

# Virginia Water Central

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## Virginia Water Research Symposium 2001

November 14-16, 2001

Doubletree Hotel, Charlottesville, Virginia

Dear *Water Central* readers,

The Water Center's annual research symposium is approaching! Come enjoy late fall in the Virginia Piedmont and learn lots about Virginia's waters at the same time.

You should have recently received by mail or e-mail the program and registration information for the symposium. If you did not and you would like a copy, please contact the Water Center at (540) 231-5624. You can also find the information on our Web-site, [www.vwrrc.vt.edu](http://www.vwrrc.vt.edu), and you can register for the symposium on-line at <https://www.conted.vt.edu/ssl/vwrs-reg.htm>.

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VIRGINIA POLYTECHNIC INSTITUTE  
AND STATE UNIVERSITY

FEATURE    ARTICLE
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## At Mid-season for Hurricanes, Southeastern Virginia Water Utilities Remember Floyd

Because hurricanes are often in the news and their disastrous potential commands our attention, it's easy to assume we know a lot about them. We know, for example, that we are in the middle of the hurricane season right now, an officially recognized six-month span from June 1 to November 30. During this period, durin conditions are ripe for generation of the kinds of storms off the western coast of Africa that can spawn Atlantic hurricanes.

We also know, courtesy of a U.S. National Oceanic and Atmospheric Administration (NOAA) report issued in July 2001, that the frequency of Atlantic hurricanes appears to be influenced by *cyclical* atmospheric and ocean conditions.<sup>1</sup> The report said that from 1970—1995, the surface temperatures of waters in the North Atlantic and the Caribbean Sea were relatively cool. This tended to cool a layer of air directly above the surface and in turn helped limit the opportunities for hurricane generation (because the storms depend on both warm water and warm air). The report also said those conditions changed rather quickly in 1995, and that the oceans are now warmer, as is the air directly over them. NOAA scientists say, based on data going back to the 1920s, that this phase should last another 25—40 years and should lead to more frequent, and more violent, hurricanes.

While that prediction is scary, being able to make it is impressive. Even though some meteorological experts question whether NOAA had enough reliable data to be so definitive in its July report, no one

questioned the agency's understanding of the conditions that spawn hurricanes.

We've made considerable progress toward knowing these storms since the days of William Redfield (1789-1857), the acknowledged "Father of Hurricane Science." Redfield, a leather worker, was known to take long walks throughout his native New England in the 1820s and 1830s. He was particularly engaged by natural conditions he observed on these walks in the aftermath of several hurricanes, and he made forays of 50 and even 70 miles on foot to take extensive notes about them. Those notes became the foundation of America's contribution to hurricane science, a store of knowledge still being expanded by studies such as NOAA's.<sup>2</sup>

<sup>1</sup> The report, *Intraseasonal Predictability of Atlantic Basin Hurricane Activity*, by Stanley Goldenberg, is available on the National Oceanic and Atmospheric Administration's web site: [www.NOAA.gov](http://www.NOAA.gov).

<sup>2</sup> In 1831, Redfield wrote "Remarks on Prvailing Storms of the Atlantic Coast of the North American States." He went on to become one of the founding members and the first president of the American Association for the Advancement of Science in 1848.



But even after nearly 200 years of scrutiny, hurricanes remain mysterious in many ways. Because of that, and because their destructive power can be so great, few people in Atlantic coastal areas can afford to be complacent about them, least of all public officials and those who manage public utilities. On the contrary, many public officials spend considerable time studying past storms in hopes of being better prepared for future ones.

One such effort was a panel discussion by southeastern Virginia water-utility managers on the effects of 1999's Hurricane Floyd—a storm that packed a number of surprises, even for those who make it part of their jobs to know and prepare for hurricanes. The panel discussion was part of the annual meeting of the Virginia Section of the American Water Works Association, held in Williamsburg in October 2000. The panel participants were the following:

- Jim Sarver, Virginia Beach's administrator of public utilities;
- Rick Saul, water-production manager for the City of Norfolk;
- Jim Spacek, Portsmouth Utilities director; and
- Amar Dwarkanarth, Chesapeake's director of public utilities.

*Water Central* noted the panel proceedings on the day of the discussion and contacted each participant by phone several months later. The participants graciously updated us on what they learned from Hurricane Floyd and on how they've revised their plans for keeping the water supply going during and after a hurricane or other disaster.

## Hurricane Planning at Four Virginia Utilities

### Portsmouth

Jim Spacek, the Portsmouth Utilities Director, made perhaps the most representative comment at the panel. "The emergency we planned for," he said, "was not the emergency we got."

He later explained that he wasn't suggesting the city had planned for every emergency other than a hurricane, only that Floyd did not perform the way officials had learned to expect from past hurricanes and from their consultations with other municipalities hit by major tropical storms. "We had a hurricane-preparedness plan in place that officials from Homestead, Florida and Charleston, South Carolina helped us prepare," he said (Homestead has weathered several hurricanes including the severe Andrew in 1992, while Charleston, too, has seen its share of calamitous storms, including Hugo, in 1989). It wouldn't be responsible for us not to expect, given where we are, to deal with a hurricane. It's just that Floyd *didn't* do what we expected a hurricane to do, and *did* what we didn't expect a hurricane *could* do."

The most harrowing example of Floyd's unpredictable severity was the swamping of Portsmouth's water treatment plant, Spacek said. "We've got pumping stations inside the city that we expected to be taken out if a major hurricane came along," Spacek said, "but our central plant is 22 miles inland, near Suffolk. It's on higher ground, and had not suffered any substantial storm damage since first going operational in 1882. We just did not expect that the torrential inland rains Floyd brought would flood the plant, but they sure did. We were completely off-line for four and a half days, which is disaster for a public utility.

"We had plans in place for a loss of power, for water contamination, for broken lines caused by trees being uprooted. But we didn't have a plan on paper for what to do if the whole plant went under water," Spacek said. "We do now."

### Chesapeake

Officials in nearby Chesapeake had a similar, if not as severe, experience, according to Mr. Dwarkanarth. "We just never imagined that the Great Dismal Swamp Canal would flood and contaminate our water source [the Northwest River]," he said. "But that's what happened along almost two miles of the canal, and the flooding carried all kinds of organics and contaminants into the river."

Dwarkanarth said the city purchases water from Portsmouth and Norfolk in addition to treating its own water from the Northwest River, and that the utility had contingency plans for the loss of service from either or both facilities during a disaster.

“We figured we could just take more from the river,” he said, “but we did not foresee the kinds of problems we would encounter if the water in the river was severely degraded at the same time.”

Chesapeake treats water from the river through a reverse-osmosis process, and Dwarkanarth said the system was heavily taxed by the increase in contaminants and particulates that clouded the river water.<sup>3</sup>

“We use alum as a coagulant that attracts particles and then settles to the bottom of our reservoirs. Our average use of alum is 120 milligrams per liter of water, but in the days following Floyd we went up to as much as 350 milligrams per liter, and that’s not good,” he said, explaining that the system’s filtering membranes can be debilitated by levels that high. Plant engineers are now testing other coagulants to be used in place of, or in combination with, alum in future emergencies.

### **Norfolk and Virginia Beach**

Neighboring Norfolk and Virginia Beach were not as severely affected as Portsmouth and Chesapeake, but Floyd caused them to recognize their vulnerabilities in new ways, according to Mr. Saul and Mr. Sarver. “You would have thought we’d be a lot worse off from a hurricane because we’re right on the coast,” Sarver said, “but it tracked west just before it reached us, and we really didn’t get much at all except a very big wake-up call when we saw what happened to Portsmouth and Chesapeake.”

What Virginia Beach officials woke up to, according to Sarver, was the fact that they weren’t as prepared as they could be for a disaster.

“We learned things like the phone numbers for some key personnel in our plan were out of date, and that listings and locations of emergency equipment were also out of date. But we also saw how crucial it was to know how to assess damage quickly and accurately,” he said. “That’s what triggers emergency aid, such as assistance from the Federal Emergency Management Agency, for example, and you really need to know how to do it well.”

He said a higher number of city and county employees than ever before are now trained in damage assessment, in hopes of speeding that part of the area’s response. Other facets of a new emergency plan, he says, are still being implemented. “It’s an evolving process. We may never actually say now that our planning is one hundred percent complete, because we’ve learned to keep asking ourselves, ‘What if...’”

Rick Saul seconded the need for wariness and continual questioning, but said the preparation effort carries its own set of problems. “I call it ‘preparedness fatigue,’” said Saul. “You can reach a point where you say, ‘All right, I’ve looked at everything that might happen, and I’m tired, so let’s move on.’ But the problem is, you probably haven’t considered everything that might happen—even if it’s something that might not happen in your lifetime. If you are serious about planning for contingencies, you’ve got to ask long strings of questions.”

As an example, Saul noted that he’d prepared for Hurricane Floyd by having every one of Norfolk’s water storage tanks filled with treated water, providing a reserve of 24 million gallons.

“But then I had to wonder—based on what we saw happen at Portsmouth, where the whole system was inundated—what the best use of our reserve would be. Would we use it to provide uninterrupted service while we tried to get our plant back on line, or would it be strictly for emergency use? Then we asked another question: If a disaster interrupted all communications in the area, how should citizens respond if they found they still had water service? Should they assume it’s treated if there’s no way we can assure them of [that]?”

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<sup>3</sup> In reverse-osmosis, water is filtered through semi-permeable membranes to remove materials in solution. The more dissolved material, the higher the likelihood the membranes will become fouled, possibly even by the coagulants used in combination with the process, and eventually inoperative.

Saul said his community's answer to the first question was a written policy stating that treated water in reserve would be directed first to hospitals, schools, and shelters until a state of emergency had passed. In the case of interrupted communications, "Our answer is *no*: If you can't get word from the treatment plant, you should assume the water is contaminated and needs to be used only with precautions like boiling and filtering."

The questions will keep coming once a community has learned to think along those lines, Saul said, and the possibility of increased hurricane activity only spurs them on. "Here's a touchy problem we've begun to address also," he continued. "The first thing people want to know in an emergency is that relief and law enforcement and other people who can be of help are on the job. But they are people too, with families to worry about, and if we can't assure them their families are safe, they're aren't going to be too interested in doing their jobs."

He cited figures from Florida's Hurricane Andrew experience, where fully half of public employees stayed away from their jobs to care for their families first. "It's a fact of life, and we ought to work it into our planning that the families of people who need to be on the job will be given some assurance of shelter. People don't like to discuss it because it just adds another layer of complication. But the point is: Sit down and do the planning."

Mr. Dwarkanarth, of Chesapeake, agreed. "Once the unimaginable happened to us, we realized that's what we needed to plan for. For instance, our treatment plant uses a reverse-osmosis system because we sometimes have to deal with saltwater intrusion in the river. It doesn't happen very often, maybe eight percent of the time, but it happens. We now have an approach in place for what we will do if we again have floodwaters in the river *as well as* a salt water intrusion. Common sense would suggest the two things cannot happen simultaneously, but now, even if the likelihood is tiny, it's something we plan for."

## Conclusion

Despite hundreds of years of study, hurricanes remain unpredictable. It makes sense then, that those responsible for public safety and public services meet regularly and compare notes on hurricanes they've weathered and on preparations they're making for storms yet to come.

It also makes sense that others would examine what has been learned about hurricanes for clues to *disabling* their destructive potential. For instance, The Associated Press reported in July that a Florida company has completed a third test—successfully, it claimed—of super-absorbent crystals it believes can defuse hurricanes before they happen.<sup>4</sup> The company that manufactures the crystals claimed that when a planeload of the crystals was dumped into a bank of storm clouds off the Florida coast in July, radar recorded a "perceptible loss of moisture in the clouds." And the supervisor of the nearby Palm Beach airport control tower reported that "there was a tall build-up of clouds, and then they were gone."

