COASTLINES

Information About Estuaries and Near Coastal Waters

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Computerized Modeling in Watersheds

National Estuary Programs (NEPs) , like all resource management programs, strive for implementation. Key components in this process include the necessity to reconcile large amounts of scientific information, make the results accessible to decision makers, and establish the credibility of the process. In the case of the NEPs, volumes of scientific studies which have been compiled about sensitive estuarine ecosystems have to be reconciled with land use patterns within the watersheds. Workable management strategies must be developed out of this subtle and complex relationship between the sea and the land. Computerized watershed models can play a critical role in this process. They attempt to quantify this relationship between land uses in the watershed, water quality parameters, and the integrity of the ecosystem.

Watershed models can be extremely powerful tools to assist in the development, implementation, and defense of practical management strategies. They can be used to relate past and existing water quality conditions to land use changes and, more importantly, can be used to predict future scenarios. Consequently, several NEP projects have applied watershed models in developing their implementation programs. In this article, we provide four examples of how this tool has been utilized.

Buttermilk Bay

Buttermilk Bay, a small embayment in Buzzards Bay, Massachusetts, is threatened with eutrophication caused by a surplus of nitrogen input into its waters. A Nitrogen Loading Model was developed through the Buzzards Bay Project to assess potential impacts of various development possibilities in the watershed. The soils in this area are sandy and highly-permeable and the estuary is dominated by ground water inflow rather than surface runoff. Consequently, for modeling purposes, a ground water drainage area was delineated based on a water table map, as opposed to the more traditional watershed delineated by surface topography.

Given these conditions, the Buzzards Bay Project chose a model which had been previously developed (and calibrated) for nitrogen loads to ground water from septic systems, lawn fertilizers, road drainage, and background precipitation. The model was applied to both existing conditions and future potential development in accordance with the zoning from the three towns which make up the drainage basin. The results of the modeling showed that impacts from the build-out population (that which is allowable under current zoning) would exceed critical loading rates for the embayment. To address this problem, amendments to the zoning of the three towns were drafted and ultimately adopted and implemented by each town.

Maquoit Bay

One of the study areas of the Casco Bay Project is Maquoit Bay, a five square mile, shallow embayment off the coast of Maine. More than one-third of its productive shellfishing areas have been closed due to fecal coliform bacteria contamination. The Town of Brunswick, which comprises the majority of the watershed, had adopted a Coastal Protection District zoning ordinance to limit additional development within the Maquoit watershed in an attempt to slow additional deterioration of the bay.

To determine the adequacy of the ordinance and to evaluate additional land use measures which might be necessary, two watershed models were applied. A fecal coliform loading model, referred to as FecaLOAD, was developed to quantify loadings from various sources within the watershed, including agricultural lands (where manure is applied as a fertilizer) and failing septic systems. A nitrogen loading model was also developed to assess the cumulative impacts of changing land use patterns within the watershed. To support the modeling efforts, a water quality sampling program was undertaken for model calibration and verification purposes. Six test sites were established within the watershed which represented discrete and homogeneous land uses (two residential, three agricultural, and an undeveloped area). These test sites and three major streams were sampled throughout the study period. Nitrogen and fecal coliform loading rates were determined from the test sites and applied across the entire watershed.

The results of the FecaLOAD modeling showed that manure was the largest source of fecal coliforms within the watershed with failing septic systems as the second major source. Significant actions have been taken by the Town of Brunswick to correct many failing systems. However, the study suggested that despite upgrades and compliance with the state code, septic systems could continue to discharge fecal coliforms due to hydrogeologic failure which may be the result of discharging sewage into soils with severe limitations , including low permeability, shallow depth to bedrock, and shallow depth to ground water.

The nitrogen loading model was applied under both current and future potential (build-out) land use conditions. It indicated that existing nitrogen loading was approximately 54% of the critical loading rate and that under build-out conditions, that nitrogen loading may approach 92% of the critical rate, suggesting that adoption of the Coastal Protection District zoning with a 5-acre minimum lot size was critical to preserving Maquoit Bay.

Massachusetts Bays

The FecaLOAD model was also applied to three case study communities in the Massachusetts Bays region: Provincetown, Ipswich, and Beverly. Like other Massachusetts coastal communities, these three are experiencing shellfish area closures due to excessive fecal coliform counts. The model is being utilized to determine relative loadings of fecal coliforms in each watershed as a model for other coastal communities. It is being applied in conjunction with data derived from a Geographic Information System (GIS) using the program ARC-INFO. Land use and soils information are extracted from the Massachusetts state digital data base.

