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Information About Estuaries and Near Coastal Waters June 2000 - Issue 10.3

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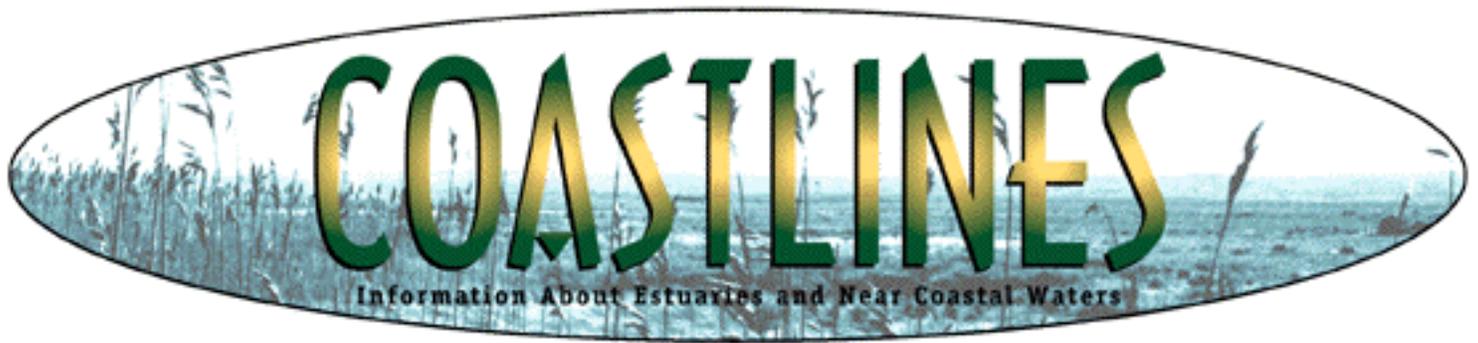
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Indian River Lagoon Study Calibrates Nitrogen Loading Model

The Indian River Lagoon National Estuary Program (IRLNEP) and the St. Johns Water Management District, working in cooperation with the South Florida Water Management District, have recently completed a study to clarify contributions of nitrogen to the Lagoon from on-site disposal systems (OSDS). The report, entitled "On-Site Sewage Disposal Systems Pollutant Loading Evaluation - Test and Validation of Indian River Lagoon Nitrogen Model," focused on developing and calibrating modeling tools to evaluate the effects of development and in particular, on-site sewage disposal systems (OSDS) on coastal water quality. The results of this study were released in March, 2000, and provide follow-up to an earlier study of nitrogen loading sources.

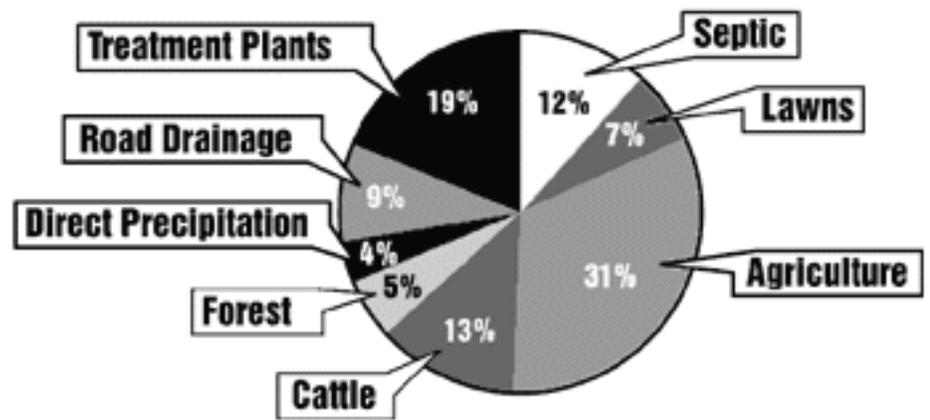
In 1996, under contract to the US Environmental Protection Agency, a report entitled "Indian River Lagoon Septic System/Carrying Capacity Study" was released. As part of the study, a preliminary nitrogen loading model was completed for the Lagoon. The model was used to assess current nitrogen loading to the lagoon and predict conditions that may result from new development and eventual build-out of the watershed. The model takes into account a variety of nitrogen sources, including sewage, fertilizers, road runoff, and precipitation. The results indicated that on-site disposal systems contributed 12 % of the nitrogen load to the lagoon, while agricultural lands contributed 31 %. The loading model provided a mechanism for calculating the total amounts of nitrogen contributed to a system, and predicts the concentration of nitrogen in groundwater based on hydrological parameters.

The March, 2000, report follows up on the earlier findings and provides details of a calibration step necessary to further quantify the amount of nitrogen actually entering into the Lagoon related to OSDS nitrogen sources in Florida. In order to calibrate the model, a series of eight test sites were chosen on the east coast of Florida within the Indian River Lagoon watershed that represent residential neighborhoods serviced by on-site disposal systems.

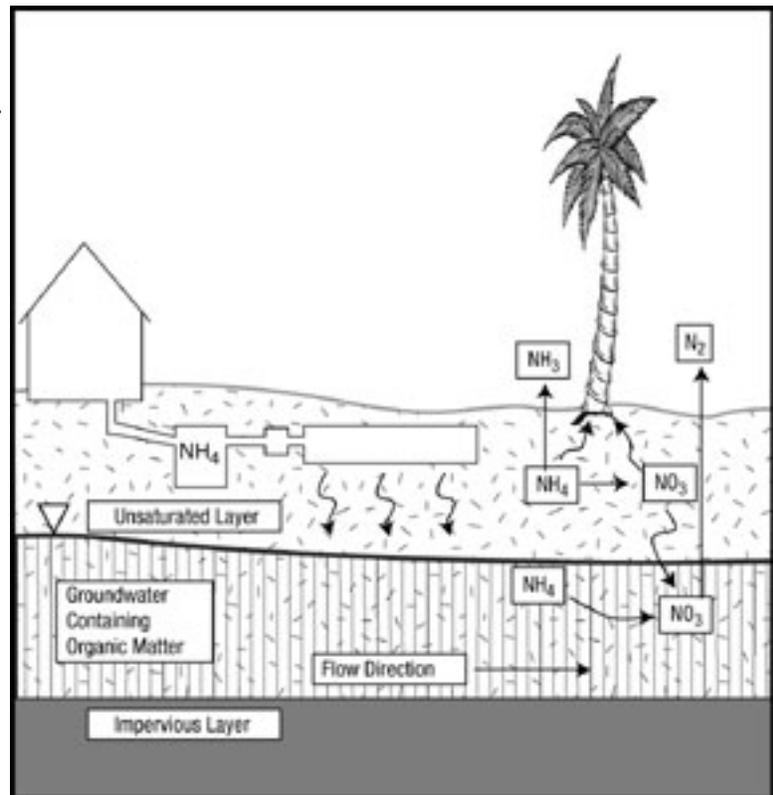
A water sampling strategy using pumping wells (capture zone sampling) provided a unique design to obtain groundwater data for model calibration. Modeling of the capture area upgradient of the wells allowed a "groundwater recharge area" to be delineated, thereby establishing boundaries for locating and enumerating on-site disposal systems contained within it.

Wells were placed in unsewered, high density residential neighborhoods, and site-specific land use data were collected from each site to be entered into the nitrogen loading model to predict groundwater nitrogen concentrations. In normal application, nitrogen loads are summarized on an annual per acre basis and the concentration is calculated based on the amount of annual volume recharged to the groundwater.

Following the initial model run, the groundwater monitoring system was used to collect representative samples of groundwater by pumping sampling wells to establish large capture zones. Sampling was conducted seasonally throughout the year. The concentrations of nitrogen in groundwater samples collected from the capture zones were then compared to model predictions and used as a basis for model calibration and discussion.



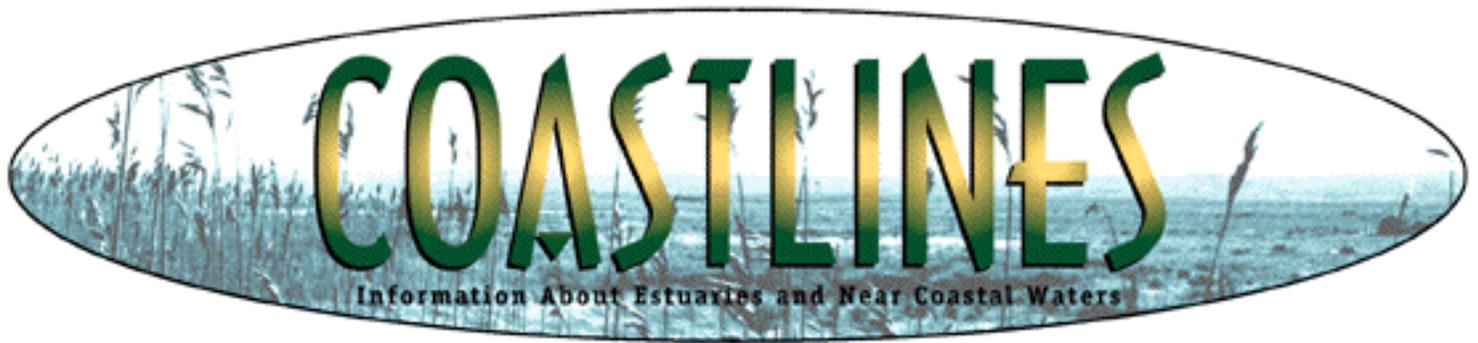
Concentrations of nitrogen in groundwater predicted by the model were significantly greater than that measured in groundwater. A possible explanation for this result may be that environmental conditions in groundwater were conducive to denitrification, which is the microbial conversion of nitrate to gaseous nitrogen (N_2) through a series of chemical reductions. Gaseous nitrogen escapes to the atmosphere and therefore is not detected in groundwater. Both low dissolved oxygen and high organic carbon, indicative of the conditions required for denitrification to occur, were observed in the field. The data revealed that 68% of the nitrogen predicted to be found was being lost in the system; this percentage was derived empirically by comparing the estimated loading with the measured total nitrogen concentration data.



The study findings reveal some of the inherent difficulties in modeling groundwater systems and pollutant inputs. Local environmental conditions can significantly affect the attenuation of nitrogen in groundwater, while replicating variations in hydrology and geology through modeling relies on detailed site-specific information.

The next phase of the study will further investigate the denitrification potential of the areas studied and clarify some of the hydrological characteristics that may not be accurately simulated in the model. The findings of the studies will provide valuable information for managers to consider in the development of wastewater management plans in Florida.

