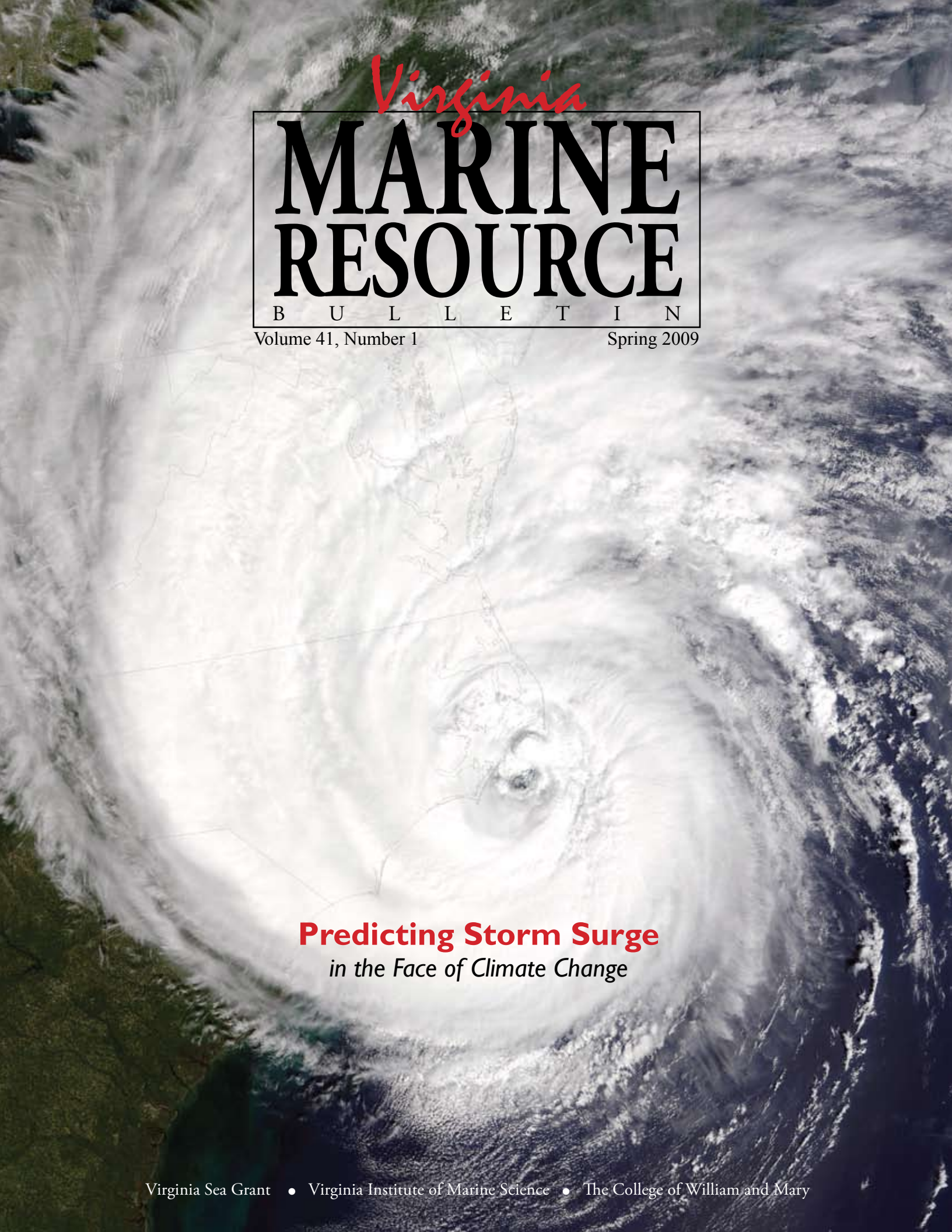

Virginia
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B U L L E T I N
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Predicting Storm Surge
in the Face of Climate Change

Virginia Sea Grant • Virginia Institute of Marine Science • The College of William and Mary

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Cover: Hurricane Isabel came ashore in September 2003, bringing devastating floods to tidewater Virginia. Photo © NASA

From the Editor

In the spirit of the season, Virginia Sea Grant (VASG) is doing some spring cleaning. To make sure our mailing list is spic and span, we're asking you to return the postcard on the cover to renew your subscription to the *Virginia Marine Resource Bulletin* and make any necessary changes to your address. You can also sign up to receive our new electronic-only edition to get an email notifying you when you can download the magazine from our website. We're hoping these efforts will help us reduce our effect on the planet and cut down printing costs while continuing to deliver the coastal and ocean news and information you expect from the *Bulletin*.

Other changes are also afoot this spring—the biggest being VASG's new strategic plan. A preliminary draft is now available on our website www.vims.edu/seagrant. Check it out and let us know what you think.

As we look to the future, VASG is combining the best of our past programs and strengths with new initiatives aimed at tackling growing challenges such as adapting to climate change, advancing sustainable coastal community development, and enhancing the resilience of communities in the face of coastal hazards.

This issue of the *Bulletin* focuses on some of those current trends and on VASG's work to deal with them. We've been exploring ways to help Virginia's coastal communities prepare for the increased sea level rise and flooding risk that come with global climate change, including funding outreach efforts to local officials and emergency managers. Over the past several years, our partners at the Virginia Seafood Agricultural Research & Extension Center in Hampton have developed Spanish-language training programs that are helping the seafood processing industry adapt to changing workforce demographics. Our well-established aquaculture programs are continuing to foster the growth of oyster aquaculture by developing and teaching innovative culture methods.

These are just a few of the ways VASG is adapting to meet the pressing needs of coastal communities and businesses. Don't forget to check out the "News from the Point" section of this issue to learn about more projects and people we're supporting, from our 2008 Knauss Fellows to 2009 research grant recipients.

