William & Mary VIMS
Virginia Institute of Marine Science
School of Marine Science

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The Crest

Current Issues in Coastal Ocean and Estuarine Science

Virtual Solutions to Real-World Problems: Physical Modeling at VIMS

By David Malmquist

When the U.S. Army Corps of Engineers realized they needed to expand Hampton Road's Craney Island landfill, they faced a dilemma common to resource managers everywhere. They needed to minimize further impacts to an already stressed ecosystem, but how could they determine the best course of action before the costly project began?

The answer to their dilemma came from researchers in VIMS' Physical Sciences Department, who were able and willing to explore the possible environmental impacts of landfill expansion using their state-of-the-art computer model.

By allowing evaluation of likely impacts before a project physically begins, computer models can help save millions of dollars. In many cases, they are the only practical method for making complex environmental decisions.

The VIMS three-dimensional Hydrodynamic Eutrophication Model (HEM-3D) allows researchers to simulate the response of an estuarine ecosystem to natural and human alterations by representing it mathematically inside a high-speed computer. By manipulating model input to reflect intended or expected changes in the actual system, the researchers can determine how the virtual system

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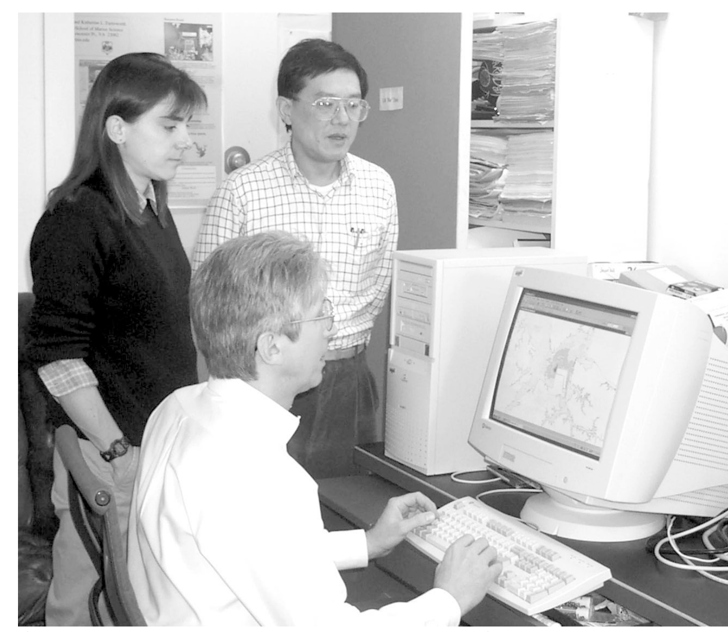

Courtney K. Harris, Harry Wang, and Mac Sisson, running a numerical model.

ChesSIE Sighted at www.bayeducation.net!

By Sally Mills

Have you seen ChesSIE? We're not talking about the fictitious Bay beast, but an online resource center of current K-12 Chesapeake Bay science education materials. ChesSIE (Chesapeake Science on the Internet for Educators) is maintained by VIMS marine educators, and an advisory committee and a teacher focus group provide valuable feedback about the site's content. ChesSIE is also supported by the EPA Chesapeake Bay Program and is part of the Chesapeake Information System (CIMS).

ChesSIE provides educators with access to quality Bay-related education resources, online data, and professional development opportunities. Researchers, resource managers, and other Bay stakeholders are supplied with a venue for sharing information and connecting with K-12 classrooms. Interested in traveling? Take part in an online field trip throughout the Bay or find a great field-trip destination. Do you need to identify a Bay critter you found sampling? Use ChesSIE to key out

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Chesapeake Bay National Estuarine Research Reserve in Virginia

a fair Bay Spring
Vol. 12, No. 1

Scientists Taking a New Look at Sources of Nitrogen in Estuaries

Ph.D. student Jason See is working with his advisor, Dr. Deborah Bronk, Department of Physical Sciences, on a discovery he calls the "humic shuttle." Humic substances are the dissolved organic compounds often give many rivers their characteristic tea color.

See's results are exciting because it means that he has discovered a new function for humics in the environment. These substances, which are defined by their extraction processes rather than their structure, make up 30 to 60% of the dissolved organic matter (DOM) and up to 90% of the dissolved organic carbon (DOC) found in the riverine environment. In the past, humics have been thought to be highly refractory, and therefore have little influence on environmental processes. Scientists believed that phytoplankton were unable to utilize nitrogen associated with humics until the humics had been broken down by bacteria. See's work appears to be changing that belief.

Scientists have recently shown that nitrogen (in the form of ammonium) can be released from sediments as the salinity level in surrounding waters increases, probably due to binding to organic compounds including humic substances. This knowledge caused See to question whether salinity could also cause humics in the water column to release ammonium. If increased salinity causes the release of ammonium, then this could be happening in rivers as salinity rises from the head waters to the river's mouth. See believes that humics, formed upriver, are capable of binding ammonium and then releasing it down river where it could fuel phytoplankton growth.


Ph.D. student Jason See working on another piece of the nitrogen puzzle.

See's initial lab results did not confirm his hypothesis, however. In fact, no ammonium appeared to be released. "These results were discouraging. But, because I thought I was on to something, I began to question my testing methods," See explained. See and Bronk then theorized that the accepted humic extraction process was removing the ammonium, and developed an alternate method of isolating humics. The results were then as they expected: ammonium was released when salinity increased. See is currently looking at release rates of ammonium in the York River and the Satilla River in Georgia, as well as commercially available terrestrial humics.

With this discovery, which includes novel techniques, new questions have now arisen. Seasonal cycles, ammonium/humic concentration ratios, and differences in terrestrial humics and marine humics are all areas See is addressing in his dissertation. In addition to the discovery of an unrecognized form of inorganic nitrogen delivery via organics in river systems, scientists will also learn from the techniques utilized. Current published photochemical rates and the belief that humics are nitrogen poor will now be challenged due to the realization that the method for extracting humics was skewing test results. Dr. Bronk commented, "We can't say what the direct results of these findings will be, but it's one more piece of the puzzle."

