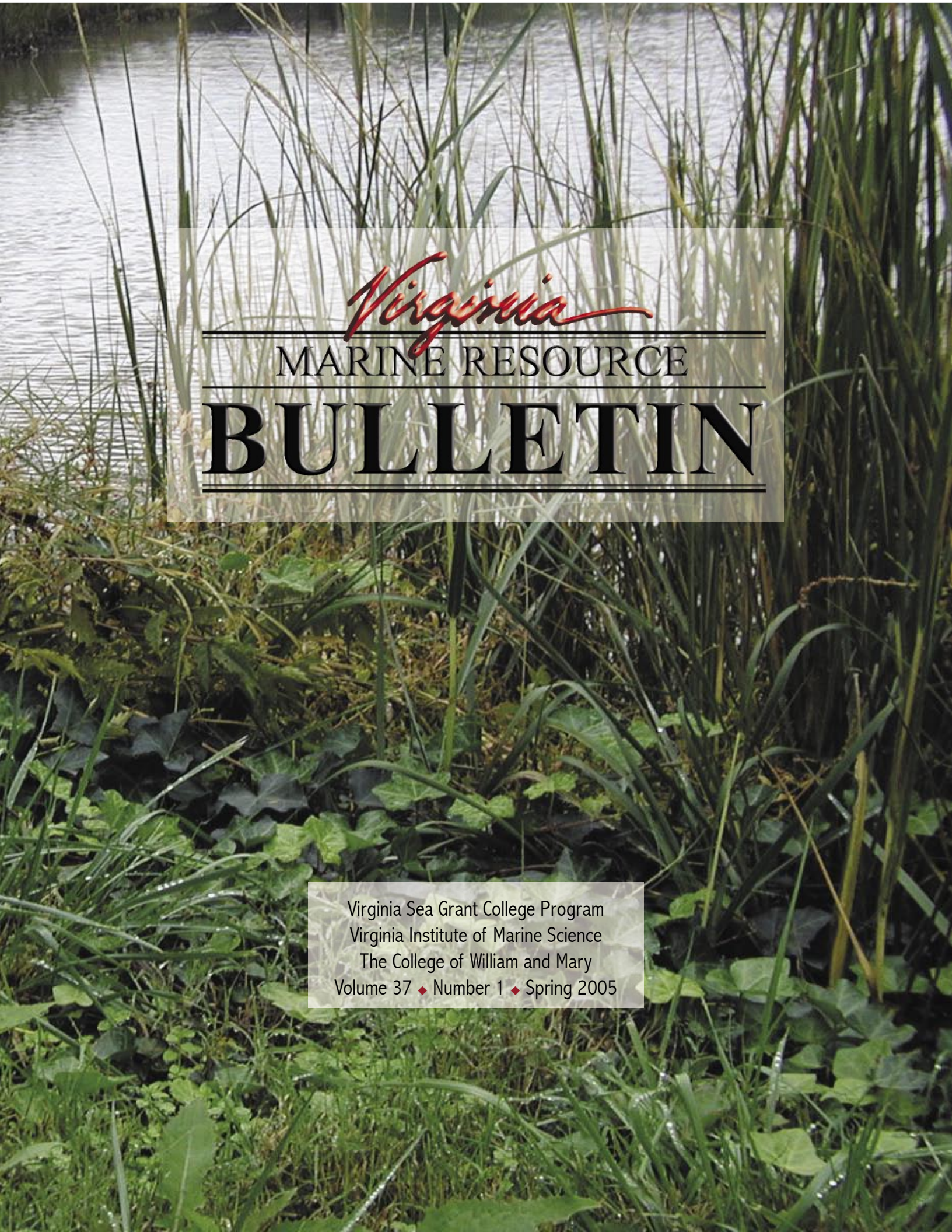

Virginia MARINE RESOURCE BULLETIN

Virginia Sea Grant College Program
Virginia Institute of Marine Science
The College of William and Mary
Volume 37 ◆ Number 1 ◆ Spring 2005

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The *Virginia Marine Resource Bulletin* is a publication of the Marine Advisory Program of Virginia Sea Grant. The magazine is intended as an open forum for ideas, and the views expressed do not imply endorsement, nor do they necessarily reflect the official position of Sea Grant or the Virginia Institute of Marine Science.

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 Tech. Dating back to 1966, Sea Grant is a national partnership of university, government, and industry focusing on marine research, education, and advisory service.

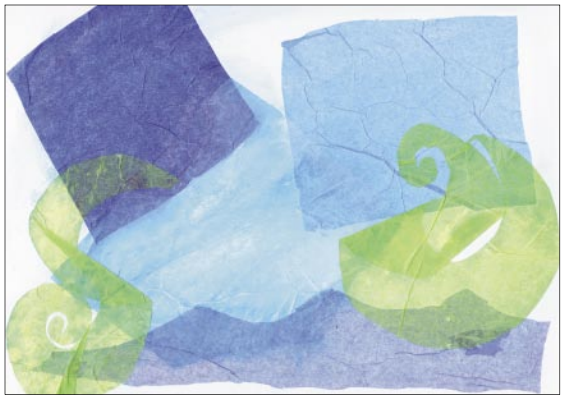
In just about 18 months, the official *2007 Celebration* kicks off in Virginia, marking the founding of our nation on the shores of Chesapeake Bay. Plans are underway to acknowledge the birth of "America" in grand fashion, 400 years after Captain John Smith sailed with a small band of men into the great estuary. To that end, historians, archaeologists, sociologists, writers, and artists have set out to capture the essence of what the 2007 anniversary means to our country. And yes, tour buses have begun to arrive in Jamestown, Yorktown, and Williamsburg—the site of Virginia's original capital.

Virginia Sea Grant is pleased to offer a series of articles leading up to the 2007 festivities and begins with a story about John Smith. It includes a side of the explorer you may not know. Smith was a man who at the young age of 22 had experienced more of life than many of us see in 80. After studying his life history—both before and after his days on American soil—it is easy to concur that he was "the right man at the right time" to make that trans-Atlantic journey.

Periodically over the coming issues, we will draw focus to some aspect of the early days of Virginia's colonial history. We promise to reveal some of the little known facts about the people, places, and events that shaped Virginia's first coastal community. In doing so, we hope to ignite a renewed appreciation for the natural wealth found along Virginia's expansive coastline. From the upland maritime forests, where the captain and his men survived on berries and wild game while enduring noteworthy attacks, to the waters of the Chesapeake and Atlantic thick with all kinds of fishes and shelled delicacies, John Smith learned first-hand what Virginia has to offer those who are fortunate enough to call it home.

Gloucester Point

On the Cover:
English ivy (Hedera helix) is a popular and widely planted evergreen vine that invades all vegetation levels as a ground cover and vertically into the tree canopy. It infests woodlands, fields, and salt marsh edges, such as the one pictured here. Its dense growth blocks sunlight from reaching nearby plants and trees, eventually causing their death. *See related story, page 7.*



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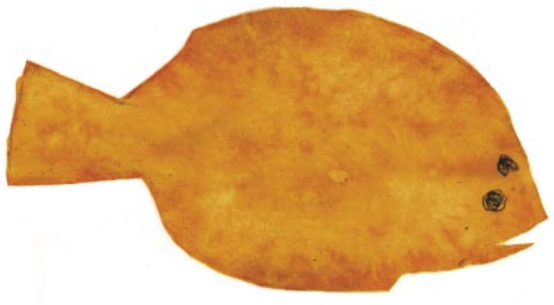

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SCHOOL OF MARINE SCIENCE

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NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

Brave New World

By Charlie Petrocci

VIRGINIA CROSSES THRESHOLD OF 400 YEARS

We all have our heroes, those with whom we cross paths either in print or first-hand who have inspired us. For this writer, it has always been Captain John Smith, an oft-overlooked American hero of sorts. He is the man who saved America's first English colony and who left us with our first recordings of a brave new world called the Chesapeake Bay.

Smith's name is familiar to most Americans, but few remember much about the man except that he allegedly had been saved by an Indian girl named Pocahontas. But there is much more to this charismatic adventurer-a world more. As Virginia slowly approaches the threshold of its 400th anniversary, John Smith and his legacy are worth exploring.