— Margaret Pizer

In This Issue

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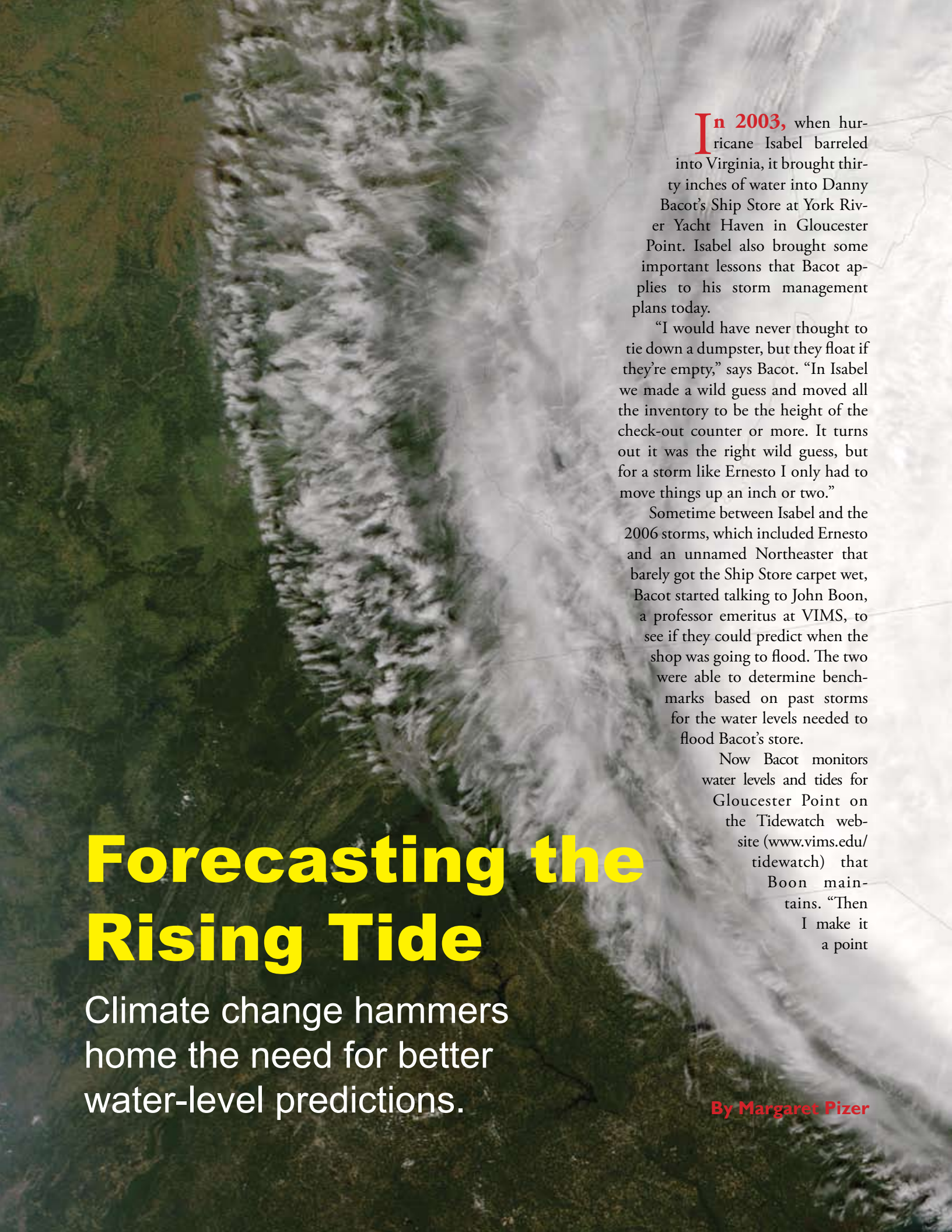


Forecasting the Rising Tide

Climate change hammers home the need for better water-level predictions.

In 2003, when hurricane Isabel barreled into Virginia, it brought thirty inches of water into Danny Bacot's Ship Store at York River Yacht Haven in Gloucester Point. Isabel also brought some important lessons that Bacot applies to his storm management plans today.

"I would have never thought to tie down a dumpster, but they float if they're empty," says Bacot. "In Isabel we made a wild guess and moved all the inventory to be the height of the check-out counter or more. It turns out it was the right wild guess, but for a storm like Ernesto I only had to move things up an inch or two."

Sometime between Isabel and the 2006 storms, which included Ernesto and an unnamed Northeaster that barely got the Ship Store carpet wet, Bacot started talking to John Boon, a professor emeritus at VIMS, to see if they could predict when the shop was going to flood. The two were able to determine benchmarks based on past storms for the water levels needed to flood Bacot's store.

Now Bacot monitors water levels and tides for Gloucester Point on the Tidewatch website (www.vims.edu/tidewatch) that Boon maintains. "Then I make it a point

By Margaret Pizer

in my storm preparations to find John and ask him what the water levels are going to do."

While not everyone in coastal Virginia has John Boon's phone number (luckily for him), Boon and several other researchers at VIMS are hard at work on projects that aim to give everyone the same type of predictive power that Bacot gets from those calls. Boon's goal is to add storm-surge and water-level predictions to the Tidewatch website, while his colleague Harry Wang is working on computer models that can predict flooding at the street level.

The potential of these projects is huge—to help all of us plan for and protect ourselves from the effects of storms that are expected to buffet our coasts with increasing frequency and more devastating effects due to climate change and sea-level rise.

Climate Change Realities

"The Chesapeake Bay has one of the longest records of sea level at Sewells Point and Baltimore Harbor," says Wang. These records have allowed NOAA scientists to calculate that sea level in the region has risen by an average of about four millimeters per year relative to the land since 1928. A recent report by the U.S. Climate Change Science Program (www.climatescience.gov) suggests a future scenario for the Mid-Atlantic region that includes an additional sea-level rise of more than three feet by 2100—an alarming possibility in a place where many homes and businesses are already within inches of the high-tide line.

Not every region has such a long record of water-level data, but a comparison of the data that are available indicates that the Mid-Atlantic has one of the highest rates of sea-level rise on the East Coast. Scientists attribute this difference to land subsidence in the region (we're sinking), which combines with sea-level rise due to global climate change. Rising global temperatures contribute to higher sea levels through melting of the Antarctic ice cap and glaciers, as well as through thermal expansion—as ocean waters become warmer, they expand slightly and thus the same amount of water takes up more space.

