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### Overview

Biological monitoring has been a key component of the Estuary Enhancement Program. The monitoring programs support the EEP's adaptive management approach that uses monitoring to assess the progress of restoration, and to help identify opportunities to improve restoration efforts and take steps to ensure the continued success of the marsh restoration. The EEP monitoring programs have also advanced the knowledge about the Delaware Estuary and its fisheries populations, and have enhanced regional decision-making regarding use and management of valuable natural resources.

The EEP has also supported a wide range of research and development programs that have contributed to scientific advances in *Phragmites* control techniques, salt marsh restoration, and technologies with potential to deter fish from cooling water intakes and minimize impacts of intakes on fish.



### Goals

The goals of the monitoring and research programs include:

- Provide data for assessing EEP success
- Expand knowledge available to resource managers
- Evaluate functional values of estuarine marshes
- Evaluate the abundance of juvenile fish in the Estuary
- Identify ways to improve restoration efforts

### Actions Taken

*Monitoring Programs:* The EEP conducts monitoring to gather information on habitat structure, species distribution, species abundance, biological productivity, and other ecological indicators. The monitoring programs have included Station impingement and entrainment sampling, fisheries surveys (beach seine, bottom trawl, pelagic trawl) and ichthyoplankton surveys involving collection and analysis of more than 5,700 individual samples each year. In addition, fisheries monitoring has also been conducted at fish

ladders and wetland restoration sites, and the EEP continues to conduct vegetation surveys of wetlands to track the success of wetland restoration, enhancement and preservation.

*Phragmites Control Test Area Program:* The EEP developed and implemented an innovative Test Area Program to evaluate techniques and treatments for reducing and/or controlling *Phragmites* cover in brackish wetlands. The only program of its kind, the Test Area Program was designed to provide a scientific approach to *Phragmites* management, by developing information in a carefully documented and systematic manner to determine the most effective way of reducing *Phragmites* cover in degraded brackish wetland sites. The 124 test areas included a variety of treatments in various combinations, including:

- Mowing
- Seeding
- Micro-topographic modification
- Glyphosate-based herbicide application
- Grazing

The EEP's Test Area Program, the only scientific research program of its kind ever undertaken for developing scientific information about *Phragmites* control, helped guide the restoration programs, and is serving to create a base of knowledge important to natural resource management globally.



*Cooling Water Intake Technology Evaluation and Design:* The EEP has assisted in the development, and has installed state-of-the-art cooling water intake system technology at the Station to minimize impacts to fish that are drawn into the facility. Ongoing studies of the cooling water intake system are providing data utilized in evaluating the effectiveness of these technologies for reducing impacts on fish; benefits that can be applied in other facilities. One technology installed by the EEP, a modified fish basket design, was an improvement over prior designs, and included the use of innovative manufacturing techniques. The EEP has also investigated leading-edge technologies with potential to deter fish from entering the Station's cooling water intake area including sound, strobe lights and air bubble curtains.



### Accomplishments

Through its comprehensive monitoring programs and support of research and development programs, the EEP and its partners in the scientific community have accomplished the following:

- Increased scientific understanding of the physical habitat structure in *Phragmites* and *Spartina* marshes, and the effects of *Phragmites* invasion on fish.
- Demonstrated the feasibility of an ecological engineering approach to marsh restoration.
- Improved scientific understanding of the ecological functions of marshes, including trophic connections with adjacent estuarine and coastal waters, and demonstrated the benefits of restoring marshes as functional habitats for natural assemblages of estuarine fishes.
- Provided valuable scientific information for managing natural resources in the Delaware Estuary as well as other Mid-Atlantic estuaries.
- Advanced basic ecological knowledge of many species including blue crab and horseshoe crab, two ecologically and economically important species.
- Demonstrated the effectiveness of the fish ladder construction program for expanding access to spawning areas.
- Contributed to advancement in the understanding and design of technologies to reduce impacts on fish associated with cooling water intakes.

The EEP restoration, enhancement the subject of much scientific 70 published scientific continue to serve as natural advancement of scientific application in resource



and preservation sites have been research, as documented in over manuscripts. These sites will laboratories for the knowledge and its practical management.