For further information, contact Jim Begley, Horsley & Witten, Inc., 90 Route 6A, Sandwich, MA 02563; Phone: (508) 833-6600; E-mail: jbegley@horsleywitten.com or Bob Day, Environmental Specialist, Indian River Lagoon National Estuary Program, Florida; Phone: (407) 984-4950; E-mail: Robert_Day@district.sjrwmd.state.fl.us



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Aquariums, Zoos, and Science Museums Collaborate on Public Education

As society continues to urbanize and technology hurtles forward in quantum leaps, real contact with nature is disappearing for most people at an alarming rate. As contact with nature decreases, people have a dwindling comprehension of even the simple principles that govern how our planet works. Most people do not realize that the ocean controls the weather. Few understand that more oxygen is provided to earth's atmosphere by oceanic photosynthesis than by all the earth's terrestrial plants combined. The general public generally does not understand the important role of the oceans in the global ecology.



A new collaborative, multi-year approach, called The Ocean Project, is being developed to cultivate changes in the way people understand, relate to, and use the ocean. The Wildlife Conservation Society (WCS), through its New York Aquarium, supported the early work of The Ocean Project and established a steering committee to lead the new initiative. Currently, it is comprised of representatives from WCS's New York Aquarium, SeaWeb, Monterey Bay Aquarium, National Aquarium, Colorado's Ocean Journey, New England Aquarium, Vancouver Public Aquarium, American Zoo and Aquarium Association, and John G. Shedd Aquarium. Aquariums, zoos, and museums have a unique opportunity to educate the public about the importance of the ocean. One in three Americans has visited at least one of

these institutions in the last twelve months and polls show that people trust these educational institutions as a credible source of information on ocean protection. Recognizing the advantage that these institutions possess, The Ocean Project formed to develop a coordinated effort to create in people a lasting, measurable awareness of the importance, value, and sensitivity of the oceans. Institutional partners now number more than 75 aquariums, zoos, and museums, and The Ocean Project is also collaborating with conservation organizations, government agencies, university and school clubs, and others.



To understand best how to proceed on such a major initiative and what to communicate to the public, The Ocean Project commissioned a comprehensive national public opinion survey last year. The survey focused upon understanding how and why people think about the oceans, what people know, and the gaps in public awareness about the oceans and related conservation issues. Focus groups and a national survey that sampled 1,500 American adults were conducted late last summer.

Major findings from the research show reasons for both pessimism and optimism

in protecting the oceans. Essentially, while Americans have little basic knowledge of ocean functions, there is broad awareness of the oceans' vulnerability. However, people do not generally perceive the oceans to be in immediate danger. A large majority of the public feels a strong personal and positive connection to the ocean, regardless of where they live. The survey shows that people tend to value the oceans for their recreational and emotional aspects, and most understand that the oceans are neither a 'bottomless sink' nor indestructible. People do know that human activities damage the oceans. Eight in ten reject the idea that the oceans are so large that it is unlikely humans can cause lasting damage to them. A similar percentage rejects the idea that they don't need to worry about the health of the oceans because we will develop new technologies to keep them clean. Importantly, even though they do not know why or how, the public understands that oceans are critical to maintaining the balance of life on the planet. Fully 92% of Americans consider the oceans essential for human survival.

At the moment, however, Americans remain largely unaware of the threats to ocean health and they greatly underestimate their own role in damaging the oceans. Most Americans are unable to correctly answer a majority of simple questions about how the oceans function. For example, only 21% of Americans know that oceans produce more of the earth's oxygen than forests. And while the poll found that people believe the oceans are threatened with serious and lasting damage caused by human activities, most people do not understand the role that each of us plays in the health of the oceans. For example, a majority of poll participants blame industry as the leading cause of ocean pollution and are much less aware of other threats to the oceans' health such as those cumulative effects, like runoff. When asked to choose the main source of ocean pollution among three sources, only 14% of Americans select the

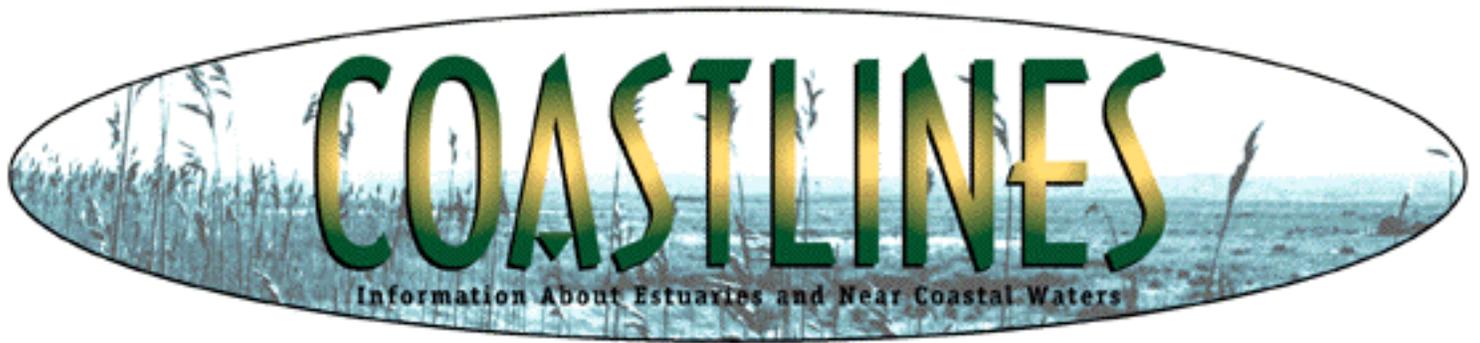
correct answer-- "runoff from yards, pavement, and farms." Most (66%) choose "waste dumped by industry," and 16% believe most pollution is from trash and litter washed into the oceans from beaches. Nearly half of the respondents agree with the statement: "what I do in my life doesn't impact ocean health much at all." There is little realization that each of us has a major responsibility (and opportunity) for protecting the health of the oceans and our planet.

Significantly, the poll demonstrates that there is tremendous opportunity for aquariums, zoos and museums to reach the public with new educational efforts that emphasize both science and the inspirational and ecological values of healthy oceans. The study identified the importance of connecting people to the oceans through their values and aesthetic appreciation before attempting to get them to focus on ocean problems. These institutions are in a unique position to channel the public's love for the oceans into a sense of individual opportunity and responsibility.

A major role for The Ocean Project to play will be to create a paradigm shift both in the way that people relate to the oceans and in the way institutions approach connecting people to ocean conservation. The Project intends to develop and promote people's natural affinity for the oceans through the creation of messages, communication tools, exhibits, events and projects that mesh science education and conservation values with memorable experiences about the oceans. Starting in North America and then expanding around the world, The Ocean Project hopes to identify and encourage people to take more active roles in protecting oceans locally, nationally and internationally.

For further information or to join in this collaborative effort, contact Bill Mott, The Ocean Project, 102 Waterman Street, Suite 16, Providence, Rhode Island 02906; Phone: (401) 272-8822; FAX: (401) 272-8877; or Email: bmott@seaweb.org

Or visit the website at www.theoceanproject.org [EXIT disclaimer >](#)

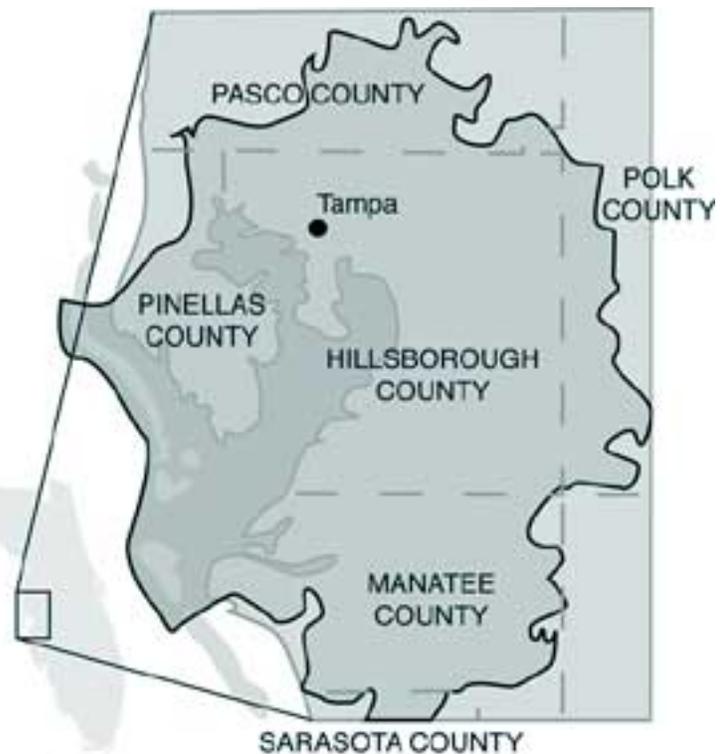


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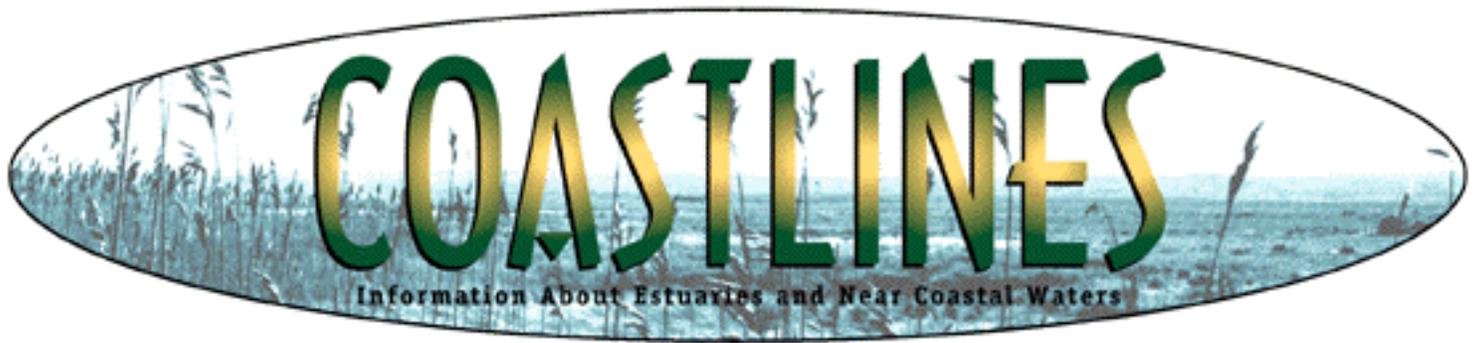
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Tampa Bay Estuary Program

Researchers working on the Tampa Bay Estuary Program's atmospheric deposition project have recently discovered evidence that the denuder/filter pack system, which collects gaseous and small particulate nitrogen species, may be missing a large fraction of particulate nitrate. The filter pack system is deployed annually in coastal areas, as recommended by Great Waters, NOAA, and EPA. Preliminary estimates from Tampa Bay indicate that as much as 40% of nitrate in dry forms may escape the current collection methods because of interactions with sea salt crystals. TBEP and its partners are examining methods for collecting these larger sea salt particles. Other programs which are currently using the annual denuder and filter pack systems to measure



atmospheric deposition, particularly over water or near the shoreline, should be aware of this potential interaction and implications for estimating direct deposition of nitrogen to estuarine waters. For further information, contact Holly Greening, TBEP Scientist; E-mail: hgreening@tbep.org



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Emission Standards for New Commercial Marine Diesel Engines

The US EPA has been regulating emissions from highway cars and trucks since the early 1970s, and in 1990 the Clean Air Act Amendments specifically directed EPA to study the contribution of nonroad engines to urban pollution and regulate them if warranted. "Nonroad" is a term that covers a diverse collection of engines, equipment, and vehicles, including marine vessel engines. In 1991, EPA released a study documenting emission levels across a broad spectrum of nonroad equipment that were higher than expected.