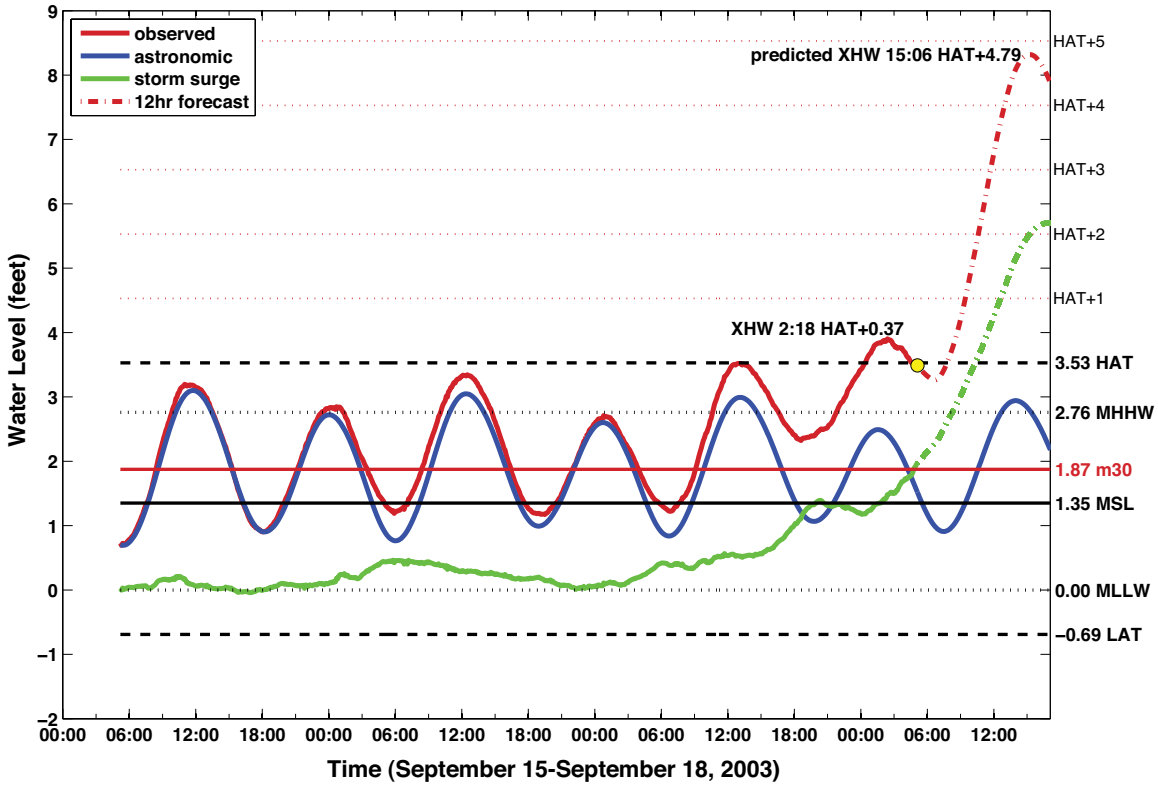
Warmer oceans can also lead to the formation of more severe tropical storms and hurricanes, but perhaps equally important for coastal Virginia is the fact that rising base sea levels mean that even less-severe storms can produce more damaging floods. In one example of this effect, Boon, Wang, and VIMS colleague Jian Shen compared the August 1933 "storm of the century" at Hampton Roads to Isabel, which was a category one storm when it hit Virginia. Despite being a weaker storm, Isabel brought maximum water levels that were comparable to those seen in the 1933 storm. Boon, Wang, and Shen attribute this to the fact that the monthly mean sea level during Isabel was about 1.4 feet higher, a difference that was mostly due to sea-level rise during the intervening seventy years.

How High Is the Water?

Scientists like Boon and Wang can sometimes speak in an alphabet soup of what they call "datums," the statistics they use to describe tides and water levels. But to understand the factors that go into determining where flooding will occur, you need to know just a few of these terms. For example, Boon has determined that flooding at York River Yacht Haven will occur when the extratidal high water (XHW) at the Yorktown Coast Guard Training Center is 2.5 feet. To understand what that means, we can take a look at one of the graphs the Tidewatch website produces (next page).

The system Boon and his collaborators, including fellow VIMS professors John Brubacker and Dave Forrest, and technicians Todd Nelson and Tim Gass, have been working on is a network of water-level gauges located at eight locations around Chesapeake Bay. The Tidewatch website updates every half hour and shows astronomical tides (in blue), observed water levels (in red), and storm surge (calculated as the difference between the two, in green) at each location.

XHW is defined as an observed water level that exceeds the highest predicted high tide for that location. Storms are the most obvious factor that can cause water levels to exceed the predicted high-tide level, and since most people in coastal areas are prepared for the typical range of predicted tides, flooding should only become a problem when water levels rise into extratidal range. On the Tidewatch graphs, XHW is measured as the height above the highest tide predicted using as-



Tides and water levels at Sewells Point, VA, during Hurricane Isabel. Observed water levels (red) are the sum of astronomical tide and storm surge. Boon has added predicted storm surge (dotted green) and used it to predict observed water level beyond the last observed data point on the graph (yellow). Key to abbreviations: HAT=Highest Astronomical Tide, LAT=Lowest Astronomical Tide, MHHW=Mean High High Water, MLLW=Mean Low Low Water, MSL=Mean Sea Level (averaged from 1983–2001), m30=Mean water level (averaged over last thirty days).

tronomical models (called highest astronomical tide or HAT).

"One of the things that we've been trying to do is put something together that has all of the information that emergency managers might need but is not so overly technical that people can't get their minds around it," says Boon. Because the storm surge is not always in phase with the tide, that next extreme water level may not occur at predicted high tide, Boon explains. "That phasing can alter dramatically when you're going to actually see your highest high water (XHW)."

"We've asked ourselves this question," says Boon, "if we knew something about what that surge was going to do in the next twelve hours, could we then add that on to our prediction of the astronomic tide and come up with a forecast of the next high water?" Storm surge predictions are available from the National Weather Service, and Boon is working to incorporate them into his graphs (dotted green line). "We think that would be very important to emergency managers," he adds. "We could tell them how high that next extreme is going to be and when it is going to occur at places where we have active water level monitoring going on."

Testing the Models

Another benefit of the network of water gauges that Boon and his colleagues maintain is that they provide ground truthing for large-scale models that show great potential for predicting how flooding will happen in the event of the next big storm. Wang is working with a team of other researchers on one such model that would provide city-block-level predictions of inundation. The model is the product of the NOAA-funded Chesapeake Bay Inundation Prediction System (CIPS).

The challenge is to model flooding over a large area, but with very fine resolution, explains Wang. "A hurricane is on the order of 300 to 500 km wide, so you don't want to wait until it reaches your doorstep. You want to track it when it's far away. But the real impact—the scale of the damage—is on the order of 100 meters, like a home or a street."

To meet this challenge, the model breaks up a large area into a grid that is finest over land, and least fine over deep water. Within each section of the grid, water levels are predicted based on wind velocities and directions, tides, topography, and water depth. "Once we simulate with the model, we need to see how well we've done," says Wang, and this is where data from the water level gauges come in. Wang can compare what his model would have predicted during Isabel or Ernesto with the actual data collected during the storms at Sewells Point or other gauges. "Right now our predictions are accurate to within about fifteen centimeters (about six inches). That's where the uncertainty begins to kick in."

One of the limiting factors for these models at the moment is the availability of good topographic data. The output of the model at the street level is only as accurate as the data fed into it about the contours of the land.

Wang's ultimate goal is similar to Boon's—to help coastal residents and emergency managers prepare for storms. "Eventually we'd like to generate flooding maps in real time, but a lot of work and investment will be needed," says Wang.

Putting Science to Work

The modeling and predictions that Wang and Boon are working on have real, practical effects for coastal residents. When a storm approaches, Danny Bacot has to decide how to manage a variety of things, from how high he moves his merchandise to whether to haul out boats from his marina. "Do I go ahead and reserve the carpet vacuums or not?" Bacot asks with a smile. "Those are the types of decisions that I make using John's information."

All joking aside, storms like Katrina have driven home the message that being able to plan and prepare for storms has life-and-death implications—from evacuating nursing home residents to protecting critical infrastructure like power grids. With this in mind, the VIMS researchers are seeking a variety of community collaborations.

Boon is hoping to work with the National Weather Service and local meteorologists to get accurate water-level predictions onto the nightly newscast. He and Wang and their VIMS colleagues have conducted workshops in communities like Poquoson and Jamestown that are at risk from flooding, and the scientists are working with city engineers, planners, and emergency managers to help them take the effects of sea-level rise into account in their development and emergency management plans. Brubaker, Forrest, and Boon have also recently garnered Virginia Sea Grant (VASG) funding for an outreach project in Middlesex County that will include workshops and demonstrations of the Tidewatch system to emergency managers and other local officials.

