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Virginia Sea Grant is administered by the Virginia Graduate Marine Science Consortium, whose members include the College of William and Mary, Old Dominion University, University of Virginia, and Virginia Polytechnic Institute and State University. Dating back to 1966, Sea Grant is a national partnership of university, government, and industry focusing on marine research, education, and advisory services.

This fall edition of the *Virginia Marine Resource Bulletin* ushers in a new format featuring more topical stories. In this and future issues, you will find articles spanning everything from the physical processes to the people and places that endure along Virginia's coast. Coastal towns cling to the strength of their cultural roots—as demonstrated each summer during the annual pony swim and auction held on Chincoteague Island. Events like this draw thousands of visitors to Virginia's coast and, in the process, infuse much-needed cash into hotels, restaurants, and other tourist services.

While Virginia's small coastal communities have always taken pride in their uniquely regional festivals, dialects, and culinary secrets, a common and undeniable link to the Chesapeake Bay and its resources has forever been a part of their history. The economic impacts of an estuary in decline have thus been reverberating through Virginia coastal villages for several decades. Features inside explore what's being done to conserve and adequately value two of the bay's flagship resources—the blue crab and the oyster—but from very distinct vantage points. This exercise serves to underscore the complexity of considerations that accompany any management strategy for the bay.

Also read inside how Sea Grant is reaching out to middle and high school teachers by bringing aquaculture to Virginia classrooms, to address a suite of learning standards from science to economics. And discover how determined, long-running efforts to tag two of Virginia's popular sport fish are starting to pay off in understanding more about their migration patterns and use of habitat throughout the Chesapeake Bay and Atlantic coast.

Remember, current and past issues of the *Bulletin* are now available online at [www.vims.edu/GrayLit/SeaGrant.html](http://www.vims.edu/GrayLit/SeaGrant.html). Let us know if you'd like to discontinue your printed copy and read the magazine from your computer screen.



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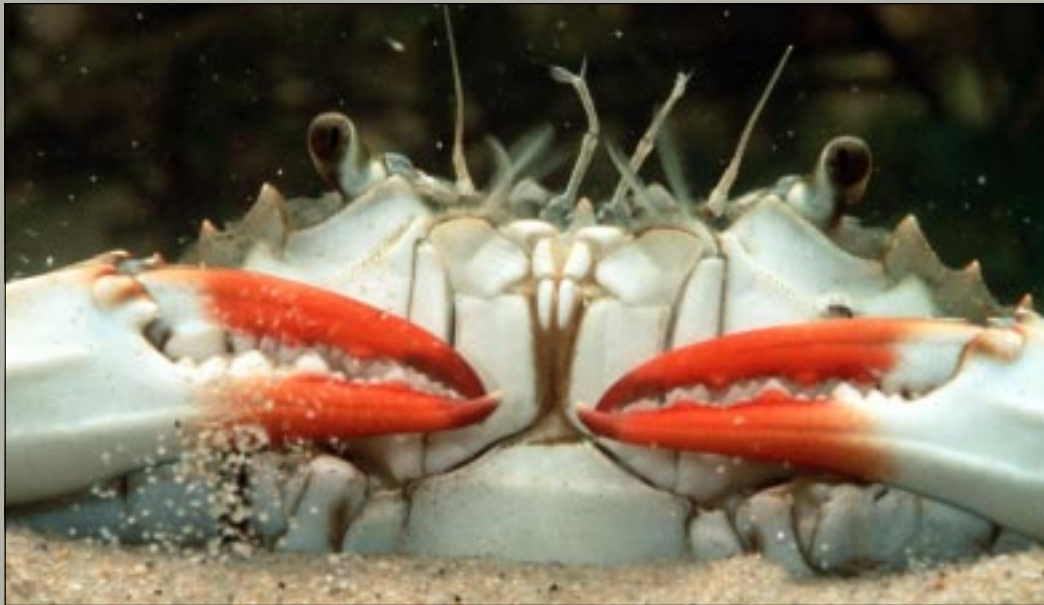
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# Providing Sanctuary



## to An Old Friend

By Dr. Romuald Lipcius and Jacques van Montfrans

The blue crab (*Callinectes sapidus*) supports the world's largest crab fishery and is widely distributed throughout the Caribbean, Gulf of Mexico, and Atlantic coast. In Chesapeake Bay, the blue crab has suffered a major reduction in the population and spawning stock. Recruitment, larval abundance, and crab size have also declined, despite earlier attempts to protect reproductive females through a small, historical sanctuary on the spawning grounds and various catch and effort controls.

Conservation of the blue crab requires knowledge of its life cycle and ecology, as well as fishery impacts. Armed with this knowledge, scientists and managers (such as the Virginia Marine Resources Commission) are able to devise innovative solutions to management and conservation problems.

### **Understanding the life cycle of the blue crab**

The life cycle of the blue crab is complex, spanning five major phases from larvae through adulthood (eggs, larvae, postlarvae, juveniles, adults). Each phase includes distinct stages of development and associated habitat use.

In Virginia, blue crab reproductive activity begins in early spring, when the waters of the Chesapeake Bay begin to warm and the crabs stir from dormancy. All winter, the females have remained on the bottom of the estuary, most of them in the deepest water. Mature males have been buried in the sediments, while the juveniles have sheltered in shallow-water habitats such as seagrass beds. During this time, the crabs have not eaten or ventured far from their hiding places. With the arrival of spring and warmer

water temperatures, male and female crabs begin to move away from their wintering grounds to look for food and seek out a mate

Blue crabs mate in the greatest numbers from spring to summer in the mid-salinity areas of the Chesapeake Bay and its tributaries. Males and females locate each other primarily through their sense of smell, using sensory structures called antennules that can detect minute amounts of chemicals coming from food sources and from members of the opposite sex. When a female crab is ready to mate, she responds to a chemical scent or pheromone released into the water in a mature male crab's urine that helps her zero in on his location.

Upon meeting, the crabs undergo a brief courtship behavior, after which the male embraces the female to protect her from predators. While being cradled by the male, the female will shed her hard outer shell, remaining soft and vulnerable for several hours. During this time, the female will flip upside down under her male guardian and the pair will mate. This terminal molt marks the female's transition into sexual maturity and is likely the last time she will shed. The sperm transferred by the male to the female in packets called spermatophores are thought to remain viable for the lifetime of the female and will serve to fertilize multiple broods.

A female may produce two or more fertilized egg masses during her lifetime from this single mating. Fertilization occurs each time a new egg mass is produced by the ovaries until the sperm reserves are depleted. Mature female crabs in the Chesapeake are thought to produce as many as seven egg masses over their lifetime under ideal conditions, if not removed from the population by fishing.

#### *Large Crabs = Large Reproductive Value*

The amount of sperm that a male transfers to a female during mating depends on both the size of the male crab and its mating history. Large males can produce larger amounts of sperm than their smaller counterparts. But regardless of their size, males that mate frequently will transfer less sperm to each individual female than males that mate less often. A large male can fully recharge his sperm stores in about 10 to 20 days. For females, larger size at maturity can mean larger egg masses, which yield more larvae. Conserving healthy numbers of mature females and large males in the Chesapeake Bay is

therefore critical to protecting the overall reproductive potential of the entire blue crab population.

#### *Larval Growth and Development*

After mating, the male blue crab remains in the middle to upper bay or its tributaries and continues to mate with other females. The mature, inseminated female crab, now called a "sook," leaves the male and moves toward higher salinity waters near the mouth of the Chesapeake Bay. In Maryland, females migrate south primarily during the fall, whereas in Virginia waters, migration takes place following the spring "peeler run" after mating and continues through the fall.

As the female crab migrates, her ovaries produce eggs that are eventually fertilized by the stored sperm and transferred to the pleopods, which are hairy, leg-like structures located underneath her apron. The egg mass, or "sponge," may contain from 750,000 to as many as 8 million eggs, depending on the size of the female crab. But even in the best conditions, it is thought that only a tiny fraction of these eggs will produce mature crabs. At first the sponge is a bright orange color, reflecting the amount of rich yolk in each egg. As the tiny larval crabs inside the eggs grow, they gradually absorb the yolk, and the color of the sponge changes from orange to light brown, then to dark-brown, and finally to black. The color change occurs as the embryos within the eggs use up the orange yolk, while at the same time two large black eyes develop on the sides of each embryo's head. The embryos take about two weeks to develop inside the egg. During this time, the female completes her migration toward the mouth of the Chesapeake Bay.

This migration from the lower salinity waters of the middle bay to higher salinity waters near the Atlantic Ocean reflects the blue crab's tropical marine origins and is critical for survival of the larvae. The eggs generally must hatch in water that is between 19 and 29 degrees Celsius (66 - 84 degrees Fahrenheit) with a salinity of 23 to 35 parts per thousand. (Open ocean water salinity averages 35 parts per thousand.)

