VIMS Collaborates to Restore Lynnhaven

In 1607, England's Jamestown settlers made their first landing in Virginia near the mouth of a pristine Chesapeake tributary today known as the Lynnhaven River.

Now, 400 years on, VIMS scientists have joined a multi-institution effort to begin restoring the river's health, just in time for the quadricentennial of the colonists' landfall.

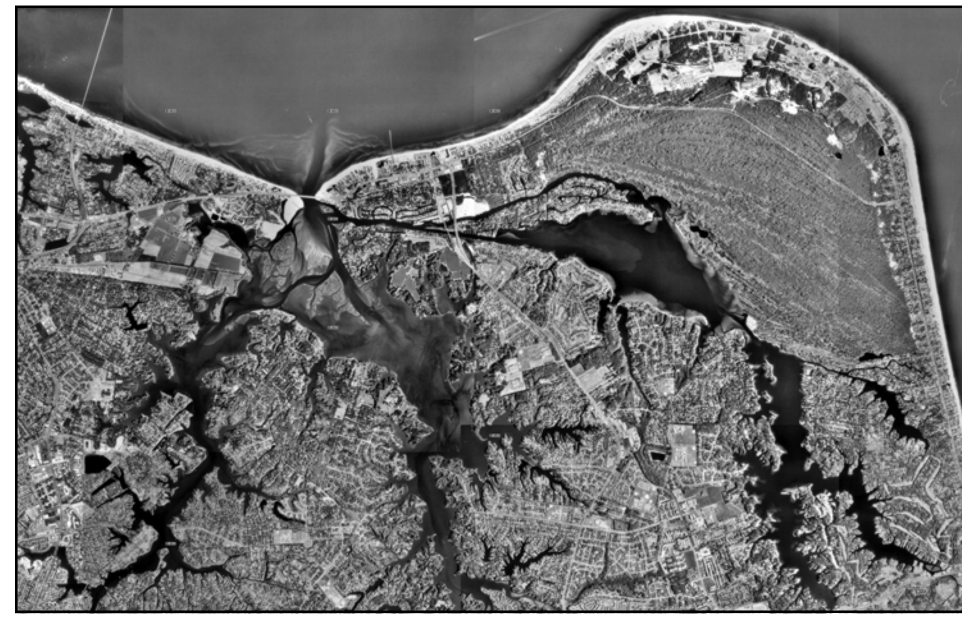
Modelers and ecologists at VIMS are partnering in the Lynnhaven restoration project with the U.S Army Corps of Engineers and the Virginia Beach City Government. VIMS oyster experts are working with NOAA, the Virginia Marine Resources Commission, the Chesapeake Bay Foundation, and the citizens group *Lynnhaven 2007*.

The Lynnhaven, whose watershed covers one-fourth the area of Virginia Beach, provides vital services to the City and its 400,000 residents—including boating, fishing, crabbing, and ecotourism. However, the river has become increasingly stressed as its watershed has urbanized.

As project lead, the Army Corps is collaborating with its state and federal partners to lessen these environmental stresses through a 5-year, $3 million coordinated effort to identify and implement the most effective strategies for improving water quality, restoring oysters and bay grasses, and managing siltation.

VIMS' role in the restoration effort is multifaceted. A key component is a 3-year, $600,000 grant from the Corps to researchers Harry Wang, Jian Shen, Mac Sisson, Albert Kuo, and Yuepeng Li. Their task is to refine the Institute's existing state-of-the-art computer model so that it can accurately simulate water flow and quality within the Lynnhaven's shallow waters. The Corps will use the model to identify the areas of the river where restoration efforts are most likely to succeed.

A unique aspect of the modeling project is a suite of related field studies (see sidebar on page 8) designed to identify and measure the biological and chemical processes that affect water quality in the river. Data from these studies will be used to both initiate and test the computer model.



The Lynnhaven River's three branches (Eastern, Western, and Broad Bay/Linkhorn Bay) cover about 65 square miles in the urbanized northern half of Virginia Beach, the commonwealth's largest city.

Other VIMS teams, led by Drs. Stan Allen, Rom Lipcius, Mark Luckenbach, and Roger Mann, are working to restore the river's oyster populations. Funding for these efforts comes largely from NOAA.