©Matthews County Public Schools

Flooding on Main St. in Matthews, VA, during Hurricane Isabel.

VASG marine extension leader Tom Murray says facilitating these outreach efforts is a natural fit. "Virginia Sea Grant supports this outreach aimed at providing the most contemporary, local, science-based information to the Commonwealth's coastal communities. A better understanding of the local risks arising from the increasing intensity of coastal storms and flooding will help residents and leaders develop practices to reduce vulnerability and allow for a quicker and more effective response when coastal flooding occurs."

Trabajadores

[trah-bah-hah-dor-ez] (n): The new workforce in Virginia seafood processing.

by Phil Marsosudiro

Johnny Graham is a fourth-generation seafood man. His great-grandfather was a fisherman, and in 1955, his grandfather founded the company that became Graham and Rollins Seafood in downtown Hampton. Graham recalls, "At our height in 1991, we had four production plants running 10,000 pounds of finished crab meat per day." The plant was full of locally grown workers processing locally harvested crab. But things aren't like that anymore.

"During these down years, we've lost our local laborers because there's no steady employment," says Graham, now the company's president. "So we've had to turn to seasonal migrant labor."

As is now common across Virginia, "seasonal migrant labor" mostly means workers—trabajadores—from Mexico and other Spanish-speaking countries such as Honduras and Guatemala.

The seafood producers like Graham vouch that Hispanic workers are a vital solution for staffing their seasonal positions, but of course this new workforce presents new challenges. One of the biggest is the language barrier, which makes it more difficult to train and communicate with workers about critical issues affecting their own safety and the safety of the products they process.

Fortunately, when it comes to food safety, Graham can rely on Abigail Villalba, food safety specialist at Virginia Tech. Working through the Virginia Seafood Agricultural Research & Extension Center (VSAREC), Villalba provides bilingual training to both Spanish- and English-speaking workers at Graham and Rollins.

"You'd be amazed at what needs to be mentioned," says Villalba. In Latin America, for example, toilet paper goes into a waste bin instead of the toilet to protect the plumbing. Here, of course, the *papeles higiénicos* go down the drain to protect against germs. Who's going to know that such a thing needs to be explained, or how to say it, if they don't know the language and culture?

Not Your Grandfather's Picking House

It's no secret that the Spanish-speaking population in Virginia has grown tremendously over the past decades. Villalba points to U.S. Census data showing that Virginia's Hispanic population tripled from 152,000 in 1990 to more than 460,000 in 2006, now representing more than six percent of the state's population. According to the American Community Survey, approximately one third of Virginia's Hispanics in 2006 were immigrants (as distinct from permanent residents or citizens).

During the same time, changes in the seafood industry have led to declining employment prospects for local watermen. Adding to the pain, it's hard to get enough skilled staff during the shortened crab season that is no longer year round, but lasts only from early spring through autumn.

"We've lost a lot of watermen," says Graham. "The crab industry shrank by ninety-five percent since the late mid-80s when I remember there were more than seventy-seven crab processors in business. Now there's less than ten, and only three of us have more than a dozen year-round staff."

© Kelly Minor/Little River Seafood

Abigail Villalba instructs employees at Little River Seafood.

In Reedville, Little River Seafood has employed seasonal Hispanic or Latino workers since the late 1980s. President Greg Lewis says, "the first year we hired around ten Latino workers. Then we kept increasing until we recently had as many as sixty at peak season in July. We still have fifteen or so Americans, mostly in processing and packing instead of picking. But every year they get fewer. Some retire and we don't get many new ones."

In Suffolk, the Wanchese Fish Company hires as many as 100 Latino workers between late spring and autumn. Matt Nowicki, Wanchese's quality

control manager, says that recruiting is a family affair. "Of our 100 Latino workers, sixty-five or seventy come from just three major families that have a long relationship with the company. Brothers, sisters, or cousins—they come for three or four years in a row. One great advantage is that because so many work here for years, they know what needs to be done." According to Nowicki and Lewis, most of these workers earn between $10 and $12 an hour and they often work overtime during the busiest part of the season.

Through Villalba, the VSAREC is helping these seafood processors make sure their Spanish-speaking staff will keep their products safe from bacteria and other contamination. "I am happy I can fill this need," she says. "In 2006, we did a survey of food producers to ask what they needed from us. Three of the big things they asked for were (1) customized training, (2) on-site training, and (3) bilingual training."

© Abigail Villalba/VASG

Sign posted at Little River Seafood in Reedville, VA.

Villalba was prepared to deliver all three. "I grew up in Puerto Rico in a Spanish-speaking family and came to Virginia Tech in 2006 after many years working in food safety for the federal government, so I had the right background for this."

Talking about Safety

In any language, product safety is always an issue. Johnny Graham takes note of the recent peanut plant closing in Georgia because of *Salmonella*. "All it takes is one recall and more than likely you're going to be out of business. You don't get multiple chances."

As a long-time seafood producer, Graham knows how hard it is to keep his crab product safe. It's challenging enough under any circumstance, but when the majority of his staff don't speak English, it's even harder. "Some folks are under the impression that we can run things with flash cards that have generic commands like 'shovel crab,' 'give me a box,' or 'here comes a boat.' But it's not realistic to think we can operate that way."

That's why Villalba's recent addition to the staff at VSAREC has been such a boon for area seafood processors. "It's just been a win-win situation for us," says Graham. "She's a scientist who understands our industry, and she's fluent in Spanish, which is essential with Mexicans as our primary workforce."

Villalba has conducted numerous Spanish-language training sessions for Virginia seafood processors. "But always also in English," she says, "I won't do Spanish-language only training because everyone is responsible for the safety of the products regardless of the language they speak. Even if 90 percent of the workers are Spanish-speaking, I still want to do the English-language training."

Matt Nowicki at Wanchese appreciates the effort. A native of Poland, he holds a master's degree in animal bioengineering and he knows the importance of appropriate training. Nowicki says of Villalba, "Not only does she know our industry, she's also authoritative because she's from the government. She's also an expert trainer who isn't one of our regular staff, so people pay attention when she speaks," whether in Spanish or English.

Nowicki also praises the customized training. "Before Abigail comes, I prepare a list of the things we may need to emphasize at the moment. Maybe we want to focus on cross-contamination between raw and cooked products. Maybe we've had some issues with certain types of equipment. Abigail changes her training to make sure we focus on the most important things." Things would be difficult without Villalba, says Nowicki. "If we had to do the training ourselves, the programs would not be nearly as good, and would take much longer to develop."

Johnny Graham also appreciates the customized help. "When we're running 24 hours a day

during the summer, we need a qualified quality control supervisor on each shift. Abigail offered the higher education and extra training to qualify my people for the job, so now I can have enough key people to work these shifts while other key people are in bed. And it's very satisfying to the Food and Drug Administration and the state agencies when we can document the training that we've done, and when they know that it's been provided by Abigail who they trust."