While the project is not yet complete, FecaLOAD has predicted loadings of fecal coliforms from residential, commercial, industrial, and agricultural land uses for each watershed. The model also predicts runoff volumes from a variety of storm events (e.g. 0.5 inches, 1 inch, and 2 inches) and computes average fecal coliform concentrations in the runoff associated with such events. This information will be helpful in diagnosing the sources of pollution which have resulted in shellfish area closures. It will also be helpful in recommending appropriate land use controls for future development and for selecting the most appropriate best management practices (BMPs) to address existing and future stormwater discharges.

Indian River Lagoon

A large scale watershed modeling effort is underway in the Indian River Lagoon watershed, which is comprised of 2,300 square miles along a 158 mile stretch of the east coast of Florida. In this case, the mission is to determine impacts from the approximately 121,500 septic systems within the watershed, most of which are in close proximity to the Lagoon.

A number of models, including nutrients (nitrogen and phosphorus) and pathogens (fecal coliforms and viruses) are being applied to quantify the loadings of pollutants associated with each land use type within the watershed. In addition to septic systems, the watershed includes extensive tracts of citrus groves which may also be significant sources of nutrients and perhaps pathogens. This modeling effort is being supported by extensive water quality sampling to calibrate and verify the models.

As seen in the examples above, the use of computerized watershed models can make sense of the mass of water quality and land use data, can demonstrate the relationship between land use and water quality, and can provide the predictive capability on which to base management decisions.

For further information, please contact:

Buttermilk Bay--Dr. Joseph Costa, Project Manager, Buzzards Bay Project, (508) 748-3600.
Maquoit Bay--Patricia Harrington, Director, Casco Bay Estuary Project, (207) 828-1043.
Massachusetts Bay--Marie Studer, Associate Scientist, Massachusetts Bays Program, (617) 727-9530 ext. 405.
Indian River Lagoon--Robert Day, Project Scientist, (407) 984-4950.

How Computerized Watershed Models Work

In their simplest form, watershed models are a spreadsheet in which the area of various land uses within the watershed are related to scientifically derived factors for loadings for a particular contaminant for that particular land use. For example, studies have shown that an acre of residential land typically produces 6.2 pounds per acre of nitrogen each year (pet waste, fertilizer, etc.) plus 5.5 pounds per person living on the land if the lot is not sewered. When this information is generated for each acre of each land use within the watershed, the computer can summarize this information and tell us how much nitrogen is being generated in the watershed.

More sophisticated models will factor in degradation or uptake of the contaminant as it moves through the watershed and provide a predicted amount of the contaminant that will enter a receiving waterbody.

This figure can then compared with the carrying capacity of the waterbody to estimate the adverse impacts that may result from the contaminant loading.

The model can also provide loading figures for various development scenarios within the watershed. For example, it can predict the changes in contaminant input to the waterbody if 500 acres within the watershed change from forest to residential use.

So what's a Buildout?

Doing a buildout for a watershed means calculating the number of structures that would be present if the current zoning patterns were fully developed. In a watershed consisting of 1,000 acres, zoned entirely as single-family residential, with 500 zoned at 1 house per acre and the other 500 zoned at 1 house per half acre, the buildout could be as high as 1500 houses in the watershed. Obviously, this becomes more complicated with a more complicated zoning system, requirements for road frontage, and with public

ownership of some of the land.

There are three steps in preparing a watershed buildout:

1. Combine a watershed delineation with local assessors maps. This will provide a base map of all existing lots within the watershed.
2. Identify existing land uses within the watershed. This may come from a Geographical Information System (GIS) or may be calculated manually by identifying land use on each lot from the assessors records. Tax codes for lots usually indicate which have been developed and type of use. They will also indicate if there is some sort of permanent restriction on development or if the lot is in public ownership.
3. Calculate buildout using lot area, road frontage, and local zoning. Zoning districts are traced onto the assessor s maps. For a parcel to be considered developable, it must meet the required zoning for minimum lot area and minimum road frontage.

If a lot with an existing dwelling unit meets all the zoning requirements for its district, but is less than twice the minimum lot size, then that lot is considered fully developed since it cannot be further subdivided. If it is more than twice the minimum lot size, it is considered subdividable.

Property having at least twice the minimum required frontage on an existing public road is divided into "Approval Not Required" (ANR) lots first, followed by the creation of additional lots on the remaining "back" land through subdivision. To determine the number of ANR lots possible, the total length of road frontage is divided by the minimum frontage required per lot. Once the ANR lots are determined, if there remains a large "back lot" with at least fifty feet of frontage, then the total number of ANR lots possible is decreased by one lot in order to provide the frontage needed for the subdivision of the back tract of land.

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San Francisco Bay Headwaters: Water Banks or Home Sites?

(The following article is excerpted, with permission, from the April 1996 issue of Estuary, a newsletter of the San Francisco Bay Estuary Project. The original article was by Susan Zakin.)

Kathleen Garr, now in her 90s, remembers walking across Indian Creek in Plumas County (CA) when she was a girl. She followed a path made of logs that spanned the shallow creek, which meandered through two valleys and a steep canyon before flowing into the Feather River and ultimately into San Francisco Bay.

