Summer 2002

The Crest, Summer 2002

Virginia Institute of Marine Science

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The Crest

Current Issues in Coastal Ocean and Estuarine Science

To B or Not to B: Pair Use Trout to Study Kidney's Role in Nurturing Fish Immune Cells

Dave Malmquist

When humans are exposed to infectious bacteria or other foreign invaders, our immune system fights back using an incredibly diverse host of cells and molecules—B cells, T cells, macrophages, cytokines, and antibodies, among many others.

As fellow vertebrates, fish produce and use the very same cells and molecules to confer immunity. But amazingly, fish generate their immune cells in a completely different organ than do humans. In fish, immune cells are thought to arise in the kidney. In humans and other mammals, it's the bone marrow.

This paradox intrigues VIMS immunologist Dr. Steve Kaattari. "What's fascinating about fish is that they don't have bone marrow," says Kaattari, "yet their immune system looks very similar to that of mammals. The same types of cells work in the same sort of way. So now we're asking, does the anterior kidney function in developing a mature immune system for the fish? How might it actually work?"

To help answer these questions, Kaattari has teamed with Dr. Patty Zwollo of the Biology Department at William and Mary. The pair recently submitted a 4-year proposal to the National Institutes of Health to continue their research into the genesis and activation of B cells in rainbow trout.

Zwollo notes that the collaboration provides "a great opportunity" to build on their shared interests and individual expertise. "We're both B-cell immunologists," says Zwollo, "but my focus has been on B-cell development in mice, whereas Steve has focused on fish."

B cells are frontline scouts of the immune system. They recognize bacteria, viruses, parasites, and fungi, then produce antibodies to help the body rid itself of these and other foreign antigens. In fish, B cells are thought to arise in the anterior kidney, though this has yet to be proven. They develop from stem cells via a complex pathway whose many twists and turns are controlled by the presence or absence of growth-regulating chemicals. Bathe stem-cell progeny in one chemical and they differentiate into mature B cells. Bathe them in another, and they grow into T cells. Encounters with antigens cause mature B cells to differentiate further—into plasma and memory cells. Plasma cells quickly flood infected tissues with antibodies. The longer-lived memory cells provide a means to recognize and rebuke an invader if it returns—whether tomorrow or years hence.

The intricacy of this process makes its occurrence within completely different organs in mammals and fish truly remarkable, says Zwollo. By studying basic immunological processes in trout, Kaattari and Zwollo believe they can ultimately shed light on how B cells differentiate in bone marrow and are activated to fight diseases in humans.

From right to left: Dr. Steve Kaattari, with Erin Bromage and Ilsa Kaattari.

Kaattari notes that activation of B cells to produce antibodies is a particularly promising area for this type of comparative immunological research. "In trout, we have some evidence that mature B cells from the anterior kidney may continue to produce antibodies

Continued on page 4

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Chesapeake Bay National Estuarine Research Reserve in Virginia

a fair Bay Spring
Vol. 12, No. 2

Cobia Anyone?

By Sally Mills

Berret's Restaurant and Raw Bar in Williamsburg took on an air of excitement and drama on May 21st when 50 of its patrons ordered the cobia special for dinner. These particular cobia entrees were unique indeed. They represented the first cobia spawned and raised completely in captivity in the United States and served in a commercial setting.

Cobia grow fast and perform well in captivity, making them an excellent species for culturing. Historically, cobia have migrated into Chesapeake Bay to spend summer months in the estuary before returning to more southern waters. The fish are keenly sought by recreational fishermen, who enjoy the challenge of their notorious fighting nature. But wild cobia are seen in fewer numbers today and recreational pressure has intensified in recent years.

As part of their participation in this tasting event, Berret customers rated the cultured fish afterward in a brief survey conducted by Virginia Sea Grant. And the verdict? A very strong, positive response from 91 percent of the recipients. In fact, the majority of taste testers rated the fish as firmly textured with a pleasant flavor. Some 23 respondents considered it better tasting than flounder, and 35 rated it better tasting than bluefish.

VIMS' cobia aquaculture project has attracted worldwide attention.

Restaurant owner Tom Austin was pleased with the turnout and the positive reaction, and promised to include cultured cobia on the regular menu if it becomes available in the future. This was music to the ears of marine specialist Mike Oesterling, whose staff have been caretakers of the fish since their spawning 11 months ago.

The Virginia Institute of Marine Science continues to collaborate with other research institutions throughout the southeast to develop cobia culture protocols, with the ultimate aim of moving this technology into the private sector.

Sea Grant

Summer Intern Program

By Susan Polk

Wet shoes and muddy shorts are part of "the color of fun" in summer. But if you've been around VIMS lately, you've seen the same browns and greens in "the color of experience." A select group of undergraduate students are happily getting experience "up to their knees" through the VIMS Summer Intern Program. This interdisciplinary program focuses on processes in local estuarine environments and offers students hands-on research experience. Former intern James Douglass said, "When I found out I had been accepted in the program and would be working with Emmett Duffy, it was great. I had heard about his biodiversity work in class and was really excited to get to work with him." Approximately twelve interns are chosen each year from 120-150 applicants from all over the continental U.S., Hawaii, and Puerto Rico.