ChesSIE
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and investigate various Bay species. Would you like a new lesson plan or classroom activity for your students? These are available for every grade level. How about real-time data? CBP/CIMS, CBOS and other online data products are accessible. ChesSIE also features a Bay education discussion list; links to Bay educational facilities: aquariums, museums, science centers, field schools; Bay science research centers and graduate programs; grants and awards available to Bay educators; state departments of education and jurisdictional information; professional organizations and event calendars: NMEA, MAMEA, NSTA; and information about CBP educational projects and partners.

So, if you're looking for a restoration project in your area, a summer program for your students, data from your watershed, or fun facts about the Bay, be sure to check out ChesSIE at http://www.bayeducation.net. For further information about ChesSIE, please contact Susanna Musick at sxmusi@vims.edu.


From left- Marine educators Lisa Lawrence, Vicki Clark, Lee Larkin and Susanna Musick.

VIMS Beach Research Reveals Erosional Hotspots

By David Malmquist

VIMS researcher Jesse McNinch likes the beach. But his trips there are anything but leisurely visits with umbrella and Frisbee. This spring, he'll be driving along an Outer Banks' beach in a 5-ton amphibious vehicle, using a high-tech sonar system to map the sandy seafloor and its underlying geology.

"Mix sand, seawater, and energy over any time scale, and I am intrigued," says McNinch. The focus of his current research is to better understand how the muddy substrates that underlie many sandy East Coast beaches contribute to "erosional hotspots." McNinch and his colleagues believe that these ephemeral patches of accelerated erosion may be hindering efforts to protect and replenish beaches all along the Eastern seaboard, and that they contribute to erosion on other sandy beaches worldwide.

McNinch's interests extend offshore as well. In 1999, he and colleagues used their geologic expertise and high-tech instruments to help explain the surprisingly fine preservation of a shipwreck discovered in the shallow waters of Beaufort Inlet, North Carolina in 1996. This vessel is thought to be *Queen Anne's Revenge*—the flagship of Blackbeard the Pirate, which ran aground off Beaufort in 1718.

Erosional hotspots are short stretches of sandy beach that suffer severe erosion during storms. Rapid removal of sand from a hotspot can undermine sea walls and topple nearby structures. Shortly after a storm passes, hotspots refill with sand, leaving little or no evidence of their previous existence.

Traditional measures of beach erosion, which entail pre- and post-storm surveys of a beach profile, can completely miss a hotspot's presence. The recent discovery of these features required the development of high-tech research tools that allow scientists to monitor beaches continuously—even at the height of a storm—and in three dimensions. These tools include time-lapse video cameras; sonar instruments capable of simultaneously measuring water depth, seafloor topography, and the thickness of underlying sediment layers; and amphibious vehicles capable of deploying the sonar equipment even in high seas.

Using these and other tools, McNinch, along with colleagues from North Carolina State University, the U.S. Geological Survey, and Oregon State University, discovered the phenomenon of erosional hotspots during a recent beach study at the US Army Corps of Engineers' Field Research Facility in Duck, North Carolina.

VIMS researcher Jesse McNinch is using a 5-ton amphibious vehicle to study erosional "hotspots." The vehicle can reach speeds of 5 knots in the water and operate up to 5 miles offshore.

Their observations at Duck suggest that hotspots are caused by a complex chain reaction that begins when large storm waves expose muddy patches beneath the sandy surf zone. Exposure of these muddy patches causes changes in bottom currents that alter the configuration of offshore sandbars. Whereas the sandbars that front most Outer Bank beaches run parallel to shore, sandbars near mud patches swing perpendicular to the shoreline and begin to grow shoreward. During fair weather, these perpendicular bars replenish sand to the shore face. But when another storm arrives, they act like open gates that allow large waves to pound and quickly erode the shore.

To test this idea further, McNinch has secured funding from the Army Research Office for a three-year field project to study erosional hotspots at Kill Devil Hills, North Carolina. This beach is particularly conducive to study because it displays both short-term hotspot behavior and long-term, chronic erosion, and has been slated for renourishment by the Army Corps of Engineers. To monitor the beach, McNinch and his team will install five computer-controlled video cameras on the roof of a local motel. These will provide a 2-mile-long panorama of hourly daylight images during the duration of the project. McNinch's team will also periodically map the beach's three-dimensional structure from a sonar-equipped amphibious vehicle.

The Corps is particularly interested in McNinch's work because hotspots have the potential to damage Corps seawalls, hinder Corps beach replenishment efforts, and disrupt military maneuvers. Especially troubling to the Corps and other shoreline management agencies is that the computer models they currently use to predict the longevity and cost of beach protection projects fail to incorporate hotspot dynamics.

"Nearshore sediment-transport models assume a fairly uniform distribution of bed roughness and sediment characteristics, and a sufficient supply of sediment," says McNinch. "Our findings at Duck contradict these assumptions and suggest that sand may be limited and that exposure of older, non-sandy substrates commonly occurs in the surf zone."

McNinch notes that the U.S. will spend about $1.3 billion on beach renourishment over the next decade, and believes that many of these projects may include an erosional hotspot that will lead to shorter than expected project duration and higher maintenance costs.

By establishing a methodology for recognizing hotspots and identifying areas where they may develop in the future, McNinch anticipates that his work will bring immediate benefits to both civilian and military coastal engineering communities.