Today, Indian Creek is a study in erosion. The Army Corps of Engineers has dredged it. Logging, grazing, and mining have taken their toll. Instead of the stream lined by meadowgrass and sedges that Garr remembers as 60 feet wide and only six feet deep, Indian Creek is a downcut, straightened channel hundreds of feet wide and 20 feet deep. The sandy loam from its exposed banks melts down into the riverbed, making Indian Creek one of the major sediment-producing reaches of the bay s upper watershed.

Restoration of Indian Creek was on the drawing board three years ago, according to Jim Wilcox of the Plumas Corporation. We thought it was all set in 1993, he says. We had landowner support. We had a strong expectation of federal support. Pacific Gas & Electric (PG&E) was supporting it for sediment reduction-- their dams were filled with our soil.

The first to go was direct federal funding. With that money out of the picture, landowners began to lose interest. Then PG&E withdrew its cash, because of a plan that allowed them to pass sediment further down the watershed. After that, the U.S. Forest Service, which was going to provide rock to restore the creek, told Wilcox that their office had run so low on money that it couldn t open a quarry.

The restoration of Indian Creek is only one of many environmental projects that has languished due to

federal and state funding cuts over the past two years. Increasingly, policy makers and environmentalists are looking to innovative methods to protect and restore land--both private and public.

Today, Garr and other local landowners are supporting efforts by the Plumas Corporation, an economic development agency, to restore headwaters of San Francisco Bay using non-traditional funding mechanisms that borrow from the latest in environmental thinking. In his groundbreaking 1989 book, For the Common Good, former World Bank economist Herman Daly espouses the idea that conventional economics fails to account for the real costs of environmental degradation. Since then, other economists have proposed an environmental GNP to address the problem.

These abstract-sounding ideas are being brought down to earth by the Plumas Corporation and the Regional Council of Rural Counties in a gutsy proposal that may not win them many friends in the ongoing battles over water supplies. Northern counties recently proposed to the California State Water Board that if it wants them to give up water and restore habitat for fish in the bay s upper watershed, then southern water users picking up the surplus flows downstream for free should help pay the price.

For some reason, California water users don t consider it a cost of doing business to maintain the natural water collection areas above the dams, says Leah Wills of the Plumas Corporation. They re used to maintaining the man-made parts of the state s water delivery system but not the God-given parts.

According to Wills, there s a notion in the headwater counties--where there s a lot of federal land but few people and where the economy has always been based on natural resources-- that they would like to be watershed stewards. But there s no economic framework for this stewardship, she says. Our resources are eroding and counties are going broke. People are fighting the fish. Maybe if we were being paid for preserving water for the fish, then we d have an incentive.

Long-term funding is likely to come from about a dozen sources, including water users state-wide and a $500 million bond issue proposed for the November ballot. One possibly contentious issue is whether restoration funds will be used above the state and federal water projects or only downstream. Northern counties are pushing for reinvestment in both areas. You re not doing ecosystem management if you cut the ecosystem off at the dams, says Wills.

Wills and others hope that new jobs created by reinvestment will help shape the county s future. Like other resource- dependent rural areas in the west, Plumas County has been encouraging housing development to stem the economic decline caused by timber market globalization and forest degradation. But Wills thinks the highest and best use of the headwaters is as watershed not subdivision, and that an economy based on land and water stewardship could help the county retain its rural character. Why urbanize the state s water banks so they then withdraw water from the rest of the state? , she asks.

There are disaffected people, loggers, and miners out of work, and ranchers concerned with regulation. The resources have been plundered and a Wise Use ethic is emerging, says U.S. EPA s Tim Vendlinski. Then there s the Plumas Corporation saying the government is not necessarily our enemy; here s what we

can do together.

For more information, please contact Leah Wills at (916) 283- 3739, or the San Francisco Estuary Program, P.O. Box 791, Oakland, CA 94604, (510) 286-0460.

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Watershed Approach to Dredging and Disposal in Marina del Rey Harbor

Marina del Rey Harbor is located in Santa Monica Bay about 15 miles southwest of downtown Los Angeles. Constructed in 1960, Marina del Rey is the largest artificial small-craft harbor in the world. The marina is immediately adjacent to the Ballona Creek flood control channel.

Ballona Creek drains a watershed of about 127 square miles, which includes the sparsely populated Santa Monica mountains to the north, as well as such densely populated cities as Hollywood, Culver City, Inglewood, and parts of Los Angeles and Santa Monica. Because the creek drains such highly urbanized areas, its discharge to Santa Monica Bay carries large amounts of sediment and pollutants, such as oils and grease, bacteria, and heavy metals. During heavy storms the creek delivers a massive amount of trash, debris, and pollutants to the bay, littering the beach and causing beach closures. In addition, sediment deposition at the mouth of the creek has created navigational problems for Marina del Rey, resulting in the need for maintenance dredging, which should occur, ideally, every 2-3 years.

