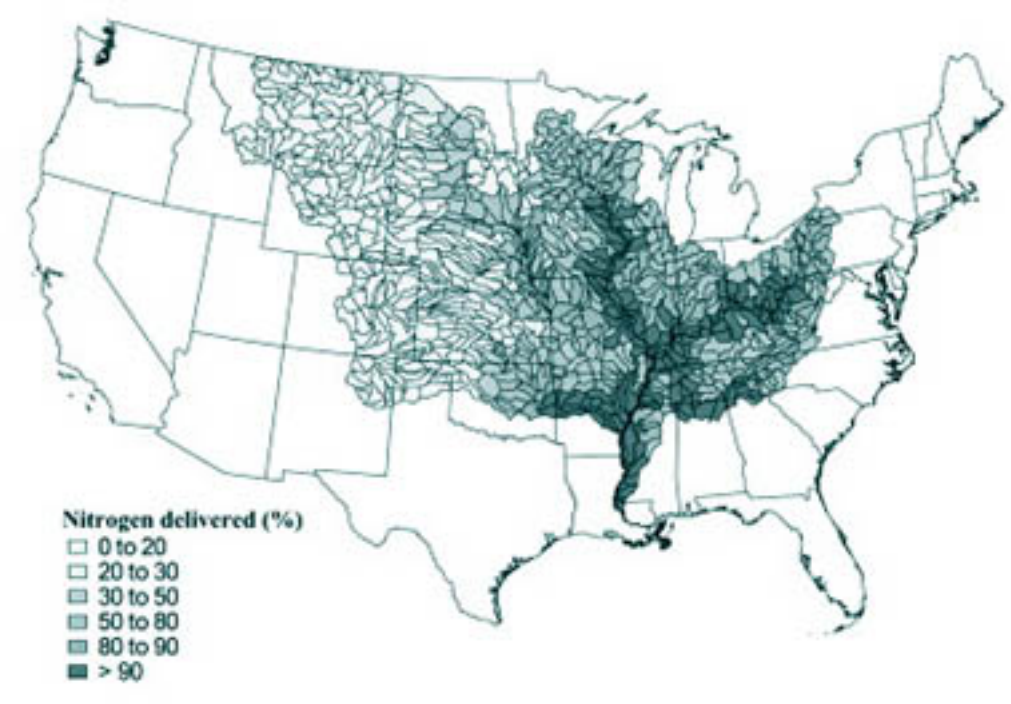

Figure 3: *Percentage of the nitrogen export from interior watersheds delivered to the Gulf*

This story is based on the USGS study by Alexander, R.B., Smith, R.A., and Schwarz, G.E., 2000, "Effect of Stream Channel Size on the Delivery of Nitrogen to the Gulf of Mexico," Nature, 403: 758-761, or contact Richard Alexander, USGS; Phone: (703) 648-6869; E-mail: ralex@usgs.gov or visit the website http://water.usgs.gov/nawqa/sparrow/nature/nature.html EXIT disclaimer

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NOAA Coastal Programs Analyzed

A recently released report, titled "NOAA National Coastal Zone Management Programs for Estuary and Coastal Wetland Protection" reviews twenty-nine NOAA coastal zone and estuary management programs in the United States and its territories. The report analyzes each state and territory individually and provides a summary. Information is presented in tabular form and includes program background, management approaches, information sharing, streamlining relationships between federal, state, and local agencies, lessons learned, and case studies. The report is available online at http://www.dfo-mpo.gc.ca/oceanscanada/newenglish/htmdocs/home.htm EXIT disclaimer

COASTLINES
Information About Estuaries and Near Coastal Waters

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Watching over Oregon's Coast, One Mile at a Time

Citizens concerned about coastal stewardship can easily feel overwhelmed. Development pressures on shorelines are relentless, human impacts are abundant and diverse, and the natural dynamism of the environment poses continual challenges. Both individuals and public interest groups can fall prey to a sense of futility in the face of so much change.