For further information about hotspot research at VIMS visit http://www.vims.edu/physical/hotspot/

Brill Named as CMER Faculty

Dr. Richard W. Brill, National Marine Fisheries Services (NMFS) Honolulu Laboratory, will join VIMS in March 2002 as Director of the VIMS/NMFS Cooperative Marine Education and Research (CMER) Program. Brill, a fisheries biologist, is internationally recognized for his extensive research on the physiology of tunas and other highly migratory fishes. The CMER Program provides a senior level NMFS scientist to serve as a full-time visiting professor who also functions as a liaison between the university and NMFS.

Dr. Richard W. Brill (left).

Brill's primary research interest is in the physiological ecology of fishes (including sensory biology) and how these relate to movements, distribution, population assessments, and other fishery management issues. He plans to continue this research at VIMS and to develop projects that will include both faculty and students. "I also plan on teaching courses on fish physiology and to provide assistance to students who would like to include physiological questions as part of their research," Brill said.

According to Dr. John Graves, Chair of VIMS' Fisheries Science Department, "The Department of Fisheries Science has long recognized a need for a fish physiologist. We are very fortunate to have an individual of Rich Brill's caliber on our faculty. He brings an internationally recognized program to VIMS, and his ties to several large research programs will provide many opportunities for VIMS faculty and students."

Physical Modeling at VIMS continued from page 1

responds, and use those responses to predict behavior in the real world.

Hydrodynamic models have applications far beyond Craney Island. “Researchers are using these models to help solve problems in geology, ecology, and the atmospheric sciences,” says VIMS researcher Courtney K. Harris. “We use them to predict modification of sediment texture, dispersal of pollutants and larvae, and interactions between water masses and storm systems.”

In the Craney Island project, VIMS researchers John Boon and Harry Wang led a multidisciplinary team including Albert Kuo, Sung-Chan Kim, and Mac Sisson that used the HEM-3D model to investigate how the Elizabeth River estuary would respond to expansion of the Craney Island Dredged Material Management Area (CIDMMA). CIDMMA is a Federally owned and operated facility near Portsmouth that receives dredged material from navigational channels and dock areas in the lower Chesapeake Bay. Operative since the 1950s, CIDMMA is now near capacity, and must be enlarged to meet plans for expansion of Virginia’s deep-water ports.

The VIMS team modified the HEM-3D model, originally designed for use in the James River, to explore the least disruptive direction for landfill expansion at the mouth of the Elizabeth. To comply with EPA regulations, the Corps of Engineers and Virginia Port Authority needed to know how different expansion options might affect the river’s tidal currents, salinity, flushing ability, and sedimentation potential. Because the Elizabeth River’s sediments are highly polluted from almost 400 years of industrial activity and urban growth, it was imperative that expansion not mobilize them by accelerating erosive bottom currents. At the same time, regulations required that expansion must not decrease the ability of the river to flush suspended contaminants out to sea.

The first phase of Boon and Wang’s modeling efforts, completed late in 2001, suggests that eastward expansion is the least disruptive option under normal river conditions. The team is now entering phase two, in which they will explore the river’s response to landfill expansion under a wider range of conditions, including the occurrence of nor’easters during both flood and drought conditions.

Although computer models give scientists and planners a powerful decision-making tool, they are only as good as the data they are fed (as modelers put it: “garbage in, garbage out.”) In addition, modelers can only test their models’ predictions by comparing them to observations of the real system. Thus a synthesis of model output and field observations is a crucial component of any modeling effort.

Harris notes that this interplay between virtual and actual is precisely where VIMS’ strength in physical modeling lies. The newest member of VIMS’ modeling team, Harris was drawn to the institute because it “has the expertise to get real data to help test model results.”

For the Craney Island project, VIMS field researchers had to provide the model with accurate measurements of the Elizabeth River’s tides, salt content, currents, and water quality. They also had to gauge non-tidal changes in water level caused by variations in atmospheric pressure and in freshwater runoff during periods of flood and drought. John Brubaker, Jerome Maa, and other VIMS researchers collected the data by deploying a network of tidal gauges, salinity meters, current profilers, and optical sediment sensors throughout the Elizabeth River estuary, a task made difficult by busy ship traffic.

Once they had collected and analyzed these instrumental data, the VIMS scientists used them to assign numeric values to each parameter (such as salinity, depth, current strength and direction) within the 45,000 grid cells on which the HEM-3D model is based. By running the model under these baseline conditions, the modelers were able to test whether it realistically simulates the estuary’s current behavior. This process of initialization and calibration is a crucial first step in any modeling project, as a model must be shown to accurately emulate a system’s observed behavior before modelers can confidently use it to predict the system’s future behavior under altered conditions.

To model the behavior of the Elizabeth River estuary at the fine time and space scales mandated by stringent EPA requirements, the VIMS researchers were obliged to significantly increase the resolution of their original HEM-3D model. Resolution refers to the spatial dimensions of a model’s grid cells, and the amount of elapsed time between model calculations. As with the pixels that make up images on a computer monitor, smaller grid cells in a model provide higher resolution, and thus a more realistic depiction of the actual system. The original HEM-3D model, which was designed to simulate movement of water and sediment throughout the James River, had a grid size of 370 meters, so that each data point represented conditions within a square of about 1200 ft. per side. In the Craney Island version, VIMS researchers decreased grid size within about 2,500 cells near the Island to only 123 meters (about 400 ft. per side). The model divides each grid cell into six vertical layers between the surface and bottom, and uses mathematical equations to calculate the physical state of each cell layer every 25 seconds. These detailed settings allow the researchers to simulate conditions around Craney Island on the much finer time and space scales needed to predict local changes.

Of course, higher resolution carries a price—each time model resolution is halved the time required for a model run increases by a factor of eight. To simulate one month’s behavior of the Elizabeth River, VIMS researcher Mac Sisson must run the HEM-3D model for six straight hours. The model also generates copious output—a single model run produces three gigabytes of data, enough to fill five CD-ROMs. To meet these computational demands, VIMS relies on a Dec/Compaq/HP ES40 computer, similar to the one used to help map the human genome.

