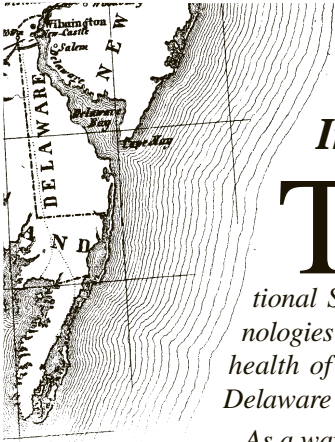


THE Coastal Courier

News about the Coastal Ecosystem Health Project

Summer 1996

UNIVERSITY OF DELAWARE SEA GRANT COLLEGE PROGRAM ♦ NEWARK, DE 19716



Developing New Technologies and Management Strategies to Improve Coastal Ecosystem Health

The University of Delaware Sea Grant College Program recently received, through a competitive proposal process, a special enhancement award from the National Sea Grant College Program to develop emerging technologies that coastal managers can use to assess and improve the health of the Delaware Estuary, Delaware's Inland Bays, and Delaware's National Estuarine Research Reserves.

As a way of sharing information about the project, we welcome you to the first issue of *The Coastal Courier*. This newsletter is designed to highlight major research results and present new developments of interest to the coastal resource management community. For more information or to suggest a future article, please contact me at (302) 831-8185 or via e-mail at Tracey.Bryant@mvs.udel.edu. I look forward to hearing from you. — Tracey Bryant, Editor

Coastal resource managers face tremendous challenges. How can they take the pulse of an ecosystem as vast as the Delaware Bay, correctly diagnose its problems, and then prescribe the right course of action that will result in teeming fisheries, lush marshes filled with wildlife, wide, clean beaches, and other features we associate with a healthy coastal environment?

The goal of the Coastal Ecosystem Health Project recently initiated by the University of Delaware Sea Grant College Program is to develop useful, new technologies for monitoring and improving coastal ecosystems and to then transfer these diagnostic tools to the people who can put them to work for the environment — coastal resource managers. Led by Vic Klemas, professor of applied ocean science, and Robert Knecht, professor of marine policy, the project brings together an interdisciplinary team of experts in satellite remote sensing,

ocean acoustics, oceanography, marine policy, education, and communications from the University of Delaware Graduate College of Marine Studies and Sea Grant College Program, with critical input from a Managers' Advisory Committee comprising representatives from the Center for the Inland Bays, the Department of Natural Resources and Environmental Control, the Delaware Estuary Program, and other coastal resource management programs in Delaware.

The special initiative is organized into three components. The first research group includes Dr. Vic Klemas, Dr. Richard Field, Ph.D. student Oliver Weatherbee, and M.S. student Allison Bailey. Their goal is to integrate land cover data gathered by satellites with other environmental indicators to create a computerized Geographic Information System (GIS) for assessing wetlands health. With its rich layers of data, the GIS should

help managers more easily assess changes in land use affecting wetlands, from encroachment by urban development, to invasion by the nuisance plant *Phragmites australis*.

The second research group, including Dr. Xiao Hai-Yan, Dr. Mohsen Badiey, Dr. Kuo-Chuin Wong, Dr. Quanan Zheng, and Ph.D. student Louis Keiner, seeks to develop a remote sensing observing system that will enable managers to view an entire ecosystem and monitor its changes. The system will include data on water temperature and salinity, suspended sediments, primary production, surface and nearshore waves, tidal flow and freshwater discharge, and other parameters derived from satellite images, space shuttle photographs, acoustics profilers, and other sources.

The third team, of Dr. Biliana Cicin-Sain, Professor Robert Knecht, Dr. Kent Price, Marine Advisory Service specialist Joseph Farrell, communications coordinator Tracey Bryant, and master of marine policy students Deborah Goldstein, Stephanie Poole, and Suzanna Delgado, is involving coastal resource managers as full partners in the effort, by communicating with them to learn more about their information needs. This collaboration will not only ensure the usefulness of the techniques the project team develops but also will advance new regional partnerships toward integrated coastal management with special emphasis on non-point source pollution control.