The intern program provides individual research experiences for students as well as group activities. The interns work closely with a mentor in developing a project that they will research in the laboratory and/or field. The students present their results in a program that is open to the VIMS community. Interns also attend weekly seminars that include topics on everything from "The Secret Social Life of Shrimp" to "How to Apply to Graduate School: Tips from the Faculty Who Read the Files." Field trips on kayaks and research vessels to freshwater systems, the Bay, and the Atlantic shoreface of the Delmarva Peninsula are a fun and important part of the program.

The students you've seen this summer are experiencing first hand what to expect as graduate students, and ultimately as scientists. Stephanie Bolton, a student intern from Wake Forest, currently working with Fu-Lin Chu shared, "Following my mentor around for the first few days showed me the grant proposal and management aspects of research that I wasn't aware of before." Intern Joel Nuebauer said that he was enjoying "actually using the equipment" he had learned about in his undergraduate courses at W&M. "I'm having a blast," said Justin Zabrecky, from Spring Hill College in Mobile, Alabama, "I love the hands-on work and working with the scientists. It's what I want to do."

VIMS summer intern "digging in" on the Eastern Shore.

The Summer Intern Program receives substantial NSF funding via a Research Experience for Undergraduate (REU) site program along with support from VIMS, W&M, and grants obtained by individual mentors. Increased participation from underrepresented groups in marine science is a program objective. Associate professor Linda Schaffner heads VIMS' program, which is now in its fourteenth year. "Most of the interns I have worked with are like sponges, anxious to learn, enthusiastic and curious, looking for opportunities to experience as much as they can during the summer," Schaffner comments, "I love it when interns from 5 or 10 years ago tell me that the internship made a big difference in their life."

New Findings Surprise Researchers

By Wanda Cohen

Although VIMS researchers have studied the oyster pathogen, *Perkinsus marinus* for years, scientists say they've reached a new stage in the work. Recently, Drs. Fu-Lin Chu and Eric Lund determined that *Perkinsus marinus* is able to synthesize arachidonic acid, an essential fatty acid that animals and humans need. Arachidonic acid is important in making hormones and in cell communication – or "cell signaling." The parasite needs the fatty acid for energy and to produce new cell membranes as it multiplies to spread through its host. In 1998, when the scientists turned their attention to how the parasite acquires and uses fats, they expected the organism to be like related parasites. But it turned out that *Perkinsus* has a major distinction. While other parasitic pathogens could produce simple fatty acids, *Perkinsus* is able to make the more complex arachidonic acid. That is significant because it may help explain why the pathogen is so virulent in oysters.

Based on these findings, the National Science Foundation recently renewed funding to enable the researchers to expand their work. "We have several important questions we plan to address in this phase of the study," said Chu. The team hopes to find out if the process of synthesizing the fatty acid takes place when the parasite is inside the oyster or when it is in the water column or both. For this portion of the study, molecular biologist, Dr. Kimberly Reece will work with Chu and Lund to identify the genes that are involved in the process of making arachidonic acid. If it turns out that inside the oyster the parasite loses its ability to make arachidonic acid, then the scientists will need to identify the underlying mechanisms that trigger the genes to turn "on" and "off." "Either way this turns out, we will know a great deal more about this pathogen," said Chu.

Drs. Fu-Lin Chu and Eric Lund led recent *Perkinsus* study.

By understanding this aspect of the parasites physiology, scientists hope they can ultimately develop strategies that would interfere with the pathogens ability to multiply in the oyster and thus interrupt the disease process.

Some parasites, like *Plasmodium* that causes malaria, need carriers — like the mosquito—to spread. But *Perkinsus* doesn't appear to have a carrier, and scientists believe it floats in the water until finding oysters to infect. *Perkinsus* can survive outside the host for some time, but it does not multiply during this phase of its life cycle.

Perkinsus marinus, which causes Dermo disease in oysters, is one of the diseases that had devastated the native oyster populations in the Chesapeake Bay and along the east coast and Gulf coasts of the United States. In the past few decades, there has been a worldwide increase in the frequency and intensity of diseases that affect economically and ecologically important marine organisms. Several parasitic species from the genus *Perkinsus* have been associated with the outbreak of diseases and subsequent mortality in many cultivated and wild populations of shellfish.

This photo shows a healthy oyster on the left, and a diseased oyster on the right.

Annual Fund Board

At its June 5th meeting, the VIMS Annual Fund Board honored outgoing Chairman John Dayton for his numerous contributions over the past several years and named Peter Clay from Richmond as its new Chairman. The Board assists the institute in fundraising and community outreach activities. Annual Fund Board member Carrie Garland chaired the VIMS Auction in April to benefit the Hargis Library Endowment. President-elect Clay said, "I look forward to continuing in the path of John Dayton's fine leadership over the past two years and supporting the mission of VIMS."

Biotechnology Initiative

VIMS Director Don Wright was named to serve on the Governor's Advisory Board for the Virginia Biotechnology Initiative, a panel charged with developing a comprehensive and coordinated statewide strategy to attract additional biotechnology investment in the Commonwealth. The Governor has instructed the Board to produce specific recommendations and actions for making Virginia a leader in the biotechnology industry by November 15, 2002.

What is Dermo?

Dermo was first documented in the Gulf of Mexico in the 1940s where it was associated with extensive oyster mortalities. The disease was found in Chesapeake Bay in 1949 and has been present in the Bay since that time. By the mid-1950s, Dermo had spread to Delaware Bay and since that time has been found in Connecticut, New York, Massachusetts, and Maine. The parasite thrives in warm water temperatures with high salinity.