Oregon's CoastWatch Mile-by-Mile program provides a practical solution to get past the "how can we possibly make a difference?" syndrome. CoastWatch, a project of the non-profit Oregon Shores Conservation Coalition (OSCC), has evolved a multipurpose program from one simple concept. While no individual and no group could possibly keep track of everything happening along Oregon's 362-mile coastline, a single dedicated volunteer can get to know a one-mile stretch of shore very well. Hundreds of individuals, each keeping watch over one mile of coastline, can collectively provide vigilance and constructive action for the entire coast.

The program, now six years old, does indeed have at least one adopter for every mile of Oregon's coast, allowing for the occasional, temporary gap that opens up when someone moves away. Any number of people may watch over a particular mile. There are now about 750 CoastWatchers, as the ranks grow slowly but steadily. To date, the program has focused only on the outer coast, but there are plans to extend the same concept to the state's estuaries.

CoastWatch mile adopters are stewards for their shoreline segments, and thus take an interest in anything that may affect the coastal environment in that area. In adopting a mile, volunteers make a minimum commitment of four visits per year (once per season), and are asked to fill out a quarterly report form that requests information on a wide range of impacts. Many mile adopters visit their shoreline segments far more often. About 70% of the participants live in the immediate coastal region, with the remainder coming from elsewhere in the state.

CoastWatch has four purposes. The first is the "Paul Revere function"-CoastWatchers spread the alarm when they discover an impact or violation. CoastWatch thus serves as an early warning system for OSCC, but the information is by no means proprietary. Mile adopters are urged to convey information, as needed, to regulatory and enforcement agencies, local officials, the media, other public interest groups, and neighboring residents. Mile adopters might report immediate problems, such as shellfish harvest violations, vehicles outside posted limits, or pollution on the beach. For example, CoastWatchers turned out in force to track oil emanating from the grounded freighter New Carissa during the past year. They also spread the word about other coastal issues, such as development proposals, applications for "shoreline protection structures," or public agency management plans.

The second purpose is to gather information. The quarterly reports go both to county-level CoastWatch committees and to the parent organization, where they are read for immediate concerns that have been noted. Over time, they will also create a long-term database that will provide a portrait of the shoreline environment that is both broad in geographical scope and deep in the span of time it covers. Information collected by a wide range of volunteers will not be as technical and precise as data gathered by trained scientists. However, it does provide a great deal of raw material, and can serve as an alert system for scientists as well as regulators. In this sense, CoastWatch may be even more useful in ten years, as volunteers become more experienced and as the fund of information deepens and captures long-running trends.

The third purpose is education. The CoastWatch program itself provides training to its participants through various means, thus creating a network of informed observers. Hopefully, mile adopters will then carry this knowledge not only to their own circles of friends and family, but to schools, service groups, youth organizations and other community settings.

Finally, CoastWatchers are asked to be advocates for their miles, as they deem appropriate. OSCC is an advocacy organization, and its work is strengthened through the alerts passed along by mile adopters. CoastWatch is an outreach program and mile adopters need not be OSCC members and are not required to endorse the parent group's agenda. The ranks of mile adopters reflect the diversity of Oregon's coastal communities, and many people who have never considered themselves to be "environmentalists" are thus able to cooperate with OSCC in protecting the immediate shoreline region. Advocacy on behalf of a CoastWatch mile is left up to the individual volunteer. Mile adopters have done everything from organizing litter pick-ups and protecting snowy plover nests to testifying in hearings, documenting violations, and rescuing native plants from the path of a bulldozer.

