Virginia Water Central

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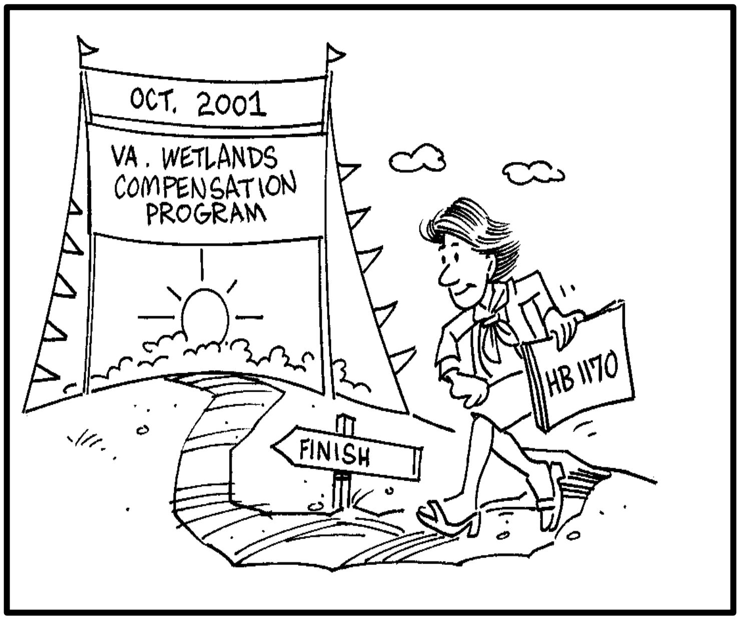
FEATURE ARTICLE

Finding the Path to No Net Loss of Virginia's Non-tidal Wetlands

The federal government and many states, including Virginia, have a goal of "**no net loss**" (NNL) of wetland acres and their ecological functions. In his campaign platform Governor James Gilmore went beyond NNL and called for a net wetland gain. Once in office he appointed a Citizen Wetlands Advisory Committee that recommended an enhanced regulatory program combined with voluntary programs to encourage landowners to restore and create wetlands. The 2000 Virginia General Assembly passed legislation—HB1170, "Non-tidal Wetlands Protection Program"—that affirmed the NNL goal and some of the advisory committee's recommendations.

In a recent *Water Central* survey, environmental leaders in the state overwhelmingly chose the non-tidal wetlands bill as the most significant legislation from the 2000 General Assembly (please see the July-August 2000 issue of *Water Central*). In this article, I discuss some of the background for Virginia's developing non-tidal wetland program, along with several options available for the state to reach its wetlands goals.



INSIDE THIS ISSUE

Non-tidal Wetlands in Virginia

A wetland is defