

IX. Research and Monitoring Plan



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Estuaries are important to the nation's economy and recreation, and are an integral part of the Earth's environment as a whole. Understanding and protecting this resource has become increasingly important due to unsound land-use practices and the increased population of coastal areas, which contribute to the degradation of estuaries. There is a need for management-oriented research to define management strategies that allow for multiple land uses, while minimizing detrimental environmental and ecological impacts upon estuaries.

The NERRS emphasis on management-related or management-oriented research is provided in 15 CFR Part 921, Subpart F. A major priority of each reserve in the System is to coordinate, facilitate, and conduct management-oriented research, which will provide information useful for local, regional, and national coastal management decision-making. The creation of permanent field sites for management-oriented research is an important step toward a more comprehensive and integrated program of research, monitoring, and management.

The St. Jones River and Blackbird Creek Reserve components of the DNERR expand researchers' opportunities to perform long-term studies in representative ecological zones of the Delaware Estuary. The two sites provide the opportunity to observe and explain basic functions of, and changes in, these natural estuarine systems, and to apply this information to other estuarine systems along the mid-Atlantic coast. The two Reserve components are managed, in part, to maintain their relatively undisturbed character and serve as controls to compare to other areas outside the Reserve; and in part, they may be modified or manipulated to accommodate research needs and maximize their research utility. Any habitat manipulations must follow guidelines provided in 15 CFR 921.60 (a) (10).

A. Issues Facing the DNERR

The DNERR addresses a wide array of research topics, but several rise to the top as dominant issues. Researchers who would like to work within Reserve boundaries should use the following list as a guide to develop projects that will be of benefit to the DNERR.

- **Development Effects on Estuarine Habitats.** As development pressures increase on the Reserve and other estuarine areas, better understanding of these pressures is needed to develop proper control measures from sediment and nutrient runoff. In addition, the fragmentation of habitat and the potential decrease of native species and increase of invasive species needs to be examined.
- **Habitat Identification and Biodiversity.** There is a need for better habitat identification, especially in the emergent and sub-tidal areas of the estuary. This information is required to preserve and protect the estuarine species and biodiversity and to direct proper restoration initiatives.
- **Management of Estuarine Natural Resources.** Increased information is needed on the natural resources of the estuary and the inter-relationships between these natural resources, including the effect of altering physical conditions on biological species preferences and interdependence between species.

B. Goals and Objectives

The research and monitoring task of greatest importance to the DNERR and the entire Delaware Estuary is the characterization of habitats and of anthropogenic impacts that contribute to habitat degradation or loss. In addressing these issues, the goals of the Reserve's Research and Monitoring Program are:

- To identify the various types, quality, and quantity of habitats available in the estuary to facilitate the proper management and protection of the estuarine ecosystem; and
- To identify, monitor, and limit the anthropogenic impacts to the estuarine system.

Specific objectives to aid in achieving these goals include:

- Collecting and building baseline databases for use in long-term and interdisciplinary studies, for monitoring differences over time, and for making comparisons to other areas to increase the knowledge of habitats and anthropogenic changes;
- Continuing to develop the on-site library's collection of research and reference materials and data repository;
- Promoting the Reserve's components in the research community as long-term field laboratories to be used by State or Federal agencies, academic institutions, and local or private environmental organizations in the study of anthropogenic changes;
- Disseminating research results and other pertinent information to local/regional decision-makers to foster proper management and protection of the estuarine system;
- Improving laboratory facilities, increasing field monitoring stations, and procuring scientific equipment and gear as necessary to support the Reserve's research and monitoring efforts; and
- Seeking agreements with other research organizations or institutions to facilitate and augment research and monitoring projects to meet the goals of the Reserve.

C. Research and Monitoring Topics and Priorities

1. National Programs

The NERRS protects more than one million acres of estuarine habitat, conducts essential research, and provides a variety of educational opportunities. Individual reserves focus on local and regional research and educational needs, but in the national network there are also many System-wide programs. These programs provide the reserves with common research standards and educational goals.

System-Wide Monitoring Program

The NERRS' System-Wide Monitoring Program (SWMP) was designed to fulfill two major overall goals: to support state-specific nonpoint source pollution control programs by establishing local networks of continuous water-quality monitoring stations in representative protected estuarine ecosystems; and to develop a nationwide database of baseline environmental conditions in the System of Research Reserve sites.

The specific goal of SWMP is "to identify and track short-term variability and long-term changes in the integrity and biodiversity of representative estuarine ecosystems and coastal watersheds for the purpose of contributing to effective national, regional, and site-specific coastal zone management."

DNERR Management Plan 2004–2009

This comprehensive program consists of three phased components:

- (1) abiotic factors (i.e., water quality and meteorological monitoring);
- (2) biodiversity monitoring; and
- (3) land-use planning analysis.

With the initial focus on phase 1, SWMP will provide data necessary for intra- and inter-site baseline studies, trend analyses, and impact assessment.

At all NERR sites, at least two locations within or adjacent to the reserve are to be monitored. In January 2001, meteorological data collection was begun at each NERR, allowing for weather events to be related to monitored water-quality conditions.

The DNERR currently supports three datalogger sites and one meteorological station in the St. Jones River watershed and two dataloggers and one meteorological station in the Blackbird Creek watershed.

Protected Areas Geographic Information System

The Protected Areas Geographic Information System (PAGIS) Project is a National Ocean Service (NOS) initiative to develop fully integrated geographic information systems (GIS), spatial data management, and Internet capabilities within the NERRS and the National Marine Sanctuaries (NMS). In conjunction with NOAA's Office of Coastal Resource Management (OCRM), Special Projects Office (SPO), and NERR and NMS sites, the NOAA Coastal Services Center coordinates GIS hardware and software purchases; provides GIS and metadata training; develops spatial data layers and associated metadata; creates and maintains an Internet homepage with an interactive GIS application; maintains a listserver; and provides technical support to the NERR and NMS sites.

The DNERR is highly involved and experienced with GIS and has numerous data coverages available for use through cooperative efforts of the DNREC and other State agencies.

Graduate Research Fellowship Program

The NERRS Graduate Research Fellowship (GRF) Program offers qualified students seeking master's and doctoral degrees the opportunity to address scientific questions of local, regional, and national significance. The result is high-quality research focused on improving coastal management issues.

All GRF projects must be conducted in a National Estuarine Research Reserve and enhance the scientific understanding of that reserve's ecosystem. While the graduate research fellows receive hands-on experience, reserve managers and coastal decision-makers receive vital ecological data. Research priority areas for the NERRS include nonpoint source pollution, socioeconomic research, the importance of biodiversity, the effects of invasive species on estuarine ecosystems, and the sustainability of ecosystem integrity. These projects are based on the reserves' local needs, the System's national priorities, and the students' interests.

Graduate Research Fellowship funds are available to students on a competitive basis. Two students per year are selected for each NERR, and fellowships may be funded for up to 3 years. The award may be used to defray the costs of living, tuition, fees, and research supplies. Graduate research fellows must commit up to 15 hours per week to the reserve.

Past DNERR fellowships have covered varied subject areas that foster the better understanding and

management of the Reserve and Delaware’s estuarine system. These topics have included, but are not limited to, the study of invasive species, nutrient processes, and geomorphology.

2. Research and Monitoring at the Delaware Reserve

Research topics at the Reserve reflect both NERRS National Research Priorities and more specialized regional or local needs. The DNERR Research Subcommittee, in coordination with State environmental representatives, assesses DNERR research topics as to current critical needs and appropriateness. The subcommittee includes members from local academic institutions and State agencies that commonly deal with estuarine issues.

The DNERR identifies and promotes study of research topics of particular interest to coastal resource managers in Delaware and the Middle Atlantic region. These topics may be modified based on Reserve and site-specific management needs that are identified through initial baseline surveys and environmental monitoring. Current critical research and monitoring topics for the DNERR are:

- Eutrophication and Contaminants in the Estuary
- Toxic Effects of Contaminants and Bioaccumulation
- Effectiveness of Agricultural and Stormwater BMPs
- Estuarine Community Health
- Biodiversity and Impacts of Land Use on Estuarine Habitats
- Mapping of Estuarine Habitats
- Investigation and Control of Invasive Species
- Management of Estuarine Resources and Wildlife

Research at the Reserve should engage a holistic approach to watershed management and its effects on the estuary. Environmental studies may include experimental research relating to natural resources, cultural resources, or socioeconomic topics. Investigations will be approved and may be supported based on the research priorities of the NERRS Research Plan, NERRS Monitoring Program, DNERR management plan, and site-specific relationships between human stresses and ecological effects. Studies may include historical and archaeological perspectives on these issues.

Physical Estuarine Research

Environmental resource research at the Reserve may include manipulative experiments appropriate to improve management of estuarine systems. The environmental effects of approved manipulations should be temporary or reversible and cannot affect adjacent core areas. What activities constitute “substantial” habitat manipulations, and what manipulations may be considered to be “temporary” or “reversible,” will be addressed in a habitat manipulation plan; considerations will be the ecological impacts and responses and the long-term utility of the Reserve’s lands for the goals and objectives of



Figure IX-1. Nutrient Monitoring.

the DNERR. A habitat manipulation plan must be submitted to the Reserve Research Coordinator and approved prior to any project commencement. The plan must satisfy the requirements of NERRS regs. 15 CFR 921.3 (a)(10). Designated areas where major habitat manipulations may occur will be contained within confined sub-watersheds of the Delaware Reserve, not spread over the Reserve's areas in patchy or mosaic fashion. Experimental habitat manipulation in the designated areas requires prior approval by the State, NOAA, and, where applicable, the Reserve property owners. Any habitat manipulations requiring Federal or State environmental permits must be granted such permits prior to implementing the perturbations.

Cultural Estuarine Research

Cultural resource research may include prehistoric and historic archaeological excavations, historical research, and folklore and oral history studies. Paleo-environmental research, including soil studies, geomorphologic studies, and pollen studies, may also be conducted to provide the environmental background for cultural studies. Such research conducted under the auspices of the DNERR should focus on the relationship between the estuarine environment and the human groups that have exploited and changed it through time. Providing information to meet the Reserve's educational goals is a priority.

D. Research Value of the Reserve

It is anticipated that the DNERR research program will be most helpful in addressing coastal issues that require technical information which is best obtained via scientific methodology (e.g., controlled testing of alternative hypotheses) or via descriptive survey, particularly if the issues require inventory of biotic populations or assessments of ecological systems of environmental processes.

Specific factors that contribute to the DNERR's research value include:

- Current baseline databases of water quality, meteorological, and habitat data for use in long-term studies and for making comparisons to other areas
- An on-site Coastal Resource Library of research and reference materials on various estuarine and coastal topics to aid researchers
- Availability of data collected on-site and at other National Estuarine Research Reserves
- Availability of the Reserve's components to the research community as long-term field laboratories
- The ability to disseminate research results and other pertinent information to local/regional decision-makers quickly and effectively
- Laboratory facilities, field monitoring stations, and scientific equipment and gear necessary to support various research and monitoring efforts
- Ability to coordinate research between other organizations or institutions for the facilitation and augmentation of Reserve research and monitoring projects

1. St. Jones River Reserve Component

The Lower St. Jones River offers several attractive features for estuarine research, primarily because of its accessibility and the juxtaposition of an urbanized, developed upper watershed with an agrarian, relatively undisturbed downstream component.

Being adjacent to intensely managed State Wildlife Areas offers opportunities to develop and evaluate habitat enhancement or restoration methods. It is probable that most habitat management manipulations would occur on the proactively managed Wildlife Areas, with much of the St. Jones River Reserve component serving a control function. However, carefully planned and sited habitat manipulations could still occur in the DNERR component on a limited scale for research purposes. It is anticipated that the primary habitat management research topics (on-site or off-site) would focus on restoration and management of impounded marshes for multiple resource objectives; on mosquito-abatement practices; on phragmites control; on management of waterfowl, migratory shorebirds, horseshoe crabs, and upland game species; on management for endangered or rare species; and on effects of sea-level rise on emergent wetlands.



Figure IX-2. Horseshoe Crab Egg Sampling.

Basic ecological studies on structure and function of mesohaline-polyhaline emergent wetlands could be an important component of the Research and Monitoring Program. Studies of commercial fisheries for blue crabs, oysters, shad, white perch, weakfish, striped bass, and eels could be conducted in the adjacent open waters of Delaware Bay and in the lower end of the St. Jones River. Research opportunities in the Lower St. Jones River basin also exist to assess the impacts of farming practices on the estuary, particularly in terms of nonpoint source runoff of nutrients, sediments, and pesticides going either into the headwaters of tidal tributaries or into the upper wetlands fringes. New or innovative farm management practices designed to lessen these problems could be implemented and evaluated.