Sediments in the harbor channel and entrance have been found to be contaminated however, so that dredging operations have been few and very controversial. In response to this problem, the California

Coastal Commission requested that the Army Corps of Engineers (ACOE) and the Los Angeles County Department of Beaches and Harbors enter into a Memorandum of Understanding (MOU) and form a Task Force to develop a long-term solution that would minimize contaminated sediments and find a suitable disposal area(s) for the dredged material from Marina del Rey. The Task Force was established in December of 1994 and an MOU was signed in August of 1995.

In September of 1995, the ACOE completed a Reconnaissance Study that examined the problems and improvement measures associated with shoaling and contaminated sediments at the harbor entrance channels. This effort was based on interest in improving navigation, reducing storm damage potential, and restoring the degraded environment in the harbor and vicinity (including Ballona Creek and adjoining wetlands). The Task Force has adopted a watershed management approach to assess the impacts of sediment loads and contamination emanating from the watershed, the major source of sediments and suspected major source of contamination.

In addition, the ACOE is investigating options other than ocean disposal for dredged material. These options include shipping the contaminated sediments by rail to Utah, aquatic capping, upland landfill, geocontained capping, treatment, and nearshore containments. With an approximate shoaling rate of 45,000 cubic yards per year, the need for a disposal and management plan is critical.

Within the next 2-3 years, the ACOE plans to complete a Feasibility Study for dredging and disposal. This study will incorporate a long-term watershed strategy to be developed over the next year and a half by the Task Force which includes the Santa Monica Bay Restoration Project (a National Estuary Program) and various environmental groups. The strategy is to reduce sediment loading from the watershed, along with related pollutants, thereby reducing not only difficulties in disposal of dredged material, but also the need to dredge. It is hoped that this type of coordinated, long-term planning approach will not only reduce the conflict and uncertainty over dredging projects related to Ballona Creek, but will also serve as a model for other community-based efforts to resolve environmental problems.

For more information, contact Paul Michel, Southern California Watershed Section, US EPA Region IX, San Francisco, CA, 415-744- 1999.

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Water, water, everywhere.....

It s not always pollutants moving down the watershed that disrupt the environment of a harbor or bay. In an increasing number of instances, changes in the amount, or timing, of freshwater inputs can have major impacts. Take the case of one site in Florida.

Apalachicola Bay is one of the most productive estuaries in the northern hemisphere on a production per acre basis. Over 90 % of Florida's and over 10 % of the nation's oyster harvest comes from this embayment. The bay also supports a fin-fish and blue crab industry. At the consumer level, annual economic value of the industry is approximately 70 to 80 million dollars. Although impressive, these values don't come close to estimating the economic importance of this estuary. Apalachicola Bay feeds into the Gulf of Mexico, from which 42 % of all US seafood is harvested--more than either the Atlantic or Pacific Oceans. Over 95 % of all species harvested commercially in the open Gulf of Mexico have to spend a portion of their life cycle in an estuary. Blue crabs, for example, migrate as much as 300 miles to spawn in Apalachicola Bay. They spend their larval and juvenile stages in bay marshes, then scatter throughout the Gulf, as do shrimp and fin-fish.

Although the bay is presently in good condition, increasing local development and upstream uses represent a threat to the ecological integrity of the system. The Apalachicola River is the terminal segment of a tri-river basin formed from the confluence of the Chattahoochee, Flint, and Apalachicola Rivers (CFA). Of the 19,800 square mile drainage basin, 88 % is in the states of Georgia and Alabama. Based on average flow in the system, 84 % of fresh water that feeds (or in some cases carries pollutants to) Apalachicola Bay originates outside the state of Florida.

Increasing water demands from municipal, industrial, and agricultural interests in the upper portion of the CFA River system threaten to reduce freshwater discharge to the Apalachicola estuary, which could result in higher bay salinities. Although these increases are likely to be more pronounced during drought periods, alterations to flow allocations may potentially affect conditions during other flow periods as well. The States of Alabama and Florida are currently involved in litigation with the State of Georgia and the US Army Corps of Engineers over proposed reallocation of upstream water and its uses. Several

studies are currently underway which will endeavor to provide information to help describe the relationships between environmental parameters so that Apalachicola Bay can be recognized as a legitimate competing water-user in the system, rather that at the "end of the pipe that receives the leftovers".

According to Woodard Miley, Manager of the Apalachicola National Estuarine Research Reserve, Florida's decision-making process for regulating freshwater withdrawals does not address the issue of maintaining target salinities in the estuary. To this point, there have not been sufficient economic or scientific data to make such targets defensible.