Modeling

Other than a few boating channels, most of the Lynnhaven River is only a meter or two deep. The river's shallowness, plus a convoluted shoreline that snakes more than 150 miles, makes modeling its circulation and water quality a real challenge.

VIMS' state-of-the-art "UnTRIM" model takes full advantage of modern computing power to simulate conditions within shallow, complex estuaries like the Lynnhaven. It does so by using a mesh of grid cells that are small enough to

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New Construction
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working with aquatic pathogens that pose a more serious risk to human health. A toxics laboratory will permit analysis of the health impacts of waterborne pollutants. Benthic ecology and coral reef labs, a radiation room, and an entrance suite with offices and an exhibit /conference space complete the facility.

VIMS Facilities Manager Wendell Goodwin says that construction on the two buildings is progressing according to schedule.

"The underground utilities have all been installed for Andrews Hall, allowing construction to begin," says Goodwin. "Excavation for the first floor is now complete, and work on the wall footings has started . Underground utilities within the building pad can then be scheduled for installation. Once the first floor walls are completed, construction of the upper floors can go forward."

"For the seawater lab, most of the piping and electrical conduit has been installed, and pouring of the trench walls is in progress. The galvanized steel framing is in place, roof installation will commence in the next week or so, and then the first floor slab can be poured and construction of the walls and infrastructure will commence."

The project is scheduled for completion in March of 2007.

Virginia Secretary of Natural Resources W. Tayloe Murphy Jr., Cynthia Andrews, and W&M President Gene Nichol break ground for VIMS' new marine research complex during a September 30th ceremony in Gloucester Point. Numerous other dignitaries joined in the ceremony. When completed, the complex will feature a 46,000 square-foot seawater laboratory and the 71,000 square-foot Andrews Hall, named in honor of Cynthia Andrews and her late husband Hunter B. Andrews, a long-time Virginia senator and VIMS supporter.

Lynnhaven
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capture the intricacies of the river's circulation, and by incorporating the bottom processes that dominate water quality in shallow systems.

High-resolution computer models that simulate both circulation patterns and water quality are relatively new, as they require both high-speed computers and sufficient field data.

Sisson, who works as Project Manager for Lynnhaven model development under the guidance of modeling-group leaders Wang and Shen, notes "We use an integrated modeling approach that combines field measurements with high-resolution interactions between hydrodynamic, water-quality, sediment, and watershed models. Because shallow-water systems are inherently more difficult to model, we measure sediment nutrient fluxes and sediment re-suspension rates seasonally in each branch rather than just calibrating for these. High-resolution water-column measurements also play a key role in model calibration."

This integration and resolution comes at a price. "Even with today's high-speed microprocessors, a year-long simulation of circulation patterns and water quality in the Lynnhaven still takes six days of computer time," says Sisson.

Dr. Mark Brush, another VIMS modeler involved in the project, notes that most of the models used for management were developed for Chesapeake Bay and other large estuaries. "Now there's a real need to take these models into the shallows, into the small systems that we actually manage at the local level. Harry's group has been able to adapt their model for that use."

"The beauty of the model," adds Sisson, "is that the Corps and City can turn around and use it as a management tool. They can run scenarios where they cut nutrient loading in an area by 50%, and see what that will do to water quality throughout the river. That's the great thing about modeling, you can handle the what-if questions."

Process Studies

For the Lynnhaven project, Brush has set aside his modeling hat to focus on field studies of the ecological processes that affect water quality, including fluxes of oxygen and nutrients between the water and sediments. He and other VIMS researchers have also employed a battery of sensors designed to measure salinity, temperature, dissolved oxygen, chlorophyll, turbidity, and other variables.