Could this company actually have something? Could its product suck away the moisture that helps drive storms to hurricane levels? Some meteorologists suggest it's not a bad approach, though it mirrors a similar effort by federal researchers years ago—a project ultimately abandoned as unworkable—to dissipate threatening clouds with the use of aluminum silicate.

So, one day in the future, it *might* be possible to use airplanes and crystals to erase hurricane threats. But until then, it's a good thing public officials and utility managers keep meeting and keep learning what they can about preparing for the present reality of hurricane season.

—By David Mudd

*Water Central* thanks James Hudgins (National Weather Service, Blacksburg) for reviewing this article.

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<sup>4</sup> The crystals absorb hundreds of times their own weight in water, become saturated and gel-like in the atmosphere, and fall into the ocean where, the company claims, they dissolve harmlessly.

## Hunting for Better Knowledge of Hurricanes

Dave Toomey, who taught technical writing at Virginia Tech until 2000, has moved on to the University of Massachusetts. But it was while Toomey was at Tech, researching a book he wrote several years ago about female astronauts, that he became interested in hurricanes. He's specifically intrigued by the people who often risk injury and even their lives to get close enough to active hurricanes to measure atmospheric conditions in and around them. Toomey is focusing a current book (to be published in June 2002) on a particular group of hurricane hunters whose plane vanished as they were tracking Hurricane Janet in 1955. "I see it as a kind of 'Perfect Storm' story, except at 30,000 feet instead of sea level," he said in a telephone interview with *Water Central* (referring to the recent book and movie about a ship caught in a terrible ocean storm). "There were six people on [the] plane tracking Janet through the Gulf of Mexico, and at some point it just went down and hasn't been found yet."

Toomey said his impression from the research he has done to date is that most hurricane hunters have less daredevil in them than a very strong urge to discover new information about storms. "[But] there *are* the hot dogs, of course," he said, "like the first pilot ever known to have flown voluntarily into a hurricane. He flew all the way into the eye of the storm and back out, and then he turned around and did it again just to prove how tough his plane was. He said he felt like he'd been snapped up and shaken like a dog with a bone." Others have voluntarily skydived into hurricanes, Toomey said.

"I might not do choose to do something like that myself," Toomey noted, "but I can understand that overwhelming desire to figure these things out." He said one of the most intriguing puzzles he's encountered so far is the relative *infrequency* with which hurricanes occur. "Conditions are right for these storms on an average of once a day during the season," he said, "and nobody knows why they so often fail to develop."

—D. M.

## TEACHING WATER Especially for Virginia's K-12 teachers

### This Issue and the Virginia Standards of Learning

*Below are suggested Virginia Standards of Learning (SOLs) supported by this issue's Feature and Science sections. Water Central welcomes readers' comments on whether the articles actually do, in fact, help teachers with the standards listed or with others. Abbreviations: BIO=biology; ES=earth science; LS=life science.*

#### Feature Article—Hurricanes and Water Utilities

Science SOLs: 3.10, 4.6, 4.8, 5.6, LS.12, ES.11, ES.13.  
Social Studies SOLs: 10.2, 10.8, 12.9.

#### Science Article—Exotic Aquatic Species

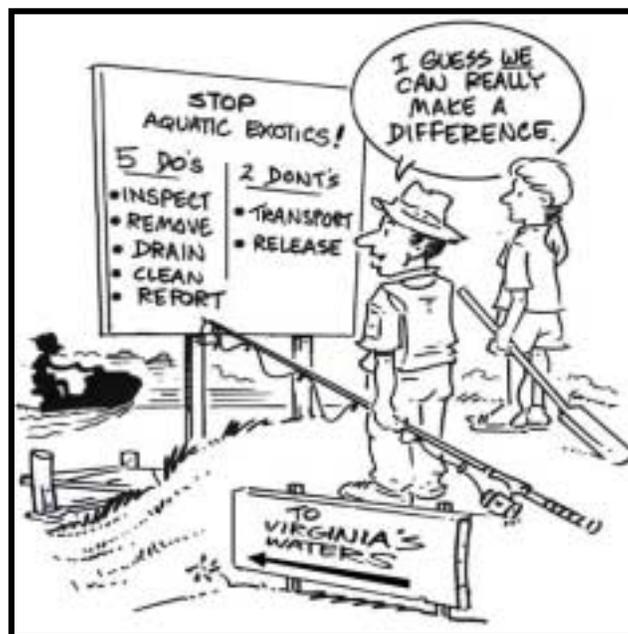
Science SOLs: 4.5, 6.9, LS.7, LS.9, LS.12, BIO.8, BIO.9  
Social Studies SOLs: 10.2, 10.9, 12.6, 12.16.  
Computer Technology SOLs: 5.3, 8.4

## When Aquatic Visitors Become Unwelcome Residents

In 1999, various organizations involved with Smith Mountain Lake created a task force to make recommendations for improving and protecting the lake's water quality. One of the "high priority" recommendations of the task force was "detailed communication for marinas and the general population on regulations pertaining to, and hazards associated with, exotic species introductions."

In February, 2001, the Smith Mountain Lake Association (SMLA) published a review of the progress made to implement the recommendations of the 1999 task force. Regarding the recommendation for information about exotic species, the February 2001 review noted that "virtually no work" had been done with the general population; moreover, while the Virginia Department of Game and Inland Fisheries had done some work with marinas on Zebra Mussels, that effort needed "to be updated and expanded to other species."

This relatively long "Science Behind the News" article seeks to fill that information gap. It builds upon an earlier Water Center publication on Zebra Mussels<sup>5</sup> and expands the discussion to other harmful, or potentially harmful, exotic aquatic organisms. The first several sections—through "Conclusions about Introducing Species" on page 12—present a fairly broad picture of the non-native aquatic species issue. After that, four additional sections focus particularly on Virginia and provide "stand-alone" tools for citizens concerned about these issues to reproduce and use for public education.



<sup>5</sup> In 1991 and again in 1993, the Water Center published *Citizens Alert: Zebra Mussels Threaten Virginia's Waters*. The publication describes damage caused by Zebra Mussels in U. S. waters and how citizens can help stop the species from spreading. The publication is available on-line at [www.vwrrc.vt.edu](http://www.vwrrc.vt.edu), or in paper (for the cost of photocopying) from the Water Center.

## Some Lessons from a Very Common Fish

Why is the Common Carp (*Cyprinus carpio*)<sup>6</sup> so common? Native, or **indigenous**, to Asia, this fish species has been **introduced** to new water bodies for hundreds, if not thousands, of years. The fish was first introduced to North America in the 1830s, with the first *large-scale* introduction occurring in 1872 when fish were brought from Germany to northern California for fish farming. In the late 1870s, a “carp craze” swept the country, resulting in the species being introduced practically nationwide.<sup>7</sup> As a result of these *intentional* introductions, along with natural events like floods that helped spread the species, the fish became one of the most common in the country. In Virginia, where the first known introduction was in 1880, Common Carp now occurs in all major river basins.

The Common Carp is only one of many aquatic species that have been intentionally introduced (at least initially) to an area outside of their natural range by human activities. Many other species have been *unintentionally* introduced by various human activities, which are described in more detail below. The U. S. Geological Survey (USGS) Web-site on non-native aquatic species (<http://nas.er.usgs.gov>) gives the following numbers (approximate) of introduced aquatic organisms in the United States: 50 algae; 36 worms; 135 crustaceans (crabs, shrimp, etc.); 140 mollusks (clams, mussels, etc.); 71 other invertebrates; 600 fish; 43 amphibians; 62 reptiles; and 1 mammal.<sup>8</sup>

Collectively, these species are usually referred to as introduced species, **exotic** species, **non-native** species, or the most comprehensive term, **non-indigenous species**, which you may see as the acronym “NIS.”<sup>9</sup> Some people use “exotic” to refer specifically to organisms introduced into the United States from another country, and use “introduced” or “transplanted” to refer to species moved within a state or other political boundary but outside of its historic or native *range* (for example, Pacific salmon introduced into the Great Lakes). The USGS makes this distinction, so the numbers of non-native species listed in the previous paragraph include species native to the United States but introduced outside their native range.

The Common Carp is also an example of one potential *result* of introductions, whether intentional or unintentional: the species may find suitable environmental conditions and become **established** in the new area(s). Becoming established means that a species has a successfully breeding **population** that does not depend on human management; as mentioned above, the Common Carp is established in all of Virginia’s major river basins. It has become part of the **community** of living organisms and the aquatic **ecosystem** (the living organisms plus the non-living components of their environment) in many of Virginia’s waters.

Being part of a biological community and an ecosystem means that an organism interacts with other organisms and with the environment within the ecosystem. Such **ecological interactions** include competition for food, space, or other resources; predation of one species upon another; transfer of disease-causing organisms; and physical or chemical effects on the environment. An established exotic species becomes part of an area’s ecological interactions by what it eats (if an animal), how it grows (if a plant), where it lives, how it reproduces, and what diseases or parasites it carries.

Whether or not a non-native species establishes a population or remains as scattered individuals, the species *may* have a significant effect on its new habitat, on the other organisms living there, or on the human uses of that resource. Then again, it may *not*. In fact, much of the

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<sup>6</sup> From this point on in this article, the scientific name of each species is given when the species is first mentioned and in all tables.

<sup>7</sup> R. E. Jenkins and N. M. Burkhead, *Freshwater Fishes of Virginia* (Bethesda, Md: American Fisheries Society, 1994), p. 274.

<sup>8</sup> The USGS site did not have a list of introduced aquatic plants.

<sup>9</sup> Other terms used synonymously with “exotic” are “alien” and “foreign.”

concern about non-native species results from this very uncertainty about just how species will react when introduced to a new environment.

Most intentionally introduced species in the United States, including many major agricultural crops, have had beneficial impacts, while many others have had no significant impacts. The beneficial impacts of aquatic non-native species include aquaculture, aquatic-weed control by fish, sport-fishing, and (sometimes) restoration of aquatic habitats degraded by human activities. An estimated 25 percent or more of all game fish caught by U. S. anglers are from introduced populations.

But some introduced aquatic organisms have traits related to feeding, reproducing, or disease that result in clearly harmful impacts on ecosystems or on economic uses. In 1993, the U. S. Office of Technology Assessment (OTA) did a comprehensive study of the nationwide impacts of harmful introduced species (including terrestrial as well as aquatic species). That study found that, of some 4,500 introduced species that have become established in the United States, about 15 percent of these cause “serious harm.”

In many cases, an introduced species is **invasive**, meaning that it can spread widely and displace other organisms. The box below details some adaptations that allow certain species to spread widely and have a serious impact on native organisms. Introduced aquatic organisms that do become widespread pests are often referred to as **aquatic nuisance species**.

## Aquatic Nuisance Species Problems and Pathways

### Who Are These Nuisances, Anyway?

Different states (including Virginia) have particular aquatic nuisance species of concern, depending on a state’s native species, its climate and geography, and the human activities that have affected its ecology. Even so, some species have such an impact that they are of *national* concern. The **Aquatic Nuisance Species Task Force** (ANS Task Force) is a federal, interagency effort started in the early 1990s to prevent, monitor, and control unintentional introductions of aquatic nuisance species. At its Internet site, <http://anstaskforce.gov>, it lists several “Nonindigenous Aquatic Species of Concern”; the table on page 10 lists those species. Please note these three considerations about this list: 1) the species listed may not necessarily be of concern in all states or watersheds; 2) many other species may be of concern more locally; and 3) new introductions occur frequently, so lists like this one are always subject to change. The table also includes notes on the species’ occurrence in Virginia, based on various sources (listed at the end of the table).

