Impact

Hurricane Dorian coming ashore Sept 6, 2019. ©Aileen Devlin / VA Sea Grant

TRADE-OFFS REVEALED BETWEEN ECOSYSTEM RESISTANCE AND RESILIENCE TO HURRICANES

As we enter another hurricane season, have you ever wondered: when confronted by a storm, is it better to be resistant like an oak or resilient like a willow?

In a new study of the ecological impacts of hurricanes, an international research team addressed that centuries-old question. Their findings, reported in the March 4th issue of *Science Advances*, can help guide

managers as they plan for climate change and a growing coastal population threatened by more intense tropical storms. The findings also provide a framework for guiding management decisions related to other disturbances, such as nutrient pollution or wildfires.

The study's lead author, VIMS' Dr. Christopher Patrick, said "We found that coastal ecosystems display

consistent tradeoffs between resistance and resilience to tropical cyclones. Our findings emphasize that managing for increased resistance may result in decreased resilience, and vice versa. That knowledge is key for coastal decision making."

The team's findings suggest that managers seeking to enhance both resistance and resilience in coastal ecosystems may face an impossible task. On the other hand, their findings provide valuable guidance for choosing the single most effective management strategy for a particular location.

"If you can't manage for both resistance and resilience," asked Patrick, "which should you focus on? The answer depends on both specific project goals and the expected intensity and frequency of disturbance events."

The research team's study is linked to a research coordination network funded by the National Science Foundation to synthesize knowledge concerning ecosystem responses to hurricanes.

ANNUAL "REPORT CARDS" PROVIDE LOCALIZED PROJECTIONS FOR SEA-LEVEL CHANGE

The Virginia Institute of Marine Science has issued its annual sea-level "report cards," which provide U.S. coastal communities from Maine to Alaska with a localized projection of sea-level change to 2050.

The project's founder, VIMS emeritus professor Dr. John Boon, said "This year's report cards are especially informative when compared to the global projections issued by the U.N.'s Intergovernmental Panel on Climate Change (IPCC) last August as part of its latest assessment report." Boon emphasized "Our report cards are in no way a substitute for the IPCC's global projections, but they do provide added value to communities, businesses, military installations, and other coastal stakeholders concerned with changes in sea level, as acceleration

in sea-level rise varies from place to place."

The team's web-based report cards project sea level to the year 2050 based on an ongoing analysis of tide-gauge records for 32 localities along the U.S. coast. The analysis now includes 53 years of water-level observations, from January 1969 through December 2021. The interactive charts are available online at www.vims.edu/sealevelreportcards.

"As in past years," said VIMS marine scientist Molly Mitchell, "rates of sea-level change in 2021 varied markedly among localities, from a peak rise of 8 millimeters in Grand Isle, Louisiana, to a drop of almost 14 millimeters in Juneau, Alaska." She noted, however, that the tide gauge records from 2021

SURVEY REVEALS CRABBERS' PERCEPTIONS OF DERELICT GEAR

At any given time, some 145,000 lost or abandoned crab pots are present in the Chesapeake Bay, with another 12-20% of licensed pots becoming derelict every year. These derelict pots are more than a nuisance, they trap and kill blue crabs annually, reducing blue crab harvests by as much as 30% according to scientific studies.

A survey of Virginia crabbers was conducted by VIMS researchers to gauge their perceptions of these derelict crab pots and the activities most preferred to help mitigate issues they pose in the Chesapeake Bay. An analysis of the survey results was published in the academic journal *Marine Policy* and have also been shared with the commercial crabbing community in Virginia.

"Our goal with the survey was to improve management decisions by accounting for the perspectives and preferences of watermen," said James DelBene, who conducted the survey for his master's thesis at VIMS. His research team included VIMS professors Andrew Scheld and Donna Bilkovic. DelBene was also mentored on the project by J.C. Hudgins, a lifelong crabber and president of the Virginia Watermen's Association.

"I think the process worked well," said Hudgins, "it was an opportunity to reach out to most all the watermen in Virginia and get their input and thoughts on the derelict crab pot situation, and what we could do about it."