In June 2001, the Office International des Epizooties (OIE), designated VIMS as the world reference laboratory for *Perkinsus* and *Haplosporidium.* These two pathogens cause disease in shellfish worldwide. (See CREST, Vol.3 No.2 Fall 2001.) Over the past fifty years, the institute has been a world leader in research on these pathogens. Today, most laboratories use techniques developed at VIMS for identifying the parasites. VIMS continues to lead the way in shellfish disease research that has economic impacts worldwide.

VIMS Researchers Use Sonar To Study Impact of Poundnets on Sea Turtles

By Dave Malmquist

Preliminary work with a sonar system that allows VIMS researchers to peer beneath the murky waters of Chesapeake Bay suggests that entanglement of sea turtles in poundnet "leaders" may occur less often than commonly thought.

A leader is a long, fence-like drapery of mesh used by commercial anglers to steer herring, menhaden, and other fish into a net-floored impoundment.

A program of surface observations begun in the mid 1980s by VIMS' Dr. Jack Musick and his graduate students showed that poundnet leaders with large mesh and vertical "stringers" can pose a threat to sea turtles. These leader types provide openings large enough to snare a turtle's flippers or head. Ensnared turtles can then succumb due to drowning or exhaustion.

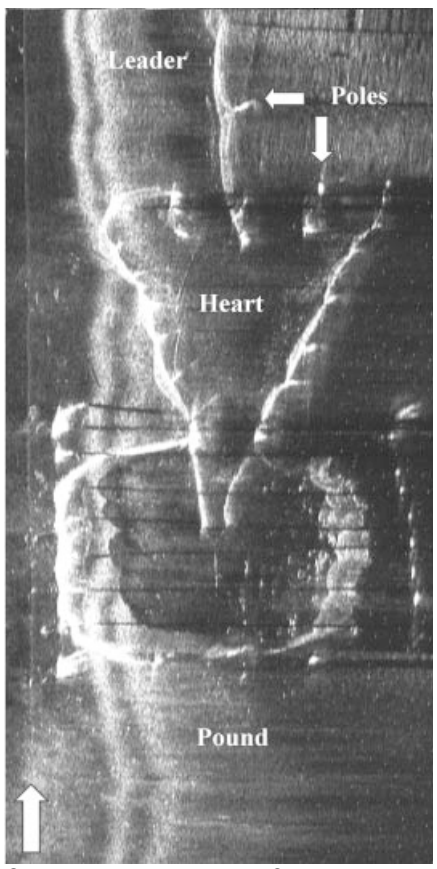
Poundnetters use large-mesh leaders to reduce clogging by jellyfish, seagrass blades, and assorted flotsam in regions where Bay currents are strong. The number of large-mesh leaders in the Bay has declined significantly since the 1980s, both through voluntary removals by concerned pound netters and an overall decline in the poundnet fishery.

Musick's team and other local sea turtle researchers have traditionally relied on observations from boats, airplanes, and the shore because the turbid waters of Chesapeake Bay obscure what might be happening in deeper water. If turtles tangle there, beneath the view of surface observers, the number of sea turtle mortalities may be underestimated.

"That's why sonar is important," says Kate Mansfield, a Ph.D. student in Musick's lab. "Some poundnet leaders reach depths of 30 feet, but we can only see a few feet into the murky water. Sonar allows us to see what's going on beneath the surface" (see sidebar on page 8).

Musick and Mansfield's sonar project is funded by the National Marine Fisheries Service (NMFS), as part of its larger effort to assess the impact of commercial fisheries on sea turtles in the Chesapeake Bay. All sea turtles in U.S. waters are classified as either threatened or endangered under the Endangered Species Act, and thus NMFS is legally bound to protect them from intentional or incidental harm due to poundnet fishing, gill netting, dredging, blasting, boating, or any other human activities.

Each year, tens to hundreds of sea turtles wash up dead on Virginia's beaches. Most of these stranded turtles are juvenile loggerheads. Because many are severely decomposed, it is often impossible to determine their cause of death through autopsy. NMFS considers poundnet entanglement the logical cause for many of the beached carcasses, citing Musick's mid-1980's observations of surface entanglement in leaders with large mesh and stringers, the possibility of additional entanglements under water, and a lack of other explanations.



Sonar image of western Chesapeake Bay poundnet.

Continued on page 8

To B or Not to B....
continued from page 1

long after their initial exposure to an antigen. We're really interested in why that is. There are some elements that seem very reminiscent of bone marrow."

Recent studies with mammals show that bone marrow sometimes holds long-lived plasma cells that constantly trickle antibodies targeted at previously encountered invaders. Traditional thinking holds that plasma cells are short-lived, dying off as soon as an invader is vanquished, and that memory cells in the spleen provide the long-term protection. But memory cells must be activated before they can respond. Retention of active plasma cells could thus help the immune system react more quickly to future invasions. "You save time doing it this way," says Zwollo.

If Kaattari and Zwollo's research shows that the anterior kidney is indeed the reservoir for long-lived plasma cells in trout, it would support the idea that this organ is where fish develop B cells. "That's the way it works in mammals," says Zwollo, "long-lived plasma cells reside in bone marrow, the same organ that nurtures young B cells."