### Adaptations that Make Some Introduced Species Invasive and “High-impact”

- European Ruffe (*Gymnocephalus cernuus*)—This fish is a prolific breeder, matures quickly, adapts widely to environmental conditions, and competes effectively with native fish.
- Hydrilla (*Hydrilla verticillata*)—This plant is very efficient at using low light; it reproduces from fragments; and it produces long-lived tubers that grow into the bottom mud.
- Round Goby (*Neogobius melanostomus*)—This fish has aggressive feeding behavior; a well-developed sensory system for detecting movement, allowing them to feed in darkness; the ability to survive in water of poor quality; and a long summer spawning period.
- The Spiny Waterflea (*Bythotrephes cederstroemi*) and the Fishhook Waterflea (*Cercopagis pengoi*) can reproduce one new generation about every two weeks in warm water; their resting eggs can remain dormant for a long time; and they each have a long tail that makes them harder for small fish to eat.
- Water Chestnut (*Trapa natans*)—This plant produces fruits with sharp spines that dissuade animals from eating the plant; in addition, its seeds can remain viable up to 12 years.
- Zebra Mussel (*Dreissena polymorpha*)—This animal’s rapid spread is attributed to its reproductive cycle (1 million eggs per season per female); its free-swimming larvae (the immature stage of the organism); the ability of the larvae to attach to surfaces with tough threads; and its habit of individuals colonizing upon other individuals.

**Source:** Jeffrey L. and Ronald E. Kinnunen, eds. *Aquatic Nuisance Species—Hazard Analysis and Critical Control Point Training Curriculum*. Duluth, Minn.: Minnesota Sea Grant, 2001.

### Some Introduced Aquatic Species of National Concern

INTRODUCED SPECIES	OCCURRENCE IN VIRGINIA
<b>Algae</b>	
<i>Caulerpa taxifolia</i> (a marine green alga)	Not introduced
<b>Plants</b>	
Curly-Leaf Pondweed ( <i>Potamogeton crispus</i> )	Introduced into many counties
Eurasian Watermilfoil ( <i>Myriophyllum spicatum</i> )	Introduced into many counties
Flowering Rush ( <i>Butamos umbellatus</i> )	Not introduced (problem is in more northern states)
Hydrilla ( <i>Hydrilla verticillata</i> )	Introduced into a few counties
Japanese Sputnik Weed (scientific name not available)	No information
Purple Loosestrife ( <i>Lythrum salicaria</i> )	Introduced in many counties
Saltmarsh (or Smooth) Cordgrass ( <i>Spartina alterniflora</i> )	Native to Virginia coast (problem is introduction to Pacific coast)
Water Chestnut ( <i>Trapa natans</i> )	Introduced into northern area
Water Hyacinth ( <i>Eichornia crassipes</i> )	Introduced into at least one county
<b>Crustaceans</b>	
Chinese Mitten Crab ( <i>Eriocheir sinensis</i> )	Not introduced
Lumholtzi Waterflea ( <i>Daphnia lumholtzi</i> )	Not introduced; occurrences in North Carolina
European Green Crab ( <i>Carcinus maenas</i> )	Not introduced
Japanese Shore Crab ( <i>Hemigrapsus sanguineus</i> )	Introduced
Opossum Shrimp ( <i>Mysis relicta</i> )	Not introduced
Rusty Crayfish ( <i>Oronectes rusticus</i> )	Not introduced
Spiny Waterflea ( <i>Bythotrephes cederstroemi</i> )	Not introduced
Serrated Swimming Crab ( <i>Scylla serrata</i> )	Not introduced
<b>Mollusks</b>	
Amur River Clam (scientific name not available)	Not introduced
Asiatic (or Asian) Clam ( <i>Corbicula fluminea</i> )	Introduced into several areas
Atlantic Ship Worm (scientific name not available)	Not introduced
Brown Mussel ( <i>Perna perna</i> )	Not introduced
New Zealand Mud Snail (scientific name not available)	Not introduced
New Zealand Sea Slug (scientific name not available)	Not introduced
Zebra Mussel ( <i>Dreissena polymorpha</i> )	Not introduced; reported from Kentucky, Tennessee, and West Virginia
<b>Fish</b>	
Blue Tilapia ( <i>Tilapia sp.</i> )	Introduced, not established
Common Carp ( <i>Cyprinus carpio</i> )	Established and common in Virginia
European Ruffe ( <i>Gymnocephalus cernuus</i> )	Introduced, not established
Round Goby ( <i>Neogobius melanostromis</i> )	Introduced, not established
Sea Lamprey ( <i>Petromyzon marinus</i> )	Established but uncommon in Virginia
White Perch ( <i>Morone americana</i> )	Native to coastal drainages in Virginia
<b>Others</b>	
Cholera Bacteria ( <i>Vibrio cholerae</i> )	No information
Dermo Labyrinthus	In Chesapeake Bay oysters
MSX	In Chesapeake Bay oysters
VHS	No information
Whirling Disease ( <i>Myxobolus cerebralis</i> ), a fish parasite	No information

#### Sources:

For species list: Aquatic Nuisance Species Task Force Web-site, <http://anstaskforce.gov>, 8/17/01.

For occurrence in Virginia: USGS Nonindigenous Aquatic Species Web-site, <http://nas.er.usgs.gov>, 8/30/01;  
Robert E. Jenkins and Noel M. Burkhead, *Freshwater Fishes of Virginia*, American Fisheries Society, 1994;  
A. M. Harville, Jr., et al., *Atlas of the Virginia Flora III*, 1992 (out of print).

## Potential Impacts of Aquatic Nuisance Species

The 1993 OTA report found (pp. 57, 63) that “[d]espite clear benefits of many non-indigenous species, numerous others continue to cause great harm in the United States...A minority [of species] cause severe harm, [but] such high-impact NIS occur in almost all regions of the country. [These species] annually cost the Nation hundreds of millions to perhaps billions of dollars.”

Most concern about non-native aquatic species focuses on their potential to harm native *ecosystems* or *economic uses* of resources.<sup>10</sup> The main ecosystem impacts include declines or even elimination of native species, due to the native species being outcompeted by the non-native one(s); new parasites or diseases; changes in food webs; and changes in environmental conditions. By any of these means, established non-native organisms can affect the **biodiversity** of an ecosystem and, in turn, affect the ecological **functions** provided by the system.

The main *economic* impacts are to fisheries (commercial and sport), waterways, utilities that require water intakes, and natural areas (such as national parks). Here are some estimates of the economic costs from a few high-impact aquatic nuisance species:

- European Ruffe** (introduced into the Duluth, Minn./Superior, Wisc., harbor in the early 1980s)—Decline in the value of fisheries in the Great Lakes expected to exceed \$100 million.
- Purple Loosestrife** (*Lythrum salicaria*), introduced in the early 19th Century—Presently occurring in 42 states, annual management costs and lost forage equal approximately \$45 million.
- Sea Lamprey**, invasion of the Great Lakes after the Welland Canal opened in 1929—Major factor in collapse of Lake Trout populations and fisheries in 1940s and 1950s. Populations are currently controlled but at a cost to the United States and Canada of more than \$12 million annually.
- Zebra Mussel**, introduced into Lake St. Clair, in the Great Lakes region, in 1986—Grow in clusters and attach to hard surfaces, including water-intake pipes at power-generating facilities and waterworks. Great Lakes water users spend \$30 million annually to monitor and control the species.

## Ways that Non-native Species Get Introduced to New Environments

Non-native aquatic species are sometimes introduced to new environments by natural processes, such as flood waters; transport by birds, mammals, and other animals; and extraordinary weather events. These events occurred long before humans began moving species around, and they will of course continue to do so.

Human activities, however, can significantly increase the potential for and the rate of species introductions. Human activities that introduce species fall into three categories: intentional and authorized; intentional but not authorized; and unintentional (accidental).<sup>11</sup>

**1. Intentional and authorized introductions**—This includes introduction of sport fishes, bait/forage fishes, fish for biological control, or endangered species. In Virginia, for example, the Department of Game and Inland Fisheries stocks such non-native fish species as Northern Pike (*Esox lucius*) in various public lakes.

**2. Intentional but not authorized**—This includes all activities where people purposefully place non-native aquatic species into new waters without a legal reason for doing so. Examples include aquarium or water-garden owners’ release of pet fish or disposal of aquatic plants; dumping of unused bait by anglers; and illegal use of aquatic species for commercial or other purposes.

<sup>10</sup> Non-native aquatic species can also create new public health hazards. For example, ships coming into Mobile, Alabama, in 1991 brought a South American strain of the human cholera bacteria (*Vibrio cholerae*). Discovery of the organism in oyster and fin-fish samples in Mobile Bay resulted in a public health advisory.

<sup>11</sup> Herbert R. Ludwig and Jay A. Leitch, “Pathways for Aquatic Biota Transfer Between Watersheds,” pp. 36—51 in Leitch, Jay A. and M. J. Tenamoc, *Science and Policy: Interbasin Transfer of Aquatic Biota*, Fargo, N.D., Institute for Regional Studies, 2001.

3. Non-intentional—This covers accidents that release organisms, escape by organisms, transport on or in other organisms, and inadvertent transport during human activities, such as water-based recreation.

One non-intentional mechanism receiving increasing attention nationally and in Virginia is transport in **ballast water** of ocean-going ships. When ships take on water in their home port (for stability), many aquatic species existing in the home-port water are able to survive the transoceanic trip. If the ballast water is released into a new port, the non-native organisms are released along with it. Annually, billions of gallons of ballast water containing many non-native species are discharged into U. S. waters.

## Conclusions about Introducing Species

The following comments add a few final notes of perspective and focus.

- From the U. S. Office of Technology Assessment (*Harmful Non-Indigenous Species in the United States*, 1993, p. 11):

“Continued unintentional introductions are inevitable, as are illegal ones, and ones with unexpected results.”

- From the Oregon State University video, “Strangers in Our Waterways” (1995): “[The] story of exotics is not simple.... [We need careful research of] proposed introductions [to] better understand the system and species...[and to evaluate] the short- and long-term costs and benefits.... Only then can we make informed decisions about non-native species.”

- From William F. Steirer, Jr. (“Historical Perspectives on Exotic Species,” pp. 1-4 in *Introductions and Transfers of Marine Species*, South Carolina Sea Grant Consortium, 1992):

“The most beneficial introductions in American history have concerned land animals and plants and those have almost entirely been associated with agriculture.

“Almost all introductions to the waters of the United States have proven to be a mixed blessing...”

“Introduced species enter an environment more easily than they can be removed.

“...[H]uman beings who have chosen...to introduce exotics into the United States have proven to be no more able to see into the future or to avoid the pitfalls of Murphy’s Law than human beings functioning in other areas of life.”

- Finally, from the U. S. Fish and Wildlife Service (“Invasive Species,” at [fisheries.fws.gov/FWSMA/invsp.htm](http://fisheries.fws.gov/FWSMA/invsp.htm), 5/4/00):

“Public knowledge and participation are key to effectively combating [invasive aquatic species].”