By forging a strong alliance among scientists, policy experts, and coastal managers, Delaware may become a model for other regions to follow as our nation strives to improve our coastal ecosystems.



Assessing Coastal Wetland Health and Land Cover Change in the Delaware Bay Watershed

Project Team: Vic Klemas, Richard Field, Oliver Weatherbee, and Allison Bailey

Editor's Note: The goal of this research group, led by

Vic Klemas, professor of applied ocean science, is to develop a Geographic Information System (GIS) for assessing wetlands health. As reported by master's student Allison Bailey, the group has made the following progress during the past several months.

Satellite Image Processing and Analysis. Our group has acquired Landsat Thematic Mapper (TM) scenes covering the Delaware Bay study area for the following dates: September 12, 1984; June 12, 1988; July 4, 1988; July 4, 1990; May 4, 1991; and July 28, 1993. Before these satellite images can be used for wetland and land cover detection and analysis, however, they must be "pre-processed." Doctoral student Oliver Weatherbee has completed pre-processing of all images, which includes (1) *geometric registration* — correcting spatial characteristics of the images and assigning them "real world" coordinates so that they can be overlaid on each other and on other maps; and (2) *radiometric normalization* — systematically adjusting the spectral data of all images based on the image that has the least amount of haze or atmospheric interference. This step is needed for reliable comparison of the spectral data between images.

Oliver's next step is to process the most recent image (July 28, 1993) to upland and wetland land cover classes according to the classification system used for the NOAA Coastwatch Change Analysis Program (C-CAP). Under the C-CAP system, the upland classes, for example, range from developed land to cultivated land, grassland, woody land, bare land, tundra, snow/ice. In addition, he will create a map of the Normalized Difference Vegetation Index (NDVI) for the salt-marsh areas in the image. This index, based on leaf reflectance values, serves as an indicator of the vigor, and thus health, of the salt-marsh vegetation.

The processing for the 1993 image will be completed within the next month or two. Once this step is completed, Oliver will process the remaining images in the same way. We will then be able to assess the change in land cover over the past ten years and look for relationships between land cover and coastal wetland health.

Water-Quality Measurements. Dave Carter, Environmental Program Manager for the Delaware Coastal Management Program, and his team at DNREC have initiated a project to assess non-point pollution management practices on and adjacent to Delaware's National Estuarine Research Reserve (NERR) sites at Blackbird

Creek and the St. Jones River. This effort includes measurements of water-quality parameters from several locations along Blackbird Creek, the Appoquinimink River, and the St. Jones River. An automated sampler and data logger records specific conductivity, salinity, percent saturation, dissolved oxygen, temperature, pH, and water level every half hour. Richard Field and Allison Bailey are providing assistance to the project by maintaining and calibrating the instruments at Blackbird Creek and the Appoquinimink River and downloading the data from these instruments to a computer every two weeks. These measurements will help us identify correlations between pollution from upland runoff and wetland health. They will also provide data to determine "background" levels of pollutants from sites such as Blackbird Creek that are not strongly impacted by anthropogenic pollution sources.

To see examples of the water-quality data already collected for this project and a more detailed description of the data collection methods, please visit this site on the World Wide Web: <http://inlet.geol.sc.edu/delprod.html>. This Web site can also be found through the National Estuarine Research Reserve (NERR) Centralized Data Management Office home page at <http://inlet.geol.sc.edu/nerrscdm.html>.

Wetland Health Indicators: Collaboration. Allison Bailey and Vic Klemas have been communicating with two scientists from the EPA in Rhode Island about their interest in developing health and integrity measures for coastal wetland plants such as *Spartina alterniflora* (smooth cordgrass). They are focusing on the use of spectral measurements — in the lab, in the field, and from an aircraft — to assess the physiological status of these plants. For example, can they determine the rate or efficiency of photosynthesis of a particular coastal wetland plant using spectral measurements? These scientists are very interested in collaborating with our group and are willing to use the NERR sites in Delaware as test sites for their project. We are eager to work with them to continue to develop indicators of wetland health, in addition to biomass, that can be measured by remote sensing methods.