#### *The larva's ocean voyage*

As many as 8 million larval crabs are hatched by each female during an ebb tide! Called zoeae, they are microscopic in size and have an elongated shape,

more like that of a shrimp than a crab. The tiny zoeae are swept away from the mouth of the Chesapeake into the plankton-rich waters of the Atlantic Ocean's inner continental shelf, where their transportation is at the mercy of predators, ocean currents, and wind and storm events such as hurricanes. Here in this nursery area, the zoeae drift with the currents, feed primarily on zooplankton, and grow rapidly, molting seven to eight times over the course of about a month.

After its final molt, the zoea undergoes a dramatic metamorphosis and takes on a more crab-like shape. At this stage it is known as a postlarva or megalopa. Megalopae are only about 1 millimeter wide (about the diameter of a paper clip wire), but they are strong swimmers and can cling to floating debris as well as scurry along the ocean floor.

During their time in the ocean, usually about 45 days depending on salinity and temperature, larval and postlarval crabs are continuously at the mercy of coastal currents, winds, and predators. Some fall victim to predators or get transported far offshore and lost from the population, but others manage to survive and grow. A number of these will travel back as postlarvae into Chesapeake Bay, transported by currents, tides, and their own movements. The invasion of megalopae into the bay is called "recruitment," and it primarily occurs during late summer and early fall.

Upon entering the bay, megalopae use currents and a variety of chemical cues to find their way to seagrass beds or other habitats that will provide food and shelter. Here they settle onto the bottom, and molt into the "first crab" stage. A first crab has the basic shape of an adult blue crab, but its shell is only about 2.5 millimeters (0.1 inches) from point to point. These juvenile crabs may molt 18 to 20 more times over the next 14 to 18 months before reaching adulthood. As crabs become larger, they venture far from their settlement sites and move into highly turbid areas. Centers of population density shift with this redistribution, such that larger juveniles concentrate in bay tributaries outside of seagrass beds.

### Size reduction prompts new research

In addition to understanding more about the crab's life cycle, researchers also know that the average size of blue crabs has decreased significantly over the past decade in Chesapeake Bay. This suggests that a

serious, demographic alteration of the adult population has occurred. To understand why, VIMS scientists looked closely at the relationships that determine blue crab population resilience and persistence.

Adult female blue crabs were sampled both within their spawning grounds (1988 through 2002) and within lower-bay tributaries (1979 through 1998) with a trawl -- a large net towed from a research vessel to sweep the bottom. Samples were taken monthly in the spawning grounds from July through September, when larvae are released, and therefore provide a direct estimate of blue crab spawning stock.

Additional data on concentrations of blue crab larvae and postlarvae were derived from plankton samples collected under the auspices of the Chesapeake Bay Monitoring Program. Larval samples were taken from June through September, while postlarval samples were taken from June through December—the times when these life stages are found in the plankton. Sampling stations were located throughout the area that delimits their major recruitment habitat and spawning grounds, in the mainstem or near the mouth of each of the major tributaries in the lower Chesapeake Bay.

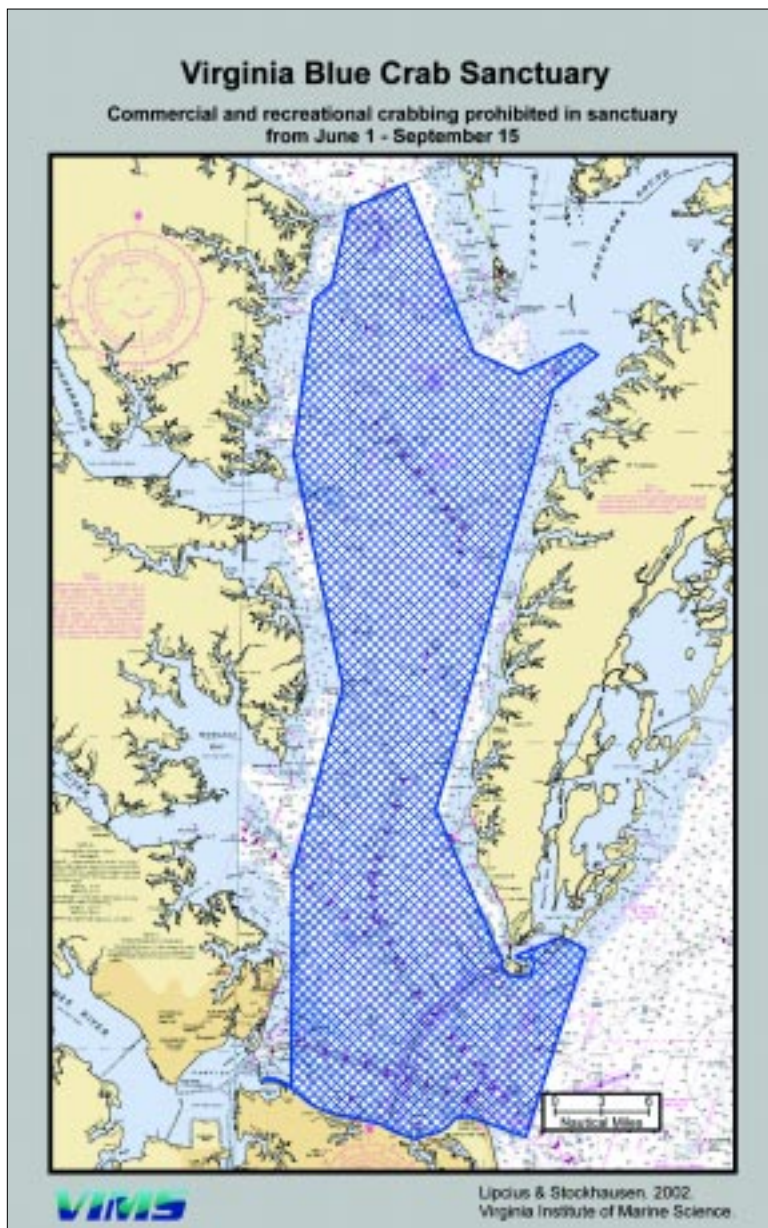


*Although the decline in average size of mature females is somewhat exaggerated in this photograph, female size has declined significantly by 8% over the past decade. The larger crab is typical of "normal" sized females, whereas the smaller mature female (equivalent in overall size to the normal crab's apron) represents a more extreme—though not uncommon—size encountered in the blue crab fishery today. Such size reductions can have significant consequences for the overall reproductive potential of the spawning stock.*

## Findings

The findings establish that there has been a concurrent, persistent, and substantial reduction in blue crab spawning stock, recruitment, larval abundance, and female size. Specifically, in the recent (1992-2002) decade, spawning stock abundance declined by 81%, female size by 8%, and spawning stock biomass by 84%. Larval abundance and postlarval recruitment were nearly tenfold lower than in the previous decade. Furthermore, these decreases occurred rapidly over 1-2 years, which indicates a complete phase shift in spawning stock and recruitment, rather than a measured, progressive reduction.

The initial decline likely resulted from poor recruitment (a low number of megalopae reaching the bay) in 1991, which may have been due to environmental conditions that hampered survival of larvae and postlarvae, despite a high spawning stock. Poor recruitment in 1991, in concert with high fishing and natural mortality, subsequently led to a diminished spawning stock in 1992 and thereafter. Research further suggests that spawning stock, larval abundance, and recruitment are unlikely to rebound to former high levels without significant reductions in fishing and natural mortality, along with improved environmental conditions. The key consequence of



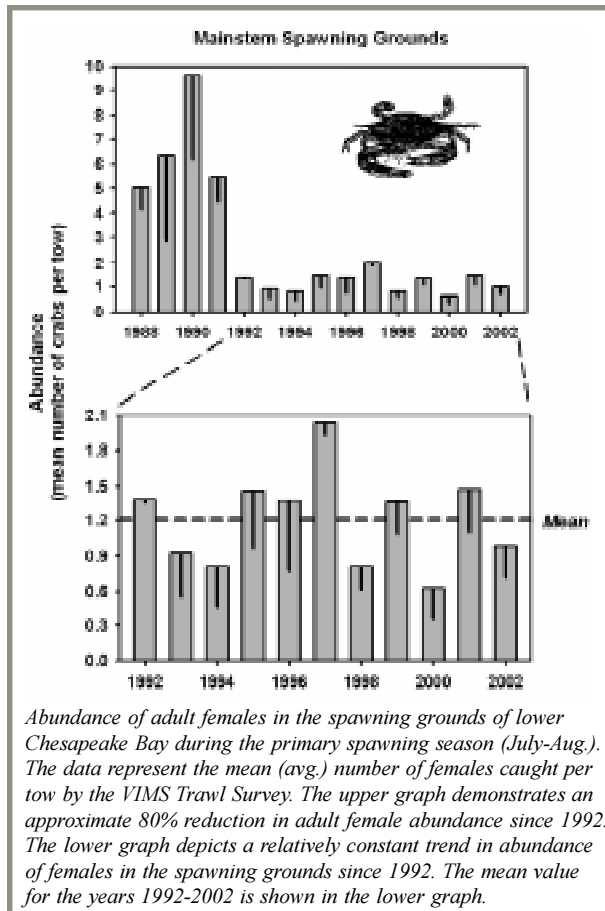
*Spatial dynamics of the blue crab spawning stock in relation to the newly expanded MPAC were examined through analyses of trawl survey data (abundances of adult females and egg-bearing females from 1989-1997 and 1995-1997, respectively) partitioned by water depth, time (month and year), and spatial zone (upper MPAC, lower MPAC, MPAC Historical Sanctuary) during the reproductive period of June through September.*

*Data reveal that adult female abundance peaks at 6-14 m water depths. Consequently, nearly half of all adult females in the lower bay mainstem found in waters deeper than 10 m and are now protected by the MPAC during their reproductive period, whereas the historical sanctuary protected about one-third that population. All MPAC segments are used by adult females at different times of the spawning season.*

*Peak abundance of egg-bearing females shifts from the northern to southern portions of the expanded, 935-square-mile MPAC as the spawning season progresses, emphasizing the importance of both areas in conservation efforts.*

the current situation is a heightened probability of recruitment failure and population collapse, particularly if environmental conditions are poor.