As mentioned at the beginning of this article, the following four sections of the article are designed to be “stand-alone” tools for Virginians concerned about aquatic nuisance species. The sections cover the following:

- Aquatic Nuisance Species of Concern in Virginia;
- Virginia Law and Regulation on Non-native Species;
- Guidelines for Individuals to Help Prevent the Spread of Aquatic Nuisance Species;
- Learning and Teaching Resources on Non-native Species.

*Water Central* invites readers to reproduce and share these sections. Please give proper credit to the Water Center and to any original sources mentioned in the sections.

—By Alan Raflø

*Water Central* thanks David Byrd (U. S. Fish and Wildlife Service), Vicki Clark (Virginia Sea Grant Program), Jay Rendall (Minnesota Sea Grant Program), and Stan Smith (Smith Mountain Lake Association) for their assistance with this article.

## Aquatic or Semi-Aquatic Species of Concern in Virginia

Like the country as a whole, Virginia has many non-native species. For example, over 400 (about 17 percent) of Virginia's plants (terrestrial and aquatic) are non-native, and there are over 120 non-native species in the Chesapeake Bay. Again, however, only some of the non-native species in Virginia are considered nuisances.

The following list compiles aquatic species of concern identified from various sources. In some cases, the concern is that a *population* of the species may become established and cause various economic or ecological harm. In other cases (such as with the reptiles mentioned), the concern is for the damage that even a few *individuals* may do.

The animals in the list are those non-native species for which a Virginia Department of Game and Inland Fisheries permit is required for possession (also listed on page 14 of this article).<sup>12</sup>

The plants are from a list compiled by the Virginia Department of Conservation and Recreation's Division of Natural Heritage and the Virginia Native Plant Society of 115 invasive, exotic plant species that "threaten or potentially threaten natural areas, parks, and other protected lands in Virginia."<sup>13</sup> The list does not identify plants considered "aquatic," but 23 plants are identified as "hydric," that is, able to live in wet conditions (wetlands, aquatic systems, or frequently wet soil). Those 23 plants are *most* likely to be found in or near aquatic ecosystems in Virginia. (Other invasive plants, however, can affect aquatic systems by affecting *watersheds*.)

<sup>12</sup> One animal listed, Veined Rapa Whelk, is not listed by DGIF but is of concern because of its potential to harm native shellfish. This species, first detected in the Chesapeake Bay in 1998, is being monitored by the Virginia Institute of Marine Sciences.

<sup>13</sup> This list, periodically updated, is available on-line at [www.dcr.state.va.us/dnh/index.html](http://www.dcr.state.va.us/dnh/index.html). For a printed copy, contact the Natural Heritage Division at (804) 786-7951.

### MUSSELS

Veined Rapa Whelk (*Rapana venosa*)  
Zebra Mussel (*Dreissena polymorpha*)

### FISH

Air-breathing Catfish (*Clarias batrachus*)  
Bighead Carp (*Hypophthalmichthys nobilis*)  
Bigmouth Buffalo (*Ictiobus cyprinellus*)  
Black Buffalo (*Ictiobus niger*)  
Black Carp (*Mylopharyngodon piceus*)  
Grass Carp (*Ctenopharyngodon idella*)  
Piranhas (*Pygocentrus* species)  
Red Shiner (= Redhorse Minnow, Rainbow Dace) (*Cyprinella lutrensis*)  
Round Goby (*Neogobius melanostomus*)  
Rudd (*Scardinius erythrophthalmus*)  
European Ruffe (*Gymnocephalus cernuus*)  
Silver Carp (*Hypophthalmichthys molitrix*)  
Smallmouth Buffalo (*Ictiobus bubalus*)  
Swamp Eel (scientific name not available)  
Tench (*Tinca tinca*)  
Tubenose Goby (*Proterorhinus marmoratus*)

### AMPHIBIANS

Giant (marine) Toad (*Bufo marinus*)  
Tongueless (African-clawed) Frog (*Xenopus laevis*)  
Barred Tiger Salamander (*Ambystoma tigrinum mavortium*)  
Gray Tiger Salamander (*A. t. diaboli*)  
Blotched Tiger Salamander (*A. t. melanostictum*)

### REPTILES

Alligator (*Alligator mississippiensis*)  
Caiman (*Caiman crocodilus*)  
Crocodile (*Crocodylus acutus*)  
Gavial (*Gavialis gangeticus*)

### PLANTS

Alligator weed (*Alternanthera philoxeroides*)  
Aneilima (*Murdannia keisak*)  
Brazilian Water-weed (*Egeria densa*)  
Bristled Knotweed (*Polygonum cespitosum*)  
Common Reed (*Phragmites australis*)  
Common Teasel (*Dipsacus sylvestris*)  
European Watermilfoil (*Myriophyllum spicatum*)  
Fennel (*Foeniculum vulgare*)  
Giant Reed (*Arundo donax*)  
Hydrilla (*Hydrilla verticillata*)  
Ivy-leaved Morning-glory (*Ipomoea hederacea*)  
Japanese Hops (*Humulus japonicus*)  
Japanese Spirea (*Spiraea japonica*)  
Japanese Stilt Grass (*Microstegium vimineum*)  
Jointed Grass (*Arthraxon hispidus*)  
Moneywort (*Lysimachia nummularia*)  
Parrots Feather (*Myriophyllum aquaticum*)  
Purple Loosestrife (*Lythrum salicaria*)  
Rough Bluegrass (*Poa trivialis*)  
Velvet-grass (*Holcus lanatus*)  
Water Chestnut (*Trapa natans*)  
Wintercreeper (*Euonymus fortunei*)  
Yellow Flag (*Iris pseudacorus*)

## Applicable Virginia Law and Regulations on Non-native Species

### Animals

#### Regulation under the Department of Game and Inland Fisheries

##### **4VAC15-30-10. Possession, importation, sale, etc., of wild animals.**

“Under the authority of Sections 29.1-103 and 29.1-521 of the *Code of Virginia*, it shall be unlawful to take, possess, import, cause to be imported, export, cause to be exported, buy, sell, offer for sale, or liberate within the Commonwealth any wild animal unless otherwise specifically permitted by law or regulation.”

##### **4VAC15-30-40. Importation requirements, possession and sale of nonnative (exotic) animals.**

“A. Permit required. A special permit is required and may be issued by the department, if consistent with the department's fish and wildlife management program, to import, possess, or sell those non-native (exotic) animals...that the board finds and declares to be predatory or undesirable within the meaning and intent of Sec. 29.1-542 of the *Code of Virginia*, in that their introduction into the Commonwealth will be detrimental to the native fish and wildlife resources of Virginia.”

The list of animals requiring a permit are given in the state fishing regulations, based on 4VAC15-30-40, is as follows:

giant or marine toad, tongueless or African clawed frog, barred tiger salamander, gray tiger salamander, blotched tiger salamander, smallmouth buffalo, bigmouth buffalo, black buffalo, piranhas, bighead carp, grass carp or white amur, red shiner, silver carp, black carp, rudd, tench, ruffe, air-breathing catfish, tilapia, swamp eel, tubenose goby, round goby, zebra mussel, alligators, caimans, brown tree snake, crocodiles, and gavials.

All other non-native (exotic) amphibians, fish, aquatic invertebrates and reptiles not listed above may be possessed, purchased, and sold. Such activities are, however, subject to all applicable local, state, and federal laws and regulations, including those that apply to threatened/endangered species.<sup>14</sup> In addition, it is *illegal to release such animals within the Commonwealth*.

Violation is a Class 1 misdemeanor.

#### Regulation under the Virginia Marine Resources Commission

Sections 28.2-201 and 28.2-825 of the *Code* address importation of marine organisms into the Commonwealth. It is implemented by regulations 4VAC20-754-10 through 40. The most relevant sections are as follows:

##### **4VAC20-754-10. Purpose.**

“The purpose of this chapter is to establish the list of approved states, waters and species, and criteria necessary for the importation of fish, shellfish, and crustacea for the purpose of placing such animals into the waters of the Commonwealth.”

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<sup>14</sup> Federal actions on non-native species include the 1900 Lacey Act, later amended to restrict the importation and possession of species that could harm agriculture, forestry, human health and welfare, or wildlife resources; the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990, which created the interagency **Aquatic Nuisance Species Task Force**; the National Invasive Species Act of 1996, which amended the 1990 law; and Executive Order 13122, issued in February 1999 by President Clinton, which established the **Invasive Species Council** to oversee activities of the several federal agencies involved in this area.

#### **4VAC20-754-30. Approved species and criteria for importation of marine shellfish.**

This section lists the marine animals that may be brought into the state and placed into state waters. Except as noted, the animals—if less than 25 millimeters in shell height and free of any known shellfish pathogen—may be brought in from any coastal waters or state in the continental United States. The provisions do not apply to molluscan shellfish (oysters, clams, etc.) from the waters of the Delaware Bay or the Maryland portion of the Chesapeake Bay and its tributaries.

“A. Pursuant to the provisions of §28.2-825 of the *Code of Virginia*, it shall be lawful to import into the Commonwealth, with the intent of placing such animals into the waters of the Commonwealth, any species listed below”:

1. any hard clam of the species *Mercenaria mercenaria*;
2. any American oyster shellstock of the species *Crassostrea virginica* (from the waters of New England, Mid-Atlantic, or South Atlantic coastal areas or states);
3. any American oyster hatchery produced seed of the species *Crassostrea virginica*;
4. any bay scallop hatchery produced seed of the species *Argopecten irradians*;
5. any surf clam hatchery produced seed of the species *Spisula solidissima*;
6. any soft shell clam-hatchery-produced-seed of the species *Mya arenaria*;
7. any pre-molt (peeler) blue crab of the species *Callinectes sapidus* from the waters of the states of New Jersey, Delaware, Maryland, North Carolina, South Carolina, or Georgia.

Violation is a Class 1 misdemeanor.

#### **Ballast Water Regulation**

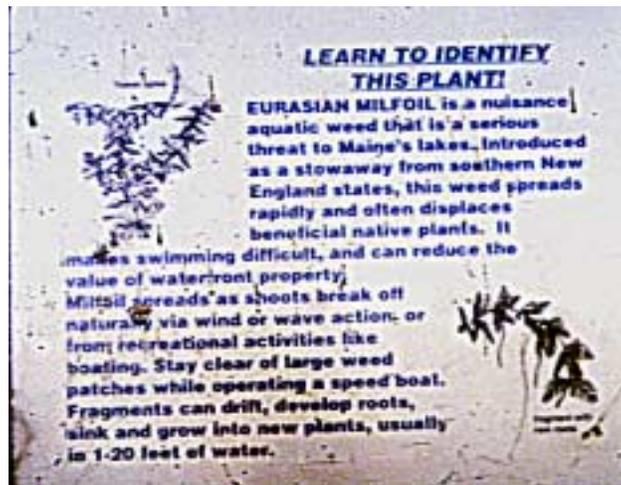
In 2001, the Virginia General Assembly passed legislation (codified at Section 28.2-110 of the *Virginia Code*) requiring commercial vessels entering Virginia waters to file a Ballast Water Control Report with the Virginia Marine Resources Commission (VMRC), unless the origin of the voyage was within the United States Exclusive Economic Zone. In that case, the report required by federal legislation (the 1996 Invasive Species Act) to the Ballast Water Information Clearinghouse suffices. Violation is a Class 1 misdemeanor.

The same legislation also provides that the VMRC shall adopt the federal guidelines governing voluntary ballast water management practices, and use the Ballast Water Control Reports to monitor compliance with these voluntary guidelines. VMRC is to submit copies of the Ballast Water Control Reports to the Clearinghouse quarterly.

## **Plants**

The state has no law or regulation regarding importation or possession of non-native plants, other than applicable federal laws regarding agricultural pests and endangered species.