Concerns for the Future

The training opportunities offered by VSAREC are undoubtedly helping the seafood industry deal with the challenges of a mostly Spanish-speaking migrant workforce. However, seafood processors are increasingly worried that their real problem will be getting their staff here to work at all.

As Minor of Little River Seafood explains, "For the last three or four years, we've had a lot of difficulties getting workers for the seafood industry under the H2-B visa program. After 9/11, the government started enforcing a cap that they hadn't before, with a limit of only 66,000 H2-B visas for the entire country." For several years after 9/11, Congress made some exceptions to the cap—through annual legislation that allowed companies like Little River Seafood to bring back seasonal workers who had an established history of working with the processor. But for the last three years, Congress hasn't renewed the legislation. "So we've been competing against hotels, landscapers, and every other employer that also wants the H2-B workers," says Minor. "Last year, we lucked out and got ours where others didn't. We got some for this year but probably won't get as many as we want. It's hard to say just yet."

The lack of access to labor is bad news all around, adds Minor. "Put it this way—if we couldn't get the Mexicans, we'd be out of the crab-picking business. And then we wouldn't have jobs for Americans, either."

Assuming that immigration problems don't push her clients into a downward spiral, Villalba plans to continue with the training—in both Spanish and English. VSAREC Director Dr. Michael Jahncke explains, "Even for workers who come back year after year, there is a need for refreshment and updating. This type of training helps keep our Virginia products safe and high quality, and that's why Virginia has one of the nation's highest compliance rates for FDA inspections."

With luck, there may be funding to add more bilingual staff like Villalba for all the training needs in Virginia. "We want to provide better training materials in English as well as Spanish for all kinds of food industries—not just seafood," she says. "This is a big effort, and we're way behind on reaching the diverse audience we have. We need to provide them with the resources they need. They want to do a good job. But if we can't take the time to explain things in their language and at their educational level, we're out of luck."

Above and on page 6: Workers pick and pack crab at Little River Seafood. Photos © Abigail Villalba/VASG

SOWING THE SEEDS

by Phil Marsosudiro, with additional reporting by Margaret Pizer

Spat-on-shell and the future of Virginia oyster aquaculture

It looks like a dirty baseball sitting under wet paper towels in a cooler, but it's actually a bundle of live oyster larvae, some 20 million of them, purchased for $4,000. Michael Congrove—Remote Setting Extension Agent for the Virginia Seafood Council—lifts them out of the cooler and puts them gently into a bucket of clean seawater. He gives them a stir and waits, then pulls a few out and places them under his microscope to check their bellies (dark means they're well-fed) and to make sure their gills are clear. If the larvae are healthy and they're treated well for the next eighteen months, there's a decent chance that they'll turn into 600 bushels of oysters. Sell them at $25 a bushel, and that's a $15,000 home run off a $4,000 baseball.

This is the dream of spat-on-shell oyster cultivation.

As aquaculture techniques go, spat-on-shell is not very complicated. You take a 10-foot diameter tank of water, drop in bags of old oyster shells, add a large batch of larvae, and wait a few days. If you've done it right, ten or so larvae will have settled and metamorphosed into tiny juvenile oysters (called spat) on each of the old shells, just like they would do in the wild. Then you take the bags of spat-on-shell and place them on leased bottoms in the open water. If all goes well, in about a year-and-a-half you'll be harvesting full-grown oysters, ready for shucking.

"It's almost like following a recipe," says James Wesson, PhD, of the Virginia Marine Resource Commission (VMRC). But he adds that if you want to make a living from it, you need three things: First, you need the proper ingredients; second, you need to work with care and skill; and third, you need an environment that will support your efforts.

The Proper Ingredients

Virginia's first experiments with spat-on-shell date back to the 1980s. But at the time, the pieces weren't all there to make it work. "Disease was widespread, and we didn't yet have a broodstock of disease-resistant oysters" that could grow to market size in sufficient quantities to jus-

tify the spat-on-shell effort, says Wesson. So Virginia had to put the idea aside while they worked on improving the broodstock.

"First, we've developed a disease-resistant oyster," says Wesson. It isn't immune to disease, but it can stay healthy long enough to get to market size, and that's all that is needed. "Second, we've learned how to breed triploid oysters, sterile oysters that put all their energy into a fast growout, and none into breeding." These improvements have put spat-on-shell back on the table and locked in the first key ingredients for a Virginia oyster revival.

"Right now, most of the shucked oysters that we 'produce' in Virginia are shipped in from the Gulf of Mexico and elsewhere," says Wesson. They're a more expensive and less reliable source. For flavor, for predictability, and for profit, "we want to produce oysters that are grown in Virginia, not just shucked in Virginia."

Mastering the Technique

After Virginia developed better broodstock and a suitable technique for cultivation, the next step was to put spat-on-shell into practice. In 2005, a dozen oyster producers began working with VIMS, VMRC, and other partners to see how spat-on-shell would work for them. After three years of progress, they decided to cross the threshold from pilot projects into independent commercial production.

To help the producers make this transition happen, Virginia's Fishery Resource Grant Program provided funds for Congrove to work with them intensively for one year. In 2008, Congrove helped each company run several sets of spat-on-shell production—from tank preparation to larvae-setting to planting the spat-on-shell in Virginia waters. With each set, commercial staff acquired more skill and sophistication with the technique, until the end of the year when all of the participating firms were ready to conduct spat-on-shell cultivation without help from Commonwealth staff.

"The collaboration really got us off the ground," says A.J. Erskine of the Bevans Oyster Company. While he and his peers might have started spat-on-shell by themselves, Erskine says, "Our progress would have been much slower and would have cost much more. Because Virginia backed us up with technical and financial support, the opportunity was a lot more tangible."

Rufus Ruark Jr. of the Shores and Ruark Seafood Company echoes Erskine's comment: "We already knew about the technique because it had a long history elsewhere." But for his own company? "Seeing is believing, and seeing how it did work (not just how it might work) was what everybody learned. I've learned a lot about the larval end of it. At first it felt like, 'just put the larvae in with the shell? That's not gonna do anything,' But then we pull our shells up several days later, and lo and behold there's fifteen oyster on it."

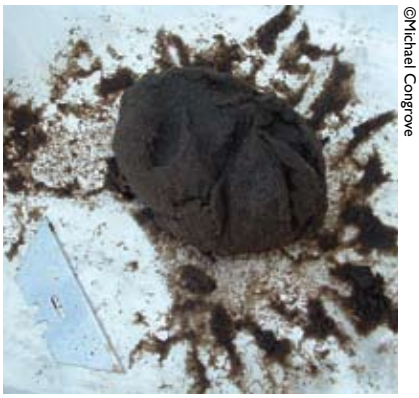
"Once I see that I can make money off it, I'll go off on it," says Ruark. "But the Commonwealth setting us up with the program is a big help—a real deciding factor. And the continuing help that they give us is a big thing."