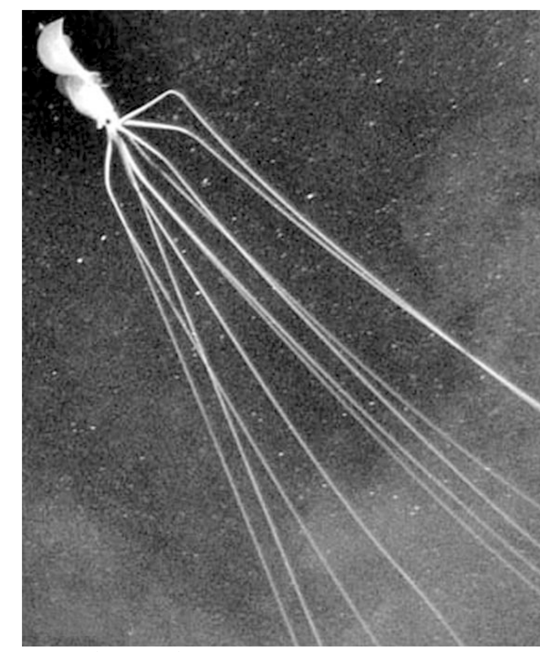
VIMS’ state-of-the-art modeling capabilities allow little rest for either computers or researchers in the Physical Sciences Department. In addition to Craney Island, VIMS modelers and field researchers are currently involved in numerous other projects, including the U.S. Geological Survey’s Community Sediment Transport Modeling effort, and the Office of Naval Research’s STRATAFORM initiative.

For further information on physical modeling at VIMS (including on-line access to the Craney Island Project final report), visit the VIMS Physical Science web site at http://www.vims.edu/physical/projects

Large Squid Discovered

In a recent article in *Science*, Dr. Michael Vecchione, Adjunct Faculty VIMS Dept. of Fisheries Science, published the first reports of what may be a new family of very large squid. The squid, which differs from any other squid previously described is estimated to be 22 feet long including a 2 foot long body, and has been observed in deep waters (over 1,000 meters) at several sites worldwide. Vecchione explains that the bathypelagic or deep-water realm is basically unexplored in spite of being the largest ecosystem on earth. “Scientists are generally looking at specific sites, such as hydrothermal vents, ship wrecks, etc. when they are in this realm. They rarely have the opportunity to simply browse. Several colleagues just happened to bump into these animals while doing other research in deep-water submersibles.”

Three years ago, Vecchione and colleague Dick Young from the University of Hawaii described a new family of squid from juveniles they discovered living within 200 meters of the surface. Vecchione suspects this new squid may well be an adult of the same family. “The juveniles we described had unusual tips on their arms and tentacles. Their general body shape with large fins and the way the fins connect to body leads me to suspect that we may now be seeing adults.” It is not unusual for adults to live in deeper waters than juveniles. Vecchione emphasizes that this underscores how little we know about life on Earth.



Video frame of unusual deep-water squid observed from a submersible in the Gulf of Mexico.

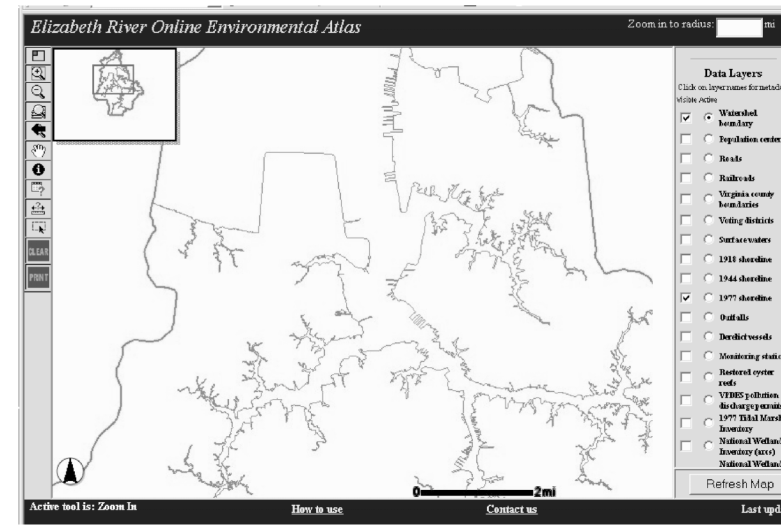
VIMS Develops New Online Tools for Managers

By Marcia Berman

The Comprehensive Coastal Inventory Program (CCI) at VIMS recently launched three Internet based interactive map applications. "This is a great advancement in Geographic Information System (GIS) technology," said Marcia Berman, head of CCI. "Through the Internet, users can access GIS data, perform queries, and build map compositions without the need for GIS software on their desktop. A user requires an Internet connection only." As the host, CCI developed an online interface which prompts a user to select from a list of GIS themes (layers). The interface calls to the host server to retrieve selected data. Using specialized tools, the user can also query the database directly for attribute information. Maps can be composed and printed.

Each interactive map application was developed for a different purpose and audience. The Shoreline Managers Assessment Kit (SMAK) was developed for state and local government shoreline planners, and allows individual access to a large archive of GIS data that characterizes shoreline conditions in Virginia. Among other things, a user can view shoreline, tidal marshes, location of bulkheads and riprap, location of boat ramps, and the extent of SAV beds in shallow water habitat.

OSCAR, the Oil Spill Clean-up and Response Tool ,was designed for oil spill responders to rapidly display a collection of geographic data themes that designate sensitive areas within the Bay. This tool will soon be extended to include a layer that illustrates the placement of booms identified in USCG-approved boom strategies for certain major military installations in the region. Combined with tidal and meteorological data, OSCAR helps responders locate environmentally sensitive resources and anticipate which areas are at risk during spill events.



Example of online GIS data application.

The Elizabeth River Online Environmental Atlas is the third interactive mapping tool. This product was developed for use by any individual with an interest in the health and quality of the Elizabeth River Watershed. Data assembled includes images, land use and land cover, water quality monitoring stations, and ecologically important resources.

All three tools can be accessed at http://ccrm.vims.edu/output/virginia/introduction.htm

Marine Industry Trends- A Tale of Two Fisheries

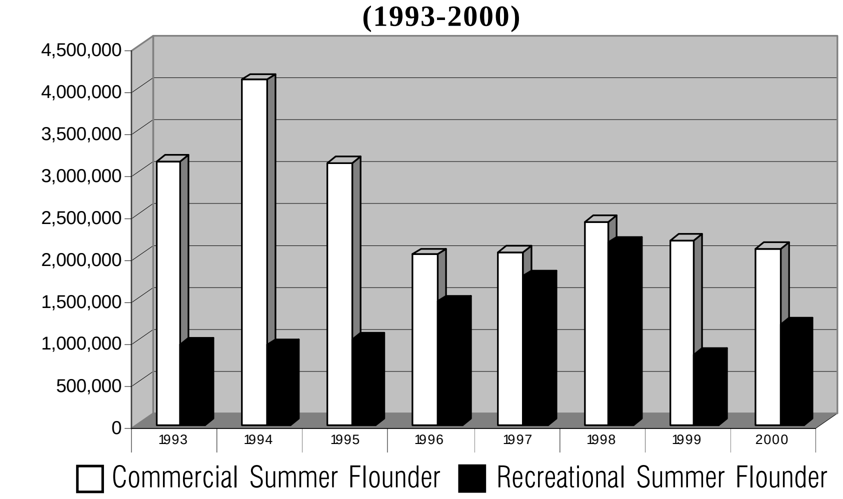
By Tom Murray

With continued growth in both recreational saltwater angling and traditional commercial fishing, one wonders how the resources—as measured by overall catches—are faring, and how relative shares of the total harvest are playing out. Most feel that although government-associated harvest data are not without some shortcomings, they represent the best information available to assess catches and gain some insight into fishery trends. And while commercial and recreational data collection efforts differ in their approaches (the former, generally mandatory; the latter, primarily by voluntary angler surveys), use of the data to track overall catch is helpful.

The striped bass represents an economically important inshore finfish species to the Commonwealth. It therefore serves as a useful example in gauging both the growth in catches overall and the relative harvests by user group. The final 2001 catch statistics are not yet available for either commercial or recreational landings. However, between the commercial catch data available from Virginia's Marine Resources Commission (VMRC) and the recreational catch estimates provided by the National Marine Fisheries Service (NMFS), some trends and comparisons are readily available for Virginia fisheries. As depicted in Figure 1, under recent management practices the average total catches in both sport and commercial fishing have increased since 1994.

Another important Virginia fishery, summer flounder, has exhibited a mixed track record for the same eight-year period according to the same databases summarized in Figure 2.

Figure 2. Sport and Commercial Catch of Summer Flounder in Virginia (1993-2000)

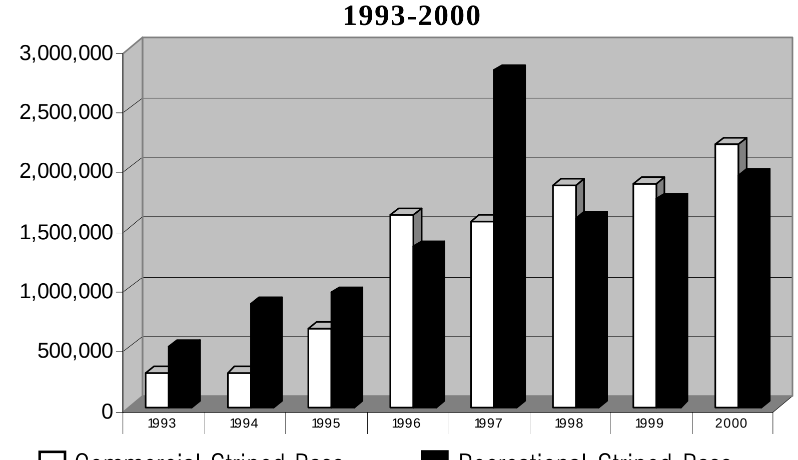


The summer flounder stock has been managed federally since 1989 and is believed to be rebuilding under a catch quota system adopted in 1993. Reportedly, the coast-wide (Maine-North Carolina) commercial summer flounder fishery continues to exhibit strength but, according to the NMFS, it has been "encountering a bumpy road along the way." Many believe that additional management measures are needed for the inshore component of the fishery.

Currently, the VMRC proposes to reduce the recreational harvest of summer flounder in 2002 by 43.8 percent in order to comply with the Atlantic States Marine Fisheries Commission's (ASFMC) *Interstate Fishery Management Plan for Summer Flounder.* The VMRC is looking at combining several management options. Increasing the minimum size limit to 18 inches, reducing the possession limit to as few as two fish, and closing seasons for several months will all be considered.

At the same time, new regulations developed by the NMFS and the ASMFC will allow an increase in catch limits for 2002. The new quota allocates 60 percent (or 14.58 million pounds) to the commercial industry and 40 percent (or 9.72 million pounds) to sport fishermen, representing an overall increase of 36 percent from the 2001 quota of 17.9 million pounds. How the future fishery for summer flounder develops is the subject of much discussion and confusion as we begin 2002.

Figure 1. Striped Bass Catch by Sport and Commercial Fishermen (lbs.) 1993-2000



VIMS Urges Caution in Commercial Release of Non-Native Oysters to Chesapeake Bay

By David Malmquist

Two recent VIMS publications help provide a scientific basis for decisions concerning the potential use of non-native oysters to help rejuvenate Virginia's ailing shellfish industry and the Chesapeake Bay ecosystem.