## Guidance for Individuals to Help Prevent Spread of Aquatic Nuisance Species



*Sign at China Lake, Waldo County, Maine, September 2000.*<sup>15</sup>

In the *Federal Register* of December 28, 2000, the Coast Guard published “Voluntary Guidelines on Recreational Activities To Control the Spread of Zebra Mussels and Other Aquatic Nuisance Species.” The guidelines apply to many different water-related activities. They provide a comprehensive, authoritative tool for educating the public on how to prevent the spread of harmful non-native aquatic organisms. Relevant excerpts from the Federal Register notice are reproduced below. For questions on the notice or the associated guidelines, call Lieutenant JoAnne Hanson, Project Manager, Office of Operating and Environmental Standards, U. S. Coast Guard, at (202) 267-2079. Copies of the *Federal Register* are stored at larger public libraries; it is available on-line at [www.access.gpo.gov/nara](http://www.access.gpo.gov/nara).

The voluntary guidelines are designed to give the public clear, concise information on how to avoid the transport of aquatic nuisance species (ANS). The first section contains generic guidelines for all types of water recreation. Following that are guidelines for five specific areas of recreation: boating; personal watercraft use; angling; harvest of live bait; and waterfowl hunting. The original Coast Guard notice also includes guidelines for scuba diving and use of seaplanes; those sections are not reproduced here.

### **Guidelines for All Water Recreationsists**

*Always do the following:*

- Always inspect equipment (in the broadest sense, *e.g.*, boats, planes, trailers, decoy anchors, SCUBA gear, and lures) for visible plants and animals before transporting.
- Always remove visible plants and animals from equipment (expel plants, animals, and water from internal parts).
- Always drain water from equipment before transporting.
- Always clean equipment that has been in infested waters before placing it in other waters (see the “Pathway-specific guidelines” section for specific methods).
- Always report questionable species to your resource agency for identification. Information is available from many sources about identification of ANS; however, specimens are needed to confirm sightings. Many jurisdictions have different rules regarding possession and transport. Always ask your local natural resources management agency for instructions.

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<sup>15</sup> The sign reads: “LEARN TO IDENTIFY THIS PLANT! EURASIAN MILFOIL is a nuisance aquatic weed that is a serious threat to Maine’s lakes. Introduced as a stowaway from southern New England states, this weed spreads rapidly and often displaces beneficial native plants. It makes swimming difficult and can reduce the value of waterfront property.”

*Avoid the following:*

- Transporting plants, animals, mud, or water to or from lakes, rivers, wetlands, and coastal waters.
- Releasing animals or plants (*e.g.*, aquarium species, bait, or water garden plants) into the wild unless you release them into the same water body or location where the species came from.

### **Boating Guidelines**

- Before leaving all waters, inspect your boat (sailboats: check centerboard and bilgeboard wells; keel boats: check the rudder-post area), trailer (check axles, runners, lights, and rollers), and other boating equipment (check anchors, water-skis, or other tow lines), and remove any plants, animals, or mud that are visible.
- Drain water from the motor, livewell, bilge, and transom wells while on land and before leaving all waters.
- Wash and dry your boat, tackle, fishing lines, downriggers, trailer, and other boating equipment to kill harmful species that were not visible at the boat launch. You can do this on your way home or once you arrive home.
- Before you transport to other waters, do one of the following:
  - (1) Rinse your boat and boating equipment with hot (greater than 40 °C or 104 °F) tap water.
  - (2) Spray your boat and trailer with high-pressure water.
  - (3) Dry your boat and equipment for at least 5 days.

### **Personal Watercraft Guidelines**

Personal watercraft that have jet-drive systems require some extra precautions to avoid ANS. A pump pulls water in through an opening under the craft, and the impeller (an internal propeller) forces water out, moving the craft forward. ANS can easily get lodged in the jet-drive system and get transported if the watercraft is taken from one water body to another. For example, a small piece of Eurasian Watermilfoil, or other ANS, caught in the impellers can infest a new lake or river; Zebra Mussels can survive in excess water in the jet drive and spread to other waters.

*In the water:*

- Avoid running the engine through aquatic plants near the boat access; and
- Push or winch the watercraft up on the trailer without running the engine.

*On the trailer:*

- After you pull the watercraft from the water, start the engine for 5 to 10 seconds to blow out any excess water and vegetation (the dark, damp, enclosed area of the impeller provides an ideal environment for aquatic nuisance plants to survive); and
- After the engine stops, pull plants out of the steering nozzle. Inspect your trailer and any other sporting equipment for fragments of aquatic plants, and remove them before you leave the access area.

*After trailering and before re-use:*

- Wash and dry your watercraft and equipment to kill or remove harmful species that you did not see at the boat launch. You can do this on your way home or once you arrive home. Choose one of the following methods of disinfection before transporting to another water body:
  - (1) Rinse your watercraft and other equipment with hot (greater than 40 °C or 104 °F) tap water.
  - (2) Spray your watercraft and trailer with high-pressure water.
  - (3) Dry your watercraft and equipment for at least 5 days.

### **Angling Guidelines**

- Dispose of unwanted live bait on land before leaving the water body. Never release live bait into a different body of water or move aquatic plants or animals from one water body to another.
- Wash and dry your boat, tackle, downriggers, float tube, waders, and other equipment to remove or kill harmful species that were not visible at the boat launch.
- Inspect all fish caught using seines, dipnets, or other types of netting; remove and properly discard all non-target species.

## Recreational Anglers' Harvest of Live Bait (Non-Commercial Harvest)

Nonindigenous species can lodge in nets and other equipment used to harvest baitfish and can be unintentionally transported into non-infested waters. Some species can survive up to 2 weeks out of water and remain viable when dislodged into another water body.

- Inspect harvested live bait for non-target species, and remove them where harvested.
- Always dispose of unwanted live bait on land (away from contact with waters) before leaving the waters.
- Never release live bait into another body of water or move aquatic plants or animals from one water body into a different water body.
- Remove all aquatic plants from boats, trailers, nets, or other equipment while on shore before leaving the water-body access.
- Before reusing nets, roll out, hand clean, and dry them.
- Drain water from boats (cooling stem of motors) and equipment (bilge pump, tubs, live wells, etc.) before leaving any water body access.
- Never use water from infested waters to transport live bait to other waters. In many States and provinces, live bait harvested from designated infested waters is illegal. Check with your local State natural resource agency before you collect live bait.
- Rinse all equipment, including boats and trailers, with tap water and dry them for as long as possible, but for at least 5 days before re-use, especially in other waters. Before re-use, you should roll out nets, hand clean them, and dry them for a minimum of 10 days, or freeze them for 2 days.
- The following applies to *disinfection, specific to Zebra Mussels, of equipment* that is difficult to treat with drying and washing methods (use these methods away from the water body):
  - (1) As an added equipment treatment, a dip of 100 percent vinegar for 20 minutes can kill small Zebra Mussels and may be effective against other ANS.
  - (2) Treatment with other chemicals, such as a one-percent solution of table salt, may be effective.

## Waterfowl Hunting

Waterfowl hunters should be aware that it is possible to spread ANS inadvertently from one lake or wetland to another via boats, motors, trailers, and decoys. Waterfowlers should assume that any fragments of aquatic plants could be potentially harmful and should not be transported from one wetland, lake, river, or coastal area to another. In addition, Zebra Mussels and their microscopic larvae can attach to aquatic plants. If fragments of these plants are transported, they can inadvertently transport Zebra Mussels to other waters. By following the guidelines on recreational activities, you can help prevent the spread of ANS via waterfowl hunting.

Along with the guidelines below, follow the Boating Guidelines above.

*Before the hunting season:*

- Switch to elliptical, bulb-shaped, or strap anchors on decoys, which avoid collecting submerged and floating aquatic plants.
- If boats are moored in waters infested with Zebra Mussels, use the following tips to remove or kill Zebra Mussels or other aquatic animals and plants that might be in or on your boat:
  - (1) Remove any visible Zebra Mussels from the boat and wash and rinse the boat with hot water; or
  - (2) Spray the boat with high-pressure water; or
  - (3) Dry all parts of the boat for at least 5 days before placing it into another water body.

*After hunting:*

- Inspect waders or hip boots and remove aquatic plants; where possible, rinse mud from boots before leaving the waters.
- Remove aquatic plants, animals, and mud that are attached to decoy lines or anchors.
- Drain the water from boats before transporting to other waters.

*Between hunting trips:*

- Inspect equipment for any aquatic plants, animals, and mud not removed after hunting; remove and dispose of them on land away from the waters.

## Learning and Teaching Resources on Non-native Species

### Publications and People

Benson, Amy J., *et al.* *Summary Report of Nonindigenous Aquatic Species in U. S. Fish and Wildlife Service Region 4*. Gainesville, Fla.: U. S. Geological Survey/Florida Caribbean Science Center, 2001. The area covered does not include Virginia but does include Kentucky, North Carolina, and Tennessee. To request a copy, phone (352) 378-8181; available on-line at [www.fcsc.usgs.gov/R4finalreport.pdf](http://www.fcsc.usgs.gov/R4finalreport.pdf).

DeVoe, Richard M. (ed.). *Introductions and Transfers of Marine Species* (proceedings of a 1991 conference and workshop). South Carolina Sea Grant Consortium, 1992.

Drake, J. A., *et al.*, eds. *Biological Invasions: A Global Perspective*. Chichester, England: John Wiley & Sons, 1989. Compilation from a conference in Honolulu, as part of the work of the Scientific Committee on the Problems of the Environment (SCOPE), an endeavor of the International Council of Scientific Unions. Very detailed and on a professional level (the table of contents alone is a detailed introduction to the subject); addresses terrestrial as well as aquatic organisms.

Jenkins, Robert E. and Noel M. Burkhead. *Freshwater Fishes of Virginia*. Bethesda, Md.: American Fisheries Society, 1994.

Leitch, Jay A. and Mariah J. Tenamoc, eds. *Science and Policy: Interbasin Water Transfer of Aquatic Biota*. Fargo, N.D.: Institute for Regional Studies/North Dakota State University, 2001.

Illinois-Indiana Sea Grant offers *Invasive Aquatic Plants: What Every Plant Enthusiast Needs to Know* (Sea Grant Publication IISG-01-22). Designed for water gardeners, this four-page flyer gives background information on invasive aquatic plants, lists wetland and aquatic nuisance species, and tells how to choose water-garden plants that do not increase the spread of invasives. For a copy, phone (217) 333-9448, or e-mail Robin Goettel at [goettel@uiuc.edu](mailto:goettel@uiuc.edu).

Minnesota Department of Natural Resources and Minnesota Sea Grant Program free publications: "A Field Guide to Aquatic Exotic Plants and Animals" (10-panel brochure);

*Aquatic Nuisance Species—Hazard Analysis and Critical Control Point Training Curriculum*;

"Purple Loosestrife: What You Should Know, What You Can Do" (16-panel brochure). To request these or other publications, contact Minnesota Sea Grant Publications, (218) 726-6191; e-mail: [seagr@d.umn.edu](mailto:seagr@d.umn.edu);

Web-site: [www.seagrant.umn.edu/pubs/index.html](http://www.seagrant.umn.edu/pubs/index.html).

U. S. Congress, Office of Technology Assessment. *Harmful Non-Indigenous Species in the United States* (OTA-F-565). Washington, D.C.: U. S. Government Printing Office, 1993.

Virginia Sea Grant's Aquatic Nuisance Species coordinator is Vicki Clark, at the Virginia Institute of Marine Science, (804) 684-7169.