Smith has a long, storied history that reaches far beyond his exploits in and around the Chesapeake. To understand the man and the lore that surrounds him, one must first look at the times in which he lived. The early 1600s were an era of constant global warfare and an age of exploration. During his life John Smith was a soldier, sailor, explorer, cartographer, writer, ethnographer, adventurer, prisoner, and at one time, even a slave. He was also a captain, but originally not of ships. Smith received the title "captain" not from commanding large sea-faring vessels, but from leading hard riding cavalry in battle throughout the mountains of Hungary and Transylvania. And by all accounts, he was the right man at the right moment in history.

A brave heart

John Smith was born in 1580 at Lincolnshire, England, the son of a tenant farmer. While being schooled, he became very adept at riding horses. As a young man his first taste of adventure was while fighting with volunteers in the Netherlands against the Spanish. In 1599, after reading books on war, he decided to become a mercenary. And so in 1600, 20-year-old Smith headed for Eastern Europe to fight the Turks.

Smith joined the Christian army of Hapsburg emperor Rudolf II in Austria and was assigned to a Slavonic cavalry battalion. Rules of engagement were none. Since the 14th century the eastern frontiers of Europe remained battlefields, with huge armies vying

for control of cities and land. "Sack, plunder, and pillage" was the only law of the day.

Smith's first battle came while trying to lift a Turkish siege of a Christian-held city in Hungary. He came up with the ingenious idea of signaling the town of their impending night attack by using lit torches from a hillside. The soldier also devised a plan to lure the enemy into attacking a false position by stringing lit tow (a coarse hemp) down a long rope, mimicking infantry weapons. With the siege lifted, Smith was rewarded for his efforts by receiving the captaincy of 250 cavalry. Thus, "Captain" John Smith was born.

In 1604 Smith was wounded and captured in a battle near the Transylvanian Alps with Tarter horsemen. Sold into slavery, he was sent north to the Black Sea. Not long after, he killed his master with a thresher and fled for 16 days by horseback to safety behind Christian lines. By 1605 he was back in England, and at age 25 was well versed in the military arts and survival skills. Smith was just the man the Virginia Company needed to help organize their new American venture known as Jamestown.

The Jamestown experiment

A self-made man, Smith's life was always filled with challenges and contradictions. An explorer and adventurer, some of his most important accomplishments took place in New England. His later published theories on dealing with Native Americans and colonization were unprecedented. But he is most noted for his ventures in the Chesapeake Bay.

John Smith arrived in Jamestown in 1607 with 103 other men and boys. Before Smith became president of Jamestown, he was the colony's chief explorer and Indian principal negotiator. Both of these roles were important to the success of the settlement, especially since the failed Roanoke colony was fresh in everyone's minds.

Smith made two lengthy voyages in the Chesapeake Bay, exploring islands, rivers, and inlets. He named Smith Island, Virginia after himself upon his first sailing. He and his men in a shallow draft boat known as a "shallop" sailed to Cape Charles and then up the Eastern Shore. They eventually crossed the Chesapeake and returned down the bay's western shore. On these voyages he explored the Patapsco, the Rappahannock as far as Fredericksburg, and even traveled above present-day Washington, D.C. on the Potomac. It is believed Smith's shallop may have sailed as far north as the Susquehanna River. On both trips, he and his men were attacked numerous times, but succeeded in repelling each advance. The young explorers also coerced peaceful encounters of trade in most cases.

Smith and his men regularly endured storms, a lack of potable water, and rotting food. Along the Western Shore he was stung by a stingray and almost left for dead. Lacking fishing gear, Smith's group tried to catch fish with frying pans or their swords. "...we found in places that aboundance of fish, lying so thicke with their heads above the water, as for want of nets we attempted to catch them with our frying pans. Neither better fish, nor more variety had any of us ever seen in any place." Captain Smith also records that sturgeon became a favorite staple of the colony.

John Smith was the first person to write extensively about the Chesapeake, recording species of fish, fowl, wild game, native plants, rivers, and land forms. He was the area's first ethnographer, recording Native American tribal names, cultural practices and village sites, while also collecting tools and weapons which he sent back to England. Smith also produced the first map of the region, setting a precedent of using Indian place names. Many of those names still persist today. And, he was the first to identify that the wealth of this new-found land was not in gold and other precious metals, but in the bounty of the Chesapeake. A prolific writer, Smith was a man who commanded others with ease because of as he like to say

"what he knew rather than who he was."

By the fall of 1608, Smith had assumed command of the fledgling Jamestown colony. The population had dropped from just over 100 to 38, due to disease, meager food portions, poor water and attacks by Indians. Though surrounded by a land of plenty, the explorers were ill-equipped to exploit the resources around them. Many of the new colonists were "gentelmen," who distained working the land. Smith wrote "send but thirty carpenters, husbandmen, gardinirs, fisher men, blacksmiths, masons and diggers up of trees; than a thousand of such we have."

Smith dealt with the Indians with a firm hand, but traded fairly. He may not have liked them, nor they he, but the two treated each other with respect. On two occasions Smith wrote, Pocahontas, a favored daughter of paramount chief Powhatan, had saved his life. "Very oft shee came to our fort..... her especially he ever much respected." Capt. Smith knew that good relations with the Indians meant the survival of colonists in this unforgiving land.

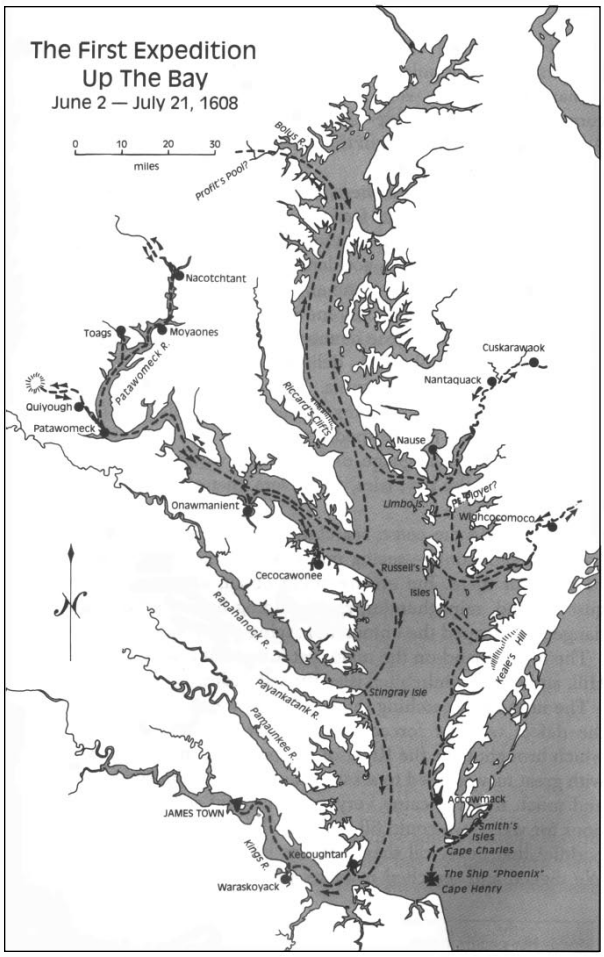
Powhatan's people traded traditional foods such as maize with Smith.