Advocacy need not be confrontational. For example, two CoastWatchers became concerned when the managers of a church camp on their stretch of shore began using a bulldozer to alter the course of a stream across the sand. They encouraged the Oregon Parks and Recreation Department (OPRD), which manages public beaches, to hold a hearing. The process was laborious, but the CoastWatchers achieved a "win-win" resolution. The camp was still allowed to modify the stream (which threatened to undercut a dune protecting the camp's grounds), but it was required to obtain a permit, meet strict requirements, and conduct regular monitoring. More importantly, OPRD reviewed and improved its permitting process for temporary modifications of the shore. This kind of detailed observation by citizens, leading to constructive interaction both with landowners and with public agencies, typifies CoastWatch.

CoastWatch provides a model for the kind of "hands-on" stewardship for which many citizens yearn. It serves as an early warning system, a means of education, and a rich source of information. Above all else, it is a way of converting individual concern, which can be baffled by the innumerable problems affecting the coast, into a cooperative network whose vigilance spans the Oregon shoreline.

For further information, contact Phillip Johnson, CoastWatch Coordinator, 605 S.E. 37th Ave., Portland, OR 97214; Phone: (503) 238-4450; or e-mail: orshores@teleport.com or visit OSCC's website http://www.teleport.com/~orshores/.

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Watershed Assistance Grants Application for the Year 2000 Now Available

Watershed Assistance Grants support the growth and sustainability of local watershed partnerships in the United States. This year, grant awards will range from $1,500 to $30,000. Grants will be made to local watershed partnerships in the United States. Grant awards may be made directly to incorporated watershed partnerships. If the watershed partnership is not incorporated, the grant recipient may be a nonprofit group, tribe and/or local government, or agency that is an active participant in the watershed partnership. Applications must be postmarked not later than August 15, 2000. Watershed Assistance Grants are a direct result of the Clean Water Action Plan (http://www.cleanwater.gov/) to create a framework for successful watershed restoration and protection.

The grant criteria and proposal guidelines for Watershed Assistance Grants (year 2000 grant cycle) are now available on River Network's web site at: http://www.rivernetwork.org/wag2000.htm

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Zebra Mussels in Lake George

Until recently, it was thought that zebra mussels had not invaded Lake George, New York. Since 1995, a zebra mussel monitoring program in Lake George conducted by the Darrin Fresh Water Institute (DFWI), had observed larval zebra mussels in two of the five years monitored, 1995 and 1997. In 1997, larval zebra mussel numbers were comparable to those observed in the Hudson River, an area of high zebra mussel colonization. However, despite the presence of larval mussels, no adult zebra mussels or settled juveniles were observed in the years of sampling. In December of 1999, the situation changed when two divers from the Bateaux Below, a non-profit organization dedicated to preserving the history of Lake George through exploration of sunken ships, found adult zebra mussels at the southern end of Lake George.

Since these findings, DFWI has been working intensively at the site to determine why adult zebra mussels were able to survive and reproduce at this site, ways in which they could have been introduced to this location, and an appropriate action to eradicate them from this location.

The finding of zebra mussels in Lake George was surprising given the low calcium content and low pH of the lake; laboratory tank experiments had previously shown that zebra mussel larvae would not survive under these conditions. However, water chemistry analyses conducted at the site where the zebra mussels were found revealed calcium and pH levels higher than is characteristic of the majority of Lake George. Further investigation revealed that water entering the lake from a nearby culvert was introducing stormwater and groundwater into the lake with calcium levels four times higher than those characteristic in the rest of the lake. In addition, the site contains numerous concrete and rock aggregates that are likely sources of additional calcium. Finally there is potential contribution of calcium from a concrete boardwalk that was built approximately one year ago near this site.

Introduction of zebra mussels may have occurred when boats contaminated with seed from other lakes entered Lake George at the boat launch adjacent to the site. Introduction could also have occurred during the construction of the nearby boardwalk via contaminated equipment. The mechanism(s) by which they were introduced may never be known for sure.