Supportive Environment

The final piece of the puzzle for Virginia oyster growers has been a supportive economic and regulatory environment that has helped encourage both small- and large-scale aquaculture efforts.

Although spat-on-shell aquaculture for shucked oysters is new, Virginia has more than a decade of experience in aquaculture for individual oysters that are sold on the half-shell market. Aquaculture for individual oysters is a much more labor-intensive and expensive process than spat-on-shell aquaculture. But the resulting product (which is sold in the shell, unshucked) can be sold for a much higher price.

Annual sales of Virginia-grown aquacultured oysters (half-shell and shucked) increased six-fold over the three-year period from 2005 to 2007. Several large commercial growers got in on the action—either adding aquaculture to shucking



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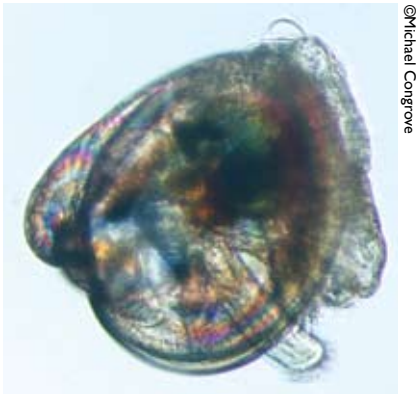

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Facing Page: Watermen plant spat-on-shell oysters. Photo © Michael Congrove.

Top: Ball of eyed oyster larvae.

Bottom: Eyed oyster larva (about 200 times actual size).

A Practical Manual

A group of Virginia scientists and seafood companies has collaborated to produce "A Practical Manual for Remote Setting in Virginia," a booklet that outlines a step-by-step process for obtaining oyster larvae, getting them to set on shells, and growing them out to harvestable sizes.

The manual was written by Michael S. Congrove of W.E. Kellum Inc. and the Virginia Seafood Council, Dr. James A. Wesson of the Virginia Marine Resources Commission, and Dr. Standish K. Allen Jr. of VIMS with collaboration from ten Virginia seafood companies and funding from the Virginia Fishery Resource Grant Program, which is administered by the VIMS Advisory Services department.

The ten seafood companies that participated in the project are:

- Bevans Oyster Company
- Cowart Seafood Corporation
- J&W Seafood
- Kellum Seafood
- Mobjack Bay Seafood
- Purcell's Seafood
- Sea Farms
- Shore Seafood
- Shores and Ruark Seafood
- Terry Brothers

The manual is available for free online or for $10 in print. Go to http://web.vims.edu/adv/frg/ or email vsgpubs@vims.edu.

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houses or starting new commercial aquaculture enterprises. Oyster hatcheries have also opened in several parts of the state, and the expanding Eastern Shore oyster aquaculture landscape now includes a major hatchery.

Oyster growers like Doug McMinn, who founded his Chesapeake Bay Oyster Company in 2003, say the motor behind the success of Virginia oyster aquaculture has been steady growth in the market for Chesapeake Bay oysters, the availability of local shucking houses, and the support of state institutions like VIMS that have helped develop the science to set oyster growers on the right track.

"I think part of why the [aquacultured] clams have done so well and why oyster farming now is doing well is because the state was in at the beginning to help come up with some of the technology but then the guys had to start putting down their own money and putting themselves on the line," says McMinn. "They're not going to walk away from the buck that they put down without a fight."

McMinn thinks Virginia has reached the right public-private balance to foster growth in the oyster industry. "This state has a lot of private individuals who run hatcheries and do a really good job, and they're willing to increase volume as the demand dictates."

In addition to hatcheries, shucking houses are an important component of the supportive environment in Virginia. In other East Coast states, many shucking houses went out of business as natural oyster harvests declined in the second half of the twentieth century, but in Virginia, the shucking houses began trucking in oysters from the Gulf Coast and were able to stay afloat.

Now, as aquacultured oysters are on the rise, these shucking houses are a natural place for those oysters to go. "Because we have shucking houses around here, we automatically have another market" for individually grown oysters that might not be suitable for the half-shell market because of their size or quality, says McMinn. Those shucking houses are also a natural market for spat-on-shell oysters from Virginia, and many of them are getting into the spat-on-shell oyster cultivation business themselves.

The Forecast

For all the progress they've made thus far, Virginia scientists and oyster producers are far from knowing that spat-on-shell will be a guaranteed success. Disease, pollution, weather-driven changes in salinity, and predation from the cownose ray remain as known risks or wildcards that could derail the potential of spat-on-shell production in Virginia.

Despite the uncertainties, commercial producers remain hopeful.

"We've already been working with some of the guys on better systems" for spat-on-shell, says McMinn. "The more we do to farm raise, whether it's spat-on-shell, whether its cage, whatever you're doing, it takes pressure off the wild stocks. I think spat-on-shell is going to be a great thing for restoration."

At Kellum Seafood, Vice President Tommy Kellum says, "at this point, spat-on-shell is producing maybe 10,000 bushels a year for us. It's

certainly in a juvenile stage for us. But given the size of our leased acreage, we could get to a point where fifty to sixty percent of our oyster supply would come from spat-on-shell in five to eight years. With spat-on-shell, I can actually see us generating enough oysters to keep the plant running year round, with 100 people working."

Rufus Ruark Jr. sums it up. "I think this is something everyone's gonna be happy with."

Below: Doug McMinn checks one of his oyster cages in the Rappahannock River. Photo © Margaret Pizer/VASG.

Facing Page: Spat-on-shell. Photo © Michael Congrove.

Crediting Oysters for Helping Clean the Bay

The Commonwealth has a strong record of supporting the science and training needed to help oyster growers succeed. In the coming years, Virginia may also have the opportunity to provide incentives for both amateur oyster gardeners and commercial aquaculture operations based on the benefits oysters provide to the environment by filtering and cleaning Chesapeake Bay waters.

One simple incentive would be a tax credit for Virginia residents who grow oysters off of backyard docks or floats. In the 2009 session of the Virginia General Assembly, a bill to establish such a credit was put forward by Senator Ralph S. Northam who represents district 6, including Accomack, Northampton, and Matthews Counties and parts of Virginia Beach and Norfolk.

"If people get involved by putting an oyster float out, the next thing you know they might realize maybe they don't need as much fertilizer on their lawn," says Northam, arguing that an awareness of the nitrogen, phosphorous, and other pollutants that oysters help remove from the water would have cascading effects on the behavior of coastal residents. Although the bill had to be withdrawn due to this year's budget crisis, Northam plans to reintroduce it in the future.

A second incentive would encourage large-scale oyster aquaculture by providing "nutrient credits" to oyster growers based directly on the pounds of nutrients removed from Bay waters.

One way to create monetary value for a credit is through nutrient trading. Nutrient trading is already on the books in Virginia. Passed by the state legislature in 2005 and slated to become mandatory in 2011, the system limits nitrogen and phosphorous output from point sources like wastewater treatment plants. Plants that exceed the limit can buy credits from others whose output is below it.