The publications are based on five years of research by VIMS scientists. Their carefully controlled field experiments with small, sterilized populations of the Asian oyster *Crassostrea ariakensis* show that this non-native species grows faster and is more disease resistant than the native oyster *Crassostrea virginica*—while tasting just as good.

These promising results suggest to some oyster farmers, watermen, and resource managers that Chesapeake Bay be opened to large-scale aquaculture using sterile *ariakensis*. Others go a step further, arguing for introduction of reproductively capable *ariakensis*, in hopes of establishing a wild population to provide some of the ecological benefits once afforded by the native oyster.

The VIMS' publications address both possibilities. The *Statement on the use of* Crassostrea ariakensis *in Chesapeake Bay* advises against intentional release of reproductively capable *C. ariakensis* into the waters of the Commonwealth, calling it "imprudent" at this time in light of the uncertain ecological consequences of introducing non-native species. The statement also argues that any decision to release fertile *ariakensis* into Virginia waters should include stakeholders beyond the Commonwealth, "for the obvious reasons that colonization is enabled by larval transport and that risks and merits of this species may vary spatially."

The VIMS' statement views the use of sterile *ariakensis* more favorably, but urges a cautionary approach. The statement advocates caution in light of experimental evidence that sterilized oysters may regain reproductive capacity in the field, and recognition of the greater risk of accidentally releasing fertile individuals if and when small-scale field trials shift to large-scale commercial operations. The statement advocates continued testing in light of the oyster's potential economic and ecological benefits. It notes that "carefully designed and monitored commercial trials serve the dual purpose of providing data on the long-term aquaculture potential and the ecological impacts of this species."


Hatchery manager, Ron Zebal, placing non-native oysters in an isolation tank.

The second VIMS report describes and codifies the "biosafety protocols" developed by VIMS researchers over the last five years to minimize the risk of accidentally introducing fertile *ariakensis* into the Chesapeake. This report was approved by the Virginia Marine Resource Commission in January, and will serve as a biosecurity blueprint for any future VIMS research on *ariakensis* or other non-native species.

Triploid *Crassostrea ariakensis* grown in the VIMS hatchery.

The report, *Standing Policy for Non-native Oyster Research in Virginia*, specifies five levels of biosecurity tailored to prevent accidental release of non-native species (or any diseases they might carry) during any stage of the organisms' life cycle. The first level entails quarantine procedures in VIMS' Gloucester Point hatchery for newly imported adult animals. These procedures are designed to prevent imported adult organisms from escaping into Bay waters, and, just as importantly, from introducing to the Bay any diseases, parasites, larvae, or gametes.

Subsequent biosecurity levels apply to second-generation organisms that have been certified disease free. These measures focus on preventing the release of adults, larvae, and gametes, and are used at Gloucester Point and the VIMS Eastern Shore laboratory in Wachapreague. They employ physical barriers to prevent the escape of adults and juveniles, and treatment with chlorine to kill any larvae or gametes in wastewater. For field trials with non-natives, the controls specify deployment of sterile organisms only. The report also specifies safeguards to prevent release due to poaching, vandalism, and severe storms such as hurricanes. Soon, most, if not all, non-native oysters will be kept in VIMS' new Kauffman Aquaculture Center, a first of its kind for isolating oysters in quarantine.

The *Standing Policy* report mostly describes biosecurity measures that have been in use since VIMS first began working with non-natives. The only exception is a plan to relax the existing labor-intensive protocols during winter, when water temperatures lower than 12°C (54°F) render oyster reproduction moot, as gametes are inviable and spawning impossible.

Standing Policy cites the use of sterile animals as a key factor in preventing the accidental introduction of *ariakensis* to the Bay. VIMS' researchers render oysters sterile through chemical treatment or selective breeding. Both methods produce "triploid" oysters with three sets of chromosomes, rather than the pair of chromosomes carried by regular diploid oysters. The extra set of chromosomes renders triploid oysters sterile. However, field tests show that some triploid oysters can over several years begin to revert to an intermediate condition wherein they contain both triploid and diploid cells. This raises the possibility that some triploid oysters may eventually regain reproductive capacity (although this has not been observed).

The report describes numerous safeguards designed to ensure the sterility of field-test oysters. These include genetic testing of sperm, larvae, and spat to ensure their triploid condition before any field releases, and routine sampling of deployed animals to track their genetic condition. If sampling indicates a high rate of reversion from triploid to diploid cells, or the presence of viable gametes, the protocols call for immediate removal of the oysters.

To read the full text of these VIMS publications on-line, visit http://www.vims.edu/newsmedia/pubs/index.html

VIMS Scientists Part of National Study in Antarctica

By David Malmquist

VIMS researchers have returned to Antarctica's frigid, stormy waters to further test one of oceanography's most controversial hypotheses—the idea that fertilizing the ocean with iron can help curb global warming by boosting the rate at which marine plants remove carbon dioxide from the atmosphere.

Supported by grants from the U.S. National Science Foundation and Department of Energy to VIMS researchers Walker Smith, Hugh Ducklow, and Jim Bauer, four VIMS graduate students and a technician are currently down under as part of SOFeX (the Southern Ocean Iron Experiment). This is a two-year collaborative effort that involves three ships, 45 tons of equipment and supplies, and 17 leading U.S. oceanographic institutions.

SOFeX is designed to test the "iron hypothesis," an idea first put forth by the late oceanographer John Martin. He argued that a shortage of iron—a minor yet crucial ingredient for phytoplankton growth—explained ocean "deserts." These are vast stretches of open ocean that support few phytoplankton despite ample stores of nitrogen and phosphorous, the two main nutrients that these tiny, floating plants require to grow.