In all, 430 of Virginia's 1,032 licensed commercial crabbers returned a survey packet, for a 42% response rate. On average, respondents reported losing 10% of pots fished in the previous year, citing vessel traffic and severe weather as the main reasons pots become derelict.

Overall, 10% of respondents perceived derelict pots to impact the bay positively, 30% perceived no impact, 29% perceived a negative impact, and 31% perceived both positive and negative impacts. The two main negative impacts identified were the costs required to replace the lost gear and that derelict pots capture and kill fishes and crabs. Some respondents included comments describing positive impacts as derelict pots provide a refuge that allows small crabs and fish to hide from predators and may serve as an "artificial reef."

Crabbers' perceptions of the impacts of derelict pots significantly affected their willingness to participate in mitigation activities. "Willingness to participate in most mitigation activities was low and non-monetary management incentives were generally ineffective in offsetting perceived costs for the average respondent," said DelBene, "however, respondents were 37% more likely to participate in mitigation activities if they believed derelict pots cause only negative impacts."

The two activities crabbers were willing to participate in or support without any incentives were recycling old pots at a facility on land and education of recreational boaters on best practices to avoid crab pot buoys and lines.

Overall, said DelBene, "The survey provided an opportunity for Virginia's commercial crabbers to share their thoughts and experiences concerning

> Dead blue crabs occupy a derelict crab pot retrieved from the waters of Chesapeake Bay. © K. Havens/VIMS.

derelict crab pots. When selecting the best actions to take against marine debris, managers and policymakers need to consider the costs imposed on stakeholders. Integration of local information and scientific knowledge can strengthen the decision-making process to ultimately address the issue of marine debris."

Annual "report cards" provide localized projections for sea-level change, continued from page 1

"were remarkably consistent with data from the previous year, with acceleration in rates of sea-level rise at 27 of our 32 stations." Mitchell has partnered with Boon to generate the report cards each year since 2017.

Boon and Mitchell said that comparing the IPCC's global mean projection of sea-level rise to 2050 with VIMS' localized forecasts offers valuable guidance at the regional and local scale, as rise and acceleration vary with location.

>Seawater floods the Hague in Norfolk during the "King Tide" in October 2019.

Mitchell stressed that recognition of these regional differences is critical for effective planning at the local level. "Individual localities will experience changes in sea level that differ greatly from the mean global rate," she said. Examples include Norfolk, Virginia, where the VIMS 2050 forecast is 8 inches higher than the IPCC's projected global mean sea-level rise; and Galveston, Texas, with a projected surplus of 12 inches. The scientists said their forecasts of a sea-level "surplus" for East and Gulf coast communities are of particular concern because they exceed the IPCC's worst-case projections.

"We have increasing evidence from the tide-gauge records that these higher sea-level curves need to be seriously considered in resilience-planning efforts," said Mitchell. "Acceleration can be a game changer in terms of impacts and planning, so we really need to pay heed to these patterns," added Boon.

The sea level report cards can be found at: www.vims.edu/research/products/slrc/

VIMS STUDENTS WIN HONORS AT WORLD AQUACULTURE CONFERENCE

Alex Marquardt and Anna Poslednik, graduate students at William & Mary's School of Marine Science at VIMS, impressed at the recent Aquaculture 2022 conference in San Diego, earning both presentation awards bestowed by the National Shellfisheries Association (NSA).

The conference is a triennial joint meeting of the NSA, the World Aquaculture Society, the American Fisheries Society's Fish Culture Section, and the National Aquaculture Association. It is the largest aquaculture meeting in the world, with attendees from more than 90 countries.

Marquardt, a Ph.D. student with VIMS professor Roger Mann, received the 2022 Thurlow C. Nelson Award for her talk describing the distribution and size range of fossil oysters on the Atlantic continental shelf, and what those data reveal about the capacity of oysters past and present to keep pace with sea-level rise.

> VIMS Ph.D. student Alex Marquardt.