Commercial diesel marine engines contribute approximately 5% of the national mobile source nitrogen oxide (NO_x) inventory, and about 1% of the national mobile source particulate matter (PM) inventory. In areas with large commercial ports or near busy shipping lanes, the contribution of diesel marine engines to the local inventory of emissions may be much higher. The April issue of Coastlines included an article entitled "The Effect of Shipping on Air Quality in Coastal and Estuarine Regions," which identified marine diesel engine emissions of carbon monoxide (CO), sulfur oxides, and nitrogen oxides, as having significant impacts on coastal air quality.

In November, 1998, EPA set challenging new standards that will address the air pollution from new marine diesel engines. The final rule for the action was released on December 29, 1999. Marine diesel engines are used for propulsion and auxiliary power on commercial vessels in a variety of marine

applications, including fishing boats, tugboats and towboats, coastal and Great Lakes cargo vessels, crewboats, and supply vessels. The emission standards, summarized in Table 1, apply to new engines made after the listed dates. The new rule does not affect used or rebuilt engines made before these dates, unless they were not previously marine engines, or if they are installed in new vessels. These EPA emission standards supersede the NO_x limits adopted by the International Maritime Organization (IMO) for these engines.

Table 1

U.S. EPA Emission Standards and Dates for Marine Diesel Engines*

Category	Displacement	Starting Date	NO _x +HC (g/kW-hr)	PM (g/kW-hr)	CO (g/kW-hr)
1	disp. < 5.0 liters/cylinder	2004	7.2	0.20	5.0
2	disp. > 5.0 liters/cylinder	2007	7.8	0.27	5.0

U.S. EPA Emission Standards and Dates for Marine Diesel Engines*

*This is a simplified table to show the approximate standards and dates for the different categories and sub-categories of marine diesel engines.

The main responsibility for meeting the new requirements will fall upon the engine manufacturers. Manufacturers of marine diesel engines must certify with the EPA that they will produce each engine to operate with the low emissions outlined in the regulations over its lifetime. Boat builders, operators, and rebuilders are responsible for keeping each engine in its certified configuration. EPA intends to cooperate with the Coast Guard to oversee the industry to ensure compliance with these new requirements.

Manufacturers are expected to use all the available time (to 2004 and 2007) to develop and commercialize the needed technologies. Most of the effort will be in adapting the same technologies that companies will use for land-based nonroad engines.

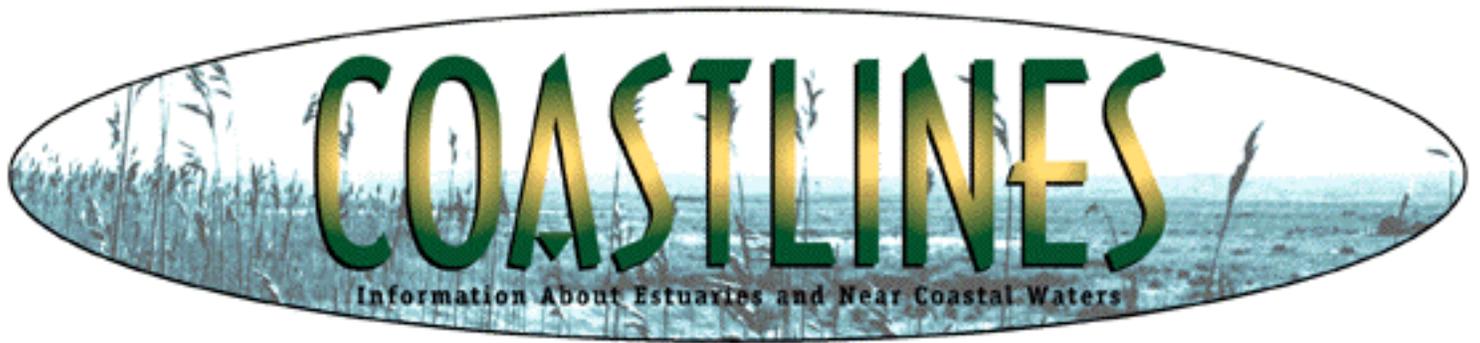
It is expected that the emission standards will reduce NO_x emissions from these engines by 24% and PM emissions by 12% in 2030, when the program is fully established. These emission reductions will be especially important in the areas around commercial ports and heavily populated coasts, reducing ozone and particulate air quality problems that cause respiratory health problems for many people.

Gasoline outboards and personal watercraft contribute about 5% of the national mobile source volatile organic carbon (VOC) inventory. However, in areas with large boat populations, the contribution of these recreational marine engines may exceed 10% of the regional hydrocarbon (HC) inventory. These engines typically employ 2-stroke technology, which has changed very little over the last 50 years. In July, 1996, regulations were put in place to control exhaust emissions from new outboards. The emission controls for these engines involve increasingly stringent standards over the course of a nine-year phase-in period beginning in model year 1998. By the end of each phase-in, each manufacturer must meet an emission standard, on a corporate-average basis, that represents a 75% reduction in HC compared to unregulated levels.

For further information, contact Alan Stout, US EPA; Phone: (734) 214-4805; E-mail: stout.alan@epa.gov or visit the website: www.epa.gov/otaq/marine.htm

Coastal and Estuarine Risk Assessment Forum

A forum on Coastal and Estuarine Risk Assessment will be held during July 20-21, 2000 in Virginia at the College of William and Mary. The forum will focus on the science of determining exposure, effect, and risk in coastal and estuarine environments. Emphasis will be placed on the logical framework for assessing causation, as well as measurement of contaminant fate and toxicity in these systems. The application deadline is April 30, 2000.



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Green Seniors

The Environmental Alliance for Senior Involvement (EASI) is a non-profit organization established in 1991 as the result of an agreement between the US EPA and the American Association of Retired Persons (AARP). The volunteer effort of thousands of seniors has been harnessed to improve the environment, one community at a time, through a network of Senior Environment Corps under the EASI program.

The EASI program has resulted in significant progress in improving the environment in a very short time, while providing a positive impact on older people across this nation and the world. There are currently over 20,000 volunteers in more than 300 senior environmental volunteer programs in all 50 states, as well as the District of Columbia. EASI estimates there will be over 1,250,000 seniors involved in the program by the end of 2005. The success of these programs has led to the establishment of EASI Senior Environment Corps in England (1998), Scotland (1998) and Ireland (1999). EASI plans to help start the Holland Senior Environment Corps in 2000.



Senior Environment Corps members are actively involved in many different projects, based on the needs of the local community. Many of these activities are intergenerational and volunteers enjoy the added satisfaction of working closely with young people to share their wisdom and life experiences. Examples of volunteer projects include monitoring the water quality of local lakes and streams, planting trees to create stream buffer zones, staffing nature and recycling centers, testing drinking water wells for possible contamination, participating in community Brownfields projects, planting and maintaining urban gardens, teaching environmental education in schools, assessing the potential sources of ground water contamination, and more.

The first statewide EASI Senior Environment Corps was started in Pennsylvania in 1997. Focused on water quality, the program has mobilized hundreds of volunteers to carry out quality-assured chemical, biological and habitat assessments. Volunteers enter the data into an electronic database created specifically for collecting and maintaining this water quality monitoring data. Volunteers on this project have performed chemical monitoring at over 400 sites along Pennsylvania waterways, carried out biological and habitat assessments at over 300 of these sites, and entered over 1,600 records into the database.

Last year, EASI received the National Award for Sustainability from the President's Council on Sustainable Development and Renew America, as well as the United Nation's Global 500 Roll of Honour Award, for implementing Pennsylvania's statewide program. The model was replicated in Virginia in 1999 and California will undertake its statewide EASI Senior Environment Corps in 2000.

With funds from a recent grant from the US EPA, EASI is expanding senior environmental volunteer activities to directly help protect source water throughout Arkansas, Louisiana, New Mexico, Oklahoma and Texas. Ten EASI Senior Environment Corps will be set up to recruit and train senior citizens to perform a variety of activities related to source water protection, nonpoint source pollution, watershed management and restoration, and water quality monitoring. Volunteers will learn how to educate their communities about water issues and how to use the innovative "Groundwater Simulator," a teaching tool for demonstrating how a community's water supply can become contaminated.

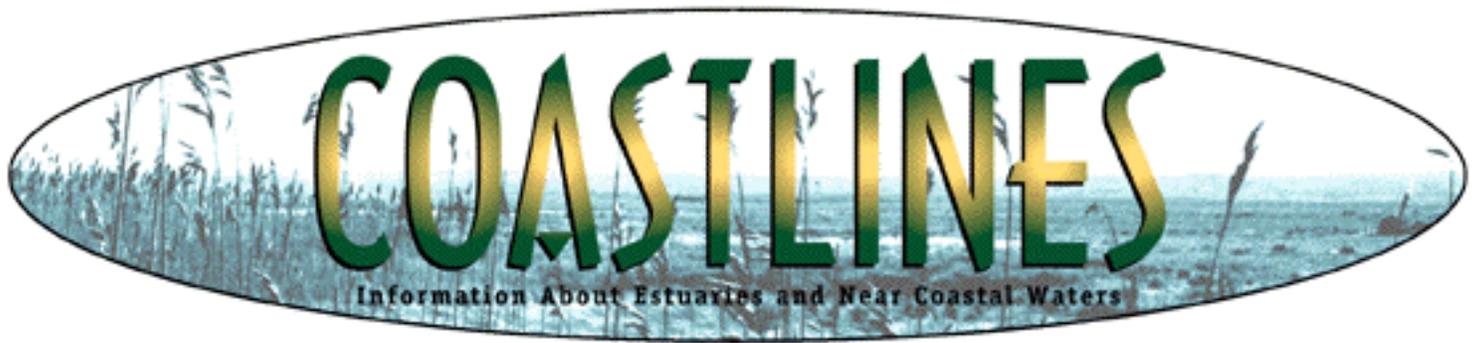
A unique new program is underway at the Retired and Senior Volunteer Program (RSVP) of Cape Cod & Islands, Massachusetts, which has managed an active EASI Senior Environment Corps for over two years. With a \$142,000 federal grant from the Corporation for National Service, it will create the first-ever AmeriCorps program composed entirely of people over the age of 55. AmeriCorps is a federal volunteer program that began in 1993. In exchange for a year of full-time (1,700 hours) or part-time (900 hours) service, AmeriCorps members receive a modest living stipend and earn a post-service education award. During the year, members will dedicate 18,000 hours of service and create six chapters of their Senior Environment Corps. One of their projects involves ammunitions clean-up at Camp Edwards, where volunteers will scour the sand trenches for bullets used by soldiers in World War II. Another project involves water quality testing, including macroinvertebrate identification. This is an engaging activity, ideal for involving grade-school children because it requires getting into swampy places and counting organisms like worms and insect larvae.