The pair's B-cell research builds on Kaattari's previous advances in developing the rainbow trout as an alternative to mice as experimental animals. Researchers have historically relied on mammalian models—the proverbial "lab rat"—to explore biomedical questions. "In our lab," says Kaattari, "we're refining trout as another model of biomedical research, particularly in immunology."

Several traits favor fish, trout in particular, as biomedical models. For one, researchers can manipulate fish reproduction to quickly produce large numbers of identical offspring. Whereas it took hundreds of generations to produce genetically identical mice, collaborators at Washington State University created strains of identical trout in only two generations. Use of genetically identical animals ensures a consistent, statistically meaningful response to immunological challenges. Young trout are also small enough that thousands can be reared in a normal-sized laboratory, yet they grow large enough (10-15 pounds) for easy manipulation and use in long-term experiments. With mice, juveniles and adults vary little in size. Finally, trout care is relatively easy, particularly now that high-tech biofilters and chillers ensure that fish in aquaria have the cold, clean water they need.

But the trout's big advantage is that it provides researchers with a model animal that is agriculturally important. Trout, and their near relatives the salmon, "are about the most important species in aquaculture," says Kaattari. "They are cultured around the world. In Virginia alone, there are at least 12 trout hatcheries."

Use of a trout model to increase basic understanding of the fish immune system thus promises significant economic return, particularly since farmed fish are crowded and therefore more prone to disease than their wild kin. Coupled with its basic scientific merits, the potential economic value of Kaattari's research makes it attractive to a wide range of funding agencies. To date, five different agencies have funded his trout work, including the National Oceanic and Atmospheric Administration, the US Fish and Wildlife Service, the US Department of Agriculture, the National Institutes of Health, and the Department of Energy.

In addition to trout, Kaattari is studying the immune response within another commercially important fish species—the striped bass.

In Chesapeake Bay, around 70% of these popular game fish are now infected with mycobacteriosis, a chronic disease whose characteristic lesions first showed up in Bay stripers in 1994. The prevalence of this disease in the Bay's striper population has raised numerous questions concerning its origin and transmission.

To help answer these questions, Kaattari and fellow VIMS researchers are developing a suite of genetic tests to determine if a striper is infected with or has developed immunity to mycobacteriosis. The tests will require only a small sample of blood, which could be taken by VIMS' Juvenile Trawl Survey team during their monthly catch-and-release sampling of Chesapeake Bay fish and invertebrates. The Trawl Survey and other population and tagging studies provide a comprehensive view of the Bay's striper population. Correlating the blood-test results with abundance and distribution data from these surveys will "allow us to look at the dynamics of disease and its impact within a wild population, and that's virtually never been done before," says Kaattari.

For further information on fish immunity research at VIMS (including video clips from Steve Kaattari's laboratory), visit the VIMS web site at http://www.vims.edu/env/research/immune.html

Scientists from VIMS and Wales Initiate New Study of Turbulence and Sediment Movement in Chesapeake Bay Tributary

By Wanda Cohen

A team of five scientists from the University of Wales, Bangor is working with a team of VIMS scientists on a project to measure turbulence in the York River estuary during a full spring neap-tide cycle. The concept for the project was conceived several years ago when Dr. John Simpson, Head of the School of Ocean Science, University of Wales Bangor, was visiting VIMS.

Using an acoustic doppler current profiler, (ADCP), researchers measured currents and turbulence throughout the water column using reflected acoustic signals. Basically, sound waves are emitted from the ADCP and reflected back creating a pulsating signal that scientists can analyze. The ADCP technology enables researchers to measure both currents and turbulence simultaneously throughout the water column. Initial experiments in the Irish Sea revealed that more turbulence occurs on the flood tide than during the ebb flow. This suggests that more particles are suspended on flood than ebb tides thereby moving more sediment upstream during the flood tide. The team of scientists from Wales and VIMS now wants to test this hypothesis in the York River estuary.

Professor Colin Jago from Wales processing samples on the R/V *Langley*.

Turbulence affects the rates at which adjacent layers of water mix with each other and exchange momentum. In the water column, turbulence involves movement in all directions and also affects the ability of water to pick up and transport sediment from the bed. This is very important because it determines where anything in the water will go – sediment, pollutants, eggs, larvae, and pathogens that may be in the water.

Research teams worked around the clock aboard the R/V *Langley*.

The scientists will deploy automated instruments for 15 days to observe and record the full spring - neap tide cycle. Samples of water and sediment will also be collected. "Basically, we will measure everything that moves," explains Simpson. Information gathered from experiments such as this provides a new dimension of data to strengthen dynamic models of movement in marine environments.

This collaboration is part of a formal agreement between VIMS and the University of Wales, Bangor established in 1998 to promote joint research and exchange programs for students and scientists. Over the past four years there have been various collaborations among scientists as well as a field course for VIMS students on the Bangor campus. During the summer of 2001, five students from Wales spent several weeks on the VIMS campus doing research. The Drapers Company of London provides support for the exchange program, including the costs of the present visit to VIMS by the Wales team.

This latest experiment is closely related to a four-year National Science Foundation grant awarded in 1999 to Carl Friedrichs entitled "Sediment dynamics of a microtidal partially-mixed estuary," which also focuses on ebb-flood asymmetries in turbulence and sediment suspension. Friedrichs' NSF grant supported vessel operations, VIMS technical staff and field supplies for the collaborative experiment with the University of Wales. Friedrichs' proposal on this topic resulted in his receiving the Presidential Early Career Award for Scientists and Engineers from Bill Clinton in 2000.