After finding zebra mussels in Lake George, the DFWI and Bateaux Below SCUBA divers carried out an extensive survey of the location to determine the size of the affected area. The zebra mussels were confined to a 15,000 square foot area with an initial estimate of approximately 10,000 mussels. For reference, in certain locations in the Hudson River there are approximately 10,000 mussels per 10 square feet. The DFWI, after consultation with state and local agencies, agreed that hand harvesting of the relatively low density mussels was the best solution. Diving at the site to remove all visible zebra mussels commenced and has been ongoing since April 2, 2000.

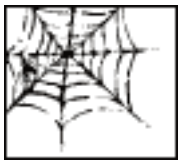
Zebra mussels have been found attached to many different substrates, ranging from wood, glass, cloth, plastic, plants, and rocks of different composition, and substrate preferences have been observed.

In total, approximately 260 dive hours were logged for this removal operation. To date, we have removed approximately 19,000 mussels and completed the intensive diving at this location. This approach has been extremely labor-intensive and, while hopefully effective, would not be feasible if multiple sites were found throughout Lake George.

A number of activities will continue, including monitoring and continued removal of any remaining zebra mussels at this site. Removal of any remaining zebra mussels is critical to reduce the likelihood of successful reproduction. In addition, mussels that are not removed may adapt to the lower calcium and pH conditions and spread into surrounding areas. Water samples will be checked for microscopic zebra mussel larvae and chemical parameters. The information will be used to evaluate success of removal efforts, determine whether to extend the monitoring area beyond the present site, and better understand local water chemistry. Finally, two spat-traps (devices that hold stainless steel plates that can serve as hard substrates for larvae to settle onto and grow) will be installed and examined for possible zebra mussel growth to see whether mussels are reproducing. Any settled mussels will also be removed.

For further information, contact the Darrin Fresh Water Institute, Dr. Sandra Nierzwicki-Bauer, Director.

Address: Darrin Fresh Water Institute, 5060 Lake Shore Drive, Bolton Landing, NY 12814, Phone: (518) 644-3541, E-mail: nierzs@rpi.edu or visit the website at http://www.rpi.edu/dept/bio/fwi/brochure.html.



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Sources of Fecal Bacteria in Urban Runoff

Like many urban areas in the United States, rivers, streams and water bodies in Nashville, Tennessee, frequently experience high counts of fecal coliform bacteria after storm events. Fecal coliform bacteria are commonly considered to be indicative of human sewage, which can contain more harmful pathogens such as pathogenic E.coli, Cryptosporidium and Giardia. However, research conducted by the Metro Nashville-Davidson County Department of Water and Sewerage Services and Vanderbilt University indicates that non-human sources of fecal coliforms may be more significant in urban areas. This recent study focused on inputs into urban streams contributing to the Cumberland River, which historically has exhibited high levels of fecal coliforms during wet weather flows, causing violations of state surface water quality standards. Potential sources of this contamination include urban and agricultural runoff, sanitary sewer overflows, and failing septic tank systems.

Sampling in the study area had shown high fecal coliform counts during rainfall events, though little of the fecal coliform loading could be attributed to sanitary sewer overflows. The sources of most of these bacteria were attributed to general urban and rural runoff. Sampling of fecal coliforms and fecal streptococci and evaluation of the ratio of these bacteria indicated a high probability that the dominant source of these bacteria was animal rather than human. However, the Metro Health Department expressed concern that some bacteria could be coming from failing or overloaded septic tanks and an investigation was designed to clarify the sources of fecal bacteria to urban streams.

Four watersheds, two sewered and two non-sewered, were selected for study. Watersheds were chosen that were close enough to be sampled during a single precipitation event, with similar topographical and

land use characteristics. Watershed basins were evaluated using sewer maps, aerial photographs, and on-site inspection; their characteristics are summarized below.