Because of the rich historical and cultural database already existing for the Lower St. Jones River, the component will lend itself to analyses of estuarine impacts or uses associated with many of man's past activities.

With the upper end of the St. Jones River watershed heavily developed by the growing city of Dover, there are excellent opportunities along an approximately 5-mile segment of the river, just upstream from the Reserve's western boundary, to examine the impacts of urbanization on the estuary. Research emphasis could be given to the impacts of commercial and residential development on nonpoint source pollution into the headwater tributaries and upper wetland fringes, particularly from stormwater runoff; on point-source discharge impacts from industry (a power plant and two manufacturers who conduct permitted discharging); and on groundwater and estuarine surface water pollution problems associated with vertical and lateral leaching from an abandoned landfill.

2. Blackbird Creek Reserve Component

The diversity of estuarine habitats found at Upper Blackbird Creek, and how they differ from those found at the Lower St. Jones River, is a major attribute of interest to environmental researchers. Some of the least-understood estuarine zones, in terms of ecological structure and function, are brackish and

tidal freshwater marshes. The interconnection of upland and marine environments starts in these zones, so a better comprehension of oligohaline-limnetic systems should yield benefits to our overall understanding of estuarine ecosystems. The Blackbird Creek Reserve component provides outstanding examples of these transitional habitats.

Other research opportunities within or near the Blackbird Creek Reserve component include studies of agricultural practices in terms of effect on estuarine biota or processes, and studies in land-use planning in terms of contending with burgeoning residential development. In the most seaward portion of the Reserve, and then for several miles downstream of this area, are some of the State's most dense and extensive phragmites stands, providing substantial opportunities for basic and applied research studies of this problem species. The site's proximity to complexes of freshwater wetland swales, the Delmarva Bays, should be of interest to hydrologists, botanists, and herpetologists.

The Blackbird Creek Reserve component also provides opportunities for archaeological and historic research. The Blackbird Creek drainage is north of the prehistoric range of oysters and provides a significantly different environmental setting for human groups. Historical research for the Appoquinimink drainage, just north of the Blackbird Creek site, indicates significant impacts from cultivar-induced siltation within 20 years of the first European settlement.

E. Research Policies and Procedures

Research at the Reserve investigates the natural processes of the estuarine system and the human impacts on these processes. One of the highest priorities of the DNERR is to coordinate, facilitate, and conduct research to provide useful information for coastal management decision-making. Through State ownership or long-term agreements with property owners in each Reserve component, the State also has the opportunity to encourage and support certain research projects in these estuarine systems.

The DNERR makes both Reserve components available to researchers as long-term field laboratories, which are especially suitable for studying estuarine problems. The DNERR program offers:

- Long-term opportunities for temporal and spatial sampling in wetland, upland, and open-water estuarine habitats
- Greater opportunities for use of observational and analytical techniques in protected or controlled estuarine subsystems
- Opportunities for long-term accumulation of comparative data at the Reserve components

To assist new researchers at the Reserve, a Site Profile document is available from the Research Coordinator. This document contains area maps and background information pertaining to each Reserve component. New researchers are also given a tour of the Reserve area and waterways to gain familiarity with the research surroundings and general location.

1. Guidelines

Research, monitoring, and educational projects receive high priority within Reserve boundaries. Traditional uses of public areas will continue as regulated under Federal, State, or local authorities. The Reserve Manager is responsible for carefully balancing uses of the Reserve to ensure that the objectives of the Reserve's programs are protected and sustained.

Research opportunities are available to any qualified scientist, faculty member, undergraduate, or

graduate student affiliated with any college, university, or school; nonprofit, nonacademic research institution (e.g., research laboratory, independent museum, or professional society); private for-profit organization; or State, local, or Federal government agency. These opportunities are also available to any individual who has the resources and capabilities needed to perform the work required.