New Dean of Graduate Studies

Dr. Iris Anderson, Professor of Marine Science, Dept. of Biological Sciences has been named Dean of Graduate Studies. Anderson, who joined the VIMS faculty in 1993, received her B.S. from Colby College; her graduate work was completed at MIT and the Medical College of Virginia, VCU. Her primary research focuses on nitrogen and carbon cycling, primarily in shallow subtidal and intertidal systems. Anderson has worked extensively in Chesapeake Bay as well as in systems in Africa, Brazil and the Czech Republic.

Dr. Iris Anderson

"The School of Marine Science attracts the best and brightest students from across the nation," said Anderson, "My immediate goals are to find additional funding sources for our students and to enhance teaching opportunities for VIMS faculty and students." Anderson has served on the SMS admissions committee for 8 years and chair or co-chair for 3 of those years. "Twenty-nine students will enter in the fall of 2002," said Anderson," I am very excited about having the opportunity to work with these students and our faculty to continue to broaden the opportunities for students at VIMS."

More Than 200 Attend VIMS Auction

The 4th Annual VIMS Auction attracted over 200 people to bid on items ranging from dinners at fine restaurants to oriental rugs to a week on the French Riviera. The event raised over $28,000 to support the Hargis Library Endowment at VIMS. Annual Fund Board member Carrie Garland chaired the event with help from more than 30 volunteers, VIMS faculty, students and staff. The Auction Committee wishes to thank all the businesses and individuals who donated items for the auction.

Attendees placing silent auction bids in the VIMS Library.

The VIMS community is very grateful for the Auction committee and all who support the library that is vital to the quality of work by faculty, students and staff at the institute.

Kauffman Aquaculture Center Groundbreaking

On May 18, 2002 VIMS broke ground for the Kauffman Aquaculture Center, the first building located at the future VIMS' campus in Topping, Virginia. This new facility will include brood stock and quarantine laboratories as well as space to provide the capability for scientists to conserve important genetic material from oyster species from around the world for breeding research. The Honorable W. Tayloe Murphy, Jr., Secretary of Natural Resources, Commonwealth of Virginia, along with Timothy J. Sullivan, President, The College of William & Mary; James E. Rogers, Campaign Chair, Kauffman Aquaculture Center; and L. Donelson Wright, Dean, School of Marine Science and Director, Virginia Institute of Marine Science, provided remarks during the ground breaking.

In April, 2001, VIMS launched a capital campaign to match a gift from Mr. and Mrs. Jack Kauffman to construct the Kauffman Aquaculture Center. Under the guidance of Campaign Chair, James E. Rogers, the campaign met its goal in less than six months.

Left to Right: W&M President Timothy Sullivan, Jack Kauffman, Boots Kauffman, Dean/Director Don Wright, Campaign Chair Jim Rogers, and Secretary of Natural Resources The Honorable Tayloe Murphy.

Virginia's Recreational Saltwater Fishing Economy Continues to Expand

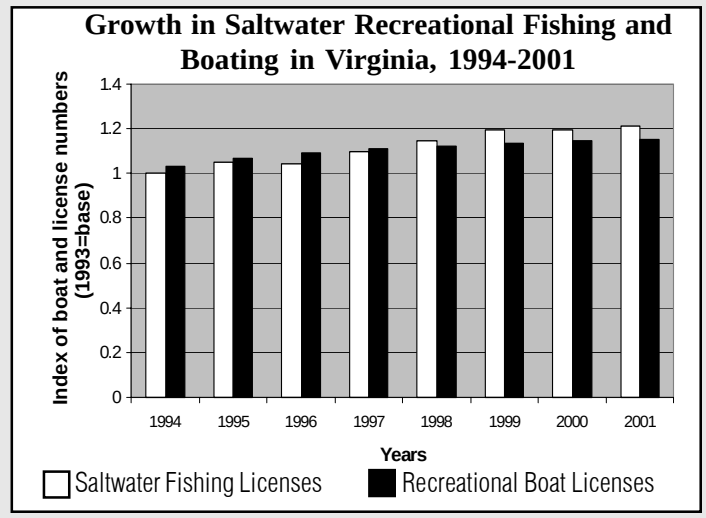
By Tom Murray

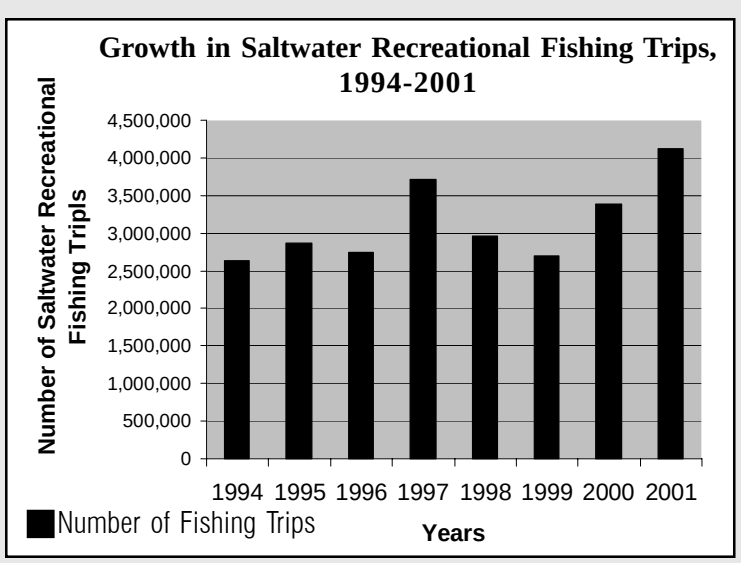
As we all know, the decade of the 1990s represented a period of amazing growth in many areas of the state's economy. In terms of increased use of Virginia's marine resources, growth in saltwater recreational angling activity led the way.