Summary of Basin Characteristics

Characteristic	Dry Creek	Johnson Hollow	Hillhurst (sewered)	Parkwood (sewered)
Total Area (hectares)	910	1600	5700	940
Slope Length (m)	1600	2600	2600	1200
Average Slope	0.056	0.042	0.031	0.033
Total Houses	42	72	170 + apartments	560
Impervious Area (hedctares)	12	21	44	86
% Impervious Area	1.3	1.3	7.7	9.1

Water was sampled from the downstream end of each watershed basin during winter and summer, covering both dry periods and storm events. The samples were tested for E.coli, fecal streptococci, coliform bacteria, and fluorescence. Fluorescence is an indicator of detergents, which contain optical brighteners and are present in the waste stream from homes and commercial buildings as a result of human activities.

Results of the sampling showed that fecal bacteria counts were higher in the sewered watershed areas than in non-sewered areas during both winter and summer and for both dry weather and storm event flows. Fecal bacteria concentrations were related to the density of housing, population, development, percent impervious area, and apparent domestic animal density in all basins. When seasonal data were compared, fecal bacteria concentrations were much higher in the summer than in winter. The ratios of coliforms to streptococci were, with one exception, less than 2, and most were less than 0.7. These low ratios of coliform to streptococci combined with the complete absence of fluorescence in the samples were indicative of primarily animal, rather than human, sources. The two developed watershed basins (especially Parkwood) were home to a very high number of dogs, suspected to be one of the primary sources of fecal bacteria.

Although these data do not prove that septic systems do not contribute bacterial loading to streams and tributaries, the data do indicate that the septic contribution is small when compared to other sources, such as animal feces in surface runoff. The conclusion from the study was that bacterial contamination from septic tank leachate in non-sewered basins was not a critical issue, while fecal bacteria concentrations from streams in sewered basins consistently exceeded the state water quality standards.

It is well known that fecal coliform bacteria are present at high levels in urban runoff, especially during and immediately after storm events. However, identifying specific sources of fecal bacteria has met with

difficulties. In 1998, researchers from the University of North Carolina showed patterns of increased coliform bacteria concentrations in streams with increased watershed development and amount of impervious area in New Hanover County, North Carolina. Results from the North Carolina study are consistent with those found from the study in Nashville, Tennessee. Despite relating fecal bacteria loads to urban density in both of these studies, uncertainty remained as to the source(s) of these bacteria.

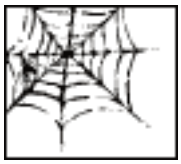
To shed more light on this, Vanderbilt researchers sampled direct surface runoff from areas with various land uses in other Nashville neighborhoods during 1999. Fecal coliform counts in preliminary samples were similar to those in the earlier study, as were fecal coliform to fecal streptococci ratios. However, this time dog population densities were low. This suggests that while animals are a primary source of fecal bacteria in runoff, dogs may not be the dominant contributors.

Initial conclusions from this most recent work include:

- the vast majority of fecal coliforms in urban runoff come from animal sources, rather than humans;
- sites with high percentages of impervious area (roofs, pavements, sidewalks, etc.) that also include trees produce higher bacteria counts, while sites with high percentages of impervious areas without trees produce lower bacteria counts;
- higher densities of trees, even in low density neighborhoods, contribute to higher bacteria counts; and
- wild birds are the most likely culprits, although in individual neighborhoods squirrels, deer, and domestic dogs and cats may be significant.

In summary, with urban surface runoff typically containing high concentrations of fecal coliforms, most likely due to wildlife, it is highly unlikely that any urban stream receiving a significant amount of direct runoff can ever meet EPA-recommended water quality standards for body contact recreation, if samples are taken during rainfall. Further research is needed to determine the real risk associated with contact with urban drainage as well as finding a more accurate tracer for human septage.

For further information, contact Edward Thackston or Katherine Young, Vanderbilt University, Phone: (615) 343-2372, E-mail: elt@vuse.vanderbilt.edu, or review the recent article: Housing Density and Bacterial Loading in Urban Streams, Journal of Environmental Engineering, 125(12), 1177.