Research Presentation and Question-and-Answer Session with Delaware State Agencies. On November 29, 1995, at the Department of Natural Resources and Environmental Control (DNREC) in Dover, Vic Klemas and Oliver Weatherbee made presentations on the Delaware NERR and Coastal Ecosystem Health projects to representatives of state and federal agencies involved in regional environmental programs. Among the 26 attendees were ecosystem specialists and data managers from DNREC, the U.S. Fish and Wildlife Service, EPA, the Delaware Estuary Program, and the Center for the Inland Bays. The presentations were followed by a vigorous discussion of data requirements and processing needs. Due to the success of this meeting, we plan to repeat it at least once a year.

Using Satellite Remote Sensing to Determine Trends in Delaware Bay's Surface Temperature

Project Team:

Xiao-Hai Yan, Mohsen Badiey,
Kuo-Chuin Wong, Quanan Zheng,
and Louis Keiner

Editor's Note: The goal of this research group, led by Xiao-Hai Yan, professor of applied ocean science, is to develop a remote sensing system for monitoring coastal water quality. The following report, by doctoral student Louis Keiner, summarizes the group's progress to date.

Using data from the Advanced Very High Resolution Radiometer (AVHRR) sensor onboard NOAA's polar-orbiting satellites, we have been studying the patterns and trends in the sea-surface temperature (SST) of Delaware Bay and the adjoining coastal ocean. We obtained three years of AVHRR images, from 1992–95, through the NOAA CoastWatch program, which provides public domain satellite data of the nation's coast to researchers at no charge.

The images obtained from NOAA, which numbered around 900, were screened for cloud cover and geographically referenced to a standard map. Finally, a Delaware Bay sub-image was selected for use in the study. Because of the high number of cloudy days over Delaware Bay, fewer than half of the initially downloaded images were usable. The remaining images were averaged by month to create a regular time series. Empirical Orthogonal Function (EOF) analysis was performed on the time series. EOF analysis decomposes a time series into its component modes, breaking up a complicated signal into identifiable parts for study.

The analysis revealed the seasonal heating cycle and the patterns of subtidal estuarine circulation in Delaware Bay. EOF analysis provides the spatial pattern of each mode, its temporal oscillation, and relative strength (see Figure 1). In Delaware Bay, the solar heating cycle (top left) accounts for over 90% of the annual temperature oscillation. Monitoring of this cycle over many years is needed to reveal the long-term trend in water temperatures in the bay, which is important in determining the bay's future biological productivity. The subtidal estuarine circulation was found to be of modified

