Focus on Field Stations

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EASTERN SHORE LABORATORY, VIRGINIA INSTITUTE OF MARINE SCIENCE, COLLEGE OF WILLIAM AND MARY

Introduction

The Virginia Institute of Marine Science (VIMS) Eastern Shore Laboratory (ESL) is located in the coastal village of Wachapreague, Virginia, on the landward margin of a mid-Atlantic barrier island–salt marsh–lagoon system. The facility serves as both a field station in support of research and teaching activities and as a site for resident research in coastal ecology and aquaculture. By virtue of its access to the unique coastal habitats, excellent water quality, and an extensive seawater laboratory, the facility affords educational and research opportunities not available elsewhere within the region.

Part of the College of William and Mary, the Virginia Institute of Marine Science/School of Marine Science is the third largest research and education center in marine science in the United States, and the nation's largest graduate research program with a focus on coastal marine science. Its tripartite mission of research, education, and advisory service makes it unique among marine science institutions in the United States. The main campus, located at Gloucester Point on the York River subestuary, has long served as a site for research focused on the Chesapeake Bay; the Eastern Shore Laboratory provides access to sites in the eastern portion of the bay and to habitats along the Atlantic shore, greatly enhancing the research and educational opportunities at the Institute.

History

VIMS established the Eastern Shore Laboratory in 1960 as an outpost to monitor the spread of oyster pathogens, *Perkinsus marinus* and *Haplosporidium nelsoni*, in nearby waters. Over its 38-year history, the laboratory has become internationally recognized for shellfish research, with contributions to molluscan ecology and culture.

Over the past decade, the Institute has been expanding the use of the facility as a general-purpose field station for research and education. Since 1992 the VIMS–ESL has undergone major renovations. Extensive wet laboratory facilities (465 m^2, over 5000 square feet) have been upgraded to include air and water temperature control, high-capacity filtration, a quarantine system, and a seawater flume laboratory. A dual-line seawater system, redundancy in pump capacity, and excellent water quality ensure a consistent, year-round wet laboratory capability. Facilities for culturing unicellular algae support the maintenance of a variety of heterotrophic organisms. A recently constructed building provides laboratory and classroom space for visiting classes and investigators. Recent renovations to an on-site dormitory have improved the accommodations for students and visiting researchers.

Site description

The Virginia Eastern Shore (centered at 37°30' N and 75°40' W) is located on the southern end of the Delmarva Peninsula, forming the boundary between the lower Chesapeake Bay and the Atlantic Ocean. The barrier island–salt marsh–lagoon system along Virginia's Eastern Shore is unique in the contiguous United States in its extent of undeveloped barrier islands. Along its 100-km Atlantic coastline, 15 of the 18 barrier islands lack any development, the only barrier islands accessible by bridge being the sites of Assateague National Wildlife Refuge and NASA's Wallops Island launch facility. The Nature Conservancy, a Washington-based, nonprofit organization, owns all or part of 14 of the barrier islands and approximately 18,615 ha (46,000 acres) of island, marshland, and adjacent uplands, ensuring that it will remain undevel-

Fig. 1. Barrier island–salt marsh–lagoon system on Virginia's Eastern Shore.

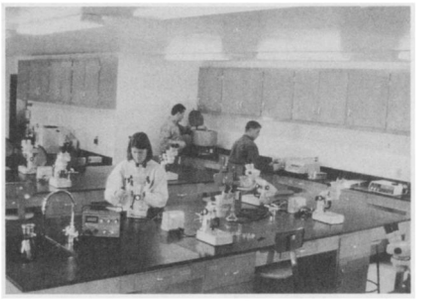

Fig. 2. Laboratory space available to visiting investigators and classes.

oped for the foreseeable future. The region has been designated by UNESCO as part of their Biosphere Reserve System, it has received National Natural Landmark status by the U.S. Department of the Interior, and is included within the Western Hemisphere Shorebird Reserve Network. Low human population density in the area and limited access to the marshes and barrier islands make this system the most nearly pristine of its kind along the mid-Atlantic coast of North America.

Formed during the late Holocene sea level rise, the barrier island–salt marsh–lagoon complex in this region is highly dynamic and continues to experience high rates of recession. Sedimentation rates behind the barrier islands over the past century have generally exceeded local subsidence rates and sea level rise, contributing to an increase in salt marsh area throughout the region. Presently, there are approximately 60,000 ha (148,000 acres) of salt marsh and back bay environments along the Atlantic coast of Virginia's Eastern Shore.