Poslednik, a master's student with VIMS professor Ryan Carnegie, received the 2022 Gordon Gunter Award winner for her poster presentation, which used long-term data on disease diagnostics from Virginia oysters to provide insights into interactions between the major oyster pathogens *Haplosporidum nelsoni* and *Perkinsus marinus*.

Each of the NSA presentation awards was established to honor a "distinctive and valuable contribution to shellfisheries science." The Nelson Award is named after the distinguished shellfish biologist who served as NSA president from 1931-1933 and contributed more than 125 papers, many relating to oyster biology. VIMS students have now won the award in three of the last four NSA annual meetings.

The Gunter Award is named after another leader in marine
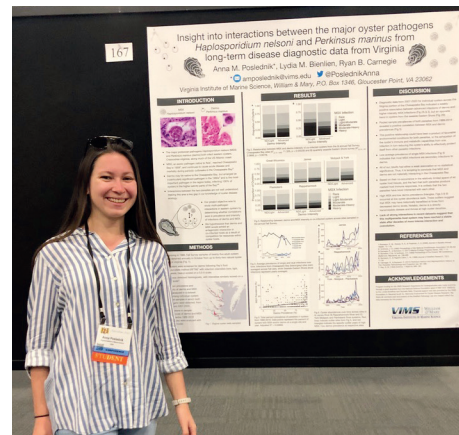
VIMS master's student Anna Poslednik with her poster during the Aquaculture 2022 international conference. © A. Marquardt/VIMS.

research and education, whose career spanned more than 60 years, including stints as director of the University of Texas Institute of Marine Science and the Gulf Coast Research Laboratory, as well as service with the U.S. Bureau of Fisheries. The eponymous award recognizes the important and essential role of poster presentations as a vehicle for research communication.

TAGGING PROGRAM HONORS COMMUNITY VOLUNTEERS

Each year thousands of Virginia fishes are tagged to advance science by individuals who may never step inside a lab! These community scientists are anglers who participate in the Virginia Game Fish Tagging Program (VGFTP).

The program uses state saltwater license funds to train 200 volunteer anglers in tagging selected species of recreationally popular marine fishes to gather data on year-to-year abundance, habitat use, and seasonal migration patterns. Established in 1995, it is a cooperative effort between the VIMS Marine Advisory Program and the Virginia Saltwater Tournament at the Virginia Marine Resources Commission.

This year the program celebrated the achievements of its top volunteers with the help of Bass Pro Shops in Hampton.

"Yorktown angler Ed Shepherd hoisted the Top Tagger trophy again this year, after tagging more than 6,000 fishes in 2021," said Susanna

Musick, marine recreation specialist and program coordinator at VIMS. The runner-up was Scott Vinson of Williamsburg. Shepherd and Vinson also placed one-two in overall recaptures.

In addition to honoring individuals for tagging the highest number of each of the program's 10 targeted

> *The Top Tagger for 2021 was Ed Shepherd of Yorktown. © S. Musick/VIMS.*

species, program administrators introduced three special awards. Ken Neill of Seaford and Danny Noland of Hopewell were recognized as the longest-standing volunteers, with 26 years of service each. Rob Collins was recognized for the most species tagged—all 10, while Bryan Lewis of Bealeton and Scott Vinson were recognized for their use of experimental tags.

Through 2022, the program has maintained a 27-year database of records for tagged and recaptured fish. The database currently includes 385,206 tag records and 38,159 recapture records, with those numbers increasing almost daily. The program has documented fishing efforts at more than 900 locations in Virginia waters.

Data collected by the VGFTP helps anglers and managers learn more about fish migration, growth, and habitat use. In 2021, VGFTP volunteers tagged more than 19,173 fishes and to date have recorded 1,570 recaptures.

Good Things Come in

For the first time in its history, the Virginia Institute of Marine Science has four female department heads – one in each of its four departments. It's a remarkable moment in their lives and in the life of the institute.

Kimberly Reece, chair of the Aquatic Health Sciences Department, was the first of the four to become department head. She was followed by Mary Fabrizio, chair of Fisheries Science; Debbie Steinberg, chair of Biological Sciences; and Courtney Harris, chair of Physical Sciences. Their paths were as individual as they are themselves.