All proposed research will be evaluated by the Research Coordinator and the Reserve Manager for consistency with DNERR goals and to ensure that the research will not unduly interfere with other research or activities at the Reserve. Projects will be evaluated based on their importance to coastal zone management issues, scientific/educational merit, and technical approach. Other project evaluation criteria include the environmental consequences of the project, immediacy of need, and the proposed project's relationship to other available information and studies.

All proposals, publications, presentations, and other releases resulting from research at the Reserve will list the DNERR and/or the Research Coordinator as *co-operators* on the project. The Research Coordinator may only be listed as *co-investigator* if he/she is directly involved with the project and is willing and able to take full responsibility for the project if other investigators forfeit their involvement.

The DNERR requires that researchers provide the Research Coordinator with timely progress reports, two copies of the final report, and an abstract and one copy of any journal publications resulting from research at the DNERR. All copies of reports will be kept at the Coastal Resource Library for reference by any interested parties. After completion of the final report, a presentation may be developed by the researcher at the request of the Research Coordinator to provide information on the project findings. This presentation will be given at the Visitors Center conference facility or other appropriate location at a time negotiated by the Research Coordinator and the researcher. These presentations will help to achieve the goal of the Reserve to provide information necessary for improved understanding and management of estuarine systems to coastal decision-makers and the public.

2. Recruitment

Recruitment of researchers is important to increase the findings in the DNERR database and promote the Reserve components as long-term natural field laboratories. Recruitment of researchers with established interest and capability is one of the functions of the Research Coordinator. Recruitment strategies include:

- Increased publicity of facilities and opportunities, including available data and GIS coverages, through academic seminars and other professional functions
- Development of a database catalogue to include available field data sets, maps, aerial photos, and GIS coverages, for distribution to researchers
- Increased DNERR presence in local coastal/estuarine meetings, gatherings, and public events
- Coordination through the Research Subcommittee
- Participation of DNERR staff in research symposia, conferences, and workshops
- Internship programs for graduate students or upper-level college students, funded by Federal, State, or other sources
- Announcements of pertinent estuarine information to local researchers
- Annual announcements of DNERR research opportunities, NOAA research funds,

and other pertinent funding opportunities

The DNERR currently offers a small internship program for university students. Generally, one seasonal position per year is available to individuals who are majoring in an environmental discipline or who express an interest in the field. An internship in the Reserve's Research and Monitoring Program is an opportunity to assist with meaningful experimental projects in the field. Students gain hands-on experience and an understanding of the many issues facing estuarine environments. Local universities have responded positively to this opportunity and there has been no shortage of candidates. However, the present internship program is limited due to supervisory and funding constraints.

3. Off-Reserve Projects

While a substantial amount of DNERR research will occur within the Reserve's two components and their watersheds, it is also anticipated that some research efforts associated with the DNERR will occur outside of these areas. It is probable that many of these off-Reserve studies will occur in close proximity to the Reserve components; however, research studies supported or assisted by the DNERR may also occur somewhat distant from the Reserve sites. In particular, research associated with the inland bays (Rehoboth, Indian River, and Little Assawoman Bays) might occur with DNERR staff participation. Although the extensive Delaware Bay system is an excellent representation of a drowned river, coastal plain estuary along the Mid-Atlantic coast, it is not characteristic of lagoon or bar-built estuaries, which are also common in the Middle Atlantic region. Delaware's inland bays are representative of these lagoon or bar-built estuaries, and research attention paid to these systems would give the DNERR an active role in examining all of the Middle Atlantic region's major estuarine habitat types. Off-Reserve projects will be conducted in partnership with the Delaware Coastal Management Program (DCMP). The DNERR may either function as the lead investigator or provide logistical and technical support to the DCMP. Each project will be evaluated for manpower and technical expertise requirements to determine which program to assign as lead investigator. The Environmental Program Manager II for the Delaware Coastal Programs, with input from the Reserve Manager, will make the final determination of project leadership.

All off-site research will be consistent with 15 CFR 921.60 (c), which states, "Monitoring projects funded under this subpart must focus on the resources within the boundaries of the Reserve and must be consistent with the applicable sections of the Estuarine Research Guidelines referenced in Section 921.51. Portions of the project may occur within the immediate watershed of the Reserve beyond the site boundaries. However, the monitoring proposal must demonstrate why this is necessary for the success of the project."