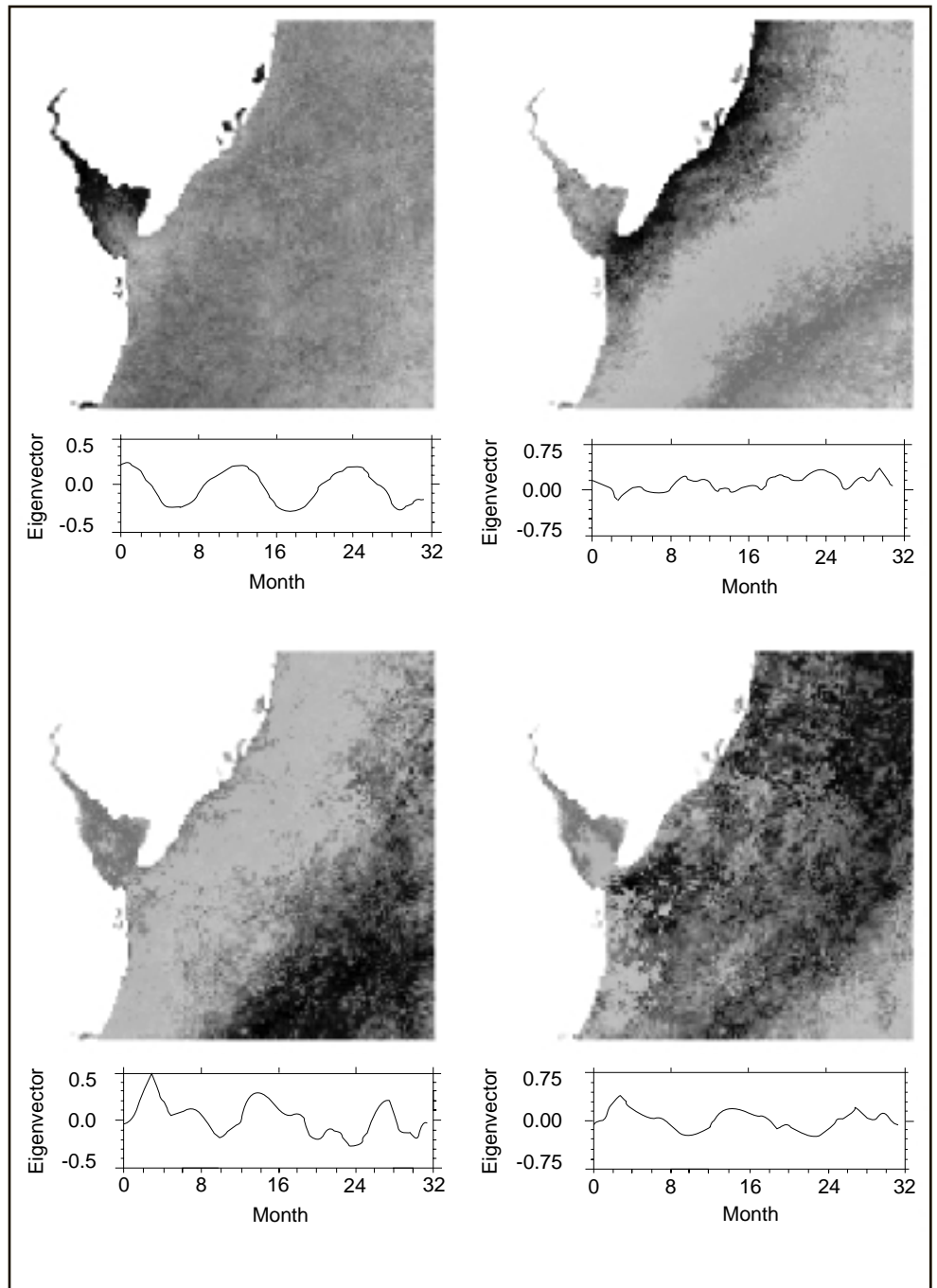


Figure 1. Taken from a time series of sea-surface temperature images averaged over the period from 1992–1995, this figure shows the seasonal heating cycle and patterns of subtidal estuarine circulation in the Delaware Bay as revealed by Empirical Orthogonal Function (EOF) analysis. In Delaware Bay, the solar heating cycle (top left) accounts for over 90% of the annual temperature oscillation.

gravitational form, with the influx of ocean water flowing up the deeper center of the bay, with the outflow occurring along both shallower sides of the bay. The determination of these circulation patterns is important in predicting the path of waterborne pollutants from both point and non-point sources.

These results have been submitted to the *IEEE Transactions on Geoscience and Remote Sensing* and were presented at the spring meeting of the American Geophysical Union. The other two studies in this project — the monitoring of sediments and chlorophyll in the bay and the monitoring of the dynamic flux of the bay — will be presented in a future *Coastal Courier*.