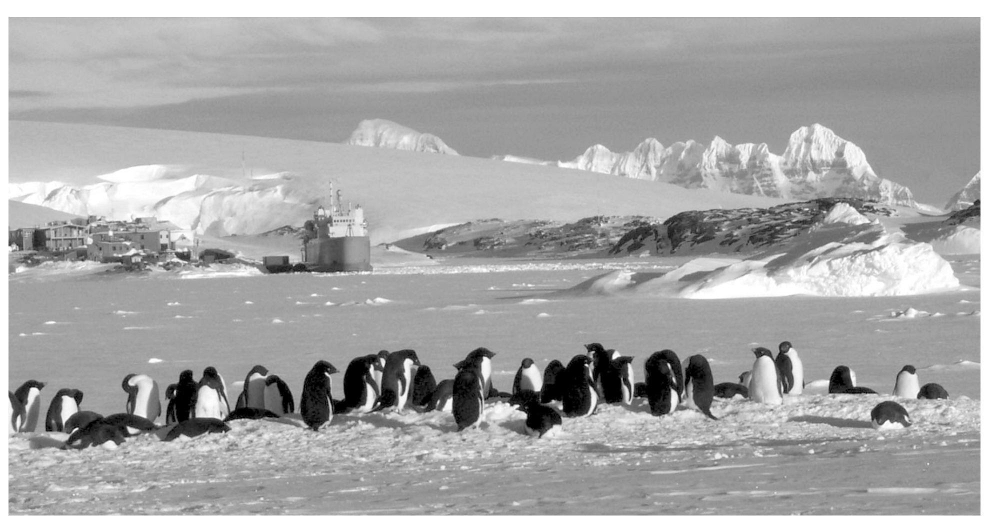
Add iron to these deserts, Martin argued, and you could make the ocean bloom. Early experiments proved him right—sprinkling just 1,000 pounds of iron across a patch of the equatorial Pacific produced a verdant bloom of phytoplankton whose biomass equaled that of 100 full-grown redwoods.

Although Martin posed his idea to help solve a long-standing scientific puzzle (the cause of ice ages), it quickly captured the attention of both policymakers and entrepreneurs. That's because phytoplankton take up carbon dioxide from seawater during photosynthesis, allowing the ocean surface to absorb more of this gas from the atmosphere. Because carbon dioxide is the main greenhouse gas, any reduction in its atmospheric concentration would help to curb global warming.

The seemingly intractable politics of global warming suddenly seemed to have a quick (and profitable) fix. Instead of spending $50-100 per ton to put scrubbers on power-plant smokestacks, a coal company could instead pay as little as $3 a ton to dump iron into the open ocean. A Virginia-based start-up, Ocean Farming Inc., already has plans to supply the iron and the boats. It argues that it could suck humanity's entire annual carbon dioxide output into the sea with 8 million tons of iron, a fleet of 200 ships, access to 10 percent of the world's ocean—and the help of countless phytoplankton.

Not so fast, say most scientists, including VIMS' Walker Smith. "The concept of [large-scale iron fertilization] is appealing, because it's so cheap," says Smith, "but most scientists think it's a bad idea."

Oceanographers are concerned because they have little knowledge of how the ocean food web might respond to a huge influx of iron. They're also unsure how much of the carbon captured by phytoplankton might sink to the deep ocean (where it would remain for hundreds of years), and how much might be cycled through the surface food web back into dissolved carbon dioxide gas (which would limit further uptake of carbon dioxide gas from the atmosphere).



A view of Palmer Antarctic Research Station.

Researchers are also uneasy because they know relatively little about the potential response of the Antarctica ecosystem to iron enrichment. Antarctica's Southern Ocean is the most likely site for any future large-scale iron-fertilization projects (it's the world's largest ocean desert and outside busy shipping lanes), but it might respond to added iron very differently than the equatorial waters where the early iron experiments were done.

SOFeX is designed to help answer these concerns, says Smith. The project began on January 5th, when the 274 ft. R/V *Revelle* left New Zealand to begin adding iron to two 80-square mile patches of the Southern Ocean near Antarctica, pumping 10 tons of iron sulfate from two 5,000 gallon on-deck tanks into the ship's wake. Researchers aboard the second SOFeX ship, the 278 ft. R/V *Melville*, which left New Zealand on January 19th, are examining the biological subtleties of the anticipated bloom.

Smith's graduate students Jill Peloquin and Liza Delizo are working to identify the particular kinds of phytoplankton that are most affected by iron fertilization, and to better understand the nature of their response. They suspect that diatoms—single-celled plants that construct a skeleton from silica—are likely to grow the fastest. Iron could boost diatoms' growth rates in a number of ways, says Smith. It might allow them to photosynthesize more efficiently, extend their peak photosynthetic efficiency over a wider range of light intensities, or achieve their greatest photosynthetic capacity at lower light levels.

Smith's team is also collaborating with other SOFeX researchers to study the role of silica—another substance that, like iron, limits phytoplankton growth in parts of the Southern Ocean. The researchers plan to study silica's role by creating their first iron patch in a silica-poor area north of Antarctica, and the second in a silica-rich area nearer the continent. Comparing the response of phytoplankton to iron enrichment in these two areas will help the scientists unravel the confounding effects of the two elements.

Hugh Ducklow's graduate student Jacques Oliver is studying the response of microbes (marine bacteria) to iron enrichment. A key question for this duo is whether bacteria respond to iron enrichment directly through their own metabolism, or indirectly, by consuming the carbon-rich organic matter produced by the iron-induced phytoplankton bloom. Microbes are a crucial

Ph.D. student Jill Peloquin in laboratory aboard the R/V *Roger Revelle.*

component of the ocean food web and carbon cycle, both in the Southern Ocean and elsewhere, because they turn the carbon fixed by phytoplankton back into carbon dioxide in surface waters. By so doing, they help maintain high levels of this greenhouse gas in the atmosphere, and thus may negate any efforts to curb global warming via iron enrichment.