4. Coordination of Efforts

A major benefit offered by the DNERR is the potential for coordination of research and monitoring efforts. The Reserve offers permanent places where various institutions can coordinate their projects and compare results to complement one another's work; through the DNERR, baseline data is compiled, assembled, analyzed, and made available for the use of other researchers, coastal managers, and the public. Research coordination also reduces unnecessary duplication and effectively decreases the cost of publicly supported research.

Coordination between Reserve Components

The DNERR Research Coordinator manages the research between the two Reserve components, with assistance from the Research Subcommittee and NOAA.

Coordination with the National Estuarine Research Reserve System

The DNERR works closely with NOAA staff, especially NOAA's Science Coordinator, to develop and assess National Research Priorities. The Research Coordinator communicates with estuarine Research Coordinators in other states, particularly other Mid-Atlantic states, on common issues.

Data from the DNERR contributes to the long-term national network study monitoring the status and trends of estuarine ecosystems. Data from the NERRS makes a substantial contribution to the understanding of long-term ecological effects on estuaries and is useful in predictive trend analysis of ecological stresses. This coordinated research network aids greatly in understanding the theoretical and practical aspects of conservation and coastal resource management.

Coordination with Other Coastal/Estuarine Research Programs

Research coordination with NOAA and other Federal and State agencies is undertaken to ensure that studies are not being unnecessarily replicated by the DNERR, and to see if any research is being performed elsewhere on those topics that are identified as high priority by the DNERR. It will be very important to coordinate DNERR research efforts with the U.S. EPA's two National Estuary Programs (NEPs) in Delaware (the Delaware Estuary Program and the Inland Bays Estuary Program). Other Federal agency programs with which coordination is highly desirable include the U.S. Fish and Wildlife Service (USFWS), the U.S. Geological Survey (USGS), and the Marine Fishery Councils.

It is also critical to coordinate research interests and efforts with other state agencies. Within the DNREC, all five Divisions have various interests in applied estuarine research: Soil and Water Conservation; Fish and Wildlife; Water Resources; Air and Waste Management; and Parks and Recreation. In particular, coordination of research and consistency of activities between the DNERR and the DCMF is emphasized. Coordination of research can involve other State agencies: the Department of Agriculture, the Division of Historical and Cultural Affairs, and the Department of Transportation.

Of primary importance for research coordination is the interaction between the DNERR and nearby academic research institutions. Research is coordinated between the DNERR and the University of Delaware (UD) College of Marine Studies, with special attention to the Sea Grant College Program. Other UD programs with research links include the Colleges of Agricultural and Natural Sciences, Engineering, and Urban Affairs, and the Departments of Geology and Geography. Research coordination between the DNERR and DSU focuses on the School of Agriculture and Related Sciences and their newly developed Masters Program in Natural Resources as well as the Environmental Cooperative Science Center (ECSC). The ECSC is a collaborative program between minority serving institutions and NOAA. Interactions with Wesley College in Dover are through their undergraduate and graduate Environmental Sciences Program.

The last area of DNERR research coordination is with private environmental organizations that



Figure IX-3. DNERR and British Trust for Ornithology Staff conducting shorebird research.

perform either independent or cooperative estuarine research. These are not-for-profit organizations like DNS, TNC, or the Delmarva Ornithological Society. Research is also coordinated with any private consulting or engineering firm whose interests concern the research priorities of the DNERR.

In addition, the DNERR Research Subcommittee members are encouraged to promote the DNERR components as research facilities, and to act as liaisons between their agencies and the Reserve in coordinating research and monitoring efforts.

F. Funding Opportunities

Various funding opportunities are available both to outside researchers and to Reserve staff. The DNERR has been involved with, and offers assistance in, projects through the Cooperative Institute for Coastal and Estuarine Environmental Technology (CICEET). Funding has been received through EPA programs, NOAA projects, and other Federal programs such as through the USGS and USDA. The Reserve also works with local nonprofit organizations on nationally funded projects and assists with Sea Grant research.

G. Dissemination of Information and Results

Information gathered through the activities of the DNERR research and monitoring programs, including the management implications of this information, is made available to decision-makers and the public in understandable forms.

The DNERR encourages the dissemination of research results at the national level through journal articles in peer-reviewed literature, presentations at professional societies, and estuarine/coastal symposiums.