Management Analysis and Outreach: Building Partnerships to Improve Coastal Resources

Project Team: Biliانا Cicin-Sain, Robert Knecht, Kent Price, Joseph Farrell, Tracey Bryant, Stephanie Poole, Deborah Goldstein, and Suzanna Delgado

Editor's Note: The goal of this research group, led by Dr. Biliانا Cicin-Sain, is to establish open lines of communication between project team members and coastal resource managers to ensure the usefulness of the techniques developed in the Coastal Ecosystem Health Project and to promote integrated coastal resource management. The following progress report was prepared by master of marine policy student Stephanie Poole.

Managers' Advisory Committee Formed. The first meeting of the Managers' Advisory Committee was held November 13, 1995, in Dover. This committee includes representatives from coastal management programs throughout Delaware and was formed to provide critical input to the research and policy components of the Coastal Ecosystem Health Project. Members currently include Sarah Cooksey, manager, Delaware Coastal Management Program, DNREC; Bruce Richards, executive director, Center for the Inland Bays; John Schneider, manager, Watershed Assessment Section, Division of Water Resources, DNREC (and former administrator of the Inland Bays Estuary Program); and Bob Zimmerman, environmental program administrator, DNREC (and member of the Delaware Estuary Program Management Committee).

The Managers' Advisory Committee will facilitate the integration of new data and techniques developed by Coastal Ecosystem Health Project investigators into current management practices and provide needed feedback to project researchers regarding the usefulness of the environmental indicators being measured. Thus, the committee will serve as a vital conduit between the coastal resource management community and project researchers.

The next Managers' Advisory Committee meeting is scheduled for late summer.

Assessing Resource Managers' Needs. Currently, Joe Farrell, Tracey Bryant, Stephanie Poole, and Allison Bailey are interviewing environmental managers regarding their management and information activities and needs. So far, members of the group have met with Kevin Donnelly, administrator, Delaware Conservation Districts; Nancy Goggin, non-point source coordinator; Jenny McDermott, environmental scientist, Non-Point Source Program; Steve Williams, coordinator, Whole Basin Management Program; Paul Petrechenko, director, Natural Resources Conservation Service, and Connie Holland, director, and Kevin Coyle, assistant director, Kent County Office of Planning. Additional interviews are scheduled for the near

future, with completion of the effort scheduled for late summer. A report will be compiled after the interviews are completed, providing an overview of the data and institutional needs of the managers of Delaware's coastal resources.

Research Activities. Several other activities have been undertaken by members of the outreach team. For example, graduate student Deborah Goldstein has developed a report on ecosystem health which will be used as a guidance document for project researchers. Deborah also spent one day a week during the spring 1996 semester at DNREC's Coastal Management Program office in Dover. The purpose of her internship was to learn as much as possible about the state program firsthand and, by working with program manager Sarah Cooksey, to gain better insight into how the Coastal Ecosystem Health Project may interface with the Coastal Management Program.

Additionally, graduate student Stephanie Poole has gathered information on four case studies relevant to the Coastal Ecosystem Health Project and will compile a chart documenting elements of adaptive and integrated management for non-point source pollution control within each study. Literature reviews on adaptive and integrated management have been completed and will be used in reviewing the effectiveness of non-point source pollution controls in Delaware. Graduate student Suzanna Delgado will continue to gather non-point source control plans from other coastal states in order to do a comparative analysis.

Delmarva's Coastal Bay Watersheds. Dr. Kent Price, in his roles as chairman of the board of the Center for the Inland Bays, director of the Sea Grant Marine Advisory Service, and a member of the Coastal Ecosystem Health Project team, facilitated the development of "Delmarva's Coastal Bay Watersheds: Not Yet Up the Creek," a regional conference held March 8-9 in Ocean City, Maryland. Tracey Bryant assisted with conference publicity through a public education and outreach grant from the Center for the Inland Bays, one of the conference's co-sponsors, and both Joseph Farrell and Stephanie Poole attended the conference.