Salinity, specific conductivity, temperature, pH, dissolved oxygen, and tide levels have been recorded since June 1992 at two stations in Apalachicola Bay. These stations are located on two of the most commercially productive oyster bars in the bay. A third station has been established in the upper portion of East Bay. In April of 1995, a fourth station was created as part of a nation-wide monitoring effort through the National Estuarine Research Reserve System. The collected data can be compared with other variables that affect the bay, such as rainfall and river discharge and, hopefully be related to events such as oyster mortality, seasonal abundance of estuarine organisms, and effects of storms. Finding such connections can then provide the scientific justification for management measures to establish target salinities and regulate fresh water flows.

Over time, these programs and others will help to ensure that Apalachicola Bay maintains the appropriate conditions to provide the spawning grounds necessary for commercially-important shellfish and fin-fish species to thrive.

For more information about the Apalachicola National Estuarine Research Reserve, contact Woodard Miley, Environmental Program Administrator, 261 7th Street, Apalachicola, FL 32320, (904) 653-8063, fax: 904-653-2297.

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Waquoit Bay NERR: New approaches in on-site wastewater treatment

The Waquoit Bay (Massachusetts) National Estuarine Research Reserve, located on the south shore of Cape Cod in the towns of Falmouth and Mashpee, has been exploring the use of denitrifying on-site wastewater treatment systems as one approach to reducing nitrogen loading from the watershed to coastal waters.

The most prevalent management issue for Waquoit Bay--and many other similar shallow coastal embayments along the northern Atlantic Coast--is eutrophication caused by nitrogen loading from various human activities in the watershed. Research at the Reserve, particularly the Waquoit Bay Land Margin Ecosystem Research Project, and elsewhere has shown that residential and commercial development combined with highly permeable sandy soils increases the amount of nitrogen in the ground water and ultimately in coastal waters. In Waquoit Bay, a shallow, moderately flushed embayment, the nutrients have led to increased growth of seaweed and plankton, reduced concentrations of dissolved oxygen during certain times of the year, reduced habitat quality, and changes in community structure. The principal sources of nitrogen are fertilizers, stormwater run- off, acid rain, and septic systems. In the Waquoit Bay watershed, research has shown that septic systems contribute a significant percentage of the nitrogen.

With this knowledge, in 1991 Reserve staff began researching ways to reduce nitrogen input from septic tanks. The Massachusetts state health code, which regulates on-site wastewater treatment systems, at that time discouraged all but the conventional tank and leach field approaches to on-site treatment. However, the Reserve staff found that several other states allowed alternative systems. In 1992 the Reserve held a conference, Nitrogen Removal On-site Wastewater Treatment Systems: Technologies and Regulatory Strategies , which brought together Massachusetts state and local regulatory officials along with people from several states that permitted alternative denitrifying systems to examine the pros and cons of their use.

Following the conference, a state-wide group eventually known as the Ad Hoc Task Force for Decentralized Wastewater Treatment formed to continue to explore the issues, including land use concerns, financial challenges, technological problems, and management approaches. This group continues to meet regularly and has grown to include several towns trying to find long-term on- site solutions to their wastewater problems.

In late 1992, the Reserve was designated as one of seven sites in the National On-site Demonstration Project (NODP) through EPA s Small Flows Clearinghouse. The purpose of the project is to demonstrate and promote the use of on-site wastewater management programs as available alternatives to full-scale, centralized sewage systems for environmentally sensitive areas and small communities. The primary objective is to install proven innovative on-site systems in states that may not currently permit these particular designs in order to evaluate the appropriateness, effectiveness, and economy of their use. An additional objective is to educate various sectors of the communities about the management of on-site systems.

The NODP planning committee has selected six denitrifying systems to evaluate within the Waquoit Bay watershed: a Waterloo Biofilter System, an I.D.E.A. Bestep-15, an Amphidrome System, an Orenco Trickling Filter/Upflow Filter, a shallow low-dosed trench field, and a denitrification barrier trench. Design work has been completed and bids are now being solicited for installation and monitoring. The systems should be in the ground in the early summer. Monitoring will continue for at least a year.

The Massachusetts Department of Environmental Protection and several local health agents have expressed concern about the management of advanced systems. They point out that people don t even pump out their current systems, so how can they be expected to manage a more complex system. In 1995, the Reserve received an EPA Environmental Technology Initiative (ETI) Grant to explore and recommend a framework for centralized management and accountability for decentralized solutions to wastewater treatment problems. This led to a December, 1995 conference called Managing Small-Scale, Alternative, and On-site Wastewater Systems: Opportunities, Problems, and Responsibilities . In addition to the ETI funds, financial support was received from the Massachusetts Bays Program (a National Estuary Program), and independent foundations. Session topics included: wastewater facilities planning for decentralized systems; site evaluation; design and engineering of decentralized systems-- choosing the right mix of technologies; and on-site management districts-- issues and examples.