Importantly, the research confirms a direct relationship between spawning stock abundance and other indicators – larval abundance, postlarval recruitment, and female size. This “cause and effect” relationship is unique for the blue crab and for marine invertebrates, in general, and indicates an urgent need to conserve the spawning stock.



### MPACs as an alternative management tool

While a small sanctuary in the spawning grounds and various catch and effort controls have been in place historically to protect the blue crab, such efforts have failed to maintain the spawning stock at a level that ensures sufficient recruitment under intense fishing pressure. Looking for a solution, scientists turned to the idea of marine protected areas, which have been used worldwide to conserve exploited marine species. A major, postulated benefit of marine protected areas is that they will enhance recruitment from the protected segment of the spawning stock.

In the case of a migratory species, however, a protected dispersal corridor is a necessary complement. But the utility of marine protected areas and corridors (MPACs) remains generally untested and uncertain due to experimental and logistical difficulties in demonstrating their impact. Regardless, MPACs offer great promise for protection of a species such as the blue crab, *Callinectes sapidus*, whose life cycle encompasses dispersal via corridors (during spawning, for example).

Recent discoveries in Chesapeake Bay confirmed that adult females concentrate in waters outside of the small, historical sanctuary and deeper than 10 meters. These discoveries suggest that spawning activity outside the historical sanctuary is substantial and that females use a part of the bay’s mainstem as a dispersal corridor to the spawning grounds. Consequently, an expansion of the spawning sanctuary and protection of a deep-water dispersal corridor as an MPAC was implemented by the Virginia Marine Resources Commission in the lower bay where adequate oxygen is present.

The initial MPAC expansion occurred in 2000, followed by a further expansion in 2002 that protects females in 935 square miles of deep waters (mostly > 10 meters depth) in the lower bay from June 1 to September 15. The seasonal closure allows females to migrate and spawn undisturbed. The expanded MPAC is much more effective than the historical sanctuary at protecting a consistent percentage of the blue crab spawning stock over the full spawning season each year, because it accounts for annual variations in the distribution of adult females throughout the lower bay.

This management approach represents an attempt to conserve the spawning stock during a critical phase of development, thereby enhancing larval and postlarval production, while also enabling the exploitation of female crabs *after* they have released their larvae. It is our hope and belief that such an approach, used concurrently with complementary management measures, will serve as the cornerstone for long-term protection and conservation of the blue crab population in Chesapeake Bay.

▣ See page 21 for references and new educational materials on the blue crab.

▣ Vicki Clark, William Stockhausen, and Rochelle Seitz contributed information in this article.



# Making a Case for the Oyster:

## Putting Ecological Benefits into Economic Terms

By Thomas J. Murray

The sadness with which Tidewater Virginians view the loss of their native oyster is countered by the hope that oyster restoration efforts might one day be successful and the productivity of the state's public and private oyster resource will once again lead the nation. By and large, proponents of native oyster restoration, as well as those who support the introduction of non-native oysters for restoration, seem to have the same vision of a time gone by. One thing all agree upon is that the oyster has been an immensely valuable Virginia resource for the economic and environmental benefits it has provided. It's quite natural, then, to consider the benefits regained if current oyster restoration efforts are successful and to speculate what it might be like if we had oysters back.

### **Applying economic theory to the oyster resource**

In the application of economic theory, there are essentially two approaches to determining the benefits, or worth, of natural resources. One approach derives an estimate of the economic impacts result-

ing from the *use* of the resource; the other attempts to value the various market and non-market *benefits received* from the resource. To an economist, the productivity of a natural system is a function of the services it produces for which man is willing to pay.

Economic impact analysis measures a region's economic well-being as defined by market activity indicators such as sales, employment, wages, and taxes. The economic impact of oysters could therefore be estimated by calculating how much of each activity is generated by tapping the resource for commercial purposes. This type of accounting is particularly useful to regions or economies where seafood industries are integral to the economic base. However, the oyster resource clearly offers tremendous "indirect" value through its delivery of vital services – water filtration and habitat for recreational and commercial fish, for example.

Similarly, economic valuations are useful measures of the benefits received from a resource by its users. Economic valuations are thus considered an appropriate measure with which to judge the gains

made by (as compared to the costs of) large-scale, public projects such as oyster restoration or beach replenishment.

Economists and policymakers alike are encouraged by the emerging, valuation methods and models that begin to quantify discernible values for natural resources – such as forest cover for the wildlife and water quality benefits it provides. Unfortunately, in the case of the oyster, the required bio-economic information needed to put the ecological benefits into economic terms is currently just not available. The challenge of adequately weighing and measuring the value of all goods and services derived from Virginia's indigenous oyster resource has therefore not been met.

### **Current research needs**

For example, it would be immensely helpful if the water-filtering capacity of the oyster could be quantified in real dollars. By so doing, the value of a particular oyster bed to produce some measurable good, say water pollution abatement, could enter into public resource recovery debates.

Taken a step further, we might ask, “What is it going to cost Virginia to meet the nutrient reduction goals currently being proposed for the entire Chesapeake Bay?” Computer models suggest that further nitrogen reductions of 100 million pounds or more will likely be needed to achieve the new dissolved oxygen standards being written for the bay and its tidal tributaries – nearly twice the amount reduced since 1987 when the Chesapeake Bay Program set its first nutrient reduction goals. Looking at the cost of achieving such vast water quality enhancement – as would be provided by a restored oyster fishery – by alternative, engineered treatment technologies is an appropriate method of deriving a partial estimate of the oyster's economic value. Realistically, it is the value that must be paid to *substitute for* the water treatment capabilities of the oyster. The exercise is complicated, though, by lack of agreement on the meaning of “productivity” and by a continued failure to adequately value the natural environment in the marketplace.

### **History provides insight**

A look at the economic impact of the historic oyster industry in Virginia begins to reveal what's been lost along the way, since the oyster's demise in the 20<sup>th</sup>

century. It is a misconception to regard Virginia's traditional oyster industry as a simple business closely akin to row-crop farming, or to think that it simply entailed harvesting nature's bounty or casting seed on some bay bottom and dredging up mature oysters a few years later.

In actuality, the oyster industry was quite complex, and all of its many parts were interconnected in a way that made Virginia's oyster a true industrial product. A consequence of the close inter-dependency among the sectors that harvested, processed, and distributed Virginia oyster seed and market oysters was the tendency for each to expand and contract as one industry. This symbiotic relationship was pointed out by a VIMS researcher years ago in the statement, “Something which influences one part of the oyster industry will ultimately influence the many other aspects, and the economic repercussions may be widespread.”

Not only were all parts connected symbiotically; together, exponential gains were realized. In 1994, for example, total oyster landings from Virginia waters of 300,526 pounds were valued at \$812,387. Total sales of oysters and related products that year reached \$81 million—a 100-fold multiplier factor! In fact, the total sales of oysters and related products exceeded the sales of all other marine fisheries combined in Virginia.

It is estimated that processors, other dealers, restaurants, and retail markets obtained approximately \$31 million worth of oysters from *outside* the state in 1994. That year, the total direct output generated by Virginia's oyster harvesters added only \$1.5 million, and yet with Virginia's traditional value-added marketing chain intact, the total output of oyster processors was \$62.8 million. By virtue of the processing industry's ability to substitute non-Virginia oysters into the system, the established distribution, food service, and retailing businesses were able to heap additional value upon them.