In addition to providing important scientific monitoring information and making tangible improvements to the environment, EASI volunteers remain an active force in the community and increase opportunities for intergenerational cooperation. EASI volunteers have already achieved a tremendous amount and look forward to future environmental accomplishments. "Together we are the stewards of our environmental heritage - a legacy that will be inherited by our children's children."

For further information about the Environmental Alliance for Senior Involvement or how to start a Senior Environment Corps in your community, visit the website at www.easi.org  or contact EASI, 8733 Old Dumfries Road, Catlett, VA 20119; Phone: (540) 788-3274; Fax: (540) 788-9301; or E-mail: easi@easi.org

Second Edition Catalog of Federal Funding Sources for Watershed Protection Now Available!

In 1997, the US EPA's Office of Water published the first edition of the Catalog of Federal Funding Sources for Watershed Protection to help organizations locate federal support. The overwhelmingly positive response prompted an update of the Catalog in 1999. The second edition highlights federal grants and loans that may be used at the local level to support watershed projects, and it contains references to many other good publications and web sites on funding and technical assistance. The document is available to view or download from the Internet at www.epa.gov/owow/watershed/wacademy/fund.html.



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Coastal Partnerships Initiative: Florida's New "Remarkable Coastal Places" Program

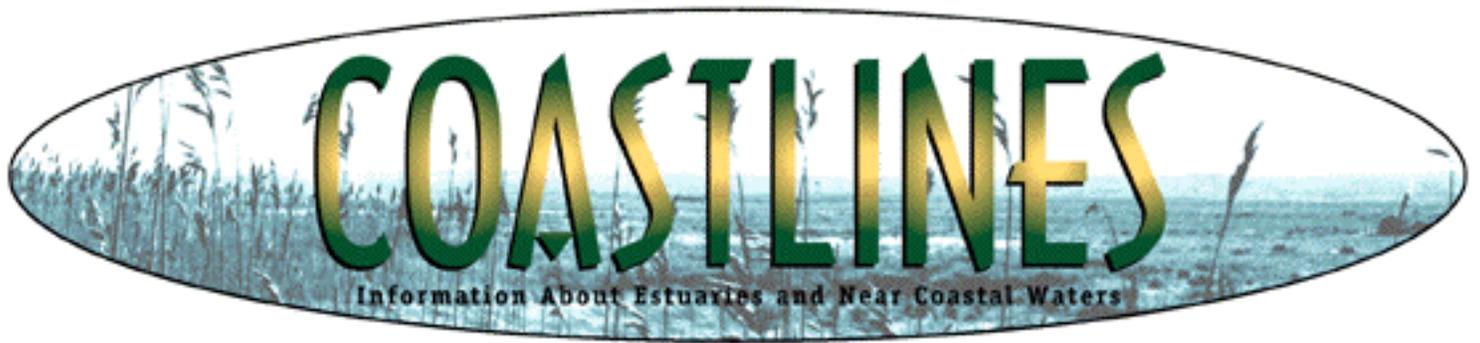
Florida's coastal communities all have unique resources that define their community identities and economic prosperity. Structural resources, such as historical lighthouses, old fishing villages, or early tourist attractions, and natural resources, such as primordial springs or endangered coastal habitat, give special character to many coastal areas in Florida. Often they lie off the beaten path, forgotten by residents and neglected by government. Sometimes they are threatened by impending development or eroding shorelines. Despite the numerous state and federal programs targeting coastal resources for protection, many programs cannot address the particular needs of these unique places.

Remarkable Coastal Places was initiated by the Florida Coastal Management Program (FCMP) this year to try to better address these needs. This is a grant and technical assistance program that encourages communities to identify places with exceptional cultural, historical, and ecological values, and helps them apply planning and management tools necessary to preserve and protect these places. Remarkable Coastal Places is only one strategy within the FCMP's overall Coastal Partnerships Initiative, but it is a major piece that the FCMP intends to expand in future years.

This summer, communities will again be encouraged to submit proposals to the Florida Coastal Management Program to protect remarkable places. The FCMP will be looking for projects that require

the kind of technical assistance that is not always available through traditional grant funding avenues. Proposed projects might include developing conservation plans for an endangered habitat area, establishing long-term administrative management for a particular resource, or creating and implementing a comprehensive public information campaign to educate local residents about a unique natural resource.

Remarkable Coastal Places differs from most programs in that after an applicant's proposal is accepted, staff of the FCMP and the applicant collaborate in designing the final project scope and deliverables. Based on the needs of the applicant, the FCMP may take an active part in implementing the project. In addition to the maximum of \$25,000 that is available to the applicant, the FCMP will incorporate technical assistance tools into the project scope. For example, the FCMP might agree to develop a number of training workshops for local government officials and residents, bring in other state agencies to assist in management or permitting activities, or help to facilitate a strategic planning process. Any tools included in the scope of work are customized to the specific needs of the project. The funding notice for Remarkable Coastal Places will be available in the late summer of 2000, and project proposals will be due in the fall of the year. Funding will begin July, 2001 and run for 12 months.



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Marineland Designated as First "Remarkable Coastal Place"

The history of Marineland is relatively unknown to many Florida residents and out-of-state tourists alike. In 1938, Cornelious Vanderbilt Whitney, Count Ilia Tolstoy, Sherman Pratt, and Douglas Bourden created a visionary undertaking called Marine Studios for the purpose of making underwater movies, which heretofore had been an inaccessible environment. This theme park was located on highway A1A near the historic city of St. Augustine, Florida. The whole concept sparked such public interest that tens of thousands of people flocked to see what was going on, and the line of parked cars on opening day stretched for miles along Highway A1A. A new word entered the English language-"oceanarium"-to describe what had been created. For a time, Marineland was the state's top commercial attraction, and today the oceanarium tanks are listed on the National Register of Historic Places.

What is less well appreciated is that the site chosen for the new oceanarium had previously been in use by local Native Americans for several thousand years. Whitney and his partners thought that they had an ideal site because it had clean ocean water, was located near a inlet where animals could be easily collected and brought into the display tanks, and was accessible to people. The fact that others thought this an ideal site is revealed by the fact that the earliest documented period of occupation dates from the 2,000-1,000 B.C. period, and that shell middens from the Native Americans' extensive exploitation of coastal lagoons stretch for two miles from the Matanzas Inlet through the Marineland property.

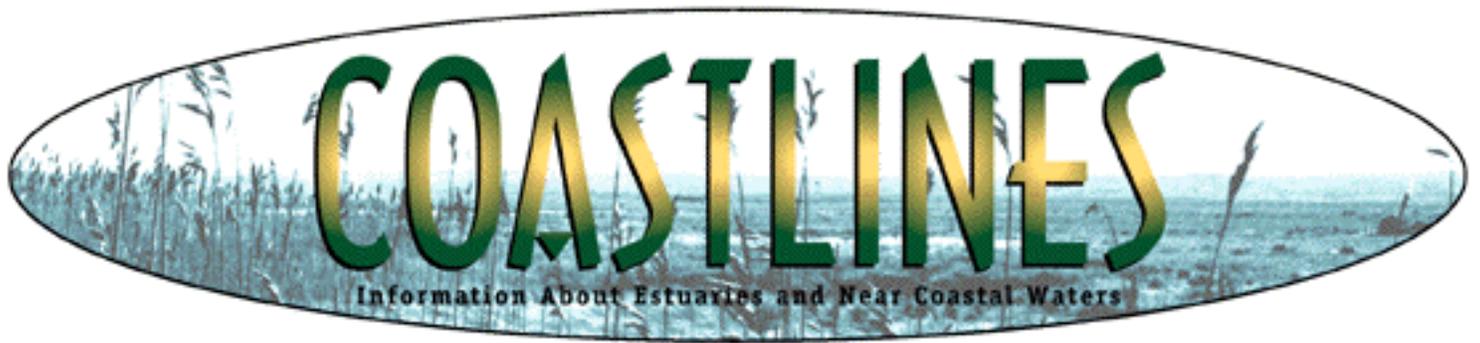
Modern day development has had a different focus; within the town limits there remain several ecologically significant environments, including a high-energy beach, sand dunes, a unique coquina outcrop on the beach at the southern town limits, coastal scrub, maritime hammock, and salt marsh. About 90 acres of this land were acquired by the Town of Marineland and Flagler County using a Florida Communities Trust Preservation 2000 grant, and the River to Sea Preserve at Marineland was established. This preserves an environmentally significant corridor connecting the ocean and the river and will protect existing natural communities, allow restoration of portions of the dune system and coastal scrub, and open the site to the public for passive land and water-based recreational uses. All of this has been accomplished in the face of a steady march of oceanfront construction toward Marineland from both the north and the south.

Today Marineland faces financial difficulties related to the bankruptcy of the original park operators and the fact that the town's tax base cannot support adequate local government activities. Currently, the Marineland property is divided among four stakeholders: 1) Flagler County and the Town of Marineland, who jointly own the 90-acre River to Sea Preserve; 2) Marine Park of Flagler, a private organization interested in developing a sustainable environmental village; 3) the Marineland Foundation, a non-profit, 501(c)3 corporation interested in maintaining the attraction as a continuing operation; 4) the University of Florida's Whitney Research Laboratory and Sea Grant College. There is also the possibility that one headquarters office for the Gauna Tolomato Matanzas National Estuarine Research Reserve will be located on the property. However, the town and its "residents" are in need of organizing themselves in a way that can meld the interests of all while conserving the features that give the place its charm.

Marineland was designated as the first of Florida Coastal Management Program's Remarkable Coastal Places in October. Its stakeholders are now working with the Florida Coastal Management Program staff to finalize a project scope that is set to begin in July. Through the Remarkable Coastal Places process, Marineland hopes to develop a strategic plan that will enable its stakeholders to conserve the many assets of Marineland. Specific needs are to redevelop the town center in order to provide a sustainable tax base that will support the research, education, and tourism programs of the various stakeholders. Other goals of the project include tapping into expertise in public financing and comprehensive planning, updating the existing comprehensive plan, and educating the public about the educational and recreational facilities available in the town.

For further information on this Remarkable Coastal Places project or to discuss possible project ideas, please contact Teresa Divers at the Florida Coastal management Program; Phone: (850) 414-6558 Email: teresa.divers@dca.state.fl.us

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Cape Cod Coastal Embayment Project

During the late 1980s, Cape Cod's attention was focused on a growing environmental crisis in Waquoit Bay. The shores of Waquoit Bay, located in Massachusetts, and the site of a National Estuarine Research Reserve, was covered on numerous occasions with thousands of dead glass shrimp, lumpfish, and crabs, all deprived of oxygen by decaying vegetation on the bay's bottom. Obvious signs of coastal water quality degradation had arrived in dramatic fashion on Cape Cod.