In addition, the DNERR utilizes other avenues of information exchange, when appropriate, including workshops and conferences at the Reserve, articles in journals of local organizations, press releases to local media, direct mailings to State and local decision-makers, and participation in conferences about local estuarine/coastal issues.

H. Action Plan for Research and Monitoring

The DNERR will engage in the following activities to address several research and monitoring topics of major significance to the Reserve and the NERRS:

- **Action 1: Eutrophication and Contaminants in the Estuary**
The DNERR staff, with their knowledge of the watershed and modeling experiences, will assist the DNREC Division of Water Resources with the development of Total Maximum Daily Loads (TMDLs) for the St. Jones River and other estuarine systems in Delaware.
- **Action 2: Toxic Effects of Contaminants and Bioaccumulation**
The DNERR will assist and supply logistical support for research by outside organizations to examine toxic effects on estuarine wildlife, such as osprey and catfish as indicators of contaminant levels and potential bioaccumulation.
- **Action 3: Effectiveness of Agricultural and Stormwater Best Management Practices**

The DNERR, in cooperation with the Kent County Conservation District, the Sediment and Stormwater Program of the DNREC Division of Soil and Water Conservation, and the Delaware Department of Transportation, will develop programs to monitor and evaluate BMPs throughout the Reserve's watersheds and surrounding estuarine regions. The DNERR will supply the monitoring equipment, human resources, and result analysis to evaluate the BMPs.

- **Action 4: Estuarine Community Health**

As a partner with DSU and other universities, reserves, and sanctuaries that compose the ECSC, a holistic model will be developed that encompasses all factors of the watershed that relate to improving and/or sustaining the health of the St. Jones Estuary. The Reserve will serve as a base of operations and logistical center for all Delaware-based research. The Research Coordinator will serve on advisory panels and assist the DSU staff in implementation of this project.

- **Action 5: Biodiversity and Impacts of Land Use on Estuarine Habitats**

The DNERR will be an active participant in the statewide Biodiversity Initiative. The DNERR will closely monitor the Blackbird Creek watershed for changes in biodiversity and environmental quality as urban development encroaches on the watershed.

- **Action 6: Mapping of Estuarine Habitats**

The DNERR will be involved in the NERRS' habitat-analysis program. The DNERR will cooperate with other State agencies in benthic mapping of portions of the Delaware Estuary. The DNERR will cooperate with and encourage remote sensing of the Reserve and other estuaries by the UD Center for Remote Sensing or other agencies. The DNERR will support the development of GIS data coverages by the digitizing and orthorectification of historic photographs.

- **Action 7: Continued Involvement in the System-Wide Monitoring Program**

The DNERR will participate and assist in the implementation of any additional SWMP initiatives as set forth by the NERRS. If the DNERR staff have expert knowledge or experience in any SWMP initiative, their participation on the relevant committees will be encouraged.

- **Action 8: Investigation and Control of Invasive Species**

The DNERR will support and assist the Delaware Coastal Management Program in the mapping and examination of innovative control measures for invasive species including phragmites, Purple Loosestrife, and Canadian Thistle. The Reserve will utilize in-house expertise and form partnerships with experts in this field, e.g., the University of Delaware, to accomplish this task. Both Reserve components will be used as field sites as well as directly benefit from any control measures that are developed.

- **Action 9: Research Staff Training**

The DNERR will promote and encourage the training of the Reserve staff in areas that will benefit the research capabilities of the Reserve. These areas could include GIS, statistics, data management, and research design.

- **Action 10: Transfer of Research Findings to Education Programs**
The research staff will assist the education staff in the development of materials based on DNERR research and monitoring findings to be used in the DNERR's education programs.

- **Action 11: Sponsorship/Co-Sponsorship of Estuarine Topic Symposia**
The DNERR will assist in the development of one or more symposia relating to estuarine and/or environmental topic(s). Potential partners include but are not limited to various divisions within the Department of Natural Resources and Environmental Control, the University of Delaware, Delaware State University, and the Delaware Geological Survey.

- **Action 12: Estuarine Resource Management**
The DNERR, will work cooperatively with the DCMP and other national/international agencies (e.g., USGS, USCOE, UD, DNC, BTO) in research that provides information for the proper management of estuarine resources including wildlife management and restoration efforts.