Four papers are being written on these topics. Two are being printed and will soon be available: Managing Wastewater: Prospects in Massachusetts for a Decentralized Approach by Frank Shephard and A Massachusetts Guide to Needs Assessment and Evaluation of Decentralized Wastewater Treatment Alternatives by Andrea Arenovski and Frank Shephard. Two more papers are in preparation: one on siting and design of a mix of technologies and one on accountability for the performance of on-site systems. These papers should be available in the fall of 1996.

The Reserve continues to work with many partners to find ways to minimize nitrogen loading to coastal embayments. It is hoped that the demonstration projects, materials, and meetings will help others reduce the impacts of land use on their coastal resources.

For more information, please contact Christine Gault, Manager, Waquoit Bay National Estuarine Research Reserve, P.O. Box 3092, Waquoit, MA 02536, (508) 457-0495.

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Human Actions in the Watershed Reflected in Historical Estuarine Changes

Otter Point Creek is a freshwater tidal wetland that is part of the Chesapeake Bay, MD National Estuarine Research Reserve. The Creek presently contains a variety of habitats, including open water, wild rice marsh, cattail marsh, cattail and black willow shrub marsh, and box elder-green ash-river birch forest. All of these are valuable in maintaining biodiversity and are deserving of protection efforts. But how long have these habitats been there and how long should they be expected to last? If habitats do change, what factors bring about those changes?

To address these questions, researchers at the Reserve have reconstructed the history of these habitats using plant fossils extracted from sediment cores. Fossil seeds, stems, and leaves (macrofossils) of many species are deposited within a few feet of where the plants originally grew. Hence, macrofossils can be used to represent the vegetation at a particular coring location through time. Fossil pollen, while abundant, is not as useful in reconstructing wetland habitats, since most pollen is transported from forests and fields surrounding the wetland. However, because of this long-distance dispersal, pollen is useful for providing a record of changing forest patterns in the watershed--changes which can have dramatic effects on wetland habitats.

Core samples were collected by driving tubes into the sediment. The cores, varying from 1 to 3 meters in length, were taken to the laboratory at Johns Hopkins University for analysis. The sediment was extracted from the coring tubes and cut into 1- cm sections. Macrofossils and pollen were then isolated and identified from each sample.

Dates for the samples were determined at the bottom of the core using Carbon-14 and at the upper part of the core using the presence of particular types of pollen to identify the time of European settlement. For example, in a two-meter core from a present cattail marsh, a bottom sample provided a C-14 date of 1700 years before present--a calendar date of 300 A.D. At that point in time, and up until European settlement, oak pollen from the adjacent upland forest was abundant. Around 1730 A.D., written records indicate

that European settlers had cleared between 5%-20% of the forest. This is reflected in the fossil record by a decrease in oak pollen and concurrent increase in ragweed pollen. (Ragweed is a plant that grows abundantly in agricultural fields.) Thus the date of 1730 A.D. can be identified at a particular level within the core. Using this as an indicator, the thickness of sediments in the core can be measured and pre- and post-European sedimentation rates determined. Approximate dates can then be assigned to each 1-cm level throughout the core.

The macrofossil record has provided some fascinating results. Roughly 65% of the present wetland, including all of the marsh and more than half of the forested habitat, was open estuary before the early 1700s. At least eight species of submerged aquatic plants, including snailseed and ribbonleaf pondweeds and the slender naiad were common. This rich habitat persisted virtually unchanged for at least 1,400 years--from 300 A.D. until the early 1700s.

As European settlement continued through the 18th and 19th centuries, deforestation increased to 50-70%. This resulted in considerable soil erosion and the release of large amounts of sediment from the watershed into the estuary. Sedimentation increased to twenty times the pre-European rates, burying the open water habitat and causing other significant changes. Within a hundred years, one sampled area went from open water to shrub marsh to the box elder-green ash-river birch forest one sees today. Within 140 years, another site went from open water to low marsh to the modern sweetflag marsh. Within 180 years the outer lobe of a cattail marsh had evolved. During the period since the advent of European settlement, at least seven species of aquatic plants have disappeared entirely.

Other habitat changes can be attributed to recent human disturbance. Sewage lagoons were created and used between 1967 and 1970. This area has since changed to a high marsh. An area which had been forested since the 13th century converted to a cattail and black willow marsh within a year after the completion of the nearby highway. It is believed that the road s forty foot embankments trap flood water, killing the box elders, green ash, and river birch that had been there.