Weigmann, Diana L., *et al.* 1993. *Zebra Mussels Threaten Virginia's Waters*. Virginia Water Resources Research Center, Blacksburg. Background information on the Zebra Mussel problem as well as a checklist of ways for individual boaters to help prevent the spread of that organism.

### "Travelling Trunks" (Kits)

Illinois-Indiana Sea Grant offers the "Zebra Mussel Mania" kit. This kit contains activities, shells, videos, posters, and background reading for teachers. The kit is available for loan from several lending centers, including Oglebay Zoo in Wheeling, West Virginia (304) 243-4033; or available for purchase (approximately \$400) from Illinois-Indiana Sea Grant, (217) 333-9448; e-mail: [r-goettel@uiuc.edu](mailto:r-goettel@uiuc.edu).

Minnesota Sea Grant also offers a kit on exotic aquatic species. This kit has nine lesson plans along with specimens of various species, books, maps, videos, and other materials. Designed for grades 4–8, it has a Great Lakes focus, but it has been used and well-received all over the country, according to the Minn. Sea Grant's Aquatic Nuisance Species coordinator Doug Jensen. It is available for rental of approximately \$35, plus the cost of return shipping. For more information call Doug Jensen, (218) 726-8712; Web-site: [www.d.umn.edu/~seagr/](http://www.d.umn.edu/~seagr/).

### Videos

"Stop Exotics, Clean Your Boat," Minnesota Sea Grant. 11 minutes video (\$10). Available for \$10 from Minnesota Sea Grant Publications, (218) 726-6191; e-mail: [seagr@d.umn.edu](mailto:seagr@d.umn.edu); Web-site: [www.seagrant.umn.edu/pubs/index.html](http://www.seagrant.umn.edu/pubs/index.html).

"Strangers in Our Waterways," Oregon State University, 1995. 28 minutes. This video is well-filmed, well-narrated, and informative. Available for borrowing from the Virginia Water Resources Research Center, (540) 231-6624; e-mail: [water@vt.edu](mailto:water@vt.edu).

## Web-sites on Exotic Species and Biodiversity

This list (slightly modified by *Water Central*) was compiled by Carol A. Heiser, Habitat Education Coordinator, Virginia Department of Game and Inland Fisheries ([www.dgif.state.va.us](http://www.dgif.state.va.us)), Richmond, Va., August 2001. Used with permission.

### “The Biggies”

- The **National Invasive Species Council**, formed by executive order of President Clinton in February 1999, has a Web-site maintained by the National Agricultural Library of the U.S. Department of Agriculture at [www.invasivespecies.gov/council/main.shtml](http://www.invasivespecies.gov/council/main.shtml). The site contains species profiles, economic impacts, education resources, and Frequently Asked Questions. From the main menu you can click on FrogWeb, Pollinator Declines, Bird Conservation, and more.
- The **National Biological Information Infrastructure** has a site maintained by the Center for Biological Informatics of the U.S. Geological Survey (USGS) at [www.nbii.gov/issues/biodiversity](http://www.nbii.gov/issues/biodiversity). This site contains links to many of the most important national and international Web-sites on genetic diversity, species diversity, and ecological or ecosystem diversity. The USGS also has another page on **Invasive Species: Biological Aliens** at [www.usgs.gov/invasive\\_species/plw/index.html](http://www.usgs.gov/invasive_species/plw/index.html).
- The **Federal Interagency Committee for the Management of Noxious and Exotic Weeds** is a site hosted by the U.S. Fish and Wildlife Service at <http://refuges.fws.gov/FICMNEWFiles/FICMNEWHomePage.html>. It contains the 1999 executive order on invasive species (which gives legal definitions of terms) and other good information.
- The **Aquatic Nuisance Species Task Force**, at <http://anstaskforce.gov>, is an inter-governmental organization devoted to implementing the Aquatic Nuisance Control Act of 1990 and the Invasive Species Act of 1996. You can learn details about these acts by going to the “What is the ANS” link. The site also contains species profiles, reports, etc.

### Sites about Invasive Plants

- The Virginia Department of Conservation and Recreation’s **Division of Natural Heritage**, at [www.dcr.state.va.us/dnh/](http://www.dcr.state.va.us/dnh/), has listings of native and non-native plants, fact sheets, and more.
- The **Biological Control of Non-Indigenous Plant Species** site, by Cornell University, is at [www.invasiveplants.net](http://www.invasiveplants.net).
- The **Virginia Native Plant Society** site is at [www.vnps.org](http://www.vnps.org).
- The **Bureau of Land Management Weeds Web-site**, at [www.blm.gov/weeds](http://www.blm.gov/weeds), explains the difference between a weed, a noxious weed, and an invasive plant. Contains many links.
- The **Center for Aquatics and Invasive Plants** of the University of Florida, at <http://aquat1.ifas.ufl.edu/pick17.html>, contains an information retrieval system (database) with references, photo images and resources.

### Other Excellent Sites to Explore

- The **American Fisheries Society** at [www.fisheries.org/resource/resource/htm](http://www.fisheries.org/resource/resource/htm). Particularly, the site includes guidelines developed for intentional aquatic introductions. At the Web-site, look for “Introduction of Aquatic Species,” part of the *Resource Policy Handbook, 1st Edition, 1997*.
- The **Virginia Institute of Marine Science (VIMS)** site is at [www.vims.edu](http://www.vims.edu). From the home page click on “K-12 Resources,” then click on “Publications” and scroll down to “Exotic Species and Diseases.” Or, you can find out about the **Veined Rapa Whelk** at [www.vims.edu/fish/oyreef/rapven.html](http://www.vims.edu/fish/oyreef/rapven.html). VIMS also offers links to **marine information especially for teachers** at [www.vims.edu/bridge/](http://www.vims.edu/bridge/) (go to “Ocean Science Topics,” then “Biology,” then “Exotics”).

## IN AND OUT OF THE NEWS

### Newsworthy Items You May Have Missed

*The following summaries are based on information in the source(s) indicated at the end of each item. Selection of this issue's items ended August 31, 2001. Unless otherwise noted, all localities mentioned are in Virginia and all dates are 2001.*

### In Virginia...

•The Virginia Sea Grant Program is involved in a number of projects under the **Oyster Disease Research Program**, a Congressionally mandated program administered by the National Sea Grant Office. These projects are examining various aspects the two diseases plaguing oysters in the Delaware and Chesapeake Bays: Dermo and MSX, both of which are caused by parasitic protozoans (one-celled animals). The topics of the current research projects are the following:

- effects of climate on the prevalence and intensity of the diseases;
- selective breeding project for oyster planting and restoration;
- comparison of physiological condition and defense mechanisms among naturally Dermo-resistant oyster populations;
- biochemical factors involved in disease resistance in selectively bred oysters; and
- identification of disease-resistant genes.

For more information about these projects, contact the Va. Sea Grant program at (804) 924-5965, or [www.virginia.edu/virginia-sea-grant](http://www.virginia.edu/virginia-sea-grant). (*Tideline*, Va. Sea Grant College Program newsletter, Spring 2001)

•The Virginia Dept. of Environmental Quality's (Va. DEQ's) Office of Pollution Prevention is trying to promote statewide **efforts to reduce mercury use** (mercury is a persistent, toxic metal). One effort is to collect mercury-containing thermometers from Virginia's high schools and provide free digital thermometers in exchange. The mercury is then processed by a qualified recycler. Collections from 17 high schools took place in May and June, and the Office is seeking support from pharmaceutical companies to sponsor additional exchanges this school year. More information on the Mercury Reduction Initiative is available by phone at (804) 698-4235, or e-mail to [jkcomfort@deq.state.va.us](mailto:jkcomfort@deq.state.va.us). (*Pollution Prevention Virginia News*, Spring 2001)

•Since May 2000, Hands Across the Mountain, Inc., a non-profit citizens group in Wise County, Virginia, and Harlan County, Kentucky, has helped finance 125 **septic-tank pump-outs in the Upper Powell River watershed** in Wise. Grant funds paid for 75 percent of the expense, with homeowners paying 25 percent. Through this activity, the Va. Department of Health (VDH) was able to determine that approximately 15 percent of the tanks pumped were failing and in need of repair or replacement; a second component then focused on those needs. The project has also accomplished elimination of 11 **straight-pipes**—direct discharges of household sewage into waterways—with another 25 scheduled to be eliminated in 2002. The work was supported by a grant from the Va. Department of Conservation and Recreation (Va. DCR). (Personal communication from Hands Across the Mountain, Aug. 31)

Meanwhile, state money is also helping to **eliminate some straight-piping in Amherst County**. In July, the state Dept. of Housing and Community Development awarded the county a Community Development Block Grant (CDBG) of nearly \$500,000 to provide water and sewer service to 12 homes and four businesses along the James River. Several of the homes have never had any on-site sewage systems, while some other homes have failing systems. (*Lynchburg News & Advance*, July 15)

And **40 households in the Millwood community of Clarke County will be getting sewer service**, following approval of a \$510,000 state CDBG for that locality. The state-funded grant will cover part of the \$1.3 million cost of upgrading plumbing, extending sewer lines, and upgrading the Boyce wastewater treatment plant. The rest of the money will come from other grants and a \$425,000 no-interest loan to Clarke County from the Virginia Revolving Loan Authority. (*Winchester Star*, June 28)

•Turning to **drinking-water financing**: In June, **11 Virginia localities** learned that they would receive over **\$14 million in grants** for drinking-water infrastructure. The grants will come from the Drinking Water State Revolving Fund. The recipients and amounts are as follows: Scott County, \$3.4 million; Henry

County, \$3 million; Russell County, \$1.9 million; Isle of Wight County, \$1.8 million; the town of Pennington Gap (Lee County), \$1.8 million; Smyth County, \$986,000; Buckingham County, \$945,490; the town of St. Paul (Wise County), \$300,800; Hanover County, \$188,000; Franklin County, \$65,000; and the town of St. Charles (Lee County), \$50,000. (Associated Press, June 26)

- The National Resources Conservation Service (NRCS) recently reported to Congress that more than **2,200 small, flood-control dams in the country need work**, at an estimated cost of **over \$540 million**. “Preliminary estimates” in the report indicated that Virginia (as of 1999) has 144 small dams, of which 16 need rehabilitation at an estimated cost of \$9.78 million. The report, *A Report to Congress on Aging Watershed Infrastructure: An Analysis and Strategy for Addressing the Nation’s Aging Flood Control Dams*, is available at the agency’s Web-site, [www.ftw.nrcs.usda.gov/pl566/agingwater/infra.thml](http://www.ftw.nrcs.usda.gov/pl566/agingwater/infra.thml). (*Natural Hazards Observer*, May 2001, and the NRCS report)

In a related item: An act of the 2001 Va. General Assembly (SB 1166) **amended the Virginia Dam Safety Act (VDSA)** to reduce the minimum height and storage capacity for dams to be regulated under VDSA, bringing some 125 more small dams under regulation. The changes to the VDSA require revisions to the state’s Dam Safety Regulations, and the revisions will be subject to public notification and hearings. More information about this law or about dam safety in Virginia is available from the Va. DCR, phone (804) 371-6095, or e-mail: [dam@dcr.state.va.us](mailto:dam@dcr.state.va.us). (Va. Lakes and Watersheds Assoc. newsletter, Summer 2001)

- Data from five surveys conducted each year and reported in the annual Blue Crab Advisory Report indicate that the **Chesapeake Bay Blue Crab stock** is “fully exploited,” “declining,” and “approaching the low” for the period 1968—2000. This situation was evidently reflected in last year’s harvest, which at 51 million pounds was 33 percent below the 1968—2000 average (about 75 million pounds). The highest recorded harvest was 113 million pounds in 1993. The annual report is compiled by the Chesapeake Bay Stock Assessment Committee, which includes representatives of marine-resource agencies in Maryland, Virginia, and the federal government. (*2001 Chesapeake Bay Blue Crab Advisory Report*, June 7) (A related item appeared in the June 2001 *Water Central*, p. 16.)