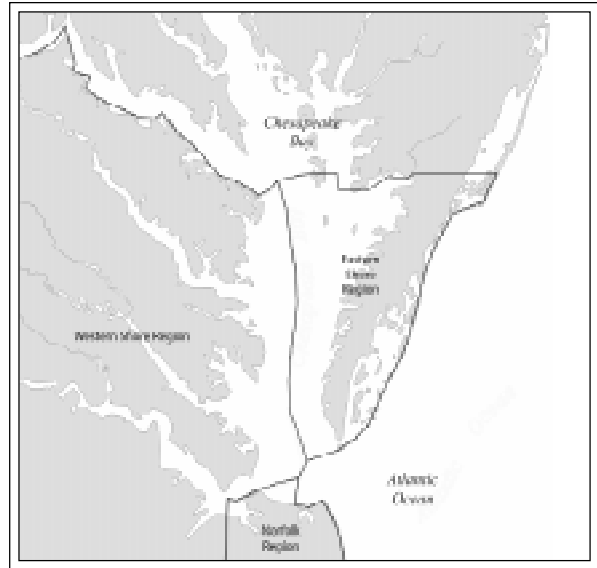
### **What if they had bought from Virginia watermen and growers?**

More recent studies of the vertically integrated oyster industry depict its continuation based upon *imported* oysters primarily from Gulf of Mexico harvests originating in Texas, Louisiana, Mississippi,

*(Continued, page 10)*

**An Industry with Broad Geographic Impacts**

This map of Tidewater Virginia shows the current boundaries of the “oyster regions.” Around 1900, districts were formed to aid the old Virginia Board of Fisheries in carrying out their responsibilities. In 1923 there were 29 districts, but since then, some have been consolidated and 24 continue today. The districts were irregularly shaped and did not follow county lines. Generally they extended to the center lines of the various river systems.

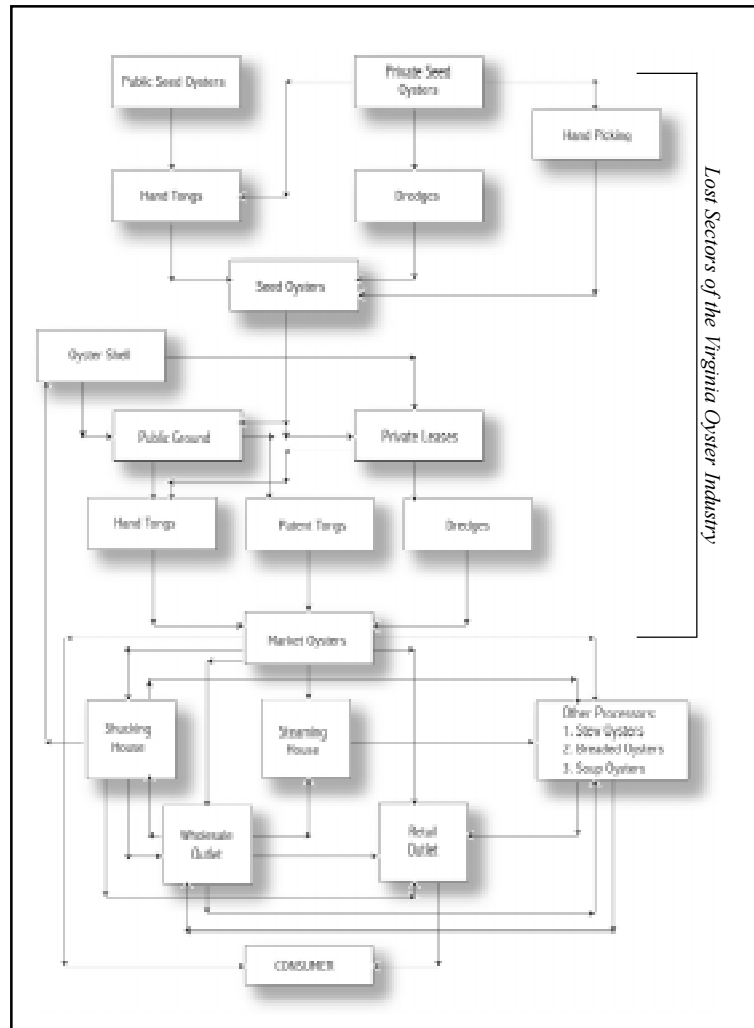


The districts were the basis for evaluating lease activity and collecting the oyster inspection, repletion and export taxes required when harvesting oysters from the “public rock.” Historically, the districts were generalized into four larger geographic regions: The Eastern Shore (Districts 24-29); All of Virginia less the Eastern Shore (Districts 1-22); Virginia, less the Eastern Shore and Norfolk (Districts 1-20); and Norfolk (Districts 21 and 22).

Historical boundaries help to illustrate the far-reaching distribution of the industry and impart a sense for the broad geographical impacts of an economy that depended upon the oyster industry. The divisions capitalized on the fact that most processing and marketing activity occurred in the same district as the harvest. The economics of shipping millions of pounds of oyster shell stock dictated that the processing of oysters take place as near as possible to their point of harvest. The underlying implication is that the historic oyster industry’s widespread economic “root system” manifested itself in the local economies of virtually every Tidewater community.

**A Vertically Integrated Industry**

The heart of the oyster industry once rested in the rural, coastal communities of Virginia and included numerous productive sectors, which both supported and relied upon Virginia’s oyster growers and watermen. With the demise of the native oyster, trucks delivering to Virginia’s oyster processors now arrive from places like Houma, Louisiana, instead of the old wharves dotting the shorelines of the Rappahannock and the James River systems. The specialized industry which once produced millions of bushels of market and seed oysters from both public and private oyster bottom has disappeared, and with it, a wealth of economic activity which took place along the waterfront.



Source: *The Oyster Industry of Virginia: Its Status, Problems and Promise*, D.S. Haven, W.J. Hargis, Jr., P.C. Kendall. VIMS Special Papers in Marine Science, No. 4, 1978.

*As illustrated, the harvesting sector is the heart of the oyster industry. The “western shore” region included oyster tax districts with familiar names, which included the prime oyster grounds of the Rappahannock, Little and Great Wicomico and Indian Creek, Piankatank, Mobjack & Horn Harbor. The Eastern Shore’s resource was generally distinguished as seaside and bayside. Norfolk’s primary production came from the public and private grounds throughout the James River system.*

Potential Economic Activity Associated with Restored Oyster Fishery Available to Processors, By Harvesting Region				
Impact Measure	Eastern Shore	Western Shore	Norfolk Region	Total Virginia Harvesting Regions
Output (\$)	10,100,000	15,200,000	6,300,000	31,600,000
Income (\$)	5,000,000	7,600,000	3,200,000	15,800,000
Employment (FTE)	185	278	116	579

*The overall production used here of 1.4 million bushels is based upon reported purchases by Virginia oyster processors of shell stock oysters from out of state (\$30 million at \$21/bushel) and an estimate of industry procurement, made by VIMS economic surveys conducted in 1994. FTE = Full Time Equivalent*

Alabama and Florida. Proponents of restoration remember when the oysters procured by Virginia processors came from the Rappahannock River, James River, or Eastern Shore, as was historically the case.

Simply put, the harvesting sector is the heart of Virginia’s oyster industry. Virginia’s “western shore” region included the prime oyster grounds of the Rappahannock, Little and Great Wicomico and Indian Creek, Piankatank, Mobjack, and Horn Harbor. The Eastern Shore’s resource was generally distinguished as seaside and bayside. Norfolk’s primary production came from the public and private grounds throughout the James River system.

A return of the basic industry of oyster growing and harvesting to Virginia would provide significant expansion of local economies by virtue of the localized, “backward linked” industries that at one time provided the means of production to oyster growers and harvesters throughout rural Tidewater. The reintroduction of Virginia-grown oysters into the state’s vertically integrated processing, marketing, and distribution sectors would essentially transfer tens of millions of dollars in economic activity from out-of-state suppliers back to Virginia.

In spite of the fact that virtually all oyster shell stock is now imported, the Virginia oyster industry today is responsible for a total annual economic impact exceeding \$80 million. With the resurgence of locally grown and harvested oysters, the immediate impact would be a more profitable processing sector which, when combined with a re-established harvesting sector, could be expected to generate over \$110 million in total economic output, \$82 million in incomes, and over 3,000 jobs for the state each year.

### Considerations for the future

Efforts to restore the native oyster resource and attempts to foster disease-resistant native and non-native oysters will continue. Much of the public interest in oyster restoration seems to arise from a genuine belief in the oyster’s potential to boost water quality throughout the bay. These benefits, or values, are difficult to quantify, but nonetheless, bona-fide. The more obvious, economic benefits that would be generated by a recovered oyster industry are more readily demonstrated, assuming we have a resource from which to rebuild a harvesting industry.

Requisite to the public discussion, however, is a recognition that measures of productivity which are adequate and useful for pure natural science are not sufficient in the world of environmental policy, where man’s socio-economic well being is of utmost concern. To truly value a natural resource such as the oyster, productivity must be expressed in terms that have meaning to society. Economists would hope that all such measurements be expressed exclusively in monetary terms, but short of that, it clearly would be desirable that measures of biological productivity be converted to some measure of social value.