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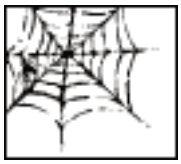
National Estuaries Day and Coast Weeks 2000

Mark your calendar: Coast Weeks 2000 kicks off its nineteenth year on September 16 with the International Coastal Cleanup and continues through October 9 with activities across the country commemorating the Atlantic, Pacific, Great Lakes, and Gulf of Mexico coasts of the United States. This yearly celebration, sponsored by the Center for Marine Conservation, is held for three weeks each autumn to highlight the country's coastal resources. As part of the Coast Weeks festivities, the twelfth annual National Estuaries Day will be observed on September 30, 2000. This event celebrates our bays, sounds, and lagoons, and is jointly sponsored by the NOAA National Estuarine Research Reserves program and EPA's National Estuary Program. The two programs include more than 50 estuaries nationwide.

For more information about Coast Weeks 2000 and the International Coastal Cleanup, visit the website at www.cmc-ocean.org or contact Emily Morgan at the Center for Marine Conservation, Phone: (202) 857-5552. For more information on local Estuaries Day festivities, go to the NEP website at http://www.epa.gov/owow/estuaries/nep.html or the NERRS website at http://nerrs.noaa.gov/ EXIT disclaimer or contact your local NEP or NERRS program office.



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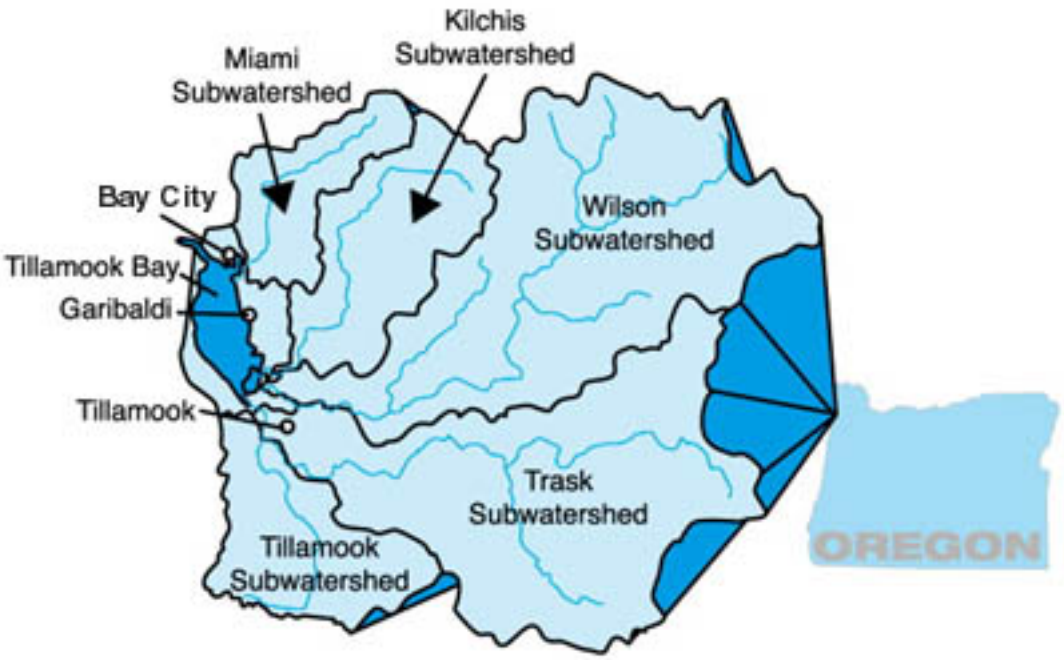
Tillamook Bay National Estuary Project