Since that time, local, state, and national concern for degradation of water quality and ecosystem function in near-coastal waters through nutrient overloading has grown, encouraging funding to assess impacted ecosystems and outline options to address the causes. In some larger coastal embayment systems, like Chesapeake Bay, significant funding has been committed to characterize these ecosystems, develop nutrient flow models, and use the information to develop management strategies to restore systems to selected targets. However, the problems are not only confined to large systems; smaller systems are seeing similar degradation from development in their watersheds.

On Cape Cod, 43 smaller embayment systems are threatened by increasing populations and decreasing open space in their watersheds. The Cape Cod Commission, a regional planning agency, has been working with a number of educational and environmental agencies and organizations to assess the sensitivity of these coastal systems to development within their watersheds and implement strategies to attain meaningful restoration and improvement of coastal water quality. The Commission's efforts have led to the development of policies and regulations that limit nitrogen loads from proposed developments to no net increase or an embayment-specific annual nitrogen loading limit (on a pounds per acre basis) based on its tidal flushing characteristics.



CAPE COD COMMISSION

During the development of these policies and regulations in the early 1990's, concerns were raised that even rudimentary assessments had not been completed for the majority of the coastal embayments surrounding Cape Cod. In 1991, the Buzzards Bay Project National Estuary Program (BBP) published recommended nitrogen loading limits that were subsequently adopted by the Commission and used in regulatory reviews on Cape Cod. However, the BBP limits required site-specific assessments of tidal flushing, delineation of embayment watersheds, and existing and future buildout analysis of watershed nitrogen loads.

To address this need for basic assessment information, the Commission began the Cape Cod Coastal Embayment Project in 1993. The project was largely funded through a grant from Massachusetts Department of Environmental Protection (DEP) and an annual commitment of Commission funds. The project began by creating a regional watershed map and prioritizing embayments, based upon the likelihood that they would be sensitive to nutrient impacts.

While this effort was underway, detailed tidal flushing studies for nine embayments were already being completed and the results from these studies were used with the BBP-recommended nitrogen limits to develop specific embayment and sub-embayment nitrogen limits. The Commission has continued to provide funding and seek DEP grant funds for the development of additional tidal flushing models, nitrogen loading assessments, and gathering of water quality information. Tidal flushing studies have been completed for 19 of the 43 major embayments and nitrogen loading assessments have been completed for at least 60 subwatersheds and watersheds.

Cape Cod communities have begun using these assessments as springboards for discussions on nutrient management strategies, wastewater management, upgrades of community and private wastewater treatment systems, citizen volunteer water quality monitoring programs, and associated costs for mitigation options. Recently, the state has funded local citizen water quality monitoring programs. Given

appropriate training and technical guidance, citizens' monitoring programs provide initial water quality information for many embayments, while educating local citizens on nutrient loading issues. In many cases, the assessment data has prompted towns to adopt regulations limiting nitrogen loading, while other towns have begun the effort of evaluating wastewater treatment options and potential costs. Rather than focusing only on upgrading town-owned centralized treatment facilities, more recent wastewater planning activities are much more comprehensive and include addressing nutrient concerns in surface waters.

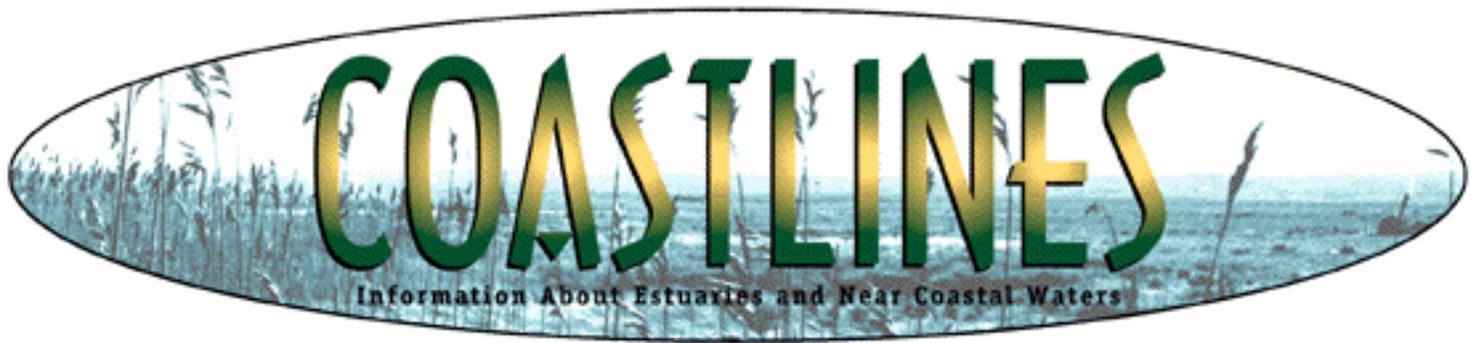
The activities over the last ten years have led to a review of the BBP recommended nitrogen limits, nitrogen loading methods, watershed delineation methods, on-site wastewater treatment technologies, centralized wastewater treatment technologies, costs for wastewater technologies, management of wastewater technologies, and local, Commission, and state regulations. The Commission, BBP, University of Massachusetts at Dartmouth, Center for Marine Science and Technology, Marine Biological Laboratory, Woods Hole Oceanographic Institute, other organizations, consulting firms, and state, federal, and town governments are engaged in active discussions about the required content and form of many of these activities.

With all the current activity at state and federal levels to resolve issues associated with 303d lists and TMDLs in mind, the Commission has been encouraging additional efforts to resolve some of the questions regarding protection strategies and implementation of management efforts. Among these questions are:

- What are appropriate regulatory nitrogen limits for coastal embayments? How clean is clean?
- What components of an ecosystem should be assessed before implementing management options?
- How much data should be collected before decisions can be based on the assessment? How should the data be collected?
- Are on-site denitrifying septic systems appropriate technologies to rely on to limit nitrogen loads?
- What sort of legal structures are needed to ensure effective management of wastewater throughout a watershed?
- What changes are necessary in state, county, and local regulations to ensure effective water quality management?

Review of the nitrogen limits has indicated that many embayments are more sensitive to nitrogen loads than previously thought. However, even if plans are made to meet the existing recommended limits, the costs associated with attaining these limits will be a matter for vigorous public debate. Every poll ever completed on Cape Cod has identified water quality as the primary concern of citizens, and they have supported regulations limiting housing densities and restricting the use of hazardous materials in order to protect drinking water quality. Protection of coastal water quality on Cape Cod, however, will require replacement of the existing wastewater infrastructure and changes in how wastewater is managed. The public will need to be educated on the implications of their wastewater management choices (e.g., will we have shellfish and eelgrass?). Much of this debate will be focused on two questions most important to the general public: How much is it going to cost and who is going to pay for it?

For further information, contact Eduard Eichner, Cape Cod Commission, 3225 Main St. PO BOX 226, Barnstable, MA 02630-0226; Phone: (508) 362-3828; FAX: (508) 362-3136; E-mail: water@cape.com or visit the website: www.capecodcommission.org 



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Fish Return Quickly to Restored Salt Marshes

Over the past 100 years, salt marshes in the Gulf of Maine in northern New England have experienced numerous human impacts: they have been ditched and drained to lessen mosquito breeding, filled for building projects, and tidal flow has been channeled and restricted, typically under roadways. It is estimated that human impacts have contributed to the loss of nearly half of New England's salt marsh acreage. Even though the Clean Water Act (Section 404) has protected salt marshes from direct human impacts such as filling since its passage in 1972, indirect impacts continue to degrade many of our remaining marshes.

Decreased tidal flow in salt marshes resulting from human activity causes a shift from the common species of salt marsh plants to invasive species which thrive at reduced flooding and reduced soil salinity, including common reed (*Phragmites australis*), purple loosestrife (*Lythrum salicaria*) and narrow leaf cattail (*Typha angustifolia*). As the height and frequency of tidal flooding decrease, large areas often become colonized with monotypic stands of these plants, leading to a dramatic decline of biodiversity and support of wildlife, including fish.



These undesirable effects of decreased tidal flow have prompted greater interest in restoring degraded salt marshes in northern New England. The most common methods of restoration to improve tidal flow include digging channels and constructing new culverts or increasing an existing culvert's size. In both cases, the aim is to restore the original hydrologic regime, including flooding height, duration, and frequency. Other restoration projects create salt marsh directly, either in upland areas, or by restoring degraded shorelines. Sites are configured to flood at appropriate intervals, and low salt marsh species are planted to complete the project.

A recent study compared fish use of restored, created, and natural marshes in four marshes in southern Maine and New Hampshire. In Stratham, New Hampshire, two of the four restored marshes were deprived of tidal exchange in the past. Another restored marsh, in Rye, New Hampshire, was used as a disposal site for dredged materials. The fourth restored marsh, in Wells, Maine, was impounded for use as a pasture during the 1800s. In all four cases, improved tidal flow to the marshes was the means of restoration. Increased culvert size and excavated channels were used in the selected marshes to improve tidal flow and re-establish salt marsh environments. The created marshes in this study were established as mitigation for the expansion of the Port of New Hampshire in the early- to mid-1990s. Degraded shoreline at these locations was reconfigured, and fine-grained sediment was brought in and contoured to appropriate elevations to allow tidal flooding of the low marsh. The sites were then planted with salt marsh cordgrass (*Spartina alterniflora*). For the study, each restored and created marsh was paired with a nearby, relatively healthy and undisturbed salt marsh as a reference site.