This event provided a forum for 200 citizens, elected and appointed officials, and other decision makers and special interest representatives to discuss the economic and environmental status of Delmarva's coastal bay watersheds, from Delaware's Inland Bays to Virginia's Chincoteague Bay. The conference helped establish a dialogue among representatives from the states of Delaware, Maryland, and Virginia, who are now planning management strategies on a regional level. As one step toward accomplishing regional management, the three states have begun working together to implement the Maryland Coastal Bays National Estuary Program. The states will also work together to establish an estuary program in Virginia. For a copy of the conference proceedings, please contact the Center for the Inland Bays at (302) 645-7325.

Meet Our Coastal Managers:



**Dr. Bruce Richards, Executive Director,
Center for the Inland Bays**

by Tracey Bryant

Excessive nutrients and loss of wildlife habitat are the chief environmental problems plaguing Rehoboth, Indian River, and Little Assawoman bays — Delaware's Inland Bays — according to the Inland Bays Comprehensive Conservation and Management Plan developed recently by citizens, local governments, scientists, and resource managers. The Delaware Center for the Inland Bays is now taking aim at these problems through a series of demonstration projects. The ultimate goal of this work is to improve the health of the bays and promote their wise use in the future, according to Bruce Richards, executive director of the center.

“Delaware's Inland Bays are priceless resources that provide an abundance of benefits to Delawareans as well as thousands of tourists who visit this area each year,” says Richards. “The center's goal is to work cooperatively with people from all walks of life who hold a stake in the bays' future — from farmers and citizen groups, to state and county agencies, local municipalities, educators, and scientists — to enlist their support in reducing nutrient overloads and habitat loss in the Inland Bays and the surrounding watershed.”

A Delaware native with a Ph.D. in agricultural and extension education, Richards came onboard as the center's executive director last October. Since then, he has established the non-profit organization's home at Red Mill Center near Lewes, begun meeting with local residents and agencies to inform them of the



Bruce Richards came onboard as the executive director of the Center for the Inland Bays in October 1995.

center's goals, initiated efforts to secure funding for the center and its activities from federal and state agencies and private foundations, and currently is administering the following demonstration projects, which are supported by a grant from the Environmental Protection Agency.

Nutrient Reduction. The nutrients nitrogen and phosphorus found in fertilizer, sewage, runoff, and other sources are reaching the Inland Bays in excessive quantities and harming the estuary's living resources. John Martin, associate professor of animal and food sciences, University of Delaware College of Agricultural Sciences, and Joseph Farrell, marine resource management specialist, University of Delaware Sea Grant College Program, are working to develop nitrogen and phosphorus mass balances, or budgets, for agricultural activities in the watershed. This task is a critical first step in the design of future nutrient reduction efforts. Satellite imagery will be used

to determine cropland estimates in the watershed. Current estimates of poultry production activities are being updated and refined.

Chlorophyll Meter Demonstration. Chlorophyll — the green pigment that gives most plants their color and enables them to make food — is an indicator of a plant's nutritional status. Thus, the amount of chlorophyll a plant contains can tell us whether it needs more nitrogen fertilizer, or if it does not. The Sussex Conservation District is demonstrating to farmers in the watershed how a hand-held meter can be used to quickly measure the amount of chlorophyll in crops. The goal is to identify a useful, inexpensive tool that will help farmers establish or amend their fertilizer management program, an important component of each farm's nutrient management plan.

Aquatic Habitat Restoration. The goal of this project, led by Ben Anderson, environmental scientist in the Division of Water Resources, DNREC, is to re-establish eelgrass and other submerged aquatic vegetation to provide habitat for fish and shellfish in the Inland Bays. In fall 1995, more than 12,000 plants were harvested from Chincoteague Bay, Virginia, and transplanted in Savage's Ditch in Rehoboth Bay. The plants' status is being monitored and evaluated by DNREC staff and volunteers from the Inland Bays Citizen Monitoring Program.

Water-Quality Monitoring. In this project, John Schneider, a program manager in the Division of Water Resources, DNREC, and other Division staff are evaluating water-quality conditions in relation to the success or failure of efforts to re-establish submerged aquatic vegetation such as eelgrass in the bays and tracking the status and trends in environmental indicators of eutrophication (nutrient over-enrichment) and habitat loss. A major goal is to integrate the data

(Please see Inland Bays, page 8)

(Inland Bays, continued from page 5)

acquired by the Inland Bays Citizen Monitoring Program with DNREC's water quality data.