Economics literature is replete with arguments about monetary units being rather imperfect measures of social value. This is probably the case. However, there is no other unit so pervasively understood as money. When more natural assets are quantified in these terms, the more likely their intrinsic value—for the goods and services they provide—will be appreciated. When such values are truly accounted for and applied to Virginia’s oyster, accurate determination and justification of the financial costs that must be incurred for its protection or enhancement may be reached.

# When it Comes to Wild Ponies,



## Legends and Lore Abound

By Charlie Petrocci

### Island Folklore Important to Economic Well-being of Many Coastal Communities

All coastal islands enjoy their share of lore, legends, and lies. It's part of the cultural fabric that makes islands unique and in many cases intriguing. Look up and down the coast, any coast, and most islands claim tales of pirates, shipwrecks, and treasure. Some places have factual connections to these stories, while others are connected purely by myth, perpetuated by local legend and folklore. But regardless of where these tales begin and end, they are important to the cultural heritage and economic well-being of many barrier islands and their residents. In some cases, they are downright big business. And nowhere is that more evident than right here in Virginia.

Enter the legend of the wild ponies of Assateague Island, Virginia, where each year thousands of visitors cram the shoreline to catch a glimpse of the famous Assateague pony roundup and swim over to Chincoteague. Owned by the Chincoteague Fire Department, these wild ponies represent an economic boom for the department and surrounding community.

Saltwater cowboys, as they are known, spend several days each summer rounding up the wild horses of Assateague and getting them ready for the swim. For wide-eyed children and adults too, it is a dream come true to make the annual pilgrimage. Many a child over the last two generations, enraptured by the best selling book, *Misty of Chincoteague*, has traveled to the island to see firsthand where that fantasy took place. For each, the book has become the lure upon which the legend becomes reality.

Rooted in maritime culture, Assateague has piles of tales from the

sea. Countless shipwrecks have taken place along its ever-shifting shoals, and the records reveal wrecks from various nations meeting a watery grave. One of the first European visitors to step ashore was there not by choice. His name was Colonel Henry Norwood of England, who in the winter of 1650 was making his way to Jamestown with several others on board the ship, Virginia Merchant.

Norwood, like many others of his day, was escaping the insurrection of Oliver Cromwell and heading for the New World to get a fresh start. But through the trickery of the ship's captain, Norwood and his small following were marooned on Assateague, which at the time extended up into Delaware (but was still considered Virginia, as was the entire northern coast to Massachusetts). After many days without food and exposure to the elements, some of the party died. Fortunately, the survivors were found by local native Americans and escorted through the lower Eastern Shore and across

the Bay to Jamestown. Norwood's accounts of that journey provide us our first, important insight into the natural history of the island.

His writings reveal that wolves (probably coyotes) roamed the island. He also spoke of the ducks, geese and oysters found near shore, but due to icy conditions and a lack of gunpowder, he was unable to harvest any for food. He also described the local vegetation and the native Americans and their villages as he passed through on his way to safety. But his writings leave no record of seeing wild horses on Assateague.

Also posed to answer the mythic question of the origins of the wild ponies here and on other barrier islands are the legends of Spanish galleons wrecking on a beach, or pirates freeing captured cargoes of horses. True, there were pirates such as Stede Bonnet and Sam Bellamy who operated off of Assateague in the early 18th century, but whether they took the time to drop off captured horses is highly speculative.



The more persistent theory of where the Assateague ponies originated from is that of a Spanish galleon wrecking on the beach and spewing its cargo, which included horses. The story is based in fact to some degree, since it is well documented that the Spanish galleon *La Galga* (or, Greyhound) wrecked on Assateague Beach in 1750. No lives were lost and the manifest makes no indication of horses being on board. But this wreck must have had far-reaching implications for the local inhabitants. According to records, the ship was part of a convoy out of Cuba headed for Spain, and it was carrying some treasure, exotic lumber, and bales of indigo—an important dye craved by Europeans. It was also loaded with cannons and small arms.

For the people who lived in such isolation during the 18th century – no matter where in the world – a wreck was considered fair game and could be a godsend of needed supplies. For many folks, it was akin to having a K-Mart wash up on the beach. So was true of the *La Galga*, as she broke apart and people from both Maryland and Virginia descended upon her carcass of goods. At some point, horses must have been used to haul off the lumber and cannons lost in the surf. So there may be a plausible explanation that horses used on Assateague to help recover the wreckage may have endured as part of the ship's legacy. Add another 200-plus years of folklore about the wreck, and the horses become forever entwined in local history. This is the classical stuff of which legends are made.

But if the Assateague horses did come from *La Galga*, or any other wreck, one must wonder why these long-distance ships would transport horses back to Europe, especially when they were trying to bring them into the New World. One reason why they wouldn't is because a seasick horse quickly becomes a dead horse, and removing one from the hold of a ship is no easy task, especially in rough seas. Yet, evidently, some Spanish vessels did carry horses back to Europe if they were favorite mounts

of officers or royal families. The jury is still out on this theory.

According to one former saltwater cowboy who is now a legend himself, Walt Clark, the island horses are the descendants of Spanish barbs—a small horse known for its toughness.

For many scholars, though, uncovering the true origin of these horses may lie in the fact that all sorts of animals were frequently grazed on coastal islands.

“Livestock on barrier islands is nothing new. Since colonial times Virginia settlers grazed cattle, sheep, goats, and horses to help hide animals from the tax collector and take advantage of the free range,” says Eastern Shore historian Dr. Miles Barnes. A fencing law in Virginia has been in place since the late 17th century to curtail extensive crop damage by livestock. One traditional way to alleviate the cost of building fences was to let livestock graze on isolated islands, and round them up as needed.

This was a practice carried out in many coastal islands of Europe long before settlers ever set foot in Jamestown.

Assateague, like many islands along Virginia's coast, had an assortment of livestock on the

*“Livestock on Barrier Islands is nothing new. Since colonial times, Virginia settlers grazed cattle, sheep, goats, and horses to help hide animals from the tax collector and take advantage of the free range.”*

*Dr. Miles Barnes, Historian*

land, including sheep, cows, pigs, horses and goats. For decades, leather goods from animal husbandry represented a major source of income for Eastern Shore farmers after the local collapse of tobacco around 1715. John Wallop, whom Wallops Island and the NASA base are named for, grazed livestock on the island as early as the late 17th century. As a matter of fact, there were still wild goats on Wallops until the 1950s. Hog Island, another barrier island to the south, still held wild cattle until the 1970s. And old-timers on Chincoteague will tell you that, as kids, they would wander Assateague Island and pick the wool off the green briers that passing sheep had left behind, years before the island became a national refuge in 1943.

So whether the horses came from the descen-

dants of a Spanish galleon, a pirate ship, or colonial livestock, it seems not to matter to the horse lover. As long as they are the wild ponies from Assateague, their fame will continue to help the tourism boom that came to coastal islands just after the Civil War. Since the 1870s, the mid-Atlantic coast has been promoted as a tourist destination for recreation and for the leisure elite from nearby cities. Sportsmen came to hunt and fish while others came to the beaches to forget the loss and misery generated by the recent war. People needed a diversion and the barrier islands of Virginia, including Chincoteague Island, offered that.

Today, the famous Chincoteague ponies command a high price among horse enthusiasts. This past year during the 77th annual Pony Swim, 89 foals were sold for a total price of \$161,800. The highest bid colt went for \$7,800, the event's

second highest selling foal on record (last year a filly went for a record \$10,500). All proceeds from the auction go to the Chincoteague Volunteer Fire Company, certainly one of the best-equipped volunteer fire companies for its size in the United States.

Every July, the town of Chincoteague enjoys the economic boom that the horses have created. Revenue spills into motels, restaurants, bookstores, and gift shops. People from around the country and overseas come to see the ponies and to enjoy the beaches of Assateague National Seashore. And as long as the ponies are there, the crowds will return.

While visitors lie baking on the beaches, it's probably not a stretch to say that visions of black flags and Spanish galleons dance in their imaginations. It's all part of the charm and lore of spending time in a place where the past and the present are brought together each day, in the form of a wild pony.



*Saltwater cowboys spend several days each summer rounding up the wild horses of Assateague.*

# 'tis the season for a storm surge



By Dr. Carl H. Hobbs, III

A storm surge, sometimes called a “weather tide,” is the difference between the predicted, astronomical tide and the actual water level. Although we tend to think of storm surges as unusually high tides, they can also result in lower than anticipated water levels.

Wind, waves, and barometric pressure are the major processes contributing to the formation of a storm surge. Sustained, strong winds blowing toward the coast push water and cause it to pile up on the shore. At the same time, large waves in shallow water move water with them. Finally, water tends to “bulge up” under areas of low barometric pressure much as water rises in a straw when suction is applied. In very rough terms, a decrease of one inch (of mercury) of barometric pressure yields about a one-foot increase in the water surface. Storm surges are important to monitor because unusually high water levels can result in flooding and deliver a destructive “punch” of associated waves to higher elevations, farther inland.