The barrier islands in this region exhibit considerable range in size, from Little Cobb Island (29 ha) to Parramore Island (2,197 ha), and include a continuum of habitat from open dune environments characterized by American dune grass (*Ammophila verigata*), salt meadow grass (*Spartina patens*), seaside goldenrod (*Solidago sempervirens*) and wax myrtle (*Myrica cerifera*) to well-developed maritime forests with large stands of loblolly pine (*Pinus taeda*) and mixed hardwoods (e.g., red cedar *Juniperus virginiana*, black cherry *Prunus serotina*, and red maple *Acer rubrum*). The salt marsh is dominated by smooth cordgrass (*Spartina alterniflora*), with high-marsh species including salt meadow grass (*S. patens*), glassworts (*Salicornia* spp.), sea lavender (*Limonium* spp.), saltgrass (*Distichlis picata*), black needle rush (*Juncus roemerianus*), and marsh elder (*Iva fructescens*).

The shallow waters of the lagoons were historically dominated by one of two structured habitats—oyster reefs and seagrass meadows. Both habitats are now greatly reduced. Oysters (*Crassostrea virginica*) once formed extensive intertidal reefs in this environment, either as "fringing reefs" along the banks of tidal creeks or as "patch reefs" in the lagoons; however, the past quarter century has seen these environments greatly altered and reduced due to overfishing and disease. Seagrass meadows composed of eelgrass (*Zostera marina*) and widgeon grass (*Ruppia maritima*) once covered large expanses of the shallow subtidal region within the back bay lagoons in this region. In the early 1930s, disease (caused by the pathogen *Labyrinthula* sp.) and major storm events virtually eliminated the seagrass meadows from this region. Restoration efforts underway at the ESL are helping to re-establish seagrasses to the northern (Chincoteague Bay) and southern (Magothy Bay) extremes of coastline and hold the promise of restoring this habitat throughout the region.

The lower Delmarva Peninsula lies near a major zoogeographic boundary for coastal marine fauna and flora. Though dominated by temperate species, frequent intrusions of warm Gulf Stream water bring subtropical species to the inshore waters behind the barrier islands. Collections conducted out of the VIMS–ESL have provided the basis for several published checklists, including ones on macroalgae, hydrozoans, nudibranchs, and a general checklist of the estuarine fauna of the region.

At its widest point the Eastern Shore of Virginia is only 32 km across from the landward margin of the salt marsh to the shores of Chesapeake Bay. The estuarine environments along Chesapeake Bay's eastern shore differ considerably from those of its western shore. In contrast to the large riverine systems discharging into the western side of the Bay, freshwater input from the east is via small creeks rarely more than several meters wide and 10 km long. As a result, descriptive and manipulative studies of estuarine processes often are more tractable in these smaller estuarine subsystems.

Facilities

The Eastern Shore Laboratory is located on 1.7 ha (4.3 acres) in the coastal fishing village of Wachapreague, Virginia. The main laboratory, opened in 1962, now serves primarily as the administration building, housing offices for the resident staff and the hub for the computing network. A local area computing network supports a central database management system, GIS capabilities, image analysis, and direct Internet access.

A new 300-m (3,200 square foot) building provides office, laboratory, and classroom space for visiting users of the facility. A library, conference room, and classroom serve visiting classes, researchers, and resident staff. A teaching laboratory with work stations for 30 students is equipped with dissecting and compound microscopes and standard labware. Laboratory bench space is available in a common-use equipment room, which contains a ultraviolet/visible spectrophotometer, fluorometer, light microscopes, an image analysis system, and balances. Other features include a fume hood, environmental chambers, –20°C freezers, an autoclave, and a muffle furnace. This building also has private offices, each equipped with a networked com-

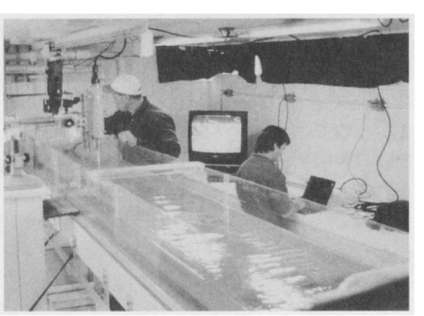

Fig. 3. Seawater flume laboratory.

Fig. 4. Dormitory for visiting users of the laboratory.

puter, for visiting investigators. This building is fully handicapped-accessible.