- Two key actions stemming from the Chesapeake 2000 Agreement** are to take place in 2001. The first action is development of new **water-quality criteria**, in turn based on a rethinking of the “designated uses” of the Bay.<sup>16</sup> The second action is establishment of new **nutrient and sediment reduction targets** to meet the water-quality criteria. Nutrient and sediment reduction allocations are to be assigned to each of the Bay’s major tributaries. Federal Register publication of the water-quality criteria is expected in early 2002. (*Bay Journal*, June 2001)

- The Chesapeake Bay region will face competition from other areas for federal funds** to help finance Bay clean-up and restoration efforts. Those efforts have been estimated (in an April report by the Chesapeake Bay Foundation) at \$8.5 billion over the next 10 years. (Please see the June 2001 *Water Central*, p. 15, for a related item.) According to Charlie Stek, an aide to Sen. Paul Sarbanes (D-Md.), people in 22 other estuaries in the country have their own clean-up plans and will be seeking federal fund to help implement those plans. (*Bay Journal*, June 2001)

In a related item: On June 14, Sen. Sarbanes, along with Sens. Barbara Mikulski (D-Md.), John Warner (R-Va.), and George Allen (R-Va.), introduced the **Chesapeake Bay Watershed Nutrient Removal Assistance Act** (S. 1044). The bill would authorize \$132 million for 2003—2007 to provide help for Bay-area wastewater treatment facilities to install nitrogen-removal technologies (to reach an annual average of 3 milligrams per liter of nitrogen in wastewater). The bill would authorize grants of up to 55 percent of the cost of such technologies. As of August 31, the bill was still in the Senate Committee on Environment and Public Works. (*Washington Post*, June 15, and “Thomas Legislative Information on the Internet,” [<http://thomas.loc.gov/>], Aug. 31)

- The acreage of submerged aquatic vegetation (SAV) in the Chesapeake Bay** and its tidal tributaries increased about one percent—to 69,126 acres—from 1999—2000. This amount is about 10 percent of the historic acreage of SAVs, and it has changed little over the last 10 years. “SAV” is the collective term for over 20 species of aquatic plants (often referred to as “Bay grasses”) that are important sources of food and

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<sup>16</sup> Under the Clean Water Act, states set water-quality standards based on a water body’s designated uses (such as swimming, fishing, shellfishing, or water supply) and on criteria established to support the designated uses (such as the minimum dissolved oxygen level needed or the acceptable temperature range).

habitat for Bay organisms. SAV acreage actually increased by 36 percent and five percent, respectively, in the upper and lower Bay regions, but the acreage decreased by nine percent in the middle Bay (from the Bay Bridge to the Rappahannock River in Virginia and Pocomoke Sound in Maryland). The losses in the middle section were attributed to algal blooms, which can block sunlight from submerged plants. Aerial photographs taken annually between May and October are used by the Chesapeake Bay Program and the Va. Institute of Marine Science (VIMS) to make the estimates. (*Bay Journal*, June 2001)

- A recent report from VIMS applied and evaluated a “**targeting protocol**” to identify land in the York River Basin where **restoration of streamside (“riparian”) forest buffers** would most likely have water quality and habitat benefits. (As a partner to the Chesapeake 2000 Agreement, Virginia has committed to restoring 610 miles of streamside forests by 2010.) The protocol identified 380 miles within the basin that “seemed to provide an opportunity for reforestation,” based on existing land uses (the entire basin has 7780 miles of shoreline). Of those 380 shoreline miles, 248 miles “have adjacent inland conditions which indicate reforestation might have both water quality and habitat benefits.” The report concludes that the targeting protocol is not appropriate for making decisions about small areas but is useful for making quick assessments of large areas. (VIMS Wetland Program Technical Report No. 01-8, Summer 2001)

- Senior Environmental Corps (SECs)** are involving Virginia senior citizens in water-related projects in various localities. The projects include the following: watershed education and restoration in Richmond; stream clean-up in Lynchburg; riparian-land monitoring along the Rappahannock and Rapidan rivers; and training for the Adopt-a-Stream program in the Clinch River watershed. (*EASI Does It* [Environmental Alliance for Senior Involvement newsletter], July 2001)

- The legal contest continues over Fairfax County’s desire to extend a **water-intake pipeline into the middle of the Potomac River**—Maryland territory. (A previous item on this story appeared in the April 2001 *Water Central*, p. 15.) In July, a special master appointed by the U. S. Supreme Court—which has original jurisdiction in disputes between states—recommended that Virginia’s suit against Maryland go forward. Ralph Lancaster, the special master, concluded that agreements in 1785 and 1877 give Virginia the right “to make improvements connected to the Virginia shore.” Maryland continues to maintain that it has the right to regulate Virginia’s use of the river, which it seeks to do under a permit issued to Fairfax in January by the Maryland Department of the Environment. Construction on the intake pipeline began after that permit was issued. (*Washington Post*, July 12)

- “**Isolated” non-tidal wetlands and other water bodies**—those not directly connected to a navigable waterway—**also continue to be debated in court**. In July, the U. S. Justice Department sought a federal court order to stop three development companies from filling wetlands on a construction site in Newport News. The Justice Department contends that the wetlands fall under the jurisdiction of the Corps of Engineers and that the developers consequently need a Corps permit for the fill action. The federal agency has been filing similar actions in other federal courts, arguing for a narrow interpretation of the U. S. Supreme Court’s January 2001 ruling limiting the Corps’ authority under the Clean Water Act to regulate isolated water bodies. (For a previous item on this issue, please see the June 2001 *Water Central*, p. 14.)

New state regulations on non-tidal wetlands take effect October 1, but in the interim there is no state regulation of such wetlands. The Newport News development groups are arguing that the 38 acres in question are indeed “isolated” and therefore the Supreme Court ruling eliminates the need for a federal (Corps of Engineers) permit. As of July 13, the federal judge hearing the case had issued a temporary halt to the work and planned a July 23 site visit.

Meanwhile, in August a dispute arose in Chesapeake over many of the same issues in a project to drain and fill wetlands on a 658-acre property. In that case, the Va. Dept. of Environmental Quality ordered a developer to halt wetland draining and filling on the property, claiming that such activities were subject to state law in effect since July 1, 2001. (*Inside EPA’s Water Policy Report*, June 18; *Richmond Times-Dispatch*, July 13; *Virginian-Pilot*, Aug. 24)

- In Russell County, the Nature Conservancy has purchased 438 acres**, including about 1.5 miles along the Clinch River, for the Cleveland Natural Area Preserve. While the Conservancy will retain ownership, the area will become part of the state’s Natural Area Preserve system. It adjoins an existing preserve, the Cleveland Barrens Natural Area. The land cost about \$400,000; over \$196,000 for the purchase came from the Virginia Land Conservation Foundation, the rest from donations by Conservancy members. (*Bristol Herald-Courier*, July 24)

•**Pulaski County citizens are paying *less money* to remove *more debris* from Claytor Lake, thanks in part to the U.S. Navy.** The Navy donated a surplus 35-foot workboat to the county, which had to pay only the cost of getting the boat to the lake—about \$5000. In past years, the county and the Friends of Claytor Lake, the local citizens group that runs the clean-up operation, spent \$12,000 to \$14,000 annually to contract a clean-up boat. With their own boat, the group expects the clean-up efficiency to increase significantly. They hope to remove about 12,000 tons of debris this year, compared to some 3,500 tons last year. (*Roanoke Times*, July 27)

•On August 6, the VDH issued an **advisory against eating carp taken from a section of the New River**, due to potentially high levels of **PCBs** (PCBs are a suspected cancer-causing agent). The affected section is from the bridge on State Rt. 114, near the city of Radford, to the state line in Giles County. The Va. DEQ is supposed to conduct testing this year (no date set as yet) to determine the source or sources of the contamination. (*Roanoke Times*, Aug. 7)

One week after local residents learned of the New River health advisory, the **New River Watershed “Roundtable”** held its first gathering in Dublin, attracting over 100 people. Roundtables seek to engage residents of a watershed in dialogue about issues, problems, and plans for actions; the Va. DCR is the lead state agency aiding the process. Several roundtables have been in progress for some time in Virginia, including ones for the Upper James River, the Upper Tennessee River, and the Roanoke River. (New River Roundtable agenda, Aug. 14)

•**A review of some flood-related events** of Summer 2001 in Virginia and neighboring states:

••On July 8, heavy rains flooded thousands of residents in West Virginia and southwestern Virginia. Bluefield and Tazewell County were the most-affected areas in Virginia. Some 700 homes and 50 businesses were damaged in Tazewell County. Parts of West Virginia received record flooding; at least one death was reported along with millions of dollars of damage.

••Heavy rains returned to the region on the last weekend of July. One death was reported in Scott County. On August 1, seven southwestern Virginia counties (Buchanan, Dickenson, Russell, Scott, Smyth, Tazewell, and Wise) were declared disaster areas by President Bush. Damage estimates included \$450,000 to homes and businesses in Scott County and \$12 million to roads and bridges in the region. Parts of West Virginia were flooded again, and western North Carolina suffered over \$3 million in damage.

••By July 31, state and federal officials had estimated that July’s floods in West Virginia destroyed 1,079 homes, damaged over 6,000 more homes, left 2,000 residents homeless, and caused damages of at least \$100 million. The presidential disaster declaration for the state covered 22 counties.

••More flash flooding occurred in Wise County on August 13, damaging 120 homes in the Pound area of the county and contributing to a “mine blowout” (where the seal of an inactive mine is broken by a build-up of water pressure from within the mine cavity).

••On August 10, parts of Washington, D.C., caught the brunt of two combining storm systems and suffered the city’s worst flood damage in over 50 years. More than 3,000 properties were damaged; streets were flooded; and the sewer system overflowed. The president declared the city a disaster area on August 16.

(*Roanoke Times*, July 10 and 13; *Bristol Herald Courier*, July 31, Aug. 2, 13, and 14; *Charleston Daily Mail*, July 31; *Associated Press*, Aug. 1; *Washington Post*, Aug. 17 and 19)

## ...and Outside of Virginia

•**North Carolina earth-movers**—operators of graders, dozers, backhoes, etc.—**can be certified as “clean water contractors”** by attending erosion- and sediment-control training by the North Carolina Sedimentation Control Commission. Participants receive instruction on the state’s Sedimentation Pollution Control Act, stream-buffer and wetland regulations, erosion-control measures, and cost estimating. (*N.C. WRR News*, May/June 2001)

•**On the arsenic watch** (please see a previous item in the April 2001 *Water Central*, p. 17): The U. S. Environmental Protection Agency (EPA) is using three panels to review the costs, health benefits, and benefits of lowering the drinking water standard for arsenic. A panel from the National Drinking Water Advisory Committee has been reviewing the cost estimates; the Science Advisory Board will be charged with reviewing the potential health benefits; and the National Academy of Sciences will update its own 1999 study of the health risks of arsenic. EPA expects to issue a “notice of data availability” this fall and solicit public comments on the three reviews.