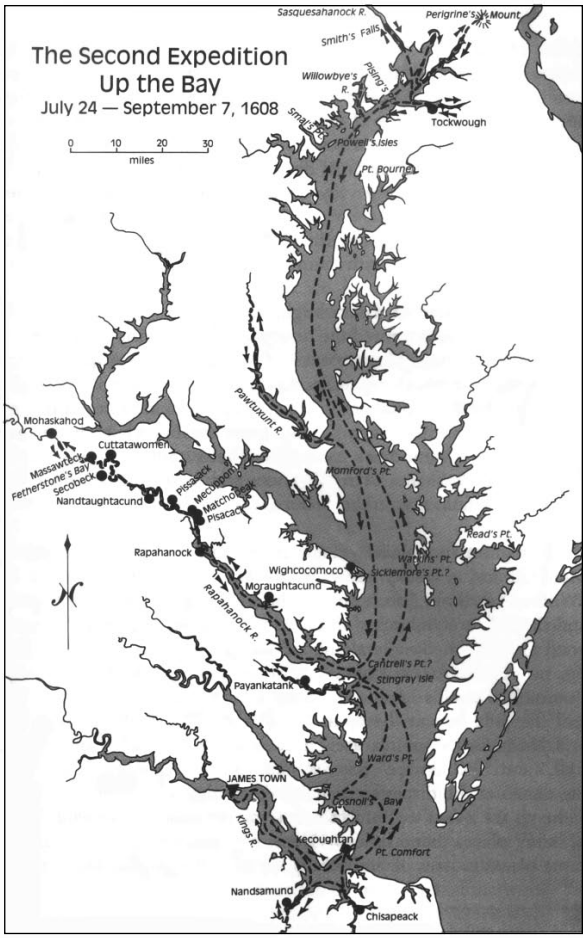
Smith organized the men, dug a deeper well, handed down strict discipline and coined the term "he who does not work shall not eat." With starvation always a real threat, corn was the key to the colonists' survival, and they bartered and begged what they could from the Indians. Often the captain forced his men "to the oyster banks, to live or starve, as he lived himself." By 1609 things were getting better for the fledgling colony, but financial backers in England wanted to see profit.

In 1609 the Virginia Company decided to redesign the government of the colony. Five hundred new colonists were sent in nine ships to bolster the settlement. But the ship carrying the new governor wrecked on Bermuda. (Eventually they built two new ships out of cedar and arrived after Smith had left. Shakespeare later based his last play, *The Tempest,* upon this event).

Smith knew he was going to be replaced, but his journey home was accelerated by an unfortunate event. While sleeping in a boat traveling the James River, his gunpowder bag accidently exploded, ripping away 10 inches of flesh. He jumped overboard to douse the flames. Upon his return to Jamestown the captain decided to return to England immediately to seek medical attention. It was the last time John Smith would see Virginia.

Ironically, as soon as Smith left, the Indians revolted "and did spoile and murder all they encountered," he wrote. The absence of Smith's firm hand in procuring food rippled through the colony. In mere months, the remaining colonists began to starve. They ate all their livestock, pets, and leather goods. There was also documented a case of cannibalism that ended in an execution, the first in English America for a crime against society. "This was known as the starving time", later wrote Smith. "It were too vile to say, and scarce to be beleeved, what we endured:





Maps © Edward Wright Haile, *Jamestown Narratives,* 1998. Used with permission.

but the occasion was our own..... and not the barennesse of the Countrie." When Smith left Jamestown, there were 480 colonists. Less than 60 remained alive when rescue ships from Bermuda finally arrived.

John Smith believed in America. During his brief time here he galvanized the efforts of the colony. He was part of an experiment that developed a model for how a colony can succeed and survive. Early on Smith realized there were no cities of gold, and understood that the true wealth of the land would be found in other natural resources. He wrote of the riches of the sea with uncountable fish and endless maritime forests. "Where is the wealth ..the Gold or Silver Mines? ..I say once again: The sea is better than the richest mine known." Captain Smith was convinced that the land's natural wealth – in seafood, for example – would be the sustaining factor in the future of American colonies.

The sea mark

After Smith returned from Jamestown he did not sit idle. He longed to return to Virginia but was denied by the Virginia company. In 1614 he explored and mapped the coast from Massachusetts to Maine and named the area "New England." In 1615 he was thwarted from establishing a colony there by French pirates (from whom he escaped). He offered to lead the Pilgrims in 1620, but instead they used his 1612 book, *A Map Of Virginia,* as their guide. In 1617, Smith was united with Pocahontas in England, now a wife (of John Rolfe) and mother. But she became fatally ill, died, and was buried outside London in 1617. Her famous father, Chief Powhatan, died in 1618, leaving a legacy of a united tribal confederacy that could not stem the flow of new immigrants.

Smith wrote profusely. He produced a number of books on the new world he explored and his adventures in fighting the Turks. His writings were often the subject of distaste since he was considered a braggart of sorts. He always put himself at the center of these tales; therefore, he is considered the first person of his time to write as an autobiographer. Historians believe his greatest writings were those found in the Generall Historie of Virginia, New England, and the Summer Isles (Bermuda).

And just as in life, John Smith never followed the rules in writing. Often he created new words. The Oxford English Dictionary cites examples of Smith as the first user of a word - technological is one.

♦ ♦ ♦

Smith watched from afar as Jamestown grew. After 1618, the Virginia Company fuel-injected the colony with numerous indentured servants, and the settlement somehow survived. On June 21, 1631 at age 51, Captain John Smith died in England. Until his final days, he continued to write about the magnitude of his accomplishments, the obstacles he faced, and how he was cheated out of credit for the success of America's first coastal community. It is only recently, through the study of his works, that we are able to view Smith as a true renaissance man with 400 years of legacy to back him up.

<u>Sources cited</u>*:*

♦ *The Complete Works of Captain John Smith,* Philip L. Barbour, 1986.

♦ *Captain John Smith, Select Editions of His Writings,* Karen Kupperman, 1988.

♦ *A Map Of Virginia,* John Smith, 1612.

♦ *Generall Historie of Virginia, New England and the Summer Isles,* John Smith, 1624. (All quotations.)

♦ *Advertisements for the Unexperienced Planters of New England, or Any Where,* John Smith, 1631.

THE GEARS ARE TURNING ON 400 YEARS

In 2007 Virginia will mark a milestone in celebrating her 400th anniversary since the founding of Jamestown, the first permanent English colony in America. This benchmark will be celebrated throughout the Chesapeake region with educational programs, lectures, plays, and a re-created sailing trip of Captain John Smith's famous explorations of the Chesapeake Bay.

Taking Over the Neighborhood

By Sally Mills

The occurrence of a newly introduced species in an ecosystem can spell big trouble for local, native flora and fauna. This is especially true when the newcomer brings special talents or traits that help it take over their new habitat. While natural resource managers have been grappling with the problems created by such "invasive" species for decades, the notion is relatively new to the public dialogue. Invasive species became part of the collective consciousness of many Americans in the 1980s, when vines like kudzu and grasses like Johnson grass began appearing in ever far-reaching expanses of the domestic landscape.

Hugging the Chesapeake Bay and Atlantic Ocean, Virginia remains vulnerable not only to attacks from terrestrial pests, but also to invasions from the sea. From the uppermost deck to the ballast tanks – and just about anywhere in between – cargo ships, military vessels, fuel tankers, and other commercial vessels have the unique ability to transport alien species to our ports with unprecedented ease. But introductions also come from the plant, pet, and aquarium trades as well as the bait industry. The Northern snakehead – making last summer's headlines – serves as a fresh reminder. In fact, a USDA team looking specifically at pathways identified some 50 mechanisms whereby organisms travel into foreign habitats—everything from a parasite hitch-hiking on a plant cutting to tiny insects buried in the sand/earth used in packing material.