"I had no idea when doing graduate work that I would end up in marine science," Reece said. Born and raised in northeast Ohio, her most vivid water-related memory was seeing the Cuyahoga River burn when she was a child. While it made her interested in what was happening to water, it did not influence her career choice.

Instead, she studied molecular genetics, where only about 30% of students in her graduate program were women. Early in her career working as a molecular geneticist in academia, there were even fewer women, and she found almost no peer support and very few female role models in the faculty.

That changed when she came to VIMS as a post doc in 1994 and found a strong network of support. "It was pretty neat when I became a faculty member here and the women of VIMS came to congratulate me," Reece said. "With my appointment, women finally made up 10% of the faculty. So, it's changed. We've come a long way." That was in 1998. Now women make up 32% of the faculty.

New York City may not necessarily seem like it would produce marine scientists, but **Mary Fabrizio** grew up on a steady diet of nature books. Her father, who worked for *Life* magazine, brought home nature books published by *Life*, including *The Sea*, which fascinated his young daughter. "At an early age I wanted to study plankton and said, 'this is what I want to do!' I knew I wanted to go to school for marine biology," said Fabrizio.

At the University of Rhode Island, she earned her Ph.D. in Biological Oceanography, and while she said the marine science field hasn't changed that much, graduate school has changed since she was a student. "There are a lot more women faculty now," Fabrizio said. "Female students were not treated the same [as the men] or afforded the same opportunities then. The typical advisor's attitude was, 'Why should I put in the effort to advise you? You'll get married and never work in the field anyway.' Are you kidding? I thought, 'How do you know what I'm going to do!' Male students, on the other hand, were very supportive."

While Fabrizio said she aspired to an academic appointment, she never pictured herself as a department chair. It's a responsibility she takes very seriously. "It's nice to be part of what moves this university forward," she said. "We are very accomplished scientists. We're leaders. We have the trust of our faculty. I'm energized when I see those around me have a shared vision."

In love with the ocean from an early age, **Debbie Steinberg** followed her brother, a marine scientist, to California for college. "I knew I wanted to be a teacher, but it wasn't clear to me that I wanted to do research," she said. "In college I went to the Sargasso Sea on a research cruise with my professor, who was chief scientist onboard and a woman." She found she enjoyed the research and the comradery onboard ship. "It was very inspiring. Beautiful sapphire blue water, great people, the science lead was a woman, and I thought, 'Wow, I can do this!'"

From that time forward, Steinberg took every opportunity she could find to do research. Then, in her senior year, there was an opportunity to go to Antarctica to study krill as one of the very first students in the National Science Foundation's Research Experiences for Undergraduates (REU) program. "Then I was totally hooked," she said, "and I decided to go to grad school to study zooplankton, because I loved doing the plankton work."

After graduate school, Steinberg worked at a research station in Bermuda and served as a teaching assistant in the summer. Five years later, she came to VIMS. "I knew I wanted

> *VIMS professor Kim Reece collects an algal sample from a York River bloom. © D. Malmquist/VIMS.*

> *Shannon Smith (L) and faculty advisor Dr. Mary Fabrizio during field work on the Piankatank River. © Nick Coleman..*

to be an academic and have my own students," said Steinberg. "I had great mentors going through school, and I wanted to play that role. Now things have come full circle."

The daughter of an early computer programmer, *Courtney Harris* grew up around that burgeoning technology. The water didn't figure prominently in her life until she discovered the Chesapeake Bay during a boat tour with her

>VIMS professor Deb Steinberg displays a horseshoe crab found during the annual new student field trip to VIMS' Eastern Shore Lab. © D. Malmquist/VIMS.

ninth-grade earth sciences class. Though she had an interest in the environment, Harris first pursued a chemical engineering degree in college, where she remembers that she was one of only 2-3 women in a program that had no female faculty members. When she realized that the chemical engineering degree was aimed at industry jobs, she changed her major to applied math and pursued a minor in computer science.