The third SOFeX vessel is the U.S. Coast Guard cutter *Polar Star*, which sailed from McMurdo Station, Antarctica on February 12th. Its goal is twofold: to help track the iron patches as winds and currents move them across the Southern Ocean, and to retrieve drifting sediment traps deployed earlier from the R/V *Revelle*.

Jim Bauer's technician Eva Bailey, along with current Ducklow graduate student Bob Daniels and former VIMS' student Chrissy van Hilst, are involved in these efforts. Their intent is to determine how much of the carbon captured by the phytoplankton bloom sinks to the ocean depths when the plankton die or are eaten, and how much remains at the ocean surface. Carbon in the deep ocean contributes nothing to global warming and can remain there for hundreds or thousands of years.

According to Smith, measurement of this "sinking flux" is crucial. Although early experiments clearly proved that iron enhances the uptake of carbon dioxide by phytoplankton, "no one has seen carbon disappear from the surface," says Smith. If marine animals and bacteria transform plankton-derived carbon back into carbon dioxide gas before it sinks to the depths, the promise of a quick-fix to global warming may prove nothing more than a tantalizing chimera.

To track the adventures of VIMS Antarctic researchers online, visit http://www.mbari.org/education/cruises/SOFeX2002/logbook.htm

Calendar of Events

—February 2002—

23 Blue Crab Bowl- ODU
27 Mini School of Marine Science, Ft. Monroe

—March 2002—

2-10 Spring Break
6 Mini School of Marine Science, Ft. Monroe
12 Mini School of Marine Science, Washington, DC
13 Mini School of Marine Science, Ft. Monroe
20-22 Revised Introduction to Wetlands ID/DEQ

—April 2002—

2-4 Advanced Wetlands ID/VDOT
9 Mini School of Marine Science, Washington, DC
15 Seafood Seminar
18 VIMS Council Meeting
20 VIMS Auction (see article below for additional information)
22 Seafood Seminar
26 Public Tours Begin (see article below for additional information)
27 Benefit Cruise- Waterside to Craney Island: VIMS Monitoring and Modelling Projects. Call 804/684-7099 for details.

—May 2002—

4 USCGA Boating Safety Class
4 Concert Series- Richard Smith and Julie Adams
7-9 Advanced Wetlands ID/VDOT
11 USCGA Boating Safety Class
12 Commencement
13 Seafood Seminar
14-17 Librarians Association Conference- SAIL
18 VIMS Open House
20 Seafood Seminar

For more information call 804/684-7101 or 804/684-7011.

Visit our website at www.vims.edu

VIMS Acoustic Masters Series

VIMS is pleased to present a series of six benefit concerts with performances by the world's foremost acoustic musicians. The series features artists from America, Australia, England and Italy. A variety of pre-concert dinners are planned to round out an exceptional evening. All proceeds benefit the VIMS Hargis Library Endowment.

Upcoming concert performances and dates are: Richard Smith and Julie Adams, May 4; Beppe Gambetta and Carlo Aonzo, June 14; Steve Smith, July 6; and Pat Donahue, Sept. 13.

Please contact Lisa Phipps at 804-684-7099 for concert and dinner information and tickets. For additional details visit www.vims.edu/calendars and select "Public Events."

Pat Donahue, from Prairie Home Companion, will perform at VIMS in September.

Pilot Sam White

The VIMS community was saddened by the unexpected death of former aircraft pilot Sam White. Until his retirement in 1998, Sam and his beloved "Beaver" were central to the success of many research projects at the Institute. He was especially crucial in the applied shoreline and wetland studies programs, programs involving surveys of fishing effort and population studies of sea turtles and dolphins and low altitude remote sensing of Chesapeake Bay water quality, as well as numerous other studies. Sam and the *Beaver* aircraft were well known and respected at the many waypoints fringing the Chesapeake Bay. On many occasions, Sam assisted boats in distress and alerted officials to oil spills.

Sam White and the *Beaver.*

For information on the Sam White Memorial Fund at VIMS, please contact Lisa Phipps at (804) 684-7099.

Tours of VIMS

Public Tours of VIMS' Gloucester Point Campus will be offered again this year on Fridays, beginning April 26th and continuing through October 25th. A brief history of VIMS, the Aquarium, and Teaching Marsh are highlights on the tour. Lasting approximately 1½ hours, this walking tour is most interesting for adults and older children. Private group tours can be arranged throughout the year. Please call in advance (804) 684-7846 or email susanp@vims.edu

VIMS Auction

VIMS 4th Annual Auction will be held in the VIMS Library on April 20th.

Extraordinary community support continues to make an exciting evening. Activities include a silent auction, live auction, and raffle as well as entertainment and hors d'oeuvres. Proceeds benefit the Hargis Library Endowment. Watch for additional details as the date draws near. For information and tickets call Lisa Phipps, (804) 684-7099 or email lcphip@vims.edu

New VIMS Council Members

VIMS is pleased to welcome Lorenzo D. Amory III, Thomas E. Kellum, and Robert P. Roper, Jr. to the Virginia Institute of Marine Science Council.

Amory, a senior member of the Virginia Pilot Association, has thirty-five years experience in port-related business. He is presently Chairman of the Board of the Virginia Maritime Heritage Foundation and serves on the development council of the Mariners Museum.

Kellum, currently Vice-President of W. Ellery Kellum, Inc., is the third generation of his family involved in oyster processing. He also serves as Regional Vice-President of the Virginia Seafood Council and is a member of the VMRC shellfish committee.

Roper, a marketing consultant, is retired from Philip Morris Companies, Inc., where he served in a number of senior management positions, including President, Philip Morris Japan. He currently serves as Chairman of the Board of Directors of the Mathews Community Foundation.

Former VIMS Council member Hon. Tayloe Murphy was recently appointed Secretary of Natural Resources by Governor Warner.

The diverse expertise of these three new members will be an excellent addition to the VIMS Council.