Point sources can also balance their emissions by buying nutrient offsets from point or non-point sources. The Department of Environmental Quality has approved several types of agricultural offsets. For example, farmers can generate offsets by reducing the use of nitrogen fertilizer or by leaving some of their land untilled.

A team of researchers, including Kurt Stephenson of Virginia Tech, Alex Miller at the Gulf States Marine Fisheries Commission and Bonnie Brown and Colleen Higgins at VCU are researching ways that oyster growers could generate nutrient credits. Oysters remove nutrients from the water by filter feeding. When the oysters are harvested, the nutrients they've eaten and incorporated into their tissues are permanently removed from the water. Oysters also accelerate denitrification, which transforms nitrogen into a gas that is biologically unavailable.

Stephenson and Miller say that one major obstacle to incorporating oyster aquaculture into the nutrient trading system is the complicated science required to quantify how much nitrogen oysters remove—which can depend on the size of the oysters, where they are grown, and a variety of other factors. If these issues can be overcome, nutrient credits promise yet another source of support for commercial oyster aquaculture operations. Oyster growers like Jack White, owner of New Point Oyster Company, hope that Virginia will be able to include oysters in its nutrient trading system. "The time is ripe to recognize the role shellfish can play in cleaning up the Bay" and to make that recognition pay for oyster growers, says White.

News From The Point

Virginia Sea Grant has awarded $655,899 in support of seven new coastal and marine research projects:

Dynamics of ichthyoplankton ingress
Every year, tiny larval fish move from the offshore Atlantic into the Delaware and Chesapeake bays. Eric Hilton and John Olney of VIMS will identify patterns in the timing and abundance of shelf-spawned fish larvae that move into each bay and discern whether there are different physical mechanisms that influence differences in these patterns between the two estuaries. The research is a continuation of a Virginia—Maryland—Delaware partnership that will allow more complete and robust conclusions on the factors influencing variation in the abundance of the commercially and recreationally important fishes studied.

Thermal inactivation of bacteria in seafood
Salmonella sp. and *Vibrio parahaemolyticus* are the two leading sources of foodbourne illness caused by seafood. Michael Jahncke and Kumar Mallikarjunan of Virginia Tech will determine the temperatures necessary to kill or inactivate three strains of each of these disease-causing bacteria. Consumers and industry will benefit from knowledge of the proper times and temperatures required to cook seafood to destroy pathogens.

Uptake and elimination of contminants from hard clams and oysters
Clams and oysters grown in urban waterways are at risk of contamination with disease-causing organisms from sewage-treatment effluent and runoff. One method used to reduce contamination levels involves moving the live shellfish to an uncontaminated waterway for a short time period before harvesting them. Howard Kator, Kimberly Reece, Corinne Audemard, and Martha Rhodes of VIMS will determine


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2008 Knauss Fellows *from Virginia. From left Chris Hayes, Bret Wolfe, former NOAA Administrator Vice Admiral Conrad Lautenbacher, Frank Parker, and Abigail Lynch. Each year, the Knauss program sends graduate students from the Sea Grant states to Washington, D.C. for a year-long experience working on coastal, ocean, and Great Lakes issues in the legislative and executive branches of government. We caught up with Virginia's 2008 recipients as their felowships concluded to find out how things went.*

First, a little background on the fellows:

Frank Parker has an MS from Florida International University and is working on finishing a PhD from VIMS. His PhD research focuses on carbon and nitrogen cycling in estuarine sediments. During his Knauss Fellowship, he served as special assistant for the Deputy Assistant Administrator of NOAA's office of Oceanic and Atmospheric Research.

Abigail Lynch spent the year working as an executive fellow in the U.S. Fish and Wildlife Service's Fisheries Program. Before the fellowship, Abigail got an MS in marine science at VIMS, studying fisheries genetics, and she will begin a PhD program at Michigan State in the fall.

Bret Wolfe worked in the U.S. Fish and Wildlife Service's National Wildlife Refuge System Marine Program during his Knauss Fellowship. Before that, he was a graduate student in environmental sciences at UVA.

Chris Hayes has an MS in fisheries science from Virginia Tech, where he studied hammerhead shark populations off the East Coast. During his fellowship, he worked at the National Marine Fisher-

ies Service headquarters doing communications and outreach and working with economists to study factors affecting seafood prices.

What parts of your Knauss experience stand out?

Frank Parker My job during my fellowship was to support the administator and assistant administrator of NOAA research. It was a treetops view of the agency and an amazing opportunity. The level of exposure I got as a Sea Grant fellow is something you can't get any other way. I was able to see the landscape of the entire organization, and now that the fellowship is over I can go back and dive into areas that were particularly interesting to me to learn more about them.

Abigail Lynch I chose to do my fellowship in an office where I knew I would also have a fieldwork component because I knew that I would want to be outside a bit, and I got to do an amazing month-long trip to Alaska to collect salmon samples and a number of other smaller trips locally. The Knauss Sea Grant Fellowship was a much more rewarding experience than I ever could have anticipated. As a graduate student, I appreciated that policy and communicating science was crucial for fisheries management, but as a fisheries geneticist, I had no practical experience in the policy arena. During my fellowship, I gained practical experience with senior-level legislation and policy development, communications and outreach, grant application review, and data reporting to partners.

Abigail Lynch conducting fieldwork in Alaska.

Bret Wolfe I got to act as marine program coordinator for the National Wildlife Refuge System while my supervisor was on another asignment and to represent the organization at international conferences on coral reefs. I also got to work for a month at Midway Atoll National Wildlife Refuge and for two weeks in the Honolulu regional office.

Chris Hayes I worked in the Atlantic Coastal Cooperative Statistics Program, which is a state-federal cooperative entity that is a one-stop-shop for fisheries data for the Atlancic Coast. We standardize data from different sources so that it can be used for stock assessments. The contacts are the most valuable things I took away from the fellowship, as well as a better working knowledge of how fisheries are managed in the U.S.

How do you think the year in D.C. will affect your future career?

Frank Parker I still work in the NOAA oceanic and atmospheric research headquarters. I'm working to help move applications from

whether this is an effective method for the elimination of viruses and bacteria from clams and oysters naturally contaminated in Hampton Roads waterways.

New reproductive norm for the blue crab

For over ten years, the blue crab population in Chesapeake Bay has been at historic low levels and has not responded to bi-state management regulations designed to curb overfishing.

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Evidence suggests that this lack of recovery may be due to changes in reproductive characteristics such as the number and quality of eggs and sperm produced. John McConaugha of Old Dominion University will examine both male and female reproductive changes that may need to be considered in the design of management policies for blue crabs.