Virginia oyster harvesters are all too familiar with the insidious nature of tiny organisms that carry a big stick. Aquatic invaders in the form of pathogens made a name for themselves among the seafood industry in the late 1950s and early '60s, with devastating results. More recently, the gastropod (snail) known as *Rapana venosa* has taken a bite out of the food web in the lower reaches of Chesapeake Bay, and the pathogen QPX has dealt serious blows to another staple of Virginia's seafood indus-

TYPES OF ORGANISMS AND DAMAGES AND/OR CONTROL COSTS (x $1 million)

Plants	
Purple loosestrife	229
Melaleuca tree	5
Eurasian watemilfoil	400
Water chestnut	200
Crop weeds	26,400
Weeds in pastures	6000
Weeds in lawns, gardens, golf courses	1,500
Sub-total	34,734
Mammals	
Wild horses and burros	5
Feral pigs	801
Mongooses	50
Rats	19,000
Cats	17,000
Dogs	250
Sub-total	37,106
Birds	
Pigeons	1,100
Starlings	800
Sub-total	1,900
Reptiles and amphibians	
Brown tree snake	5.6
Sub-total	5.6
Fishes	1,000
Great Lakes Fishery	4,500
Arthropods	
Imported fire ant	1,000
Formosan termite	1,000

Arthropods (cont.)	
Gypsy moth	11
Crop pests	14,400
Pests in lawns, gardens, golf courses	1,500
Forest pests	2,100
Sub-total	20,011
Invertebrates	
Spiny waterflea	5
Fishook waterflea	5
Mosquitoes	1,500
Green crab	100
Sub-total	1,610
Mollusks	
Zebra mussel & quagga	1,000
Asian clam	1,000
Shipworm	205
Sub-total	2,205
Microbes	
Crop plant pathogens	21,500
Plant pathogens in lawns, gardens, golf courses	2,000
Forest plant pathogens	2,100
Dutch elm disease	100
Sub-total	25,700
Diseases	
Livestock diseases	9,000
Human diseases	6,500
West Nile virus	2,500
Sub-total	18,000
All organisms	~146,772

Source: Pimentel et al., 2001; and Pimentel, unpublished data.

a) Control of Eurasian watermilfoil in Loon Lake (Washington) is reported to be 4,000 ha each year (Parsons and others 2001). The estimated cost of control per hectare is $2,000 (Maine 2003). It is assumed that 200,000 ha of milfoil are controlled in the U.S. each year at a cost of $400 million per year.

b) USGS 1999.

c) Water chestnut control in the Lake Champlain Basin is reported to be $3 million per year (NYDEC, Army and NYS Canal Corporation 2000). It is assumed that 100,000 ha are treated each year at a cost of $200 million per year.

d) Pimentel and others 2000.

e) Sea Grant (2002a) and Standing committee on Fisheries and Oceans (2003) estimate that the loss to Great Lake fishery due to invasive species is $4.5 billion per year. An addition $1 billion per year is estimated for the impacts for other invasive fish species in other aquatic ecosystems in the U.S.

f) The $4.5 billion loss per year in the Great Lake fishery alone.

g) Sea Grant. 2002b. CRC Reef Research 2003.

h) Pimentel and others 2000.

i) Estimated.

j) Just cleaning up and disposing of scrap tires that were breeding sites for mosquitoes in Maryland was estimated to cost $11 million per year (DLS 2000). Assuming that 50 states invested in a similar manner and this makes up only one third of total mosquito control, then the estimate for mosquito control in the U.S. is conservatively $1,500 million per year.

k) Holmes 2003.

l) New York State invests about $35 million per year in West Nile Virus control (Governor 2000). Assuming that all other 50 states have already or will invest in West Nile Virus control, the total is $1,500 million per year. In addition, there were 4,156 cases of West Nile virus infections in humans and 284 deaths in 2002 (CDC 2003). Assuming $3.7 million per death as suggested by EPA (Weinberg 2003), then the total cost is more than $1 billion per year.

try—the hard clam. With each newly recognized invasion, the spotlight on what might be lost shines a bit brighter.

Kevin Heffernan, a biologist with the state Department of Conservation and Recreation, Natural Heritage Program, explains that invasive species are pre-adapted in ways that allow them to proliferate in a new region to such a degree that they hurt native species and ecosystem processes.

"In their native habitat, they are in balance with other species because of relationships, such as predation, that evolve over a long period of time," Heffernan says. "But freed from those checks and balances, in a new setting invasive species have one or more advantages that allow them to out-compete natives," he continues.

Ragging on Phragmites

Phragmites australis (also known as common reed) is one of the better-known invasive species in Virginia's coastal plain, in part because of its signature, feathery tufts towering as much as 12-13 feet above ground. The sight of these slender stalks bending in the breeze is striking, especially in autumn when their pale beige surfaces reflect the early morning or late afternoon sunlight. In fact, in several European countries phragmites is often sought after.

In the U.S., *Phragmites australis* has historically occupied discreet patches of land. But over the past several decades, introduced plants from Europe have been discovered colonizing large pockets of the East Coast. This European strain is particularly adept at moving in when land is first disturbed along highways or water bodies, and during construction when a barren soil surface becomes oxidized, according to Dr. Kirk Havens at VIMS. The marsh invader utilizes an efficient underground system of rhizomes to spread rapidly when opportunities permit; densely packed grasses can form virtual walls along tidal fringes and other moist habitats. Once established, it becomes firmly attached and a voracious defender of its range. Unfortunately, phragmites also muscles out less hardy plants and often displaces native grasses that offer more nutrition as well as nesting benefits to wildlife moving along water corridors.

Because phragmites is such a tenacious contender in a marsh community, land managers have been forced to carefully pick their battles with the plant. In places that offer minimal wildlife value or where shoreline erosion is problematic, it is often deemed more practical to leave an existing phragmites stand alone. Where managers like to direct their limited resources are places of high biological diversity and nooks where endangered plants or animals are known to exist. Tidal freshwater systems and refuge areas acquired by the state represent such targets of attention.

Scientists at VIMS have concentrated lately on researching methods aimed at slowing future invasions. At the Center for Coastal Resources Management, researchers have tested perimeter ditches at the high tide line, scrub and tree plantings along upland berm areas, and buffer strips bordering agricultural fields, and found them effective blocks against phragmites intrusion.

But much of the Center's work has focused on wetlands restoration, in which replacing critical wetland functions remains the ultimate objective. That work is highly specialized, and it is here that an invasive species like phragmites represents a real, net loss. Once introduced, the plant has the ability to quickly dominate a wetland community and form a monoculture that is extremely detrimental to the entire ecosystem. Large mats form during seasonal die-offs of the plant, erasing the micro-topography. It is here, among the small ridges and valleys of the marsh surface, that insects and small fishes and mammals take refuge.

A number of methods are employed to stop the early spread of phragmites, such as cutting, flooding, burning down, and mechanically removing the plant. Biological controls that use the services of insect herbivores have also proven effective.

Key to phragmites management is prevention, however, and that is where landowners can be most helpful. When phragmites is discovered in a sensitive environment, rapid response is called for and may be the only effective defense. As the "eyes and ears" of the coastline, landowners represent the first alert system. Visit <http://ccrm.vims.edu/phragmites.html> for more information and technical assistance.

The Northern snakehead (above) and purple loosestrife (next page) have created headaches for resource managers in Virginia.

Why should Virginians care?

Differing views are held by people who have considered this problem over the years. Some dismiss the movement of species as a natural evolution of human impacts on the planet. Others point to the fact that the few particularly aggressive invaders that survive in poor quality habitat – dredge spoil, for example – fill an available niche that would otherwise go untended. Their point of view, "Some marsh grass is better than no grass," has become a familiar refrain.

But what an out-of-place grass might do, upon being introduced, is often overlooked. Invasives can squeeze out habitat for beneficial, native species—some of which are highly stressed for other reasons and at risk of disappearing. Invasive species threaten to unravel the rich fabric of biological diversity that blankets the planet. "From pre-historic times to the present, humans have enjoyed a situation where the earth's systems are balanced to a state that supports healthy human habitation," notes Heffernan, who adds, "Put simply, our very lives depend on biological diversity for food, shelter, fuel, and clean air and water!"

As biological diversity is lost, a slew of problems begin to surface as the functions served by those species are also lost – natural fire control or the amount of water available to soil – for example. Cumulatively, aggressive and unchecked invasive species exact a high toll on local ecosystems and, ultimately, local economies. What alarms biologists and other researchers studying the problem is the pace at which these introductions are occurring.

The costs of intervention

When we accept the premise that natural systems are being disrupted as never before, it's logical to project related impacts on human health, economic growth, and recreation. Wildlife watching, hunting, recreational fishing, tourism, and other, more subtle intangibles (such as landscape aesthetics) are impacted too, affecting our quality of life. Secondary impacts remain difficult to quantify, but it is well understood that tourism—which plays a significant role in Virginia's economy—will be hurt by the prospect of less vibrant landscapes and vistas. Think of the loss of eastern hemlocks currently underway in Shenandoah National Park, or imagine the loss of maples or oaks and the impact to fall foliage displays.