Conversely, strong offshore winds and high barometric pressure can cause unusually low water levels. Extremely low water levels have the potential to expose large areas of sand flats and make for tricky shallow water navigation, with water depths less than depicted on nautical charts.

Because a surge is added to (or subtracted from) normal water levels, its overall impacts are often related to the stage of the astronomical tide and to

the tidal range during its occurrence. An elevated storm surge during a spring, high tide can be very destructive, while an elevated surge occurring in a normal, low tide likely would have no consequence. Similarly, a negative surge would have greater consequences during a period of low tide as opposed to a high tide. The combined effects are magnified in areas that experience higher tidal ranges; however, a severe storm surge in an area of normally very low tidal range can bring water to elevations that are rarely flooded.

In Virginia, the longest-running record of water levels in the southern portion of Chesapeake Bay is the Sewells Point tide station in Hampton Roads, which was established in July 1927. The mean, or average, high tide level (MHW) at Sewells Point is 2.59 feet above Mean Lower Low Water (MLLW), where MLLW is the long-term average of the lower of each day’s two low tides. The highest observed water level occurred during the Chesapeake-Potomac Hurricane on August 23, 1933 and measured 8.69 feet above MLLW, or 6.1 feet above MHW. During that storm, the barometric pressure at Norfolk fell to 28.67 inches of mercury and the winds at the Naval Air Station reached 88 mph. By comparison, the lowest observed water level at Sewells Point was recorded on January 31, 1966 and measured 3.21 feet below MLLW.



# Using Aquaculture to SLAY the SOLs

By Angela Correa

In 1995, Virginia adopted a set of guidelines called the Standards of Learning (SOL). Mandatory in Virginia public schools, the process outlines topics that must be covered by the time a student completes a certain grade level. On the surface, the guidelines would seem to imply that Virginia's middle and high-school students are in for a great deal of rote memorization, especially in the sciences. While there isn't any way to completely eliminate that need, creative teachers often seek out non-traditional ways to teach their subject, incorporating multi-faceted, real-world experiences to deepen student understanding. One excellent example of this approach is the use of a recirculating aquaculture system to teach a host of science concepts, as well as economics, business management, mathematics, and even some political science.

Recirculating aquaculture uses a closed system to grow fish by filtering and recycling the water that the fish swim in. Systems can be large or small, and can be used to raise fresh- or saltwater species, food fish or aquarium fish. Basically, the systems consist of a large tank where the fish are held, augmented by a series of filtration, de-nitrification, and purification devices. After this, the water is returned to the main tank and aerated. These systems are used commercially, at universities, on farms, and in public and private aquaria. They are typically quite economical with water, and only require water to be added to compensate for evaporation, splash-out, and waste disposal.

Students involved in managing a recirculating system will need to understand and be able to utilize principles of biology, chemistry, animal science, physics, nutrition, ontogeny, and microbiology. They will utilize the scientific method on a daily basis to track and quantify the health status of their fish and the quality of the water in the tanks. They will become aware of the importance of biosecurity precautions for the animals in their care. The system can also be combined with hydroponics or greenhouse irrigation systems, making it possible to teach botany and horticulture concepts.

This type of aquaculture system can also be used to teach business management principles, economics, and marketing, and to show students how public policy and regulatory impacts can make or break such an enterprise. They will gain an understanding of the role that recirculating aquaculture plays in supplying the world's food needs, in comparison with other seafood supply sources. Geometry and algebra skills are consistently

reinforced with a regular need for calculations. All of these subjects are integrated in such a way that a student never wonders “Why are we learning this?” A tank full of healthy fish makes the rewards of good work and responsible management very tangible indeed.

The project also offers the potential to give students perspective on important global issues, including environmental protection, conservation, and resource management. Recirculating systems can be made to be highly efficient in terms of resource use (water, feed) and waste production. Supplying the seafood needs of communities through responsible aquaculture may give our oceans a chance to recover their fish and shellfish populations.

All of this makes recirculating aquaculture an exciting prospect for science and social science educators that are looking for powerful new ways to spark the imagination of their students, and simultaneously cover all the bases dictated by the SOLs.

With this goal in mind, Sea Grant and CFAST personnel at Virginia Tech teamed up with the Montgomery County Public School System, Blacksburg Middle School, and the USDA’s Extension Service, to put together a two-day workshop for middle and high school teachers from Virginia.

“This was a brand new program, with a lot of hands-on involvement. With that in mind, we set our original enrollment limit at 14. But there was so much interest in the program coming from Virginia and other states that we agreed to raise it to 20 participants,” remarks George Flick, University Distinguished Professor of Food Science and Technology at Virginia Tech. “The 20 spots filled up rapidly, and we finally had to cap attendance at 32. After that, we had to start a waiting list for the people we turned away. The response was very strong.”

The July workshop, held at the Hotel Roanoke and Conference Center, featured 19 speakers and demonstrators,

among them three visiting professors, including Albert Reid from Virginia State University, teachers from Maryland and Virginia with classroom aquaculture experience, and the National Sea Grant Program Director for Aquaculture, James McVey. Through tours, lecture sessions, and hands-on laboratory time, educators learned about different production systems, the components that make up these systems, and attendant management of water quality and waste. They learned about integrating hydroponics and other novel forms of agriculture (such as vermicomposting DEFINE) with such a system.

Participants learned the basics of caring for and feeding various types of fish, and how to recognize and treat disease in its early stages. They also learned useful veterinary skills, including how to bleed and tag fish, collect tissue samples, and perform a necropsy.

Course participants received graduate credit for their participation in the course and the completion of some additional assignments. With such a positive response from attendees, planning is underway to make *Aquaculture in the Classroom* a regular feature of future programs in recirculating aquaculture.

*Prev. page: Teachers explore the contents of worm composting bins, as Dr. Lori Marsh (VT, Biological Systems Engineering, R foreground) explains how the worm’s natural tendency to move away from light can be used to harvest fresh compost.*

*Left: Dr. Ewen McLean (VT, Dept. of Fisheries and Wildlife Sciences) demonstrates the procedure for PIT tagging tilapia. With the syringe, he inserts a small transponder into the abdomen of the fish, which can then be used to track it for research purposes.*

*Below: National Sea Grant Program Director for Aquaculture James McVey (left), and Blacksburg Middle School science teacher Posey Jones explore the contents of the composting bin.*



# Bay Sites are Magnets for Flounder and Cobia

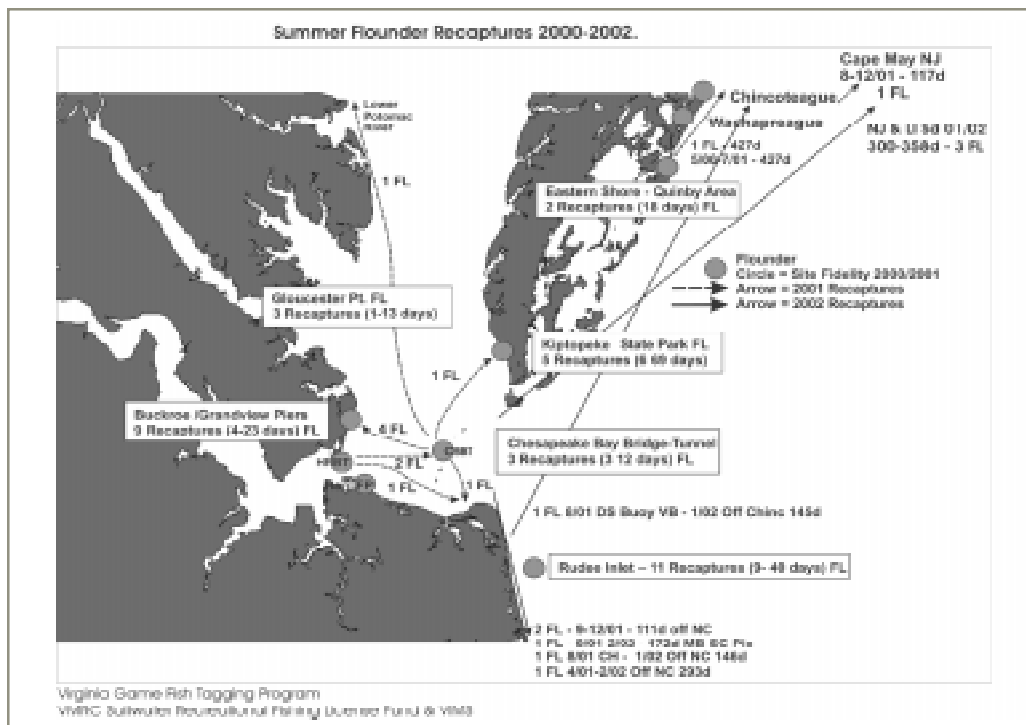
By Jon Lucy

Among the information needed to better manage Virginia's marine fisheries are data on how species use state marine waters and associated habitats. The Virginia Game Fish Tagging Program (VGFTP) directs tagging efforts of trained anglers toward recreationally important saltwater fish to help develop such information. Tagging effort can be shifted quickly to a particular species when conditions, often without much warning, result in strong year classes of young fish showing up. This flexibility has proven to be one of the program's most valuable contributions.