Although these habitats have gone through a series of changes and have been unstable since 1730, there is evidence of a new period of stability over the past thirty years at sites other than those near the sewage lagoons and the highway area. This may be due in part to the trapping of sediment by the Van Bibber Dam and sediment trap ponds created around development sites. The message to watershed and estuarine managers is two-fold: 1) there can be major impacts to the shape, size, habitats, and wildlife of the estuary from unmanaged activities in the watershed, and 2) that relatively simple techniques can be utilized to control erosion and trap sediment, thereby protecting estuarine habitats. The past record indicates that if sediment and disturbance from road building, housing development, and sewage lines can be controlled, the existing habitats may be preserved in their present state for perhaps hundreds of years into the future.

For further information about this research, please contact Mary Ellen Dore, Manager, Chesapeake Bay National Estuarine Research Reserve - MD, at (410) 974-3382, fax: (410) 974-2833, or e-mail: *medore@dnr.state.md.us.*

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Management Plan for a South Florida Coastal Watershed

The Rookery Bay National Estuarine Research Reserve (NERR) lies on the Gulf coast of Florida near Naples. In addition to the Research Reserve, the staff at Rookery Bay also manages two state-designated Aquatic Preserves: the Rookery Bay Aquatic Preserve and the Ten Thousand Islands Aquatic Preserve. In combination, these areas cover more than 110,000 acres of land, submerged bottom, and estuarine habitat.

Along with typical research and education activities at the Reserve, a Resource Management Team was developed to handle issues affecting the Reserve and to develop a Management Plan for the NERR and the Ten Thousand Island and Rookery Bay Aquatic Preserves. It was immediately clear that any such plan would have to look beyond the boundaries of the designated areas and become a watershed management plan for the entire area since development, agriculture, industry, and other activities upstream of the estuaries affect the health of these fragile systems. The Plan has allowed the Reserve to take an active stance in defining future growth and development in the entire watershed by outlining valid concerns for the future of the systems along the coast.

The resulting Watershed Management Plan, issued in late 1994, examines land use patterns within the headwaters of the estuarine systems and provides specific recommendations for the restoration and preservation of essential water flowways and natural communities. The Plan is intended to be used by

management and regulatory agencies, planners, and local governments as a source of information to support the comprehensive management and restoration of watersheds.

Consideration of how current activities affect the system is included in the Plan, as well as predictions of how future development actions might change existing conditions. Planned Unit Developments (PUDs) are identified, as well as canals, culverts, and water control structures which regulate freshwater flow. Sources of point and non-point pollution are provided along with data related to water quality and quantity for major waterways within the watershed.

Combined, these current and potential impacts are related to the status of historic flowways. General and site-specific recommendations for restoration activities within the watershed are provided along with estimated costs.

The Plan was reviewed by and distributed to federal, state, regional, and local government agencies, private environmental organizations, and private consulting firms. Additionally, it was presented at public workshops to familiarize local residents with restoration options and activities. Input from these sources and others was incorporated into the Plan.

The experience of developing this Plan leads to the following recommendations from the Rookery Bay staff for others working on watershed management plans:

- Define and map approximate hydrologic boundaries of the watershed.
- Define and map all smaller drainage basin boundaries within the watershed.
- Determine and map historic flowways.
- Distinguish and map any major obstacles to water flow.
- Define existing zoning within the watershed and map major regions of development.
- Identify, and map as thoroughly as possible, point and nonpoint sources of water pollution.
- Analyze water quality data available for the watershed.
- Determine viable conservation measures that can be employed to protect the watershed.
- Make recommendations for protecting and improving natural resources within each basin.
- Identify cost estimates for recommendations and potential sources for obtaining funds.
- Work closely with all levels of government, environmental organizations, local consulting firms, and private citizens.

Ultimately, the plan should be a comprehensive examination of the water entering the estuaries. The purpose is to examine the relationship between estuarine conditions and watershed alterations and recommend actions within the watershed with the goal of protecting and restoring estuarine water quality. Although it may take time to implement any procedures recommended to restore the water quality within the watershed, the plan becomes the basis of actions for the long-term benefit to the natural communities and water resources.

The Watershed Management Plan for Rookery Bay NERR and the Ten Thousand Island and Rookery

Bay Aquatic Preserves has been used to support state acquisition of environmentally sensitive lands, to identify environmentally sensitive areas within the watershed for regulatory purposes, and to identify areas for potential mitigation and restoration activities from developmental impacts. Groups that reviewed the plan are regularly involved in implementation activities and the stakeholders continue to enthusiastically support the plan.

For more information about the Watershed Management Plan for the Rookery Bay National Estuarine Research Reserve and Ten Thousand Islands Aquatic Preserve, contact Judy Haner at the Florida Department of Environmental Protection, 10 Shell Island Road, Naples Florida 33962, Tel.: 941-775-8845, Fax: 941-775- 7606.

URL: http://www.epa.gov/OWOW/estuaries/coastlines/coastlines6.2/apalach.html
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EPA Publication available...