By contrast, the immediate costs of controlling invasives and assessing the impacts of their displacement of beneficial, native species in a particular habitat have been more closely scrutinized. In the United States alone, rough estimates range in the billions of dollars spent each year on manpower and management efforts to eradicate invasives. Long-term monitoring and follow-up remediation adds even more to the cost of combatting the most vexing of aggressors.

A team of researchers led by David Pimentel at Cornell University has taken a hard look at a suite of trouble-makers and estimates the annual cost to the country at more than $146 billion. (See table.) In addition to management, costs are measured in the form of pro-

duction losses (from agricultural pests, for example), property damage (from introduced insects), human diseases, livestock diseases, and more.

The toll on Virginia

During a meeting of the Invasive Species Council held in December 2004, Secretary of Natural Resources Tayloe Murphy estimated the cost of eradicating, monitoring, and controlling invasive species in Virginia at more than $1 billion annually. The commitment of time and resources is often underestimated, says Dr. Kirk Havens, a marine scientist with the Center for Coastal Resources Management at VIMS. The latest research on Phragmites australis, as an example, indicates that a 5-year monitoring and maintenance program after initial removal of the plant is probably not long enough. Havens has seen many situations in which a phragmites stand begins to rapidly expand at a site after a 7- or 8-year hiatus. He estimates that the Institute will spend more than $100,000 this year on phragmites-targeted research and monitoring work alone.

The learning curve for a newly introduced invasive can also be steep. Referring to the rapa whelk, Dr. Juliana Harding of the Fisheries Department at VIMS says the timeline just to acquire adequate knowledge for a reasonably effective response often takes years. In the marine environment, organisms frequently experience a series of life history stages that may not be evident in the laboratory. Complex changes in which the animal metamorphoses several times (think, blue crab) are not uncommon. So scientists must study the animal's life cycle in detail, understand the supporting habitat for each phase, and only then begin to get a handle on the potential vectors of transport that such a creature might utilize.

In the case of the rapa whelk, it is generally acknowledged that the snail arrived in Virginia waters in larval form, transported in the ballast tanks of a ship traveling from the Mediterranean, Adriatic, Aegean, or Black Sea. Unfortunately, the rapa whelk is a prolific breeder and lays eggs several months ahead of Virginia's native whelks (channelled and knobbed). Drs. Harding and Mann of VIMS calculate that a single adult female has the potential to lay ten or more egg masses per year, each holding as many as 200,000 eggs within. That translates to as many as two million eggs per breeding season – more than a 100-fold increase over the production capacity of a native, knobbed whelk! Once released, the snail feeds on marine bivalves, including the hard clam.

During the first four years (1998-2002) of a "bounty" program, in which commercial fishermen donated the whelks for scientific analysis, more than 4,300 adults were brought in from Virginia waters. While the number of whelks captured each year rose, the good news is that early evidence suggests their geographic distribution in the Chesapeake did not expand during that 4-year period. The introduction of rapa whelk served to focus attention on the elusive nature of ballast water as an avenue for species introductions; one that poses a particularly difficult management challenge (see sidebar). Virginia Sea Grant has funded several research projects aimed at understanding more about the rapa whelk and ballast water as a transport vector for aquatic invasives.

The challenges and costs of fighting invasive species appear daunting. However expensive, those costs pale when compared to the cost of doing nothing, most believe. Over the long term, we would find ourselves living in a world stripped of cherished plants, animals, birds, and marine life, as the tightly woven threads that bind them to each other begin to come apart. The functions served by the plants and animals that are displaced will be forever lost, before we can fully understand and appreciate what those functions are. What will be lost to scientific discovery, to potential medical treatments, to immunization against future disease, to a catastrophic event… is largely unknown.

Virginia responds

Growing focus on the problems created by invasives on various ecosystems across the state has prompted Virginia to pass legislation establishing an Invasive Species Council. The council is comprised of the leaders of the state departments of Conservation and Recreation, Agriculture and Consumer Services, Forestry, Game and Inland Fisheries, Transportation, Marine Resources Commission, Health and Human Services, as well as the Virginia Institute of Marine Science. An advisory team of experts from state and federal agencies and non-governmental organizations like The Nature Conservancy and the Virginia Nursery and Landscape Association provides input to the council. The Council's mandate: to provide leadership and ensure that state agency activities concerning invasive species are coordinated, complementary, cost-efficient, and effective. This will be accomplished through a management plan – a dynamic document that will be revisited and updated every 3 years, according to law.

The advisory team is currently writing the management plan that will guide the state in assessing threats from invasives in terrestrial and aquatic environments, prioritize species to

BALLAST WATER UNDER SCRUTINY

The Virginia Marine Resources Commission has responsibility for monitoring ballast water discharges in Virginia waters through reports filed by the Hampton Roads Maritime Association. Legislation passed in 2001 specifies voluntary, best management practices that commercial vessels traveling in state waters are encouraged to adhere to. Treatments recommended include the flow-through exchange or empty/refill exchange of ballast water beyond the EEZ (200 miles offshore) in deep water. In addition, ballast water control reports are to be filed within 72 hours of ballast water discharge or upon departing a Virginia port if no discharge occurred. Reports gather information on a vessel's port of registry, and previous and subsequent ports of call.

That information is also sent to the National Ballast Information Clearinghouse, a collaborative project between the Smithsonian Environmental Research Center and the U.S. Coast Guard. The online clearinghouse streamlines the national reporting of ballast water activity of foreign-based commercial ships using U.S. ports [http://invasions.si.edu]. It is the result of the National Invasive Species Act of 1996; re-authorization of the act now makes such reporting mandatory. The U.S. Coast Guard has enforcement responsibility for the law, and under a June 2004 regulation may impose a civil penalty of up to $27,500 for a violation. According to the VMRC, the new federal law mandating the filing of ballast water control reports has resulted in a marked increase in reporting by commercial vessels in Virginia.

Ballast water is particularly hard to monitor, and the extent of the avenues of transport posed by this vector are not fully understood. A team of researchers at Old Dominion University, for example, recently studied the transport of tiny viruses that may accumulate on the filmy lining of a ballast tank (called the biofilm) after its water has been emptied. In their work, Dr. Lisa Drake and Dr. Fred Dobbs examined water samples from 73 vessels arriving in Virginia from both foreign and domestic ports. According to Drake, "All sub-vectors contained viruses, bacteria, and phytoplankton (inferred from the presence of chlorophyll a) and sometimes included pathogens." Drake and Dobbs were able to establish a hierarchy of risk, and found that the water in the tanks posed the highest risk, followed by sediment and water residuals, followed by biofilms.

"It is clear," she adds, "that microorganisms can be transported within ships in a variety of ways."

Data on the movement of aquatic pests are building, but in the meantime, several Sea Grant programs across the country have engaged in education campaigns for the industry. While commercial traffic poses the highest risk, recreational boats also contribute to the problem of aquatic nuisance species. Regional movement of new species occurs through the use of bait and the discharge of waters from both the live well and bilge system of a boat.

See the resource list to learn more.

target, recommend management actions, and highlight the need for increased resources and funding. Heffernan coordinates the activities of the advisory committee and serves as point person for the drafting of the plan.

Key to management, says Tom Smith who directs DCR's Natural Heritage Program, is coordination among the 17-plus government, commercial, and non-profit entitites working in some manner with invasive species throughout the Commonwealth. His department sees a centralized repository of information, accessible on the Internet, as the most efficient, affordable way to get the information out to the people who need it. Many states have taken similar steps and through their web sites also link into national and international databases tracking the movement of invasive species across the planet.

Virginia's online repository would also identify, organize, and hopefully streamline the network of players involved in responding to new information and outbreaks as they occur across the state. Smith views an organized, well-advertised flowchart of responsibility, acknowledged by agency department heads, as a fundamental contribution toward rapid response and management – which is often critical to successful interdiction of a new pest. However, he points out, without adequate resources, Virginia remains unable to respond to even the most alarming of new invasions. For example, the highly invasive Zebra mussels discovered in a Prince William County quarry in 2003 remain today because of a lack of emergency response funds.