In addition, the EPA published in the July 19 *Federal Register* a call for public comment on **proposed arsenic standards** of three, five, 10, and 20 parts per billion (ppb) until October 31. The current standard is 50 ppb; the new rule issued by the Clinton Administration called for a 10 ppb standard. (*Inside EPA's Water Policy Report*, June 4 and July 30)

- The EPA** is in the process of issuing its **biennial list of enforcement priorities**. For Fiscal Years 2002 and 2003, the agency has proposed the following priorities: wet-weather sewer rules and run-off controls on concentrated animal feeding operations under the Clean Water Act; microbial rules under the Safe Drinking Water Act; air toxics under the Clean Air Act; requirements under the Clean Air Act to review new pollutant sources and to prevent air-quality deterioration; and hazardous-waste permits under the Resources Conservation and Recovery Act. (*Inside EPA's Water Policy Report*, June 18)

- In June, President Bush appointed 16 people to the new **Commission on Ocean Policy**. Congress established the commission in 2000 to review the whole spectrum of the nation's marine policies. The panel is expected to issue a final report in 2003. (*Science*, June 22)

- No matter who's estimating, it will cost a lot of money** for needed repairs and improvements to the nation's **drinking-water infrastructure**. An item in the June 2001 *Water Central*, p. 15, reported that the EPA had estimated the nation's needs over the next 20 years at \$150 billion. Actually, this estimate only included water systems that are eligible for state revolving loans, a program coordinated by EPA. Two organizations, the American Water Works Association (AWWA) and the Water Infrastructure Network, *have* published (separate) nationwide estimates, running from \$250 to \$480 billion over the next 20 to 30 years. The money will be needed to replace aging equipment as well as to meet new regulatory requirements. (*Inside EPA's Water Policy Report*, July 2)

- North Carolina received 85 applications to its program to buy out hog farms** located in the 100-year floodplain. (The program is a result of hog-farm flooding caused by hurricanes Dennis, Floyd, and Irene in 1999.) This was about three times as many as the state had expected. With its initial appropriation, the state was able to buy out only 15 farms, so officials are now seeking other federal and state funds to buy out up to 44 additional farms, at approximately \$430,000 each. (*Wilmington Star*, July 10)

- Boston's drinking-water supplier should not be forced to filter its water**, according to a July 16 ruling by the U. S. Court of Appeals (1<sup>st</sup> Circuit). The EPA sued the Mass. Water Resources Authority (MWRA) to force it to install filtration after fecal coliform was found in the water. MWRA wishes instead to spend money on watershed protection, pipeline rehabilitation, improved disinfection with ozone, and public health research, and the court found in its favor. (*Inside EPA's Water Policy Report*, July 30)

- A new farm bill**—The Agricultural Act of 2001, H.R. 2646—was passed the House Agriculture Committee on July 27. That version would provide **\$16.5 billion over the next 10 years in conservation funding**, including increased acreage for the Conservation Reserve (an additional 3.6 million acres) and Wetlands Reserve (an additional 1.5 million acres). A provision that would have paid landowners up to \$50,000 for plans to protect drinking water from farming activities was dropped from the passed version. As of August 31, the bill had not moved to the Senate. (*Inside EPA's Water Policy Report*, July 30; and "Thomas Legislative Information on the Internet," [<http://thomas.loc.gov/>], Aug. 31)

- Under **an agreement between the Susquehanna River Basin Commission and Baltimore**, the city will now be able to withdraw up to **250 million gallons per day (MGD) of water from the Susquehanna**. In return, Baltimore has ended a legal challenge to the Commission's jurisdiction over the river. The Commission retains the right to reduce Baltimore's withdrawal to 64 MGD during droughts. The Commission, created by Congress, has representatives from Maryland, New York, and Pennsylvania. (*Baltimore Sun*, August 10)

- Finally, if you need proof of **the value of water**, take yourself out to the ol' ball game. On August 19 at Cinergy Field in Cincinnati (home of the Reds), with water fountains readily available, bottled water (the one-serving size) was selling for \$3. That made the ice cream—also being sold by the water vendor—a bargain at \$2.50.

# N O T I C E S

## On the Public Calendar

- Oct. 4, 9 a.m.**—State Water Control Board meeting. General Assembly Building, Richmond. For more information contact Cindy Berndt, e-mail: [cmberndt@deq.state.va.us](mailto:cmberndt@deq.state.va.us), or by phone at the DEQ Central Office in Richmond, toll-free in Virginia, (800) 592-5482.
- Oct. 20, 10 a.m.**—Advisory committee assisting in development of proposed amendments to Virginia water quality standards. Va. Dept. of Environmental Quality (DEQ) Central Office, Richmond. For more information, contact Elleanore Daub, e-mail: [emdaub@deq.state.va.us](mailto:emdaub@deq.state.va.us), or by phone at the DEQ Central Office (see number above).
- Nov. 13, 10 a.m.**—Advisory committee assisting in development of proposed amendments to a general stormwater-discharge permit for construction activities. DEQ central office, Richmond. For more information contact Burton Tuxford, e-mail: [brtuxford@deq.state.va.us](mailto:brtuxford@deq.state.va.us), or by phone at the DEQ Central Office (see number above).

## America's Water Resource Challenges

An on-line report documents the opinions of citizens and other stakeholders on issues related to the nation's waters in the 21<sup>st</sup> Century. The comments were gathered in listening sessions conducted in 2000 by the U. S. Army Corps of Engineers. Copies of the report and information about the sessions are available at [www.usace.mil/iwr/waterchallenges](http://www.usace.mil/iwr/waterchallenges).

## National Watershed Network

Through this Web-site, watershed groups can connect to other groups nationwide addressing similar issues. The network is an initiative of the Know Your Watershed Program, located at Purdue University in Indiana. For more information, or to register on-line, visit the following Internet address: [www.ctic.purdue.edu/KYW/nwn/whyregister.html](http://www.ctic.purdue.edu/KYW/nwn/whyregister.html). You can contact the Know Your Watershed Program at (765) 494-9555.

## Funder Finder

The U. S. EPA/Region 3 (D.C., Del., Md., Penn., Va., and W.Va.) offers an on-line list of sources of funds for organizations doing environmental education in the region. This list includes the state(s) in which grants are made, contact information, and (in some cases) links to the funder's Web-site. The list is located at [www.epa.gov/reg3ocgr/ee/fundorgs.htm](http://www.epa.gov/reg3ocgr/ee/fundorgs.htm).

## Using Biosolids (Wastewater Sludge) in Virginia Agriculture

*Applying Biosolids: Issues for Virginia Agriculture* is an April 2001 report available from the Rural Economic Analysis Program (REAP) at Virginia Tech. The report examines economic and environmental issues associated with the application of wastewater-generated sludge on farmland. To request a copy, contact REAP at (540) 231-9443; e-mail: [reap01@vt.edu](mailto:reap01@vt.edu); Web-site: [www.reap.vt.edu](http://www.reap.vt.edu).

## Virginia Wetland Activity Report

The Va. Institute of Marine Science (VIMS) has published a summary of the acreage of tidal wetlands and the miles of shoreline affected by permitted activities from 1993—2000. The report is VIMS Wetland Program Technical Report No. 01-4 (Summer 2001); for a copy, contact VIMS at (804) 684-7380.

## Stormwater Information Sources

The Center for Watershed Education (Ellicott City, Md.) has published the *National Pollutant Removal Performance Database* (2<sup>nd</sup> ed.), summarizing over 135 urban pollutant-removal monitoring

studies. It includes a comparison of removal rates for six groups of stormwater-management practices. \$25, plus s/h.

The Center for Watershed Education also maintains the on-line “Stormwater Manager’s Resource Center,” at [www.stormcenter.net](http://www.stormcenter.net). The site includes a searchable library, slide shows, a manual builder, an ordinance selector, and excellent fact sheets on many topics.

For more information about either item, contact the group at (410) 461-8323; Web-site: [www.cwp.org](http://www.cwp.org).

### Flood Mitigation Successes

The Association of State Floodplain Managers (Madison, Wisc.) offers for sale *Mitigation Success Stories* (3<sup>rd</sup> ed.), a collection of case studies about reducing the potential for damage from floods. Available in print for \$25 or on CD-ROM for \$20, plus s/h. To order, contact the Association at (608) 274-0123; e-mail: [asfpm@floods.org](mailto:asfpm@floods.org); Web-site: [www.floods.org](http://www.floods.org).

### Meet the Folks at Fall Conferences!

•**Water Works Operations Conference.** Oct. 4—5 in Staunton. Sponsored by the Virginia Section of the American Water Works Association. For more information, contact Gerald Julian at (757) 441-2652; e-mail: [gjulian@city.norfolk.va.us](mailto:gjulian@city.norfolk.va.us).

•**Optimizing Nitrogen Management in Food and Energy Production and Environmental Protection.** Oct. 14—18 in Potomac, Md. Sponsored by the EPA and other groups. For more information, contact Rhonda Krantz at (202) 833-8773, ext. 212, e-mail: [N2001@esa.org](mailto:N2001@esa.org); Web-site: [esa.sdsc.edu/n2001](http://esa.sdsc.edu/n2001).

•**Wetlands Regulatory Workshop.** Oct. 29 in Atlantic City, N.J. For more information, contact the Wetland Regulatory Group (Stafford, Va.) at (540) 286-0072; e-mail: [reillygroup@msn.com](mailto:reillygroup@msn.com).

•**Operational Issues and Process Control: Keeping Ahead of the Curve.** Nov. 6 in Richmond. This is the annual Education Seminar held by the Virginia Water Environment Association (Richmond). The seminar will focus on the latest operational issues affecting the wastewater industry. For more information, contact Gary Nickerson at (703) 849-0310, or Teresa Moore at (804) 330-2917; Web-site: <http://vwea.org>.

•**North American Lake Management Society 21<sup>st</sup> International Symposium.** Nov. 7—9 in Madison, Wisc. For more information about this large meeting (about 1000 delegates, 200 presentations, 150 posters), contact the Society in Madison at (608) 233-2836; Web-site: [www.nalms.org](http://www.nalms.org).

### At the Water Center

For more information about the item(s) below, call the Water Center at (540) 231-5624; e-mail: [water@vt.edu](mailto:water@vt.edu); Web-site: [www.vwrrc.vt.edu](http://www.vwrrc.vt.edu).

•**Grant Received:** By Tamim Younos and Ray DeLeon from the Cabell Brand Center, for “Stroubles Creek Watershed Initiative—Database Management and Web Interface Development.” The objectives of the project are to enhance the Stroubles Creek Watershed Initiative’s Web-site and to develop a database system for the data collected on watershed characteristics.

### CORRECTIONS FROM THE PREVIOUS ISSUE OF *WATER CENTRAL*

1. In the General Assembly inventory in the June 2001 issue (Issue #17), page 2/item 8, the bill summary mentions a role for the “SWCB.” This refers to Virginia’s Soil and Water Conservation Board, *not* the State Water Control Board, as the list of abbreviations on page 9 would imply. *Water Central* thanks a reader for pointing out this oversight.

2. Two recent issues (April and June 2001) mentioned Virginia-related reports from the U. S. Geological Survey’s National Water Quality Assessment (NAWQA) Program. Previously we said that two, then three, reports covered parts of Virginia. Actually, *four* circulars covering parts of Virginia are available: 1157, Albemarle-Pamlico Basin; 1166, Potomac River Basin; 1204, Kanawha-New River Basin; and 1205, Upper Tennessee Basin. The Delmarva Peninsula is also a NAWQA study unit, but no circular is available for that basin yet.

## Virginia Water Central

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### "Hey, Wilbur!" said Charlotte.

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