The study found that fish use of both the created and restored marshes rose to levels similar to the local unaltered reference marshes as soon as one month after the creation or restoration was accomplished. These similarities persisted over time, and have been measured for up to eight years at one of the studied marshes. Fish assemblages were similar in the restored, created, and paired reference marshes. The results of the study showed that similar kinds of fish in similar numbers quickly and



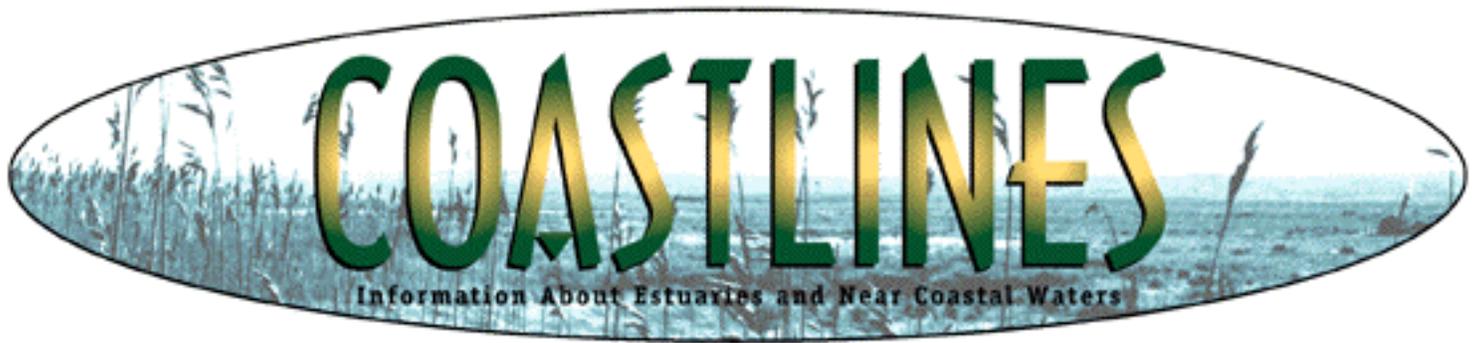
persistently used restored marshes as habitat. Fish may utilize marshes restored by culvert enlargement or culvert flap removal to a greater extent than they utilize marshes restored by digging new channels or deepening existing channels. These differences in fish utilization may arise because these two restoration strategies affect tidal regime in different ways; culvert enhancement is more likely to increase overall diurnal flooding of the marsh surface than excavated or deepened channels.

While restoring salt marshes may yield large amounts of fish habitat relatively quickly, restoration efforts are often met with strong resistance. Barriers that stand in the way of the removal of tidal flow restrictions include political, social and economic factors. In highly developed coastal zones, many property owners perceive increased tidal flow as a threat to property value. Once local stakeholders see that habitat benefits and reduced spring flooding outweigh the risks of restoration projects, strategies that remove berms and flap gates and deepen ditches are often utilized.

The results of this study suggest other investigations that could be pursued in future research. For example, a spring run of American shad (*Alosa sapidissima*), an important migratory game fish, was observed at one of the restored marshes where tidal flow had been eliminated for 25 years. An examination of how transitory and migratory fish species utilize restored, created, and undisturbed salt marshes might be useful. Future study focusing on the long-term survival and growth of fishes in these areas would provide valuable information on the long-term benefits of salt marsh restoration projects.

Improving tidal flushing in degraded Gulf of Maine salt marshes quickly increases habitat, and, as this study showed, fish rapidly move into newly available marsh areas. The bottom line is, "If you build it, they will come."

For further information, read "Fish utilization of restored, created, and reference salt-marsh habitat in the Gulf of Maine" by M. Dionne, F.T. Short, and D.M. Burdick, in the American Fisheries Society Symposium, volume 22, pp. 384-404, published in 1999, or contact Fred Short at the University of New Hampshire, Email: fred.short@unh.edu.

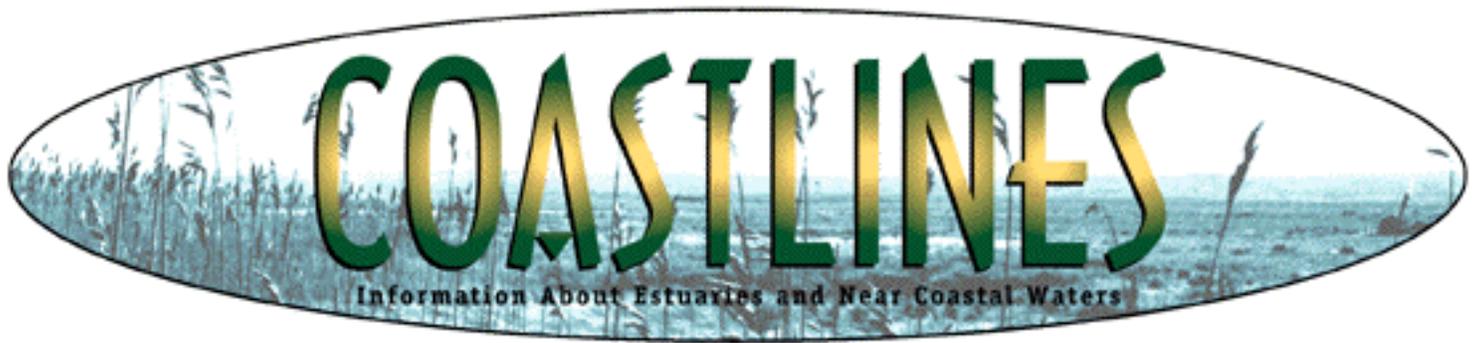


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Long Island Sound

Autumn, 1999, marked the beginning of significant lobster mortalities in western Long Island Sound. In response to Connecticut and New York Governors Rowland and Pataki's December, 1999, request for disaster assistance under the sustainable Fisheries Act amendment to the Magnuson-Stevens Act, Commerce Secretary William Daly declared the region a disaster area. Currently, officials and scientists from New York and Connecticut are examining the possible causes of the mortalities. The disaster designation could free up millions of dollars in federal aid for 1,200 lobstermen who fish the Sound. The Long Island Sound lobster fishery is the third largest in the nation, bringing in over \$40 million per year. A workshop on the potential causes of the lobster die-off, scheduled in April by the Long Island Sound NEP, will be the subject of an article in an upcoming issue of Coastlines.



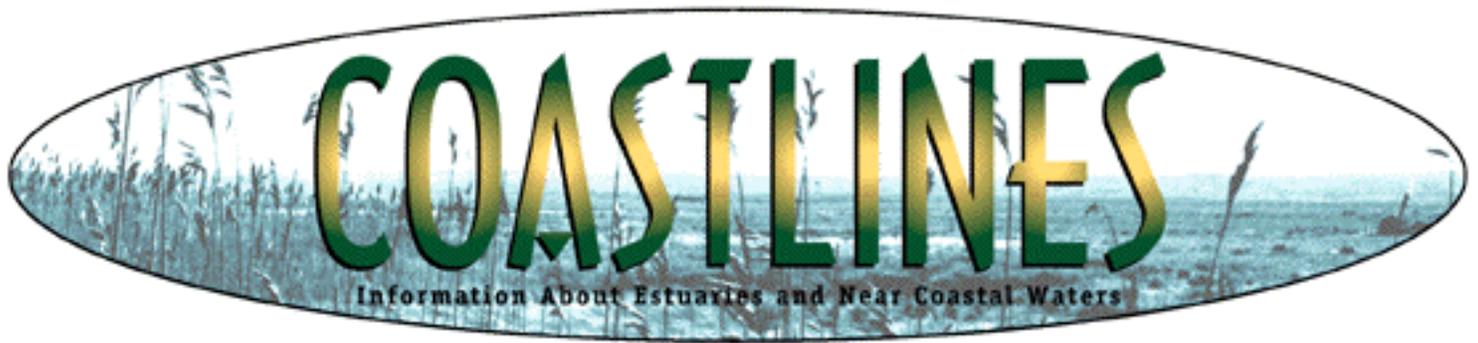
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Coastal Bend Bays & Estuaries Program

The Coastal Bend Bays & Estuaries Program in Corpus Christi, Texas, has been awarded \$1,500,000 as the result of a settlement between EPA/Texas Natural Resources Conservation Commission and Koch Petroleum. Koch has had a number of spill incidents from their pipeline operations over the last few years. While this funding cannot support staff or other overhead costs, the Coastal Bend Bays & Estuaries Program will be able to use these funds to implement the Coastal Bend Bays Comprehensive Conservation and Management Plan.

For further information, contact Theresa Trainor; Phone: (361) 260-3009.



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Recent Study Suggests Sea Level Rise Could Threaten Beaches Along U.S. East Coast

Rising sea levels, caused at least in part by global climate change, are already contributing to beach erosion along the U.S. East Coast and seem likely to do so even more in the future, according to a recent study published in the scientific journal *Eos*.

On the U.S. East Coast, over 80% of beaches have experienced erosion over the last 150 years. There is, say the study's authors, "likely a global cause for the pervasive erosion phenomenon," but the cause is not immediately obvious. Storms are a major contributor to beach erosion, "but there is no apparent overall increase in storminess this century." In addition, human interference, often also a factor, "is neither worldwide in extent nor uniform regionally."

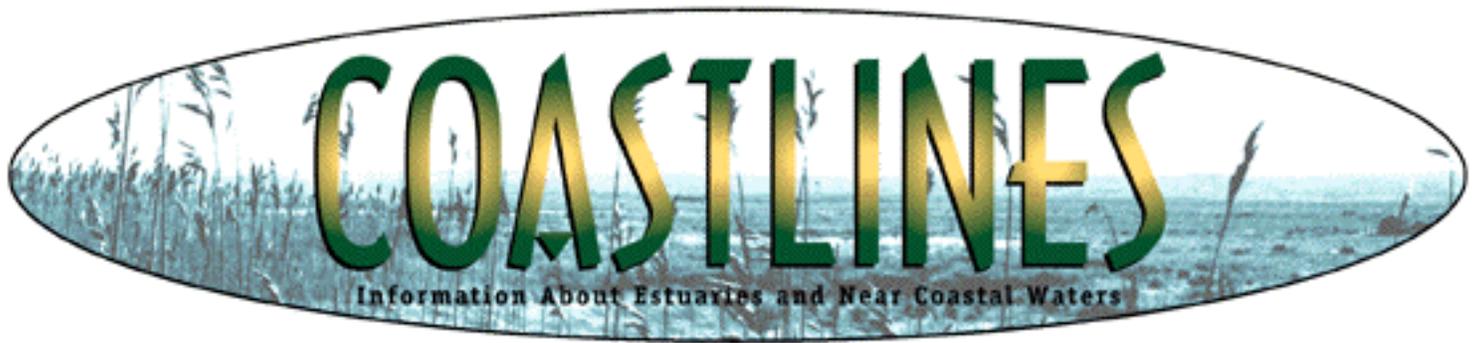
However, the authors note, "what nearly all of the earth has experienced during the last century is an increase of relative sea level." Global mean temperature has increased about 0.5 degrees Celsius in the 20th century. This temperature rise could be responsible for a significant portion (up to about 1/2) of the observed global sea level rise of nearly 20 cm during that period, due to thermal expansion of the oceans and melting of small glaciers. An increasing concentration of greenhouse gases in the atmosphere is expected to raise global temperatures 1.5 to 4.5 degrees Celsius in the 21st century and cause accelerated sea level rise. If it does, it will exacerbate already severe beach erosion problems along the highly

developed U.S. East Coast, and oceanic beaches everywhere else."

In conclusion, the authors note that the Intergovernmental Panel on Climate Change (IPCC) projects a further global sea level rise of 20 cm by 2050; combined with ongoing regional post-glacial subsidence, sea levels along the coasts of New Jersey, Delaware and Maryland will rise about 40 cm during that period. "This projected rise," they conclude, "will result in as much as 60 meters of erosion on average, about two times the average beach width, causing enormous problems for the many cities on the beach in these highly urbanized coastal areas."