After a few years in a telecommunications job, Harris decided to switch careers and attended graduate school to study earth science. "I knew I wanted to be on more of an academic campus," Harris said, and she found her way to VIMS after post-doctoral work with the US Geological Survey and Woods Hole Oceanographic Institute. At VIMS she found strong female mentors, including Rebecca Dickhut and Debbie Bronk, who were among the first female department heads at VIMS, as well as supportive male colleagues.

Harris found her niche as a 3-D modeler, improving understanding of sediment transport in continental shelves and estuarine environments. Though being a department head was not an aspiration, Harris said, "it's an honor and an important responsibility. It gives you an opportunity to do your part to better your department and the institute."

Today, these women support and challenge each other, as well as other women on campus. "This group is easy because we have been friends for a while," said Steinberg. "One of us may have a sticky issue, and the four of us can talk about it and give advice." Reece agreed, "It's so nice, the shared experiences. We've all had our challenges. We know what it's taken to get where we are. We have that bond."

>Professor Courtney Harris reviews satellite data and numerical modeling results from the Ayeyarwady Delta in Myanmar.

SCHISM RECOGNIZED AS NEXT-GENERATION TOOL TO MONITOR, MANAGE RESTORATION EFFORTS

The U.S. Environmental Protection Agency has chosen a computer model developed by VIMS researchers as its next-generation tool for managing Chesapeake Bay restoration in an era of rapid climate change.

The selected model, known as SCHISM for Semi-implicit Cross-scale Hydroscience Integrated System Model, was developed by Dr. Joseph Zhang of VIMS' Center for Coastal Resources Management (CCRM).

Selection of the SCHISM model is the first step in a 6-year, $1.65M cooperative agreement between VIMS and the EPA's Chesapeake Bay Office, in collaboration with the many other federal, state, and tribal partners that make up the Chesapeake Bay Program (CBP). Joining Zhang on the modeling team are Drs. Harry Wang, Jian Shen, Marjorie Friedrichs, Pierre St-Laurent, Fei Ye, Zhengui Wang, Qubin Qin, and Nicole Cai of VIMS, along with Dr. Jeremy Testa of the University of Maryland Center for Environmental Science. Slated to begin operating in 2025, SCHISM will replace a model that has been used to monitor and guide the CBP's restoration efforts since the early 1990s.

"This award represents a firm commitment from CBP to adopt our next-generation technology, fulfilling a dream conceived more than 10 years ago," said Zhang. That's when he and other members of the SCHISM team began working with multiple collaborators to bring their modeling technology into the mainstream of Chesapeake Bay science.

Lewis Linker, modeling coordinator for EPA's Chesapeake Bay Program Office, said "SCHISM is state-of-the-science and will become the main bay model in a new suite of integrated CBP models." He noted that SCHISM will integrate with new and updated models of the watershed, airshed, and future land use, all directed to assess challenges to the Chesapeake watershed and bay beyond 2025, in particular the 2035 climate risk to bay restoration goals.

SCHISM's capabilities will allow it to incorporate climate-change impacts and help assess all Chesapeake Bay water-quality standards, two key requirements of the Bay Program's search for a new modeling platform.

That search took place as the Chesapeake Bay Watershed Agreement struggles to meet its 2025 restoration deadlines and program partners shift their focus to restoring and maintaining bay health despite its rapid warming.