Watershed Tools Directory (841-B-95-005) is a useful collection of 250 one- page watershed tool summaries, each including key information such as a description of the tool, contact names and phone numbers, and information about intended users. These tools were canvassed from EPA headquarters and regions, other federal agencies, states, and watershed organizations. If you have a watershed tool you would like to include in the next update of the Directory, please see the form in the Directory s introduction. Updates will be completed as new tools are received.

The Directory was developed primarily for watershed stakeholders in the field, but may also be a valuable tool to anyone interested in watersheds. A copy of the Directory can be obtained by mailing or faxing a request with your name, address, and telephone number to:

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NCEPI
11029 Kenwood Road, Building 5
Cincinnati, OH  45242
(513) 489-8695
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The Directory is also on the internet at http://www.epa.gov/OWOW/watershed/tools. For more information about the Directory or about adding your tool(s) to the collection, contact Chris Laabs with EPA s Office of Wetlands, Oceans, and Watersheds at (202) 260-7030.

Louisiana Coastal Wetlands Workshop
October 19-20, 1996
Louisiana Universities Marine Consortium (LUMCON), Cocodrie, Louisiana

The Eighth Annual Louisiana Coastal Wetlands Workshop will be held in Cocodrie LA, October 19 and 20, 1996, at the LUMCON research and education facility. The workshop is a program of the Coalition to Restore Coastal Louisiana in cooperation with the Barataria/Terrebonne National Estuary Program, Orleans Audubon Society, LUMCON, and Women for a Better Louisiana. Attendance is on a first-paid

basis.

For more information, please contact University of Orleans Conference Services at (504) 286-6680.

The Delaware Estuary Program has announced the departure of Program Coordinator Robert Tudor who will be returning to the NJ DEP to take on new challenges. Mr. Tudor has been on loan from the DEP for the last three years.

Because the Management Plan for the Delaware Estuary will be sent to the Governors and EPA for approval early this year--thus signaling the end of the program as it has existed for the past six years--the NEP has decided not to hire a replacement and instead utilize existing EPA and state staff to cover these responsibilities.

New Manual About Best Management Practices Available

A new booklet about the cost-effectiveness of best management practices (BMPs) has been prepared by the Casco Bay Estuary Project. This free booklet will be especially useful to town governments, businesses, developers, and shorefront property owners. The booklet features case studies of Maine homeowners, businesses, and municipal officials who have used BMPs and believe they are cost-effective.

To obtain a copy of the booklet, call the Casco Bay Estuary Project at (207) 828-1043.

URL: http://www.epa.gov/OWOW/estuaries/coastlines/coastlines6.2/miscblrb.html
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Coastal Zone 97: Charting the Future of Coastal Zone Management

Coastal Zone 97 (CZ 97), the premier international symposium on coastal and ocean management, will be held in Boston, Massachusetts July 20-26, 1997. The 10th in a series of biennial international conferences, CZ 97 will provide a forum to examine the complex, multidisciplinary problems facing the world s coastal zones.

Conference participants include public and private policy makers, non-governmental organizations, planners, business and industry interests, managers, and academicians.

The session themes are entitled: Where Have We Been?, Where Are We Going?, and New Directions: Charting the Course.

The first session will explore coastal zone management in the past quarter century by focusing on lessons learned, weaknesses discovered, and unresolved issues and knowledge gaps. The second session will address how the roles of and relations between government, business and industry, academia, non-governmental organizations, and the public are expected to change over the next twenty-five years. The third session will focus on innovation--reinventing ways to meet the objectives and challenges of the next twenty-five years by exploring ideas and technologies that lead to improved coastal zone management capabilities.

CZ 97 is co-sponsored by the National Oceanic and Atmospheric Administration, National Ocean Service; Massachusetts Office of Coastal Zone Management; Army Corps of Engineers, Coastal Engineering Research Center; and the Urban Harbors Institute at the University of Massachusetts-Boston.

Abstracts for conference sessions and posters are being invited.

- To receive a Call for Papers announcement or for more information about the conference please contact Dr. Martin Miller, USAE Waterways Experiment Station, ATTN: CEWES-CR-O, 3909 Halls Ferry Road, Vicksburg, MS 39180.
- Professionals interested in chairing or co-chairing a technical session should submit a letter no later than September 1, 1996, expressing their interest, curriculum vitae, and topics of interest to Jessica Cogan, US EPA, 401 M Street, SW 4504F, Washington, DC 20460.
- Those interested in hosting a professional meeting at the conference should contact Gary Magnuson, NOAA, National Ocean Service, 1305 East-West Highway, Silver Spring, MD 20910, Fax: (301) 713-4263 for further information.

Registration fees for the conference will be announced in the preliminary program which will be mailed in March 1997.

URL: http://www.epa.gov/OWOW/estuaries/coastlines/coastlines6.2/cz97.html
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About Coastlines...

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