The Virginia Invasive Species Council seeks innovative ideas and methods to stem the tide of aggressive, introduced species invading the state. The legislation enabling this work is due to "sunset" in 2006, however. To that end, it is incumbent for Virginians to voice their opinions about the continued need to focus on the Council's mission.

ADDITIONAL RESOURCES

■ Natural Heritage Program,
Virginia Department of Conservation and Recreation
Educational information, fact sheets
http://www.dcr.virginia.gov/dnh/invinfo.htm

■ Virginia Institute of Marine Science
1) Center for Coastal Resources Management
Technical Information on Phragmites
http://ccrm.vims.edu/phragmites.html
2) Sea Grant Marine Advisory Program
Educational materials on rapa whelk
http://www.vims.edu/adv/pubs/index.html

■ Virginia Dept. of Game & Inland Fisheries
1) Zebra Mussel Fact Sheet and Map
http://www.dgif.state.va.us/gis/MOM-December2004.html
2) Snakehead Identification Fact Sheet
http://www.dgif.state.va.us/fishing/snakehead_comparisons.pdf

■ National Park Service and the
U.S. Fish and Wildlife Service
Plant Invaders of Mid-Atlantic Natural Areas
Booklet available to download
http://www.nps.gov/plants/alien/pubs/midatlantic/

■ National Invasive Species Council
A gateway to government resources
http://www.invasivespecies.gov/council/main.shtml

■ National Sea Grant Program
1) National Aquatic Nuisance Species Clearinghouse
http://aquaticinvaders.org
2) Nonindigenous Species
http://www.sgnis.org

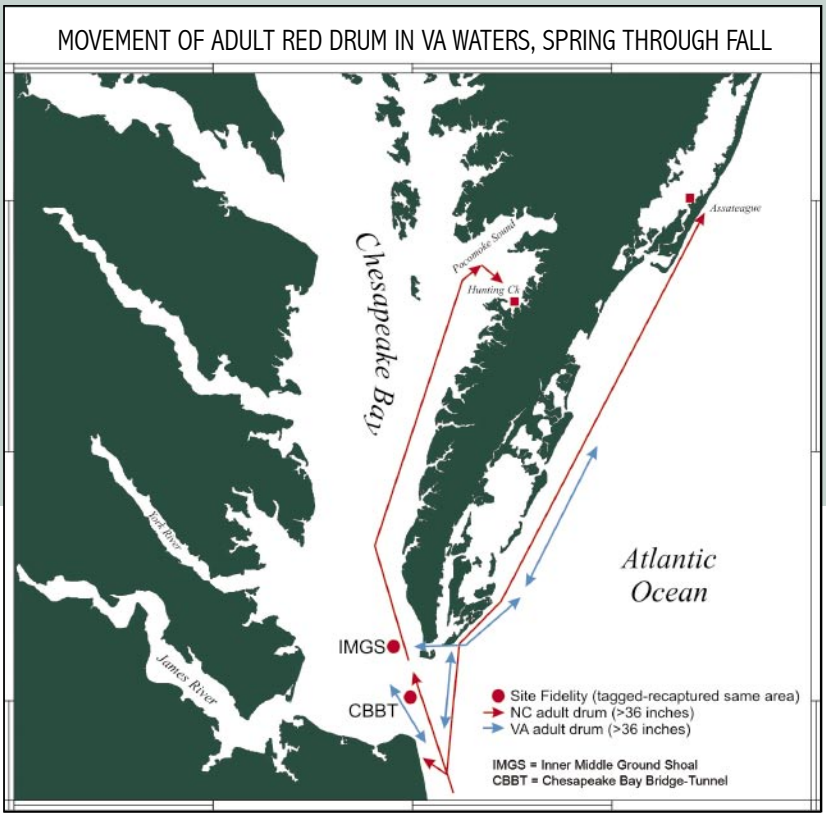
■ Smithsonian Environmental Research Center,
National Ballast Water Information Clearinghouse
http://invasions.si.edu

■ Stop Aquatic Hitchhikers Campaign
U.S. Fish & Wildlife Service and U.S. Coast Guard
http://www.protectyourwaters.net/

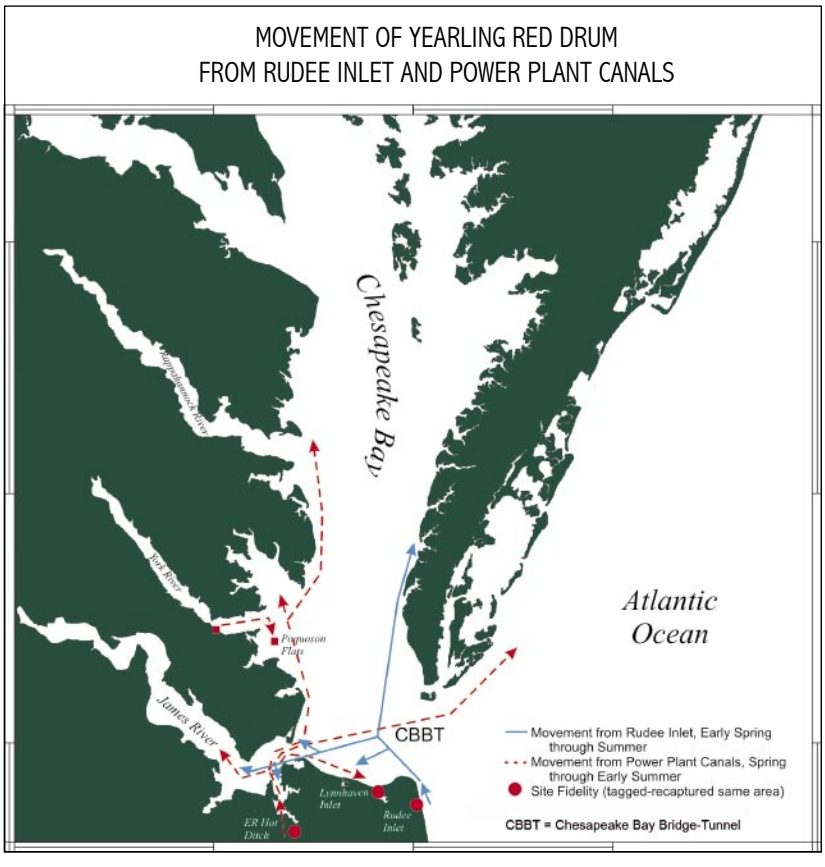
■ U.S. Geological Survey
Nonindigenous Aquatic Species
http://nas.er.usgs.gov/

Angling for Answers

By Jon Jucy



ADULT RED DRUM:
Adult drum (41-48 inches) in Virginia, some carrying 1 to 2-year-old tags, have yet to be recaptured outside of state waters. Tagging large numbers of adult reds (45-55 inches) since 1986, North Carolina has received only 7 reports of recaptures in Virginia (inside the bay and along barrier island beaches). Dynamics of adult drum movements between the two states remain unclear.



YEARLING RED DRUM:
Beginning in late summer, up to 20% or more of yearling drum migrate out of the bay to winter in North Carolina waters. Some 14- to18-inch drum also remain in the bay, over-wintering around power plants. At certain plants from December to March, most appear to move back into lower bay areas during spring and summer months (dotted red arrows). Small drum also can congregate at Rudee Inlet during spring. During March-May 1999, tagging showed that drum remained inside of the inlet up to 6-7 weeks, while others moved out to lower bay fishing grounds (solid blue arrows).

A trained corps of 150-200 anglers is doing big things for Virginia. They are part of a decade-long effort, collecting data on ten marine species that are major contributors to Virginia's billion-dollar-a-year recreational fishing industry. Under the auspices of the Virginia Game Fish Tagging Program, between 8,000 and 12,000 fish are tagged by trained anglers each year. To date, their contributions have resulted in close to 80,000 tagged fish which have generated complete tag-recapture records on nearly 8,000 individuals (about a 10% recapture rate).