Fish Friendly Tide Gate Replacement Project

CHARACTERISTICS

Tucked between the rugged Coast Range and the Pacific Ocean, Tillamook Bay drains a 597 square mile watershed that includes some of North America's richest timber and dairy land. The entire watershed lies within Tillamook County, and is home to over 140 dairies, worth $199 million, while 90% of the land cover consists of the Tillamook State Forest and Siuslaw National Forest, supporting a large timber industry. In addition, Tillamook Bay supports an oyster



aquaculture industry and boasts some of the best salmon fishing on the West Coast. The bay has hosted prime commercial and sport fisheries for generations, however, in recent years, due to declining salmon populations, these fisheries have suffered. Historically dependent on resource industries, the Tillamook Bay economy increasingly relies upon tourism and transfer payments to support its 25,000 citizens. Yet dairy farming, logging, and fishing continue to define the cultural landscape of the area.

Years of development and change to the land, due largely to a series of forest fires, have created several environmental problems that define the priority concerns of Tillamook Bay's National Estuary Project. Those concerns are water quality degradation, habitat loss and simplification, erosion and sedimentation, and flooding. For example, high bacterial inputs from agricultural and urban sources cause closures of shellfish beds approximately 90 days per year. In other cases, important fish and wildlife habitats have been modified due to transportation, agriculture, urban development, and forestry.

The interaction of human activities with dynamic natural systems has increased the magnitude, frequency, and impact of flood events. Flooding has impacts on the other three priority problems, which are water quality, habitat loss, and erosion. In an effort to partially alleviate this situation, a modern twist on a long-used device has been developed: "fish-friendly" tide gates. These modified tide gates are designed to protect farmland from floodwaters while providing higher quality water and access to habitat for young fish.

Introduction to Tillamook Bay

Tillamook Bay is part of a temperate rainforest ecosystem, receiving an average of 90 inches of rain per year in the lowlands to over 200 inches per year in the uplands! Five rivers feed the bay, the Trask, Wilson, Tillamook, Kilchis and Miami Rivers, providing diverse estuarine and wetland environments for many aquatic species. The bay itself is very shallow, averaging only 6.6 feet deep over 13 square miles; at low tide approximately half the estuary bottom is exposed as intertidal mudflats. Although much of the Tillamook Bay Watershed is forested uplands, the lower alluvial plains have been drained over the past century with numerous dikes, levees and ditches for dairy farming. Consequently, the natural drainage patterns of the landscape have been severely altered, negatively impacting both fish passage access and water quality.

Because of the high annual precipitation rate, Tillamook County experiences periodic catastrophic flooding that has caused million of dollars in damage to farmland, livestock, private property and businesses. During the 1980s, urban

development expanded into a large section of the historic floodplain. In 1996, massive flooding caused $52 million in damages to life and property. Efforts to minimize such losses led to the county being designated as a "Project Impact Community" by the Federal Emergency Management Agency in 1999. Membership in Project Impact allows Tillamook County to leverage resources for mitigation in addition to flood prevention projects.

Project Overview

The Tillamook County Performance Partnership is an organizational entity designed to implement the Tillamook Bay Comprehensive Conservation and Management Plan produced by the Tillamook Bay National Estuary Project. This group has been working over the past three years with local, state and federal agencies, as well as local consultants, to design a "fish friendly" tide gate. Observations made during a reconnaissance study in 1997 found that while the existing tide gates prevented salt water from encroaching on the dairy pastures, the exchange of salt and fresh water behind the gates in the minor waterways running through the pastures was poor. These low-lying channels potentially provide high quality off-channel habitat for juvenile salmonids, according to studies performed by Oregon Department of Fish & Wildlife. Much of this habitat was blocked to fish passage by the nature of how these old tide gates operated, and the search began for a way to meet both needs.

Grant funding was requested and received from the Oregon Department of Environmental Quality and the Governor's Watershed Enhancement Board. Both of these organizations fund projects that are specifically aimed at improving water quality and fish habitat.

Project Objectives

Through partnering with private landowners, the project aims to:

- Restore and protect native salmonid habitat,
- Improve water quality,
- Protect valuable farmland from negative effects of flooding,
- And improve overall floodwater dispersal across the landscape.