A hallmark of the ESL is a large, flexible seawater system. Approximately 50 flowing seawater tables are located at the facility, some inside buildings, others outdoors. Tanks of various sizes, ranging from small aquaria to a 56,000-L tank are available for use in either flow-through or recirculating modes. Accessible plumbing and portable tanks support easy modifications to the system to meet the needs of individual investigators. Varying degrees of temperature control are available, and the 56,000-L tank features a high-capacity chiller. A recently installed seawater quarantine system provides the capability to conduct work on nonindigenous species with a water treatment capacity of approximately 75,000 L/day (~20,000 gallons/day). A 5 m long recirculating seawater flume is available for controlled flow experiments. This flume features steady two-dimensional flow for modeling benthic boundary layer conditions. Temperature control and several filtration options permit investigators to control seawater conditions within the flume. An acoustic doppler velocimeter is available for characterizing velocity and turbulence structure within the flume. Video imaging and analysis capabilities complement the seawater flume.

The dormitory facility at the Eastern Shore Laboratory is a 370-m^2 (4,000 square foot), two-story house, converted from a single-family dwelling. With a total sleeping capacity of 40 people, the dormitory includes some private and semiprivate rooms for small groups and a bunkhouse arrangement for larger classes. Kitchen and dining facilities, located on the first floor, are available for use by guests. Full handicapped access is provided to the lower floor.

The Eastern Shore Laboratory maintains a fleet of small vessels for the support of research and educational activities. The emphasis in this fleet is on small, shallow-draft vessels 4.6–9.2 m (15–30 feet) in length, which provide access to shallow-water habitats along the sea side and bay side of the Eastern Shore. Sampling gear available with these vessels include dredges, trawls, gill nets, and plankton nets, and some vessels are equipped with booms and power winches for retrieval of heavier gear.

Research efforts

Research conducted out of the laboratory has focused on geophysical and ecological processes in the barrier island–salt marsh–lagoon complex along the Atlantic margin of the peninsula and in the tidal creeks and shallow-water habitats on the eastern margin of Chesapeake Bay. Investigations into the tidal hydraulics of Wachapreague Inlet have contributed to our knowledge of local hydrography as well as to nonlinear tidal inlets in general. The highly dynamic nature of the barrier islands in this region, coupled with their lack of development, have made them the focus of numerous investigations, including student theses, on sediment transport, stratigraphy, and geological history.

Restoration ecology has been a central theme in much of the recent research conducted at the Eastern Shore Laboratory. Previous successes in restoration of submerged aquatic vegetation (SAV) and oyster reef habitats have led to landscape-level restoration projects coupling both types of habitats and water quality. Aerial surveys of SAV resources, conducted by VIMS researchers along both sides of the Eastern Shore for over 20 years, have documented dramatic increases in the spatial extent of SAV beds on both sides of the peninsula over the past several years. Ongoing studies at the ESL are revealing the importance of dispersal and colonization dynamics in population dynamics of seagrasses.

Harmful algae blooms are generally perceived to be a growing threat to inshore and near-shore coastal waters. Research projects conducted at the Eastern Shore Laboratory over the past several years have monitored for the presence of blooms and characterized their impacts on some molluscan shellfish species. Recently, much attention has been paid to the presence of fish with lesions in tidal creeks on the Eastern Shore, presumed (but not confirmed) to have been caused by the heterotrophic dinoflagellate *Pfiesteria piscicida*. Interestingly, finfish monitoring programs conducted over the past two decades out of the Eastern Shore Laboratory reveal that the occurrence of such lesionous fish is not a new phenomenon in the area.

Other research on finfish at the Eastern Shore Laboratory is revealing different life history attributes of Atlantic silverside (*Menidia menidia*) populations on each side of the peninsula. Ongoing studies characterizing juvenile finfish nursery habitats ranging from the surf zone, to tidal creek headwaters, to bayside mud/sand beaches, are providing details on habitat utilization of many ecologically and recreationally important species (e.g., bluefish *Pomatomus saltatrix*, spot *Leiostomous xanthurus*, permit *Trachinotus falcatus*, and striped bass *Morone saxatilis*). Laboratory studies on tag retention in weakfish (*Cynoscion regalis*) and tautog (*Tautoga onitis*), conducted in the large seawater tanks at the Eastern Shore Laboratory, are supporting mark and recapture studies underway in adjacent coastal waters.