The Tagging Program is a cooperative effort of the Virginia Institute of Marine Science (VIMS) Sea Grant Marine Advisory Program and the Virginia Saltwater Fishing Tournament (directed by Claude Bain, III, of the Virginia Marine Resources Commission, VMRC). Primary funding comes from license fees paid by saltwater recreational anglers, and is administered by the VMRC.

Target species are carefully selected by program coordinators, taking into account both developing and expanding fisheries. Species selected must be important and provide useful data to coastal anglers. Tagging should have the potential to produce useful management data for the fish, and those selected must not be regularly targeted for tagging by scientific programs. Since 2000, the program has focused on black sea bass, black and red drum, cobia, flounder, gray triggerfish, sheepshead, spadefish, speckled trout, and tautog.

"Using saltwater fishing license funds for the tagging program is a positive thing for anglers. The tagging program provides the angling community a way to express its conservation ethic. Not only are anglers investing their license money in the future of their own fishery, they are building a working relationship with fishery managers," said Richard Welton, who recently directed the Coastal Conservation Association of Virginia. Welton added, "Anglers remain apprehensive about the accuracy of scientifically collected data on saltwater recreational fisheries. By anglers tagging fish and reporting recaptures, there is a built-in angler confidence factor in the results."

Mechanics

Tags are anchored in the shoulder muscle of the fish, near the base of the dorsal fin. To be effective, tagging programs must regularly evaluate tag retention issues. Some tag loss always occurs: tags work out of the fish's muscle over time, rub off against a structure, or may be "bitten off" by other fish.

Program coordinators researching tag retention issues hold tagged fish at VIMS or in net pens in open water. Double-tagging field trials are also conducted using high-retention, internal anchor tags (or "belly tags" as anglers often call them), to certify retention of the shoulder-anchored type. Such trials are in progress on black sea bass and speckled trout.

Angler-assisted tagging programs are instrumental in leveraging tight research budgets to acquire basic life history information required for fishery management plans. Those plans build upon information collected about local movements, seasonal migrations, water area-habitat preferences, and more. Also, researcher-angler partnerships result in more nimble responses when a recreational species experiences a sudden change—such as a jump in abundance. Typically, research institutions have little flexibility to quickly put a systematic tagging effort in place during such events.

Bain pointed out, "This is a major reason we worked to establish the tagging program. The scientific and angling communities both missed great opportunities in the past to gain new information on key Virginia fisheries such as red drum."

Only tautog over 14 inches are keepers.

Tautog provide fall to spring fishing in Virginia.

Tautog management example

Since 1995, tautog have been tagged inside the bay and on wrecks out to 30 miles offshore. Had it not been for the tagging data on tautog, Virginia's recreational fishery could have experienced serious catch limits, largely based upon data from New York to Rhode Island waters.

Dr. John Hoenig of the Fisheries Department at VIMS has a special interest in tautog tagging and works with NOAA's Marine Recreational Fisheries Statistical Survey (MRFSS) data. Since 1997-98, at the request of the Atlantic States Marine Fisheries Commission's (ASMFC) tautog technical committee, the tagging database has supplemented the MRFSS data set for the fishery's more southern region (NJ south). Paul Caruso of the Massachusetts Division of Marine Fisheries and past chair of the technical committee recently requested more data.

He explained, "The Virginia tagging data for tautog now accounts for about 50% of all release data available for the fishery's southern area, data needed to characterize size distribution and numbers of fish released alive by anglers."

Dr. Hoenig was able to use age composition data (VMRC catches sampled from anglers in Virginia ports) to produce catch curve analyses—which show changes in catch over time of tautog at different ages. His results indicated that tautog mortality rates in Virginia have been lower than in other states.

The tautog technical committee questioned why that should be the case. Committee members wanted to know if there was a biological explanation for the lower mortality in Virginia.

According to Hoenig, "The tagging data provided an explanation: Virginia tautog can experience lower mortality rates than elsewhere because they largely stay 'at home' in Virginia. Of over 1,100 tag returns of small and large tautog (tagged both inside the bay and on wrecks offshore Virginia), no recaptures have occurred in waters from New York northward."

"If Virginia's fishing mortality is lower

than the target level desired by managers, and if Virginia tautog do not move out of state to any appreciable extent, then forcing Virginia to cut back its fishing does nothing to reduce the fishing mortality in states where it is excessive," Hoenig further pointed out.

In the end, only the states of Rhode Island and Virginia were exempted from a 25% reduction in their annual recreational landings of tautog. The issue will naturally be revisited in the future. Tagging data will again play a critical role in justifying the most appropriate management strategy for Virginia's recreational fishery.

Red drum data show promise

In 2001-2002, under the ASMFC Red Drum Management Plan, the states had to further reduce fishing mortality on young and adult fish. The objective was to move the overfished stock more rapidly toward an effective rebuilding schedule (changes to result under Amendment 2).

During 2001, in preparing for input to Amendment 2, the VMRC requested a summary of red drum movement patterns from the tagging program. "The tagging data were important, both for Virginia and for the updating of broader plans," asserted Rob O'Reilly, VMRC Deputy Chief of Fisheries. "Understanding movements of sub-adult drum and their escape rate into the fishery, where they then contribute to the spawning stock, were crucial elements to making the management plan more effective," he added.

Virginia tagging data were able to document that lower Chesapeake Bay waters support occasional strong year classes of drum. Tagged and released drum enhance Chesapeake Bay recreational fisheries in Virginia and Maryland. More important, however, tagging data showed that thousands of sub-adult fish were released (tagged) in Virginia's fishery. Over a several year period, those released fish are expected to join the spawning stock.

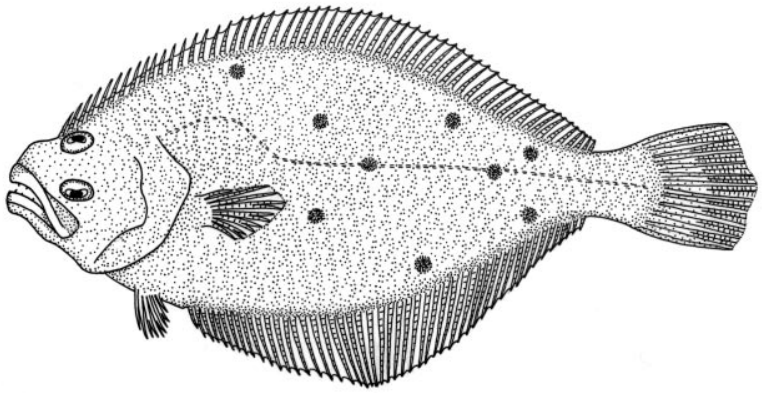
While documenting relative increases in the abundance of sub-adult fish in Chesapeake Bay during1999-2000, the tagging program also proved that Virginia fish exhibit overwintering behavior in the lower bay. Concentrations of puppy drum were tagged during January-February 2000 in areas near an Elizabeth River power plant (known by anglers as the "Hot Ditch"). From recaptures it was learned that while a sizable portion of the fish stayed in the ditch into March, a few moved into the lower bay. Tagging of similar sized drum was accomplished again in the winter of 2002-2003 with similar results. Tagging at two power plants, the Elizabeth River location and the Yorktown plant, was enhanced through special tagging rodeos in cooperation with Dominion Resources.

"Understanding movements of sub-adult drum and their escape rate into the fishery, where they then contribute to the spawning stock, were crucial elements to making the management plan more effective."

Rob O'Reilly
Deputy Chief of Fisheries, VMRC

The charts on page 14 show how the tagging program has made progress toward filling basic life history voids for red drum. By revealing where target fish come from and go to, tagging data contribute to better management decisions for related state fisheries. The program also provides the angling community with hard evidence that catch and release works in marine waters. It proves that released fish are hearty and survive being caught (sometimes more than once.) In many cases, those fish are caught again by other anglers in mid-Atlantic waters – keeping the circle turning.