Dr. Kirk Havens, CCRM director, said "SCHISM's next-generation capability offers an essential planning tool as climate change continues to impact communities and economies not just in the bay but around the world."
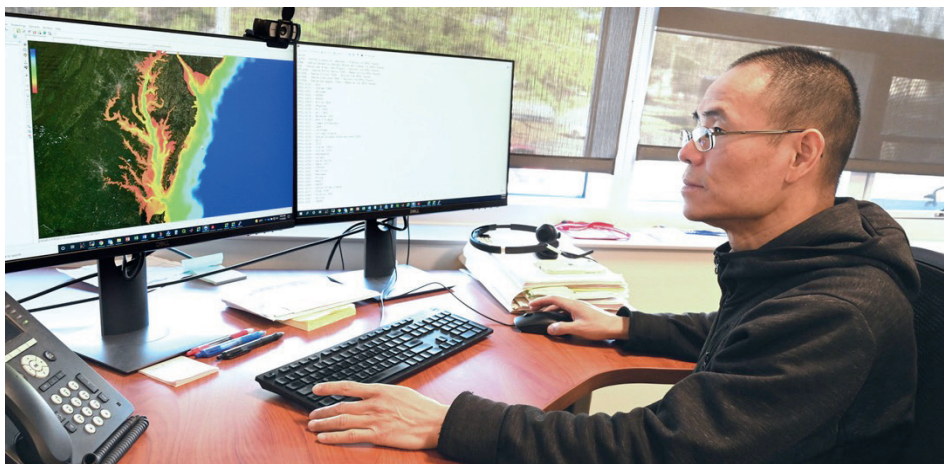
> Dr. Joseph Zhang, research professor in the Center for Coastal Resources Management at VIMS, examines a simulation of water motion in Chesapeake Bay and the coastal mid-Atlantic as performed by the SCHISM model. EPA recently selected SCHISM as the new regulatory model for Bay restoration. ©Laura Patrick/VIMS

HEIN RECEIVES THOMAS JEFFERSON TEACHING AWARD

Dr. Christopher Hein, associate professor at VIMS, received the Thomas Jefferson Teaching Award during William & Mary's annual Charter Day ceremony in February.

Charter Day is an annual tradition that celebrates W&M's founding in 1693 by royal charter. It is also an occasion to honor outstanding faculty, student, and alumni contributions.

Dr. Linda Schaffner, associate dean of Academic Studies at VIMS, said "Chris is truly 'all in' on the education front. His students and advisees describe him as enthusiastic and effective and give him high accolades for being authentically committed to their learning. His prowess as a researcher in the field of coastal geology allows him to provide exciting training opportunities for the next generation of scientists."

"I dedicate a lot of time to teaching," said Hein, who has also received both the VIMS Outstanding Faculty Teaching Award, the W&M Alumni Fellows Award for Teaching

Excellence, and a Plumeri Faculty Award.

"This award in some way, it doesn't validate the ability; it validates the time and the value I place on teaching. I find it a nice recognition of the enormous commitment and dedication required to do that to part of my job well, and I am grateful to VIMS and William & Mary for also valuing dedication to teaching."

> Dr. Christopher Hein

SHARING RESEARCH WITH OUR COMMUNITY

Research at the Virginia Institute of Marine Science is valuable to the worldwide scientific community, but it also provides value to individuals, businesses, and government agencies, particularly in coastal areas. Data products – including annual forecasts and real-time monitoring tools– largely focus on the Chesapeake Bay and adjacent coastal and watershed areas, however a number also provide value to residents of coastal areas nationwide.

- **ADAPTVA** – Short for Adapt Virginia, ADAPTVA is an information gateway on climate change adaptation for individuals, local programs, and agencies. See ADAPTVA for short- and long-term sea level maps, flood mapping and decision-support tools, legal and policy resources, stories that explain adaptation through maps and images (below), and more.

- **Blue Crab Survey** – Every winter, a Chesapeake Bay-wide dredge survey by VIMS and the Fisheries Service of the Maryland Department of Natural Resources provides a comprehensive look (below) at the bay's blue crab population. Check out survey results to learn how the population is changing.


Chesapeake Bay Blue Crab Population

- **CCRFR** – The Commonwealth Center for Recurrent Flooding Resiliency combines expertise and resources provided by VIMS, the William & Mary Virginia Coastal Policy Center, and Old Dominion University to conduct studies, provide training,

and offer a variety of recurrent flooding resilience services to residents, local governments, state agencies, and industries.

- **Dead Zone Forecasts** – Computer modelers at VIMS are at the forefront of efforts to predict the extent, duration, and severity of low-oxygen dead zones (see map at right) in coastal ecosystems. View their Chesapeake Bay daily forecasts and Gulf of Mexico seasonal forecasts online.