For example, during 1999 significant numbers of one- and two-year-old flounder (averaging 11-16 inches long in early summer) appeared in Chesapeake Bay. Hopefully, that was in part due to tightening regulations to rebuild an over-fished stock. In the

winter of 2000, the VGFTP instructed its members to begin tagging flounder the coming spring. After tagging and releasing 7,500 undersized flounder during 2000 and over 11,000 fish in 2001, an 8% recapture rate is producing interesting results.

A distinct, previously undocumented behavior pattern has been observed. With only a few exceptions, fish are being recaptured at the same sites where they were initially tagged; for example, fishing piers, other structure sites, and inlets. While not unexpected over short periods of time, this "site fidelity pattern" also holds for periods ranging up to 3-4 months post release (as supported by multiple recaptures of numerous fish). The pattern remains consistent, regardless of whether the fish were tagged in late April-May or during August-September (see map).





Tagged fish, like this cobia ready for release by Capt. Bill Hall, result in rewards for anglers reporting them (see tag sticking up by second dorsal fin).  
Photo courtesy of Chesapeake Angler Magazine.

Multiple recaptures only occur when special efforts are made to re-release tagged fish. While leaving the tag in place, the angler writes down the tag number (rather than remove the tag) and promptly phones in the recapture data. An example follows for Buckroe Pier.

Five fish tagged on May 26, 2001 were all recaptured at least two times again at the pier:

- fish one, recaptured after 2, 8, and 15 days at large (DAL);
- fish two, after 42, 60, and 90 DAL;
- fish three, after 50 and 85 DAL;
- fish four, after 99 and 121 DAL; and
- fish five, after 27 and 112 DAL.

Grandview Pier, just over one nautical mile to the north, has also demonstrated similar patterns along with other sites such as Harrison's Pier, the Kiptopeke Pier (bayside Eastern Shore), and both Hampton Roads and Chesapeake Bay Bridge-Tunnel complexes. As close to each other as the Buckroe and Grandview Piers are, fewer than a half-dozen returns show any movement of flounder between the structures, an impressive pattern of fidelity to specific sites.

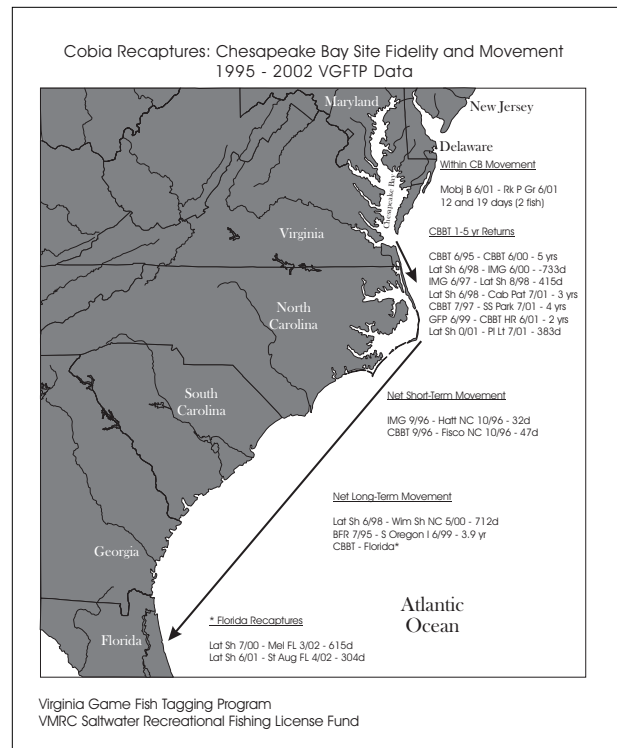
Some instances of year-to-year site fidelity are also being recorded for flounder that return to their initial tagging site after wintering offshore. Fish tagged during 2000 were recaptured again in 2001 at the Grandview Pier, Lynhaven Inlet, and Kiptopeke Pier, as well as at Quinby and Chincoteague inlets. Offshore movement of flounder from summer/fall

tagging at the bay mouth has shown fish to move south (off North Carolina and at Myrtle Beach, SC) as well as north (off Chincoteague and New Jersey, and in Long Island Sound). Such findings complement VIMS flounder tagging research performed in 1987-89.

The inter-year site fidelity pattern observed for young flounder appears to be a more dominant feature for adult cobia tagged in the lower Bay. This species ranges along the central-southeastern Atlantic and Gulf coasts, and tagged fish are generally greater than 37 inches long. From the recapture chart (below), it is clear that cobia return annually, sometimes over

multiple years, to forage and spawn in lower Chesapeake Bay. Virginia tagged fish are also ranging as far south as St. Augustine and Melbourne, Florida.

More detailed information on both flounder and cobia tag-recaptures (as well as other species) can be gleaned from the Virginia Game Fish Tagging Program's *2001 Annual Report* (available through the VIMS Sea Grant publication office or the VIMS web site [www.vims.edu/adv/recreation/](http://www.vims.edu/adv/recreation/)).



# News from the Point



As one presenter noted when assembling the group, "It's like herding cats."

## MARINE EDUCATORS MEET AT VIMS IN OCTOBER

More than 100 marine educators met on the shore of the York River October 4-5 for the 2002 Mid-Atlantic Marine Education Association (MAMEA) Conference, *Down by the River: Watersheds and the Chesapeake Bay*. Hosted at VIMS by the Virginia Sea Grant Marine Advisory Program, the conference drew teachers, museum and aquarium educators, and resource managers from North Carolina to Pennsylvania.

Friday field trips included a trip to the Mariners Museum, a tour of the VIMS campus and teaching marsh, a trip to a local "Clean Marina," and a kayak adventure in the pristine Dragon Run swamp. Those not attending a local field trip could opt for a virtual field trip to marshes through a webcast by *EstuaryLive*. That night, participants gathered at VIMS for a keynote address by Dr. Mark Patterson entitled "20,000 mm Under the Sea: Adventures Living & Working Underwater."

Saturday marked the heart of the conference with more than 20 workshops and concurrent sessions aimed toward enriching classroom teaching. Participants learned new concepts and experienced fun, hands-on activities, many of which focused on watershed science and related Chesapeake environmental issues. With a variety of topics covered, from a GIS computer workshop to a demonstration on knotting lines, there was something for everyone.

During the annual business meeting, Va. Sea Grant marine educators Susan Haynes and Lisa Ayers Lawrence were re-elected to the board and Frances Larkin was honored for her many years of service as newsletter editor. A pig roast and auction under the stars wrapped up the event.