Producing fungal biomass as fish oil replacement in aquaculture

The fatty acids present in fish oils are an essential component of the diet of marine fish grown in aquaculture. However, fish oils obtained from wild fish pose a risk of heavy metal contamination, and depend on fisheries that must be limited to protect wild fish. Certain fungal species produce omega-3 fatty acids that could be used as an alternative to fish oil. Zhiyou Wen, of Virginia Tech, will investigate using crude glycerol derived from biodiesel production as a cheap source of carbon for growing omega-3 fatty acid rich fungi.

Effluent organic nitrogen in Virginia coastal waters

Nitrogen levels released from waste-water treatment plants are regulated in the Chesapeake Bay to help prevent high levels of nitrogen, which can lead to algal blooms and other problems in the Bay ecosystem. Different chemical forms of nitrogen are more or less useable by organisms (bioavailable) and thus more or less harmful to the ecosystem. Deborah A. Bronk of VIMS and Margaret Mulholland of Old Dominion University will study the bioavailability of a subset of the nitrogen

released by treatment plants in order to better inform regulators about which types of nitrogen need to be most carefully controlled to protect the Bay.

Climate change impacts in Virginia
In order to respond to the effects of climate change in the Commonwealth, we need a better understanding of what those effects might be. Roger Mann, Carl Hershner, and Marcia Berman of VIMS will assemble and make widely available integrated databases describing past climate impacts on the ecosystems and environments of Virginia. These databases can be used for retrospective analyses of climate change trends. The data may also allow researchers to begin to make predictions about climate change effects on ecosystems in the Commonwealth, and to identify the economic effects of those effects.


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VASG has also funded one program development grant and one regional project:

Conservation easements as a means of sustainable building
This program development grant to Scott L. Reichle of Old Dominion University will fund a legal analysis of how conservation easements can be designed to simultaneously provide: 1) financial benefit to the developer; 2) benefits to the end-users of the property; 3) overall positive environmental impacts; and 4) acceptable government impacts relating to issues such as long-term maintenance issues and tax consequences.

Forecasting the response of Delmarva lagoons to changing land use and climate
This regional project, jointly funded by the Virginia, Maryland, and Delaware Sea Grant programs, will be carried out by Mark Brush and Iris Anderson of VIMS; Lora Harris and Walter Boynton of the University of Maryland Center for Environmental Sciences; and Arthur Trembanis of the University of Delaware. The research will aim to link nutrients to ecosystem


Frank Parker working on his graduate research at VIMS.

the National Weather Service to NOAA research. I've gotten to learn about how things work within both agencies. Long term, I'm not sure I know at this point what I want to do, but there's definitely a draw to the mission-oriented, applied science as opposed to the basic science I was doing in academia, and I think that's more in line with my future.

Abigail Lynch This experience has provided me with a solid understanding of natural resource management in the federal system and has catapulted me into a PhD program at Michigan State in fisheries and climate change with an emphasis on policy and the human dimension. I'll start in the fall, working with one of the professors I worked with on the National Fish Habitat Action Plan during my fellowship. I've made more contacts within NOAA and FWS and other federal and state agencies and NGOs than I ever would have expected in one year.

Bret Wolfe I am currently working temporarily in the same position where I served my fellowship. I have made many contacts at FWS, NOAA, and at NGOs. These will be great job contacts or connections for whatever I may do in the future.

Chris Hayes I've thouroughly enjoyed the fellowship, and I'm enjoying what I'm doing now working with the same program. I may think about going back and getting a doctorate at some point, but for the time being I'll probably pursue this work.

Boat tax study released

A survey of recreational boat owners who make Hampton their home port recently concluded that these boaters bring $55 million to the city and help create nearly 700 full-time jobs.

The study, conducted by Tom Murray and James Kirkley of VIMS and Doug Lipton of the University of Maryland, was commissioned by the city of Hampton. The authors surveyed both Hampton resi-


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Hampton Marina.

dents and non-residents who keep boats in the city to determine the economic impact of their boating-related activities.

In 2002, the boat tax in Hampton was reduced from $1 per every $100 of assessed value to $0.000001, and boat taxes have not been collected by the city since then. On April 8, the Hampton City Council discussed the study results and the question of whether to reinstate the boat tax. The council directed the city manager to calculate a boat-tax rate that would satisfy members of the public who think boat owners should pay taxes to help maintain the waterways and facilities they use, but that would not discourage boaters from continuing to call Hampton their home port.

A full report on the study can be downloaded at http://web.vims.edu/adv/econ/analyses.html.

Bishop Sullivan Wins Blue Crab Bowl

Bishop Sullivan Catholic High School of Virginia Beach repeated as champions of the annual Blue Crab Bowl, a regional academic competition that tests students' knowledge of the oceans. The team earned the right to represent Virginia in the National Ocean Science Bowl (NOSB©) in Washington, D.C., on April 25–27. There the team faced 24 other regional champions from around the nation. They won two out of three of their round-robin matches and made it to the third round of double elimination—further than any previous Virginia team has gotten at NOSB©.

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From left to right: Coach William Dunn, Team Captain Christine Chesley, Jack Hall, Mary Chang, Mike Stolz, and Nate Taylor.

This year's Blue Crab Bowl, held at VIMS, featured sixteen teams representing fifteen high schools from all corners of the Commonwealth. Eighty students spent the day in heated tournament competition focused on the marine sciences. Grafton High School took second place. In third place was Chesapeake Bay Governor's School-Glenns Campus, followed by Seton School of Manassas in fourth place. Seventy-five faculty, staff, and graduate students from VIMS and Old Dominion University donated many hours of their time to ensure the success of the event. Virginia's contest, now in its twelfth year, is among the inaugural marine science bowls started in 1998.

function, emphasizing the roles of submerged aquatic vegetation (SAV), algae, and other photosynthetic organisms.

The Virginia Fishery Resource Grant Program, administered by VIMS Advisory Services, funds research by fishery-industry participants aimed at reducing the environmental impacts of fishing, restoring and protecting habitat, developing new aquaculture techniques, and developing seafood products to improve quality and efficiency. The program has awarded four new grants totalling $243,831:

New products from cownose ray

Cownose rays are abundant in Chesapeake Bay and are an important predator on oysters and clams. C. Meade Amory of L.D. Amory Co. will study the use of cownose ray meat and cartilage and on the development of efficient processing methods for rays.

Bycatch in Virginia's spring striped bass gillnet fishery


© VMRC

George Earl Trice will test gear alterations intended to reduce bycatch of endangered Atlantic sturgeon in the gillnet fishery for striped bass. The research is a continuation of an ongoing study of the effect of gear alterations on sturgeon catch rates and whether the modified gear are as efficient at catching striped bass.

Channeled whelk assessment

Richard B. Robbins Jr. of Bernie's Conchs will study size distribution, sex ratios, and size at reproduction in channeled whelks to help managers design effective and sustainable size limits for the whelk fishery.

Producing triploid oyster larvae using heat shock

A.J. Erskine of Cowart Seafod Corporation, will investigate heat shock as a method to produce triploid native oysters. Triploid oysters are desireable for aquaculture because they do not devote any of their food resources to reproduction and thus may grow faster and can be harvested during spawning season.

Sea Grant
Virginia

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