Bottom Oxygen: Nowcast June 14, 2022
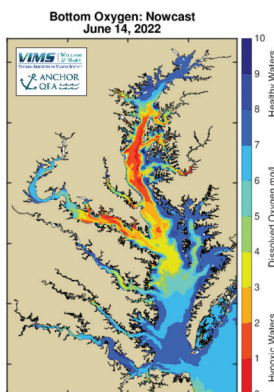
- **Seagrasses** – VIMS researchers have been using aerial photography and ground surveys to monitor seagrass beds in the Chesapeake Bay since 1978. State and federal resource managers use data from the monitoring program as an indicator of water quality and ecosystem health. See annual reports or explore the data for yourself.

Yorktown Coast Guard Training Center (YRCG)
Extratidal Water Level: 36-Hour Forecast

- **Tidewatch** – Tidewatch Charts provide an effective way to visualize and predict the magnitude and impacts of coastal flooding at locations within the Chesapeake Bay and along Virginia's seaside Eastern Shore. Access observations and forecasts for Tidewatch stations on your computer. (Example above)

- **VECOS** – The Virginia Estuarine and Coastal Observing System website distributes results of water quality and meteorological data monitoring efforts from the Chesapeake Bay and associated tributaries within Virginia. Data is provided by the Chesapeake Bay National Estuarine Research Reserve at VIMS.

These VIMS data products and more are available at www.vims.edu/research/products/index
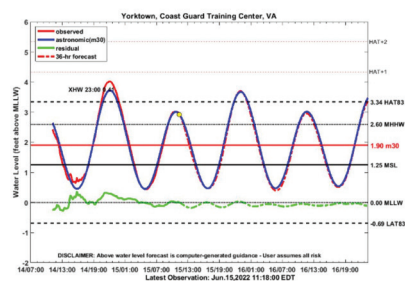
YOUNG SCIENTISTS CREATE FREE CURRICULUM FOR EDUCATORS

This year the Virginia Scientists and Educators Alliance (VA SEA) program at the Virginia Institute of Marine Science welcomed its 5th cohort of graduate students who, like their predecessors, are creating lesson plans for middle and high school science teachers.

Lisa Lawrence, Marine Education Program Leader, said the VA SEA program has been very successful. "Lesson plans created by our first four cohorts have been downloaded more than 5,222 times by educators in 121 countries," she said.

Since 2015, 54 graduate students from VIMS, the University of Virginia, Virginia Tech, and Old Dominion University have participated in VA SEA. The students attend training sessions to learn best practices in science

education and then develop science lesson plans related to their areas of research.

Lessons plans are vetted by classroom teachers, and a science-fair-style open house is held each April to introduce the newly created materials to educators. In addition to creating meaningful content for teachers, graduate students in the program enhance their science communication skills by learning how to communicate their research.

Visit www.vims.edu and search VA SEA lesson plans to see the full list. Lessons from this year's cohort will be available later in the spring. The VA SEA program is a collaborative project of the Chesapeake Bay National Estuarine Research Reserve (CBNERR) and the VIMS Marine Advisory Program education teams.

SAVE THE DATE

ESL OPENS DOORS FOR DAY OF FUN AND EDUCATION

The Virginia Institute of Marine Science, Eastern Shore Laboratory (ESL), will once again host its annual Marine Life Day on Saturday, September 17. The event will take place from noon until 4 p.m. in the Seawater Laboratory located on Atlantic Avenue in Wachapreague, VA.

Everyone is invited to visit the ESL and experience a fun and educational day exploring marine life found on Virginia's Eastern Shore. Visitors of all ages can enjoy learning about marine science research being conducted in local waters.

Guests will have the opportunity to interact with a variety of marine organisms in touch tanks and live displays, study creatures under microscopes, learn about marine science through activities and crafts, and discuss current research projects with scientists from various fields of study. Featured research and displays will include shellfish, crustaceans, fish, sharks, and much more.

The event is free, but registration is requested: www.vims.edu/mld. For more information, contact Hollis Parks at hfparks@vims.edu or call 757.787.5816.

> *Marine Life Day visitors explore a water environment in miniature.*