It is interesting to review two benchmark studies on sport fishing conducted during the period that chronicle this rapid growth. By linking those data collection efforts on recreational fishing and boating activity in Virginia, a general index for estimating current expenditures and economic impacts associated with these activities can be developed. In 1994, a study by VIMS economist Dr. Jim Kirkley, "Saltwater Angling and Its Economic Importance to Virginia," utilized survey data to document angling expenditures as a basis for estimating an economic impact model for the recreational fishery. That cornerstone study is still useful today because it provides a base from which to benchmark expenditure and impact estimates using more current participation and expenditure data released periodically by the NOAA Fisheries Service.

In addition to angler effort data for the years following the VIMS study (1994-2001), NOAA published a "Marine Angler Expenditure Survey in Northeast Region, 1998," which includes information on saltwater fishing expenditures similar to that collected by VIMS in 1994. As seen below, the aggregate level of fishing activity has risen an estimated 57% since 1994 according to the National Marine Fisheries Service's Marine Recreational Fisheries Statistics Survey (MRFSS). The most recent MRFSS results estimate that over 4.1 million saltwater fishing trips from all fishing "modes" (i.e., shore, private/rental boats, and party charter) were conducted in Virginia during 2001.

Over the same time period, the number of licensed recreational saltwater fishermen has increased 21% and the number of recreational watercraft registered has grown by 15%.[1] Along with such growth in the number of anglers and fishing activity, overall economic activity associated with saltwater angling has grown. The VIMS study estimated that saltwater anglers in Virginia incurred fishing trip expenditures[2] of $180.3 million in 1994. The 1998 MRFSS survey work estimated that anglers in Virginia spent $334.8 million on the same "trip expenditures."[3]





Saltwater Angling Leads to Economic Growth

In addition to angler expenditures, the 1994 study also estimated the total economic impact arising from recreational angling activity in Virginia. Using total ("trip" and "annual") fishing expenditures, a "direct impact" on the state of $191.5 million was estimated to initiate a total economic impact of $477.2 million during 1994. Adjusting for general price increases, that would represent $579 million in 2002 dollars. When also accounting for the increased recreational saltwater fishing activity reflected by the indicators above, particularly the number of angler trips taken, total economic activity associated with the fishery has likely grown significantly, and a reasonable estimate can be made.

Comparing the results of the two studies, the average expenditure per fishing trip in 1994 was $68, while in 1998 – according to the MRFSS – it was estimated at $113. By adjusting for inflation over these periods and averaging the two estimates of trip expenditures in 2001 dollars, an average expenditure per fishing trip of $102 is estimated. Multiplying the average expenditure by the estimated number of saltwater angling trips of 4,128,242 (MRFSS 2001), $421.1 million are estimated to have been spent on fishing trips during 2001.

The VIMS study also found that such trip expenses were 59% of the total expenditures made by recreational saltwater fishermen during 1994. Assuming the same relationship, it is estimated that $708 million was spent on recreational saltwater angling in Virginia last year. Finally, by using the VIMS '94 survey-derived economic impact assessment and the most recent fishing effort data, the overall economic impact from saltwater angling during 2001 is estimated at just over one billion dollars.

Sea Grant

[1] Virginia Department of Game & Inland Fisheries. Fishing license numbers are through November 2001; boat registration numbers were through December 2001.

[2] Trip expenditures include transportation, food, lodging, boat fuel, fees, equipment rental, bait, ice, etc. but exclude costs for equipment and gear purchases and the "annual costs" such as boat ownership, insurance, taxes, etc. The total including those costs in 1994 was estimated to be $303.5 million and is estimated to be $605 million in the 1998 MRFSS survey. When adjusting for inflation over the time period, the 1998 figure would be $555 million, or an increase of 82%.

[3] $183 million were expenditures by non-residents, compared to $151 million spent on fishing trips by Virginia anglers.

Chesapeake Workboat Races Part of Hampton Roads Heritage

Jon Lucy

Workboat captains have always raced. The tradition is part of a daily competition to get to the dock first, not only with the freshest product, but also to get the top market price. If the truth be known, however, pride in one's boat, since often more time is spent there than at home, and how much speed can be coaxed from its engine is what really drives the racing tradition. It's all for bragging rights, whether racing for fun or during organized events as part of waterfront celebrations (bigger bragging rights!).

Jon Lucy, VIMS Sea Grant Marine Advisory Program has helped coordinate workboat races in Tidewater for the past twenty-one years. Norfolk's Harborfest Committee approached Lucy in 1981 to assist in diversifying their maritime heritage festival by helping to organize workboat races. "It has been a terrific experience for me and VIMS," says Lucy. "The opportunity to get to know and work with such great captains, marine businesses, civic leaders, and Norfolk's FestEvents team has helped keep VIMS in touch with the practical workings of the waterfront."