Implementing the Project

At various locations along the five rivers that enter the bay, 1950s era tide gates exist. Tide gates were originally installed as a component of the levee system to drain pasturelands after heavy rains or high tides. Prioritization of tide gate replacement is based on landowner cooperation, potential for improved fish habitat and water quality, and potential for flood relief. The new tide gate is a five-foot tall steel culvert with a flap door at the tidally influenced side; the tubes are installed with a backhoe by pulling

out the old, often rusted and failing tidegates, and replacing with the new. The other end of the tube opens on the side of the levee facing the pastureland. The newest "fish friendly" model uses a float arm on a stainless steel shaft to hold the gate open longer and allow for inflow into the channel behind the gate, increasing the exchange of water. This mitigator arm also provides a better opportunity for juvenile fish to access essential off-channel habitat in search of food and cover, as well as benefit from improved water quality. The present design is the latest in a series that has seen several improvements and continues to evolve.

Installation is timed with the tides so that the disturbance of the levee causes the least amount of turbidity. The process of pulling out the old gate, then setting and stabilizing the new gate takes just a few hours. After the tidegate is anchored securely, banks are stabilized and replanted with native plant species to complete the restoration process. Once the plants gain height – a very short time for some native species – they provide important riparian shade protection, vital to keeping water temperatures from rising above the levels appropriate for salmonids.

Seventeen of these tidegates have been replaced since 1998, eight of which are "fish friendly." The cost to install can vary from $5,000 - $9,000, depending on ease of access to the site, whether extra equipment is needed to remove the old tidegate, and the amount of restoration work required for a particular site. There are a total of 26 tidegates within the Tillamook Bay Watershed. The Tillamook County Performance Partnership hopes to complete replacement of the remaining ones within the next two to three years, dependent upon funding.

With these new tidegates in place, crucial smolt habitat is given a twice daily flushing with the tide changes, largely eliminating the stagnant, warm water so detrimental to water quality and juvenile fish. This spring, large numbers of salmon smolts were observed behind the gates, indicating a potential increase in fish use.

Success of the Project

- Landowners and resource agencies have partnered in an effort that brings both economic and environmental benefits to the region.
- The new fish friendly tide gate, along with better pasture drainage, provides a win-win situation for landowners and for fish.
- Flooding is a major concern, and frequently overrides other issues in this county. In November, 1999, a flood event occurred that, under previous conditions, would have caused extensive damage. However, its effect was greatly minimized because of an array of strategically placed tidegates.
- Access to vital salmon habitat that had been unavailable or impaired is being restored.
- Dissolved oxygen and temperature, a priority water quality concern of the Tillamook Bay

National Estuary Project, is improved through more complete exchange of farmland drainage with river and estuary flows.

Lessons Learned

Over the last three years, much has been accomplished in terms of developing working relationships between landowners and agencies through the development of this project. Dairy farming and fishing are among the lifeblood industries of the area, but there is no consensus on how to best maintain each at optimum levels without one or both being asked to compromise more than desired.

The permitting process is laborious and time-consuming. It is imperative to do the research and obtain all necessary information for permitting before plans are put in place for installation or replacement of a tidegate.

Project partners acknowledge that monitoring should have been put into effect before the first tidegates were replaced, for parameters such as dissolved oxygen, water temperature, sediment, bacteria, pH, and numbers of smolt. At this point, increased water quality and fish use improvements are mostly anecdotal. Plans to incorporate monitoring are being developed to address this deficiency.

For further information, contact Don Reynolds, Contract Specialist, Tillamook Bay National Estuary Project/Tillamook County Performance Partnership; Phone: (503)322-2222; E-mail: dreynold@co.tillamook.or.us.

Visit the TBNEP/TCPP website at http://www.co.tillamook.or.us/ EXIT disclaimer