For further information, read the article in American Geophysical Union's EOS Transactions, February 8, 2000 entitled Sea level rise and coastal erosion, by Leatherman, S.P., K. Zhang, and B. Douglas. Or contact Bruce C. Douglas, Senior Research Scientist, Department of Geography, University of Maryland at College Park, College Park, MD 20742; Phone: (301) 405-3203; FAX: (301) 314-9299 or E-mail: bd54@umail.umd.edu

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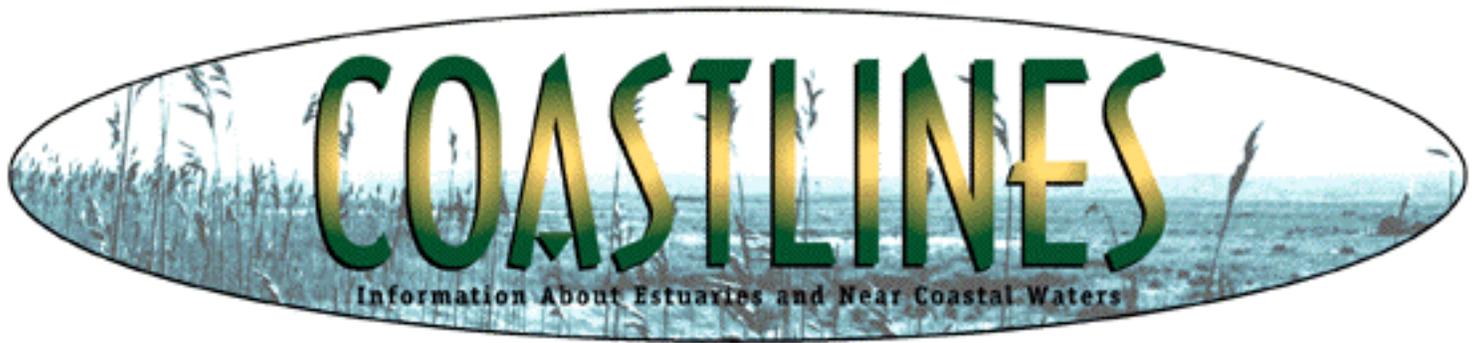


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Tillamook NEP CCMP Released

The signing ceremony celebrating approval of the Tillamook Comprehensive Conservation and Management Plan (CCMP) was held on February 9th in Tillamook, Oregon. Governor Kitzhaber, EPA Deputy Regional Administrator, County Commissioners, and members of the Tillamook National Estuary Program spoke to approximately 200 attendees. The Governor commended the efforts of the program and pledged support from the State of Oregon during CCMP implementation. Tillamook is the 21st NEP to gain approval of its CCMP, and is addressing issues related to erosion and sedimentation, declines in fisheries, flooding, and bacterial contamination. To view or download the CCMP, visit the website: <http://www.co.tillamook.or.us/gov/estuary/tbnep/ccmp.html> [EXIT disclaimer ►](#)



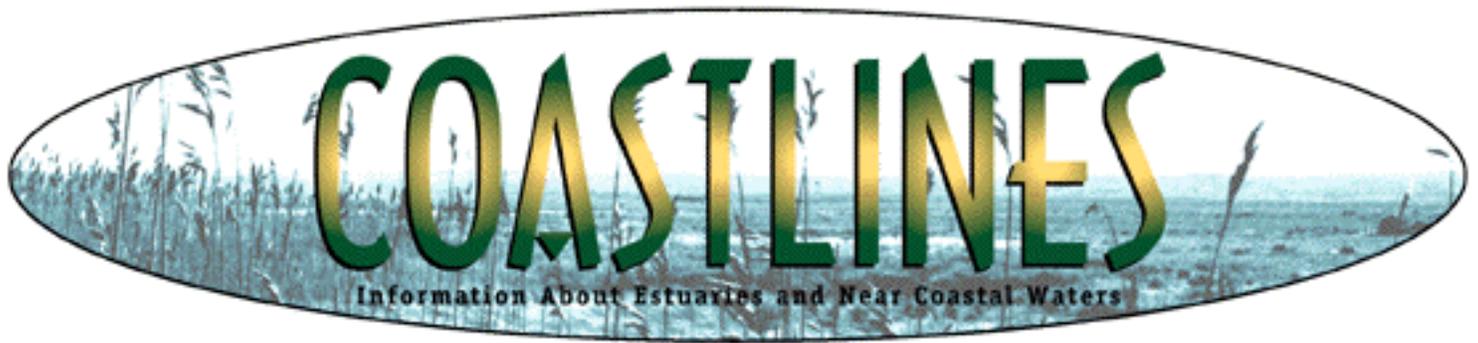
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Field Guide for Chesapeake Bay Available

The Chesapeake Bay Program has just completed a new brochure, entitled Chesapeake Bay: Life in the Shallows. The brochure has illustrations of a number of bay organisms on one side, and an identification chart for the 12 most common species of underwater bay grasses. The brochure, jointly sponsored by the U.S. Fish and Wildlife Service, Alliance for the Chesapeake Bay and the EPA Chesapeake Bay Program Office, is laminated and intended for use in the field.

For further information, contact Sandi Van Horn, Phone: (410) 267-5756.



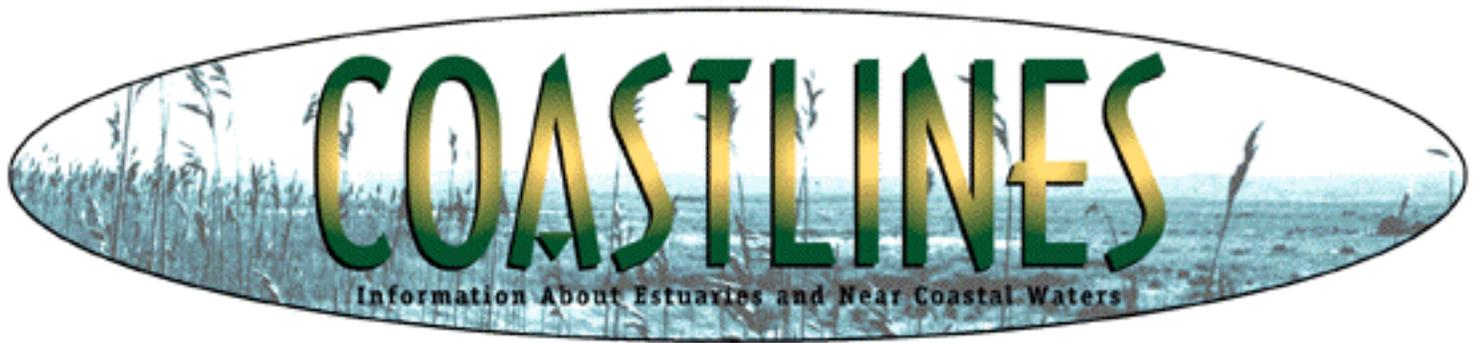
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Rivers Journal Website

A new website offering abstracts from the peer-reviewed journal RIVERS is now available. RIVERS is a refereed publication that offers an interdisciplinary forum for research and professional literature addressing the issues of instream flow. Manuscripts that relate to instream flow in North America or that offer a strong transnational instream flow application are encouraged. RIVERS is committed to aggregating the various instream flow specialties in one publication, presenting a balance in scholarship reflecting both the theory and application of instream flow, and providing an open forum that facilitates an ongoing dialogue between scientists and managers. The journal's central focus on research findings, policy analyses, and practical management experiences provides a wide range of information for the instream flow specialist confronted with technical and political problems in the management of instream uses of water.

For further information, visit the website at www.instreamflow.com (No Longer Available).



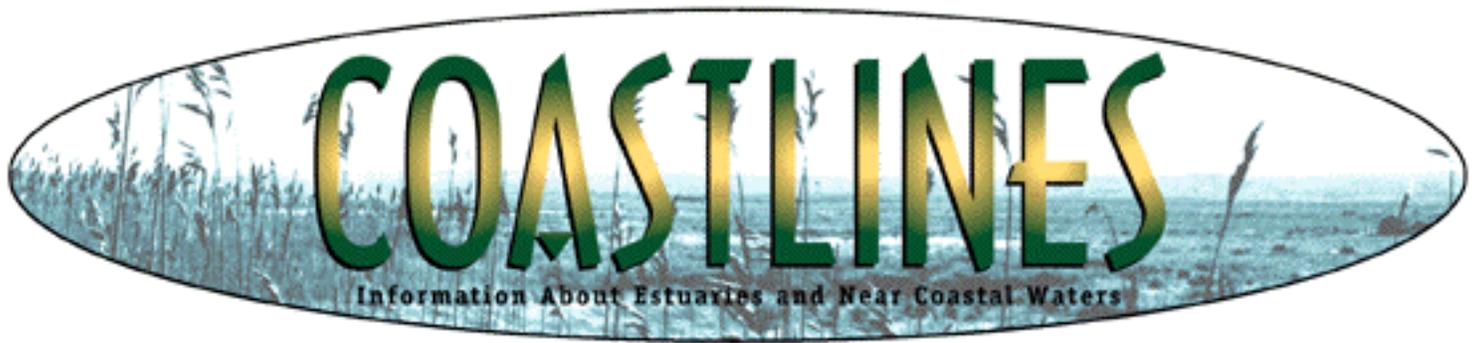
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Historic USGS Maps Online

Ever wondered what a landform might have looked like 100 years ago? Fifty year ago? The University of New Hampshire (UNH) recently placed historic USGS maps of the New England states on-line. This web site will help environmental managers compare historic land uses with newer maps to understand how land use changes may have occurred. The United States Geological Survey began its topographic atlas of the United States in 1882. The UNH Dimond Library's Government Documents Department holds a working collection of over 55,000 current paper USGS maps. This online collection of USGS topographic maps includes complete geographical coverage of New England from the 1890s to 1950s. Some people may ask, why aren't current maps placed on the website? The answer is, simply, that current maps are readily available in both paper form and on CD-ROM from a number of sources. They are also often available in the larger public libraries. Historic maps are not readily available, which is why this web site was created.