Over the years Harborfest events (always the second weekend in June) have expanded to include a workboat parade (decorated boats process along the waterfront), and most recently, a docking contest. "There is no better showplace than Harborfest for people to see close up boat design features key to working under all weather-sea conditions imaginable, but also how designs and materials have changed over the years. In Nauticus harbor, the boats typically range from new to over 75 years old with more fiberglass boats joining the workboat fleet each year. "But for real excitement, nothing beats seeing the captains competing against each other during the docking and racing events," Lucy explains. "And hearing the events skillfully narrated by co-coordinator Sonny Insley (from a Poquoson waterman family) is a treat unto itself!"

Capt. Timmy Lindsay, from Poquoson, on *Kristen Marie* racing for the finish line.

Capt. Todd Smith, from Gwynns Island, on *Bay Lady* as he powers to first place.

At Norfolk's Harborfest June 7-9, 2002, nearly 70 workboats rafted up at Nauticus, representing perhaps one of the largest gatherings of workboats in recent years from Chesapeake Bay ports. The wood and fiberglass boats, coming from as far as Tangier Island, ranged in size from crab skiffs (16-18 feet) to conch, gill net, and clam boats up to 47 feet long, the latter capable of working both Bay and ocean waters. A record eighteen races were run plus several runoff challenge races (for what are called "Top Eliminator Workboat" bragging rights). The workboat events at Harborfest, like those in Yorktown (changed to late July for next year) and Poquoson (set for October 13), help remind all of us about the technical skills associated with commercial fishing while underscoring the importance of the seafood and maritime industries to the Commonwealth.

Workboats daily harvesting seafood from the waters of Chesapeake Bay are a mainstay of Virginia's seafood industry. Indicative of the importance of these traditional vessels to Virginia's maritime heritage, in 1988 the Chesapeake Bay deadrise was designated by the Virginia General Assembly as the "Official Boat of the Commonwealth."

Sea Grant

Recent Faculty and Student Awards

Faculty

Dr. John (Jack) A. Musick, Department of Fisheries Science, was awarded the 2002 American Fisheries Society Excellence in Fisheries Education Award.

Dr. Carl Hershner, Director, Center for Coastal Resources Management, was recently elected Chair of the Scientific and Technical Advisory Committee to the Chesapeake Bay Program. His term will begin in 2003.

Dr. Deborah Steinberg, Dept. of Biological Sciences, has been elected Secretary of the Ocean Sciences section of the American Geophysical Union (AGU). Ocean Sciences is the largest section of AGU and includes about 20% of the 40,000 scientists in AGU.

Dr. Linda Schaffner, Dept. of Biological Sciences, will begin serving a term as president of the Estuarine Research Federation (ERF) in 2003. ERF is an international organization representing estuarine and coastal ocean scientists and has a membership of about 1500.

Dr. Michael Newman, Dept. of Environmental and Aquatic Animal Health, was recently appointed to the Science Advisory Committee to EPA Administrator Christie Todd Whitman. Only 100 scientists nationwide are appointed to serve in this capacity.

Dr. Morris Roberts, Dept. of Environmental and Aquatic Animal Health, was named 2001 Science Advisor of the Year by Elizabeth River Project.

Gov. Warner recently appointed **Dr. Kirk Havens** Assistant Director of the Center for Coastal Resources Management.

Student

Tom Ihde, Ph.D. student, Dept. of Fisheries Science was awarded a NOAA NMFS Stock Assessment Fellowship. Previously, Tom received funding from the Wildlife Conservation Society for his work in Belize.

Dave Gauthier, Ph. D. student, Dept. of Environmental Sciences, won best student presentation at the Annual Meeting of the American Fisheries Society Fish Health Section and 42nd Western Fish Disease Workshop held June 26-29, 2001 in Victoria, Canada.

Kate Mansfield, Ph.D. student, Dept. of Fisheries Science, was awarded an EPA STAR Fellowship for three years.

Joel Hoffman, Ph.D. student, Dept. of Fisheries Science, received a National Science Foundation Graduate Research Fellowship Award.

Todd Gedamke, Ph.D. student, received the *Thurlow C. Nelson Award* at the 2001 National Shellfisheries Association annual meeting in Mystic, CT. The Nelson Award is given to a graduate student of research for the outstanding oral presentation representing a distinctive and valuable contribution to shellfisheries science.

Annual Awards Ceremony

Annual VIMS Awards Ceremony was held May 10, 2001 to recognize outstanding student and employee performance for the year 2000-2001.

Student Awards

Craig Smith Fellowship: Ph.D. student Chris Earnhart, supported by friends and family of late VIMS faculty Craig Smith

Mathew Fontaine Maury Award: Ph.D. student Art Trembanis, supported by Captain Maury Werth and family

Kelley Watson Fellowship: John Pohlman in honor of VIMS student Kelley Watson

John Zeigler Award: Janet Nestlerode, supported by friends and family of the late Dean of Graduate studies John Zeigler

Dean's Prize for Advancement of Women in Science: Elizabeth Hinchey

Hargis Award: Kristen France, supported by friends and family of former VIMS Dean and Director, Dr. William J. Hargis, Jr.