## BLUE CRAB BOWL ENTERS 6TH YEAR OF COMPETITION

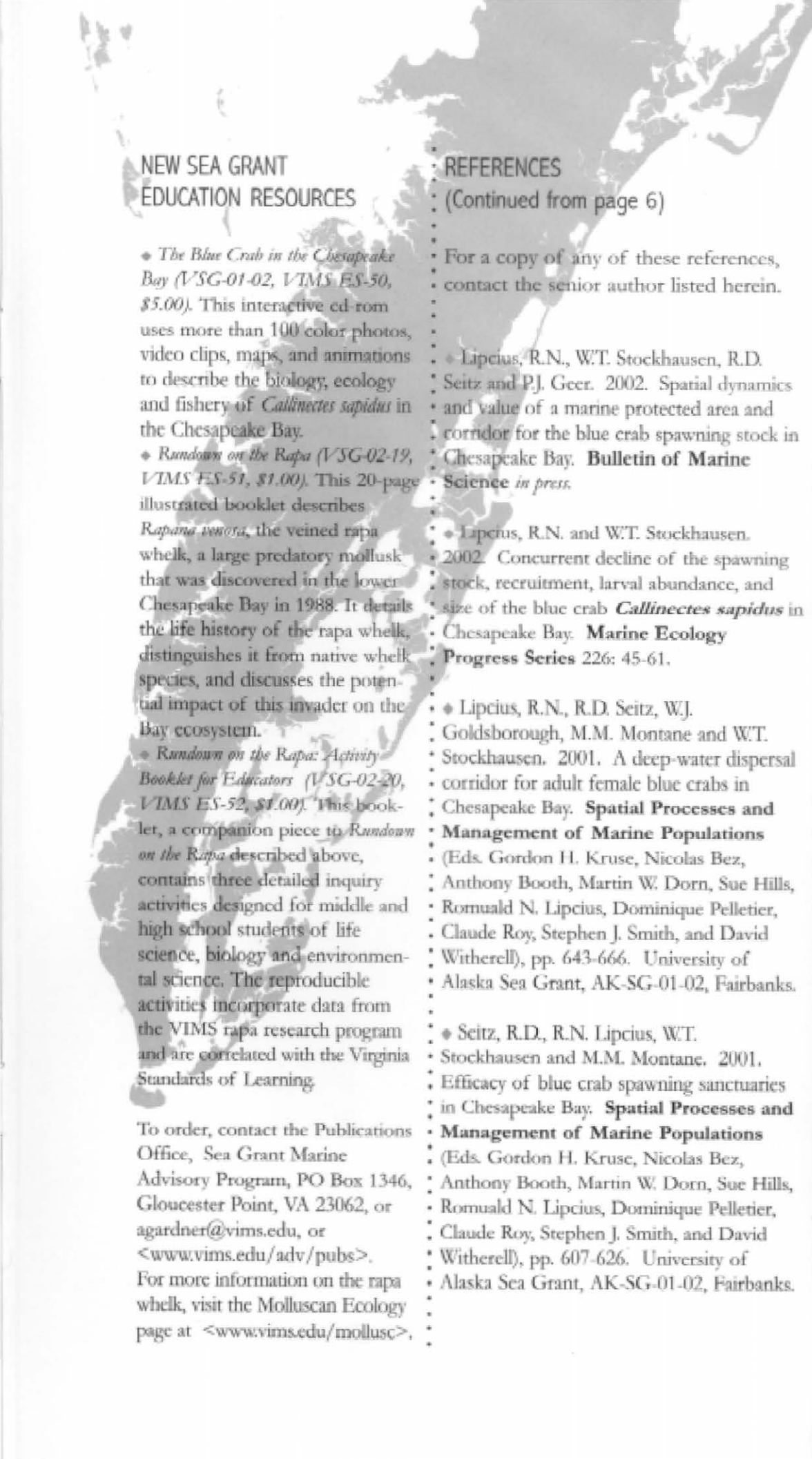
Virginia students are gearing up once again for the annual Blue Crab Bowl, to be held at the Virginia Institute of Marine Science (VIMS) of the College of William and Mary on Saturday, February 22, 2003.

The Blue Crab Bowl represents one of 21 regional National Ocean Sciences Bowl competitions held throughout the country. It will be conducted as a round-robin, double-elimination academic tournament. All questions will be about the world's oceans.

Several new features have been added to this year's event, including a possible tour of the Virginia Marine Science Museum and Marine Stranding Network.

Winners from regional bowls will receive an all-expenses-paid trip to La Jolla, California to participate in a national competition April 25-28, 2003. A variety of prizes for teams and coaches are awarded at both the regional and the national bowls.

Sponsors of the Blue Crab Bowl include the Sea Grant Marine Advisory Program at VIMS, and the Department of Ocean, Earth, and Atmospheric Science as well as the Center for Coastal Physical Oceanography at Old Dominion University.



## NEW SEA GRANT EDUCATION RESOURCES

◆ *The Blue Crab in the Chesapeake Bay (VSG-01-02, VIMS ES-50, \$5.00)*. This interactive cd-rom uses more than 100 color photos, video clips, maps, and animations to describe the biology, ecology and fishery of *Callinectes sapidus* in the Chesapeake Bay.

◆ *Rundown on the Rapa (VSG-02-19, VIMS ES-51, \$1.00)*. This 20-page illustrated booklet describes *Rapana venosa*, the veined rapa whelk, a large predatory mollusk that was discovered in the lower Chesapeake Bay in 1988. It details the life history of the rapa whelk, distinguishes it from native whelk species, and discusses the potential impact of this invader on the Bay ecosystem.

◆ *Rundown on the Rapa: Activity Booklet for Educators (VSG-02-20, VIMS ES-52, \$1.00)*. This booklet, a companion piece to *Rundown on the Rapa* described above, contains three detailed inquiry activities designed for middle and high school students of life science, biology and environmental science. The reproducible activities incorporate data from the VIMS rapa research program and are correlated with the Virginia Standards of Learning.

To order, contact the Publications Office, Sea Grant Marine Advisory Program, PO Box 1346, Gloucester Point, VA 23062, or [agardner@vims.edu](mailto:agardner@vims.edu), or [www.vims.edu/adv/pubs](http://www.vims.edu/adv/pubs). For more information on the rapa whelk, visit the Molluscan Ecology page at [www.vims.edu/mollusc](http://www.vims.edu/mollusc).

## REFERENCES

(Continued from page 6)

For a copy of any of these references, contact the senior author listed herein.

◆ Lipcius, R.N., W.T. Stockhausen, R.D. Seitz and P.J. Geer. 2002. Spatial dynamics and value of a marine protected area and corridor for the blue crab spawning stock in Chesapeake Bay. **Bulletin of Marine Science in press.**

◆ Lipcius, R.N. and W.T. Stockhausen. 2002. Concurrent decline of the spawning stock, recruitment, larval abundance, and size of the blue crab *Callinectes sapidus* in Chesapeake Bay. **Marine Ecology Progress Series** 226: 45-61.

◆ Lipcius, R.N., R.D. Seitz, W.J. Goldsborough, M.M. Montane and W.T. Stockhausen. 2001. A deep-water dispersal corridor for adult female blue crabs in Chesapeake Bay. **Spatial Processes and Management of Marine Populations** (Eds. Gordon H. Kruse, Nicolas Bez, Anthony Booth, Martin W. Dorn, Sue Hills, Romuald N. Lipcius, Dominique Pelletier, Claude Roy, Stephen J. Smith, and David Witherell), pp. 643-666. University of Alaska Sea Grant, AK-SG-01-02, Fairbanks.

◆ Seitz, R.D., R.N. Lipcius, W.T. Stockhausen and M.M. Montane. 2001. Efficacy of blue crab spawning sanctuaries in Chesapeake Bay. **Spatial Processes and Management of Marine Populations** (Eds. Gordon H. Kruse, Nicolas Bez, Anthony Booth, Martin W. Dorn, Sue Hills, Romuald N. Lipcius, Dominique Pelletier, Claude Roy, Stephen J. Smith, and David Witherell), pp. 607-626. University of Alaska Sea Grant, AK-SG-01-02, Fairbanks.

## SEEKING READER INPUT

The Virginia Sea Grant College Program developed its initial long-range strategic plan three years ago in preparation for an overall program review by the National Office of Sea Grant. The program is scheduled for a similar program evaluation in 2004. To prepare for that evaluation, we will conduct a review of our strategic plan during 2003.

The plan identifies program priorities related to the following topical areas: aquaculture, commercial fisheries, seafood technology, coastal economic development, coastal ecosystem health, and fostering an environmentally and scientifically informed citizenry.

At this time, we invite public comment on the strategic plan, its priorities and its directions. If you feel that a marine or coastal issue or problem or opportunity has been overlooked, please let us know what you believe should be added to (or removed from) the strategic plan.

We welcome comments from any interested individual, and we will consider all input that is provided to us.

You can learn about the Virginia Sea Grant College Program by accessing our website – [www.virginia.edu/virginia-sea-grant](http://www.virginia.edu/virginia-sea-grant) and clicking on "About Us." The strategic plan can be viewed by scrolling down and clicking on "Virginia Sea Grant Strategic Plan."

Comments can be mailed to Director, Virginia Sea Grant College Program, 170 Rugby Road, Charlottesville, VA 22903; faxed to 434-982-3694, or e-mailed to: [wlr4z@virginia.edu](mailto:wlr4z@virginia.edu). Please include your name and address as well as a brief description of your connection to Virginia's coastal and marine resources and/or environments.



Come late October, loggerheads make their seasonal trek out of the bay and head south to Hatteras and points offshore to bask in the relative warmth of the Gulf Stream. One loggerhead, in particular, has made quite a name for herself with commercial fisherman Fred Jett. Jett has been calling the VIMS Sea Turtle Stranding Center each of the past four years to come rescue the turtle, affectionately named Josephine, who has once again been caught in his pound nets at the mouth of the Potomac. It seems that Josephine – formerly called Joe until her sex was confirmed – favors the catch in this particular stretch of the river and considers Jett's net a live well for her dining pleasure.

Josephine was first tagged in 1994 at adult size and, after a brief interruption, has been recaptured in the same nets every year since 1999. Weighing in at 250+ pounds, her growth has remained fairly stable since '94, indicating that the turtle has shifted her energy from growth toward reproduction. During three of the last four years, in fact, ultrasounds performed by local veterinarian Dr. Bob George confirmed that she was bearing eggs.

While making her seasonal migrations along Virginia's coast, Josephine is providing valuable information to VIMS researchers. Ph.D. student Kate Mansfield has been tracking the turtle's movements via satellite and radio telemetry to determine her migration routes, over-wintering habitat, and diving patterns. This research has helped shed insight into the movements and foraging behavior of sea turtles—cherished seasonal visitors to the Chesapeake.



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