A joint research program between VIMS and University of Virginia researchers is currently investigating the role that macroalgae play in nutrient dynamics within the salt marsh–lagoon system. Other research is suggesting that the deposition of *Spartina* detritus in the high marsh is contributing to a state change from an organic to a mineral marsh.

Molluscan ecology continues to be an important research area at the Eastern Shore Laboratory. Current re-

Fig. 5. A variety of coastal habitats are available for educational activities. (Photograph to show students and instructor in a high-marsh environment.)

search includes investigations into the reproductive biology, ecology, and pathobiology of nonindigenous oyster species. Research programs on the population and molecular genetics of commercially exploited species are currently being initiated at the laboratory. The high-capacity quarantine facility, flexible seawater system, and excellent water quality at the laboratory make it ideal for conducting this type of research.

Research projects conducted in the seawater flume at the Eastern Shore Laboratory in recent years have included chemical induction of settlement behavior in oysters, biophysical transport of eelgrass *Zostera marina* seeds, biomechanics of swimming in the brief squid *Lolliguncula brevis*, and orientation behavior in the horseshoe crab *Limulus polyphemus*.

Several research programs at the laboratory are focusing on coastal landscape issues, particularly the relationships between land use and water quality. Since Virginia's Eastern Shore is composed of many small watersheds, land use throughout entire watersheds can be readily delineated and replicate watersheds studied. Distinguishing between the impacts of autochthonous and allochthonous carbon sources on the dynamics of harmful algae blooms is the focus of one study at the laboratory which is taking a watershed-based approach. Another study uses digitized aerial photography to map agricultural land use in several watersheds as part of a GIS-based approach to evaluate the impacts of agricultural runoff on water quality and living resources in tidal creeks. Expanding use of an agricultural practice which uses impermeable plastic ground covers in vegetable cultivation (*plasticulture*) has raised concerns about pesticide runoff on the Eastern Shore. A multidisciplinary, multi-institutional research program conducted out of the Eastern Shore Laboratory is combining the efforts of environmental chemists, ecotoxicologists, soil scientists, erosion control specialists, and farmers to identify and correct problems resulting from this practice.

Education

The VIMS–ESL is undergoing a dramatic increase in use as an educational field station. The facility regularly serves in a support role for graduate and undergraduate education at VIMS/College of William and Mary by providing a field station for classes in coastal geology, experimental ecology, malacology, and invertebrate zoology. Additionally, the field station is used extensively by other institutions for graduate and undergraduate education. Over the past 5 years, approximately 900 graduate and undergraduate students from 19 institutions have participated in field trips and other educational activities at the laboratory. Current educational use of the ESL ranges from 1-day field trips to full laboratory sections of courses taught on main campuses (VIMS, Old Dominion University, and West Virginia University). Summer field courses, currently planned to begin in 1999, will further enhance the educational opportunities at the laboratory. Graduate students conducting research at the ESL typically make the 2-hour commute from the main campus during the semesters and are resident at the field station during the summer. More than 40 theses and dissertations have resulted from work conducted by students primarily at the ESL.

A wide range of public education activities are offered by the ESL. In collaboration with the Nature Conservancy, the ESL has provided primary and secondary school students from the area with the opportunity to take field trips to the barrier islands and marshes and receive instruction in marine science. A Marine Science Camp, conducted jointly with the 4-H Program, provides expanded educational opportunities for schoolchildren at the ESL. Training sessions for teachers and resource managers are routinely conducted at the facility, and frequent public seminars are held at the laboratory. An on-site Elderhostel program brings about 60 senior citizens each year to the ESL for a week of instruction in coastal marine science. Additionally, faculty and staff at the laboratory are involved daily in a wide range of outreach activities to the general public and to marine industries in the region.

The VIMS Eastern Shore Laboratory encourages use of its facilities by graduate and undergraduate classes from other institutions; interested instructors should contact one of the people identified below.

Visiting investigators

Visiting investigators are supported through access to the full range of resources at the laboratory. Boat operations and technical assistance are provided as needed. Office and laboratory space are generally available at no cost; modest fees are assessed for dormitory and vessel use, and additional fees are imposed only when required to cover exceptional costs. A limited number of summer internships are available for undergraduates to gain work experience at the field laboratory.

Use of the laboratory by visiting investigators ranges from single-day collecting trips to full summer residence.

For further information

To obtain further information about the laboratory and to reserve space contact Mark Luckenbach or Nancy Lewis at the address below or visit the VIMS Web site, <http://www.vims.edu>.

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