Classified and Faculty Awards

Research and Advisory Service: Vicky Clark, Marine Education Specialist

Faculty Advisory Service: Romuald Lipcius, Dept. Fisheries Science

Classified Trades: Danny Gouge: Dive Master

Safety: Paul Nichols, Safety Office, Tom Grose: Safety Office

Technical Support: Mike Seebo, Dept. Fisheries Science

Administrative Support: Patricia Hall, Information Technology and Networking Services

Calendar of Events

—August 2002—

02 Public Tour
09 Public Tour
14-16 Wetland Plants ID Course
16 Public Tour
23 Public Tour
26-27 Fall Semester Orientation
28 Fall Semester Classes Begin
30 Public Tour

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

—September 2002—

02 Labor Day – Closed
06 Public Tour
13 Public Tour
Pat Donahue Concert
17-20 Wetlands Delineation Workshop
19 VA Native Plant Society
20 Public Tour
27 Public Tour
27-28 VIMS Council

—October 2002—

01 TOGA Board Meeting
04 Public Tour
04-05 Mid Atlantic Marine Education Association (MAMEA) Conference
10 Garden Clubs of Virginia Presidents Meeting
11 Public Tour
14 Chef Symposium
18 Public Tour
25 Homecoming Weekend, Tour @ 2pm
25 Public Tour
26 Donor Day

Visit our website at www.vims.edu

VIMS Researchers Use Sonar To Study Impact of Pound Nets on Sea Turtles
continued from page 4

To date, Mansfield's research does not support this view. She has so far seen no evidence that poundnet leaders are trapping live turtles at depth, regardless of leader type. "We've seen a few turtles in the nets," says Mansfield, "but these are severely decomposed and may have floated in with the tide after death."

To help explain these results, Mansfield notes that the 1980s study took place when there were more than 300 pound nets in the Bay, over half of which were large mesh. "Now," she says, "there are far fewer nets being fished, and less than 20 are considered large mesh." The Chesapeake's main stem currently holds from 50-75 active leaders. Of these, 10-15 feature large mesh, vertical "stringers," or both.

Mansfield's grant allows her to monitor sea turtle interactions with active leaders in Virginia's Chesapeake Bay waters from May to June, when sea turtle strandings in Chesapeake Bay traditionally peak. This is when turtles begin to migrate into warming Bay waters to start feeding on a summertime bounty of blue crabs, horseshoe crabs, and fish.

If the weather allows, Mansfield visits and scans each active leader every week or so. To corroborate and extend her findings, Mansfield would like to monitor the nets more frequently, and throughout the sea turtle residency season, which continues in the Bay until autumn cooling. Surface entanglements and strandings are much less common after the migratory peak ends in late June.

"There's some evidence," says Mansfield, "that turtles are more likely to become entangled when they first migrate into the Bay because their energy reserves are low and they're unable to avoid or escape the leaders in areas where currents are strong and the leader mesh size large. Some of the loggerheads have migrated to the Chesapeake from as far away as the Florida Keys and the Gulf of Mexico."

The decline in entanglements during the remaining warm-weather months may occur because turtles have had a chance to regain strength by feeding in Bay waters and to establish regular feeding grounds.

By helping to determine if pound nets are a hidden source of turtle mortality or instead pose a diminishing threat due to their decreasing numbers, Mansfield's work can help the National Marine Fisheries Service (NMFS) refine its regulations concerning human interactions with Chesapeake Bay sea turtles. A recent NMFS ruling banned leaders with large mesh and stringers from the Virginia poundnet fishery from early May to the end of June.

For additional information on the VIMS Sea Turtle Stranding Program, visit http://www.fisheries.vims.edu/turtletracking/stsp.html


Juvenile Kemps Ridley turtle.

Passing sailors may have thought them a nautical apparition, two pirates sending a pair of shrouded shipmates to Davy Jones' locker.

But the "pirates" are really VIMS researchers Kate Mansfield and Bob Gammisch, their "shipmates" the frozen bodies of a loggerhead and Kemp's ridley sea turtle. The burial shroud is a length of fishing net, and the pirate ship is the VIMS R/V *Coot.*

Mansfield and Gammisch are using the preserved turtle specimens as models, snapping sonar images of their net-bound carcasses to help better envision how a living or newly dead turtle would look on sonar if tangled in a poundnet "leader." Certain types of leader nets have been implicated in sea turtle mortality and strandings in Chesapeake Bay (see accompanying article).

By scanning submerged carcasses of a loggerhead and Kemp's ridley (on loan from Dr. Jack Musick's specimen collection), Mansfield and Gammisch are able to develop a "search image" of each species' characteristic shape, size, and capacity for reflecting sound waves. Most entangled turtles are juvenile loggerheads.

Some of the resulting images are so detailed and crisp, says Mansfield, that using them to calculate the dimensions of a scanned carapace gives values within inches of physical measurements of the actual shells.

Scanning of the frozen carcasses is a necessary first step in developing techniques for quick and accurate sonic identification of leader-entangled turtles. Even with the latest in high-tech gear, recognizing a turtle in a sonar image still requires a practiced eye. The reflected sound waves that create the sonar image also echo back from the leader netting, fish, suspended sediments, and assorted flotsam.

Mansfield and Gammisch have also developed a catalog that contains a sonar image of each active leader when turtle-free. These provide a baseline to help identify any entangled turtles on subsequent surveys of the same net.

If a sonar image shows a shape that resembles their search images, Mansfield lowers a video camera to confirm that it is indeed an entangled sea turtle, and not a clump of flotsam or seaweed. Use of video obviates the need to send a diver into the water, a risky enterprise given that many poundnet leaders are located in areas with strong currents.