To view historic USGS maps visit the web site at <http://docs.unh.edu/> [EXIT disclaimer ►](#)

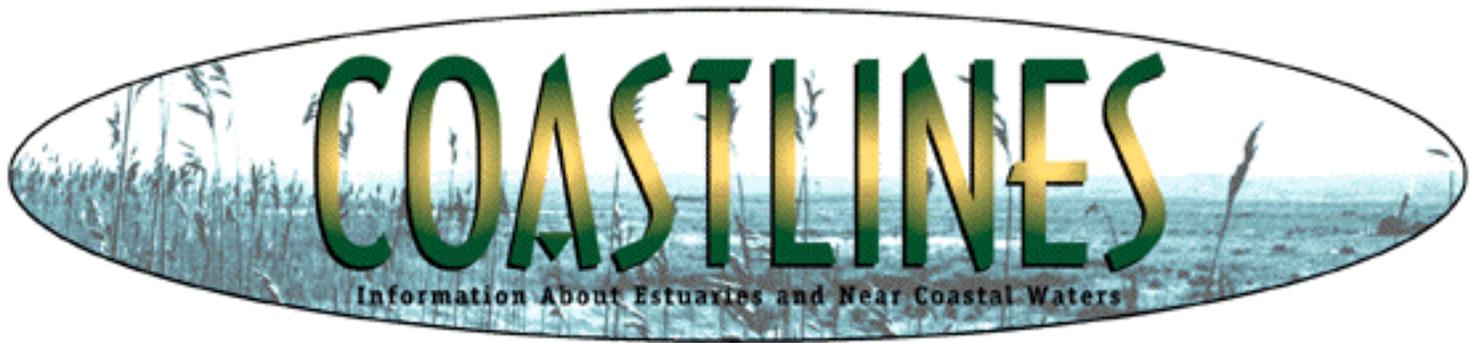


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Online Catalogue of Tools for Watershed Protection

The Center for Watershed Protection offers an on-line catalogue of watershed protection tools, where you can find books and CD-ROMs on rapid watershed planning, stormwater systems, site design and more. Prices range from \$3 to \$60 for various items, which includes shipping. For further information, contact the Center for Watershed Protection, Phone: (410) 461-8323; Fax: (410) 461-8324; or visit <http://centerforwatershedprotection.gomerchant7.com/> or visit http://www.cwp.org/tools_protection.htm



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Indian River Lagoon National Estuary Program

Using Baffle Boxes to Treat Stormwater
CHARACTERISTICS

Located along Florida's east coast between the mainland and barrier islands, the Indian River Lagoon stretches 155 miles from Volusia County to Palm Beach County. The Lagoon has been labeled as the most diverse estuary in North America - a blend of salt and freshwater within both the temperate and subtropical climatic zones - with a biological diversity of more than 4,300 species of plants and animals. This natural productivity and diversity makes the Indian River Lagoon one of Florida's most popular fishing destinations, with more than one million anglers visiting the region annually. Tremendous strides have been made to protect the Lagoon, which contributes \$731 million annually to the economy. Protection initiatives include passage of Florida's Surface Water Improvement and Management Act in 1987, and the inclusion of the Lagoon in the federally funded, locally managed National Estuary Program in 1991. The Proem



The Problem

The Indian River Lagoon watershed historically was long and narrow, draining approximately 1,000 square miles. For more than a century, projects were undertaken to develop or reclaim lands for agricultural and urban development. These projects involved altering hydrology to control flood waters or lowering the water table by draining these water to the Indian River Lagoon. The size of these projects ranged from a few acres or less to hundreds of square miles. As a result, the drainage basin of the Indian River Lagoon has doubled in size to more than 2,000 square miles.

Many of these projects were completed prior to present-day stormwater treatment requirements. As a result, these systems have little or no stormwater retention, detention or treatment capabilities to remove pollutants before they reach the Indian River Lagoon. In addition to reducing salinities in the Lagoon, the large input of stormwater carries pollutants and sediments. Stormwater discharges represent the largest nonpoint source of pollution to the Indian River Lagoon. The Lagoon receives 2,600 tons of nitrogen, 351 tons of phosphorus and 60,000 tons of suspended solids annually through nonpoint source runoff. By 2010, these figures are expected to increase by 30, 21 and 16%, respectively, unless corrective action is taken.

Over the years these discharges have resulted in muck or ooze deposits and sedimentation in the Lagoon and its tributaries. The sedimentation has caused seagrass bed losses with resulting impacts to fisheries and other valuable resources in the Indian River Lagoon.

Introduction to Indian River Lagoon

The Indian River Lagoon is located on the east coast of Florida and stretches for 155 miles, from Ponce de Leon Inlet south of Daytona Beach to Jupiter Inlet near West Palm Beach. The drainage basin encompasses nearly 2,280 square miles, and includes 145 square miles of coastal mangrove, wetland and seagrass habitats. The Lagoon is located in a zone where tropical and temperate climates meet. Thus flora

and fauna contain both tropical and subtropical species, and the Lagoon is considered one of the most biologically diverse estuaries in North America.

Rapid growth has occurred in the Indian River Lagoon region since 1970. Between 1970 and 1990, the population within the five counties along the Lagoon grew by 124%, from 303,000 to 678,000. It is anticipated that by 2010, a population of more than one million will live in the region.

Historically, a gentle, meandering drainage pattern consisting of sloughs, creeks, rivers, and wetlands was found in the Indian River Lagoon drainage basin. As the region was settled, most colonization and agricultural activities occurred in close proximity to the Lagoon. The 1916 Drainage Acts of Florida allowed the establishment of special taxing districts to promote agricultural production and flood control. These taxing districts eventually became known as Drainage Districts. Between 1916 and 1950, many of the natural tributary streams and rivers far to the west, which were historically part of the St. Johns River or Lake Okeechobee watersheds, were diverted to the Indian River.



Project Overview

To reverse some of the hydrologic alterations of the Lagoon, the St. Johns Water Management District, which includes Brevard County, has developed a five-year, \$80 million comprehensive plan that directs the District and state, federal and local agencies to work together to divert and treat the flow of major stormwater drainage systems away from the Lagoon. Sediment and pollutant loadings are being addressed by removing sediment before it flows into the estuary, through the use of stormwater best management practices.

With the advent of National Pollution Discharge Elimination Stormwater Permits, many municipalities are confronted with the daunting task of retrofitting existing stormdrains in developed areas, which can contain a wide range of pollutants, including oils and heavy metals, yard clippings, fertilizers, pesticides, pet wastes, dirt and trash, to name a few. The traditional method of treating stormwater in Florida has been through the use of retention ponds. While this may work for new developments with ample land, ponds are a less feasible option in older developed areas with no available land or very expensive land. A new treatment technique was explored using "baffle boxes" which are essentially large tanks placed inline connecting existing storm drainpipes. Baffle boxes consist of concrete boxes that slow the rate of stormwater runoff and trap sediments from runoff.

Implementing the Project

Between 1994 and 1996, Brevard County, Florida Surface Water Improvement Division, in cooperation with the Indian River Lagoon Program, implemented a demonstration project to install baffle boxes at five sites on Merritt Island, within the Indian River Lagoon drainage basin.

The concrete or fiberglass baffle boxes are placed inline or at the end of existing storm drain pipes. Typically 10-15 feet long, 2 feet wider than the pipe, and 6-8 feet high, the box is divided by weirs into 2 or 3 chambers set at the same level as the pipe invert. There are trash screens or skimmers to trap floating trash and yard debris. Manholes are set over each chamber to allow access for cleaning with vacuum trucks. Installation costs for each baffle box averages \$20,000 - \$30,000, depending on the utilities to be relocated.



The five sites chosen were located within Brevard County, Florida. The first project site, located at the Sunrise Village Condominiums, and contained a large (63"x48") drainpipe which drains 3.2 acres of highway and 63 acres of residential property. The second project involved working with a developer building a Publix Shopping Center. The drainage system contained 5 acres of highway with curb and gutter drainage, 5 acres of highway with roadside swales, and 157 acres of residential area. A three-chambered baffle box was poured in place rather than a pre-cast box, due to the weight of a pre-cast box.

The Merritt Winter Apartments project site drains approximately 3 _ acres of commercial and apartment land uses. The stormwater system consisted of two existing culverts located in the parking lot of the apartment building and ultimately to the Indian River Lagoon. A two-chambered baffle box was configured to combine and treat the outflows into a single box pipe.

The fourth site drains 100 acres, including 12 acres of school, 3 acres of wetland, 14 acres of undeveloped land and 71 acres of older residential properties. The drainage outfalls to a dead-end canal with one opening into the Indian River Lagoon. The canal is completely filled with muck and sediment. Two existing inlets were replaced with two pre-cast baffle boxes in series, with a three-chambered and two-chambered box, respectively. With the heavy sediment loading, it was expected that the second box would be needed for effective sediment removal.



The last site drains 2.4 acres of residential land into a canal. Due to utility conflicts, the existing inlet was kept and the baffle box was installed behind it. An exfiltration trench was built downstream of the box to test combining best management practices. At the end of the exfiltration trench a weir was installed to store water in the trench; when higher flows occur water will overflow and drain to the canal.

Both water quality monitoring and maintenance are ongoing at the sites. Initially, a private company cleaned the baffle boxes at a cost of approximately \$800 a day or \$38,400 per year for these boxes. At the beginning of the project the boxes were cleaned monthly. Currently the boxes are cleaned once a year with County resources, reducing the annual maintenance costs.

Success of the Project

Baffle boxes are effective at removing sediments and some floating debris but have limited effectiveness at nutrient removal. Results of monitoring and maintenance indicate a high sediment removal rate. Between all five sites, a total of 518,934 pounds of sediment, mud, lawn waste and trash have been removed from these baffle boxes which otherwise would have ended up in the Lagoon.

The ability to pinpoint areas which have unusually high existing loadings was an unforeseen outcome of the project. For instance, at Sunrise Village, a site which had some of the highest sediment loadings, stream bank stabilization remediation projects upstream helped to decrease the heavy loadings to the box.

The inline installation makes baffle boxes ideal for connection to existing pipes which require minimal easements and utility relocations. This system offers a solution for many areas where retention ponds are neither cost effective nor politically feasible. Since this demonstration project was implemented, 34 baffle boxes have been installed throughout Brevard County! Brevard County intends to continue to monitor these boxes, improve their design, and install 3-5 more baffle boxes per year.

Lessons Learned

- Costs ranged from \$16,298 to \$28,435 and were dependent on pipe sizes, depth of pipes, base flows in pipes, groundwater elevations, utility relocations and pavement restoration. Brevard County has about 2,000 outfalls and many are small diameter pipes. Installing a \$20,000 baffle box at each outfall would not be cost effective. However, for larger outfalls, where there is no right-of-way available, the costs are justifiable.
- Baffle boxes are effective for sediment removal in small to medium size drainage basins. Baffle boxes are not effective for nutrient removal, but can be more effective when combined with exfiltration trenches.
- The tradeoff for the low cost treatment method is the perpetual maintenance expense, although maintenance costs are highly dependent on rainfall events. The maintenance costs have decreased because of droughts in the area.
- Traditional water monitoring techniques do not effectively determine many of the pollutants found in stormwater, such as yard clippings trash.
- Maintenance and cleaning of baffle boxes is essential for effectiveness and should be incorporated into the placement of the box. It is recommended that a manhole for cleaning be placed over each chamber.
- The trash screens will trap floatables but during high flows are designed to release, losing the accumulated trash.



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Visit the Indian River Lagoon Web sites at <http://www.sjrwmd.com/programs/outreach/irlnep/index.html> or http://sjr.state.fl.us/programs/acq_restoration/s_water/irl/irl.html 