A New Niche for Fluke



By Angela Correa de Yalowitz

Mid-Atlantic flounder fishermen sell most of their catch through standard marketing channels, but there is increasing interest in exploring a new avenue – the sashimi market. Sushi and sashimi are increasingly popular product forms, and can be significantly more profitable than selling in regular markets.

For sashimi and sushi, only the highest quality flounder (or, fluke) can be utilized. 'Sashimi' means 'raw' in Japanese and usually refers to an artistically-arranged plate of raw seafood and fish, served without rice. 'Sushi' refers to 'vinegared rice', so while sushi preparations always have rice in them, they may or may not include raw seafood. Sashimi often precedes a sushi meal.

Once selected, sashimi quality flounder must be handled gently and processed according to a specific protocol that maintains optimum quality and freshness. A number of processors are interested in getting started in this market, and needed to know how to proceed.

With funding from Virginia Sea Grant, a collaborative effort between economist Dan Kauffman (Virginia Tech), Commercial Fisheries Specialist Bob Fisher (Virginia Institute of Marine Science), and Seafood Marketing Specialist Mike Hutt (Virginia Marine Products Board) resulted in a one-day workshop for processors, which took place at the Virginia Seafood Agricultural Research and Extension Center (Hampton, VA) in February of 2005.

The workshop began with an overview of the sashimi market, and the quality demands that processors must meet in order to be successful. For flounder, it is important that the fish be bled to prevent undesirable changes in color and texture. Fish must also be kept chilled throughout processing. Workshop participants learned how to perform the techniques required, first through demonstrations, and then with hands-on practice.

Michael Kim, owner and chef of Musasi Sushi Restaurant showed why it is so important that the fish reserved for the sashimi

market be of the highest quality, and how mishandling the fish during processing can affect final quality. Kim then prepared samples for the workshop participants, some of whom had never tried sashimi before. Ben Sugujima, an employee of True World Foods showed how to prep the fish for sale in the sashimi market. True World distributes seafood from 22 locations in the U.S. and Canada. Mr. Sugujima then had the attendees practice the techniques on fish provided by the workshop. Additional discussions covered specialized techniques needed to pack the fish, and how to control and monitor the potential food safety problems that may arise.

Several teleconferences with buyers during the workshop helped participants understand how to market sashimi-prepped flounder. The workshop organizers wanted to bridge the gap between processors and buyers.

The workshop has served to energize processors, and to demystify the process of entering the sashimi market. As a result of this workshop, negotiations have begun between several industry personnel who attended the workshop and area sashimi distributors. One difficulty that must be overcome is how to supply flounder when weather makes the seas rough – it is difficult to conduct flounder fishing operations, much less process the fish on-board when the boat deck is rolling. Further work will be undertaken to mitigate this problem.

The workshop was a good example of how a small amount of funding can be leveraged into a tangible benefit for the region's fisheries. By paying attention to the needs of harvesters and processors, and at the same time knowing what distributors want, it was possible to put these two groups together – a winning arrangement for all concerned.

Angela Correa de Yalowitz heads up communications efforts in the Virginia Sea Grant, Blacksburg office.

Photos: (Top) Workshop participant confirms cut location with Ben Sugajima of True World Foods. (Middle) Michael Kim, the sushi chef at Musasi Restaurant, cuts the fillet off a sashimi processed flounder. (Bottom) Ben Sugajima and Dan Kauffman from Virginia Tech show Denise Daniels of Old Point Packaging where to place knife for sashimi cut.

News from the Point

WELCOME!

In April, Dr. Carol Hopper Brill joined the Marine Advisory Program staff as a marine education specialist. Carol grew up in California and received her early training at the University of California-Davis where she earned a B.S. and M.A. in zoology. She moved to Hawai'i to pursue doctoral research on the ecology and reproductive biology of reef-contributing snails and received a Ph.D. in marine zoology from the University of Hawai'i-Mānoa. In contrast to small snails with low mobility, she later studied the reproductive cycles of Pacific blue marlin, a much larger and far ranging species.

While in graduate school, Hopper Brill became aware of the importance of science education as a vital outcome of scientific research. She worked at the University of Hawaii's Waikīkī Aquarium for more than 20 years, designing programs aimed at making marine science more accessible to a broad range of community audiences, especially schools and families. Science interpretation for multigenerational audiences remains one of her special interests.

In her position with VIMS, Carol will focus on programs for high school students like the Blue Crab Bowl and Outlook on Ocean Science. New directions will bring greater emphasis on serving educators, and she will add her expertise to teacher professional development courses and other MAP education efforts that support teachers.

CHARTER BOAT WORKSHOP A SUCCESS

Virginia Sea Grant's Marine Advisory Program recently completed a 3-year outreach effort, coordinating 9 educational workshops for charter boat operators from New York to North Carolina. The most recent workshop was held in Ocean City, Maryland, where 65 charter boat operators spent the day learning about fishery and business management issues. Overall the series has provided in-service education to over 400 operators in the mid-Atlantic area.

The mid-Atlantic charter and party boat fleet provides in excess of 1 million individual angler trips annually. This "for hire" fishery is a keystone sector in the sense that it provides vital linkage between non-boat-owner anglers and the full spectrum of inshore, offshore, and highly migratory fisheries.

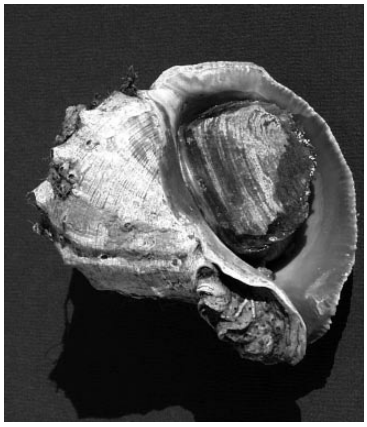
Virginia Sea Grant educator Vicki Clark and VIMS scientist Rochelle Seitz are working with a team of educators from the Mathematics and Science Center in Richmond, the College of William & Mary, and several other Virginia universities to improve Earth Science education in the Commonwealth. The purpose of the "Virginia Earth Science Collaborative" is to develop a statewide network of oceanography, astronomy, geology, and meteorology courses specifically designed to increase the pool of endorsed Earth Science teachers, and to improve students' achievement on the Earth Science SOL Test. Courses will be conducted in 2005 and 2006. Seitz and Clark will work with Dr. Mark Luckenbach and staff at the VIMS Eastern Shore Lab to conduct oceanography field workshops each summer during the project.

Funds have been provided by the Virginia Department of Education through a competitive grant made possible by the "No Child Left Behind Act" of 2001. For course schedules and more information on the program, see <http://VirginiaEarthScience.info>.

STURGEON SUBJECT OF STUDY

Virginia Sea Grant is currently helping in a cooperative research effort investigating sturgeon that are being captured in commercial gill-net fisheries. Collaborators from several institutions are involved, including the Virginia Institute of Marine Science, U.S. Fish and Wildlife Service, and NOAA Fisheries. The driving force behind the project is the commercial fishing industry, and some interesting data have been observed. Log on to our web site at <www.vims.edu/adv> for more information.

The Science of Biological Invasions: Profile of the invasive veined rapa whelk
June 28-29, 2005,VIMS, Gloucester Point, VA



The rapa whelk is a large Asian predatory snail which has invaded the Chesapeake Bay. This program for secondary level science teachers will include an overview of aquatic species biological invasions and rapa whelk biology, life history, and zoogeography in relation to Chesapeake Bay. Participants will work with VIMS scientists using standard research techniques to collect descriptive data from live rapa whelks and egg masses. Hands-on activities and teaching materials in support of secondary science standards and topics (e.g, population ecology, adaptations, energy dynamics, human impacts, nature of scientific investigation) will be provided. This workshop is supported by the Chesapeake Bay Restoration Fund Advisory Committee and VIMS Department of Fisheries Science and is sponsored by the VIMS Molluscan Ecology Program and Virginia Sea Grant. For more information contact Vicki Clark (vclark@vims.edu) or Juliana Harding (jharding@vims.edu). Information will be available from the VIMS VORTEX website, at: <http://www.vims.edu/mollusc/education/vortex.html#schedule>.

Sea Grant
Virginia

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