Faculty and students from all departments at VIMS are involved in efforts to restore the Lynnhaven River

Modeling and Process Studies

- Harry Wang, Jian Shen, Mac Sisson, Albert Kuo, and Yuepeng Li: Integrated modeling
- Carl Friedrichs, Grace Cartwright, Larry Sanford* and Steve Suttles*: Sediment re-suspension studies
- Bob Gammisch, Wayne Reisner, and Tim Gass: Measurements of tides, currents, salinity, and temperature
- Carl Hershner and Howard Kator: Fecal coliform bacteria in runoff
- Ken Moore and Britt Anderson: Mapping water quality with *Dataflow*
- Mark Brush, Iris Anderson, and Hunter Walker: Sediment fluxes and water quality

Oyster Restoration Studies

- Stan Allen and Lionel Dégremont: Disease tolerance of native oysters
- Jens Carlsson: Oyster genetics
- Rom Lipcius, Sebastian Schreiber, David Schulte, and Russ Burke: Population dynamics of historical and extant oyster reefs
- Rom Lipcius, Mark Luckenbach, Russ Burke, and P.G. Ross: Oyster survival on alternative reefs
- Rom Lipcius, Justine Woodward, and Russ Burke: Oyster survival on rip-rap reefs
- Mark Luckenbach and P.G. Ross: Oyster settlement patterns

Other Restoration Studies

- Mark Brush and Lance Gardner: Sea grasses and water quality
- Rochelle Seitz and Amanda Lawless: Benthic community structure and shoreline development

* University of Maryland, Horn Point Laboratory

VIMS Laboratory Instrument Maker Wayne Reisner (L) and Lab specialist Tim Gass (R) attach a current-meter to a Lynnhaven channel marker.

Other VIMS researchers are measuring physical variables such as tidal level, current direction, and the re-suspension of bottom sediments.

All these variables are being incorporated into the UnTRIM model to provide an unusually comprehensive data set for both initializing the model and testing its performance.

The new sensor network is far more comprehensive in space and time than previous sampling efforts in the Lynnhaven. The sensors, which are deployed on navigational markers and from moving vessels, measure water-quality variables at intervals from a few seconds to 30 minutes. One sensor measures conditions on the bottom. Samples were previously taken twice monthly, and only near the surface.

"There's a critical need when you build a model to have the data to validate it and show that it's working right," says Brush. "The Lynnhaven project is a great example of how you should do these things. It's been done smartly because we have all these pieces feeding data into the model."

Field data are particularly important in a shallow-water system like the Lynnhaven, where bottom processes exert much greater influence. "Relative to a deep system you have a more complex bottom that's more important in terms of friction, drag, and channelization," says Brush. "The hydrodynamics are much more complicated, there are many more driving processes."

Bottom-dwelling organisms also play an exaggerated role in shallow water. "These are systems where light reaches the bottom," says Brush, "so you have benthic microalgae, macroalgae, and seagrass, plus epiphytes on the seagrass. You have a diversity of primary producers. Clam and oyster filtration is also critical. You just don't know how much impact some of these critters have on water-column dynamics until you take measurements."

Oysters

The Lynnhaven was a well-known oyster ground until disease, declines in water quality, and frequent shellfish closures shut down the fishery in the early 1970s. Project partners seek to revive the river's oyster stocks through a combination of reef construction and planting of disease-resistant native oysters. *Lynnhaven 2007*, whose Executive Director is VIMS alumna Laurie Sorabella, aims to restore edible oysters to the river by that year through reductions in bacteria levels.

Dr. Roger Mann, VIMS' Director of Research and Advisory Service, says the project benefits significantly from lessons learned during earlier oyster restoration efforts elsewhere in Chesapeake Bay. "We've learned that oyster restoration works best when it's done in conjunction with efforts to improve water quality to the levels that oysters need to thrive, and at a scale sufficiently large to overcome natural variations in oyster spawning stocks."

Mann notes that the Lynnhaven was chosen for oyster restoration because it has supported natural oyster populations in recent years and had a history of regular spat settlement and significant private oyster production before the oyster disease MSX became established in the 1960s.

Collection of information on current populations requires a variety of techniques. Mark Luckenbach and P.G. Ross have been using video and GPS to prepare high-definition maps of shoreline types, while Rom Lipcius, Russ Burke, and Justine Woodward have been sampling rip-rap and other shorefront structures to quantify oyster populations. Lipcius will use output from the UnTRIM model to estimate how far and fast oyster larvae are likely to be carried before they settle to the bottom.

These approaches will combine with others to estimate the current population size as a baseline prior to intensive restoration efforts that involve both habitat rebuilding (the Army Corps constructed three-dimensional reefs in the waterway in 1997, 2001, 2002, and 2003, and is considering more) and selected addition of brood stock.