Public Outreach and Education. Tracey Bryant, marine outreach coordinator in the Marine Communications Office, University of Delaware Sea Grant College Program and Graduate College of Marine Studies, is working with the center's staff to launch a public education program to encourage residents and visitors to become stewards of the bays. Projects include press releases, photography of bay activities, a full-color art poster to increase awareness and appreciation of the bays, and an interpretive sign of the Inland Bays watershed for the Environmental Learning Center at Lord Baltimore Elementary School in Ocean View.

Farmland Preservation. The goal of this project, led by Michael McGrath, manager, and Lisa Ralph-Williams, planner, of the Agricultural Lands Preservation Foundation, Delaware Department of Agriculture, is to preserve forest and farmland — and the needed wildlife habitat, open space, water recharge areas, buffer areas, and air cleansing capacity they provide — by creating Farmland Preservation Districts and Agricultural Easements. Nearly 2,000 property owners in the Inland Bays watershed have been contacted to inform them of the project's goals and the benefits of preserving their land. Follow-up discussions with interested property owners are under way.

The Center for the Inland Bays is a non-profit organization governed by a board of directors. Chairman of the board is Kent Price, associate professor of marine biology-biochemistry, at the University of Delaware Graduate College of Marine Studies, who also serves as chairman of the center's Scientific and Technical Advisory Committee. Board members include James Alderman, chairman of the Citizens Advisory Committee, and his vice-chair, Grace Pierce-Beck, conservation director, Delaware Audubon Society; Jack Tarburton, Secretary of the Department of Agriculture, and his alternate, Ed Ralph; Christophe Tulou, Secretary of the Department of Natural Resources and Environmental Control, and his alternate, Gerard Esposito; James Falk, vice-chair of the Scientific and Technical Advisory Committee; Greg McCabe, representative of the Sussex Conservation District, and his alternate, Eric Buehl; John Johnson, representative of the Sussex County Association of Towns, and his alternate, Matthew Falls; Robert Stickels, administrator, Sussex County Council, and his alternate, Lawrence Lank; Danny Magee, the appointee of the President Pro-Tem of the Delaware State Senate, Richard S. Cordrey; and Pat Campbell-White, the

Center for the Inland Bays: Goals & Objectives

The Delaware Center for the Inland Bays was established as a non-profit organization in 1994 under the Inland Bays Watershed Enhancement Act (Chapter 76, Section 7603, *Delaware Code*). The center's mission is to oversee the implementation of the Inland Bays Comprehensive Conservation and Management Plan and to facilitate a long-term approach for the wise use and enhancement of the Inland Bays watershed by conducting public education, developing and implementing conservation projects, and establishing a long-term process for preservation of the Inland Bays watershed.

The center's goals are as follows:

- (1) To sponsor and support educational activities, restoration efforts, and land acquisition programs that lead to the preservation and enhancement of the Inland Bays watershed.
- (2) To build, maintain, and foster a strong partnership among the general public, the private sector, and local, state, and federal governments, which is essential for establishing and sustaining policy, programs, and the political will to preserve and restore the resources of the Inland Bays watershed.
- (3) To serve as a neutral forum where Inland Bays watershed issues may be analyzed and considered for the purposes of providing responsible officials and the public with a basis for making informed decisions concerning the management of the resources of the watershed.

appointee of the Speaker of the Delaware State House of Representatives, Terry R. Spence. Ex-officio members include Charles App, representative of the Environmental Protection Agency, and his alternate, Jim Butch. The board meets quarterly; the public is welcome to attend.

For more information about the Center for the Inland Bays, please contact Bruce Richards, executive director, at (302) 645-7325. The center is located at Suite 125, Red Mill Center, 467 Highway 1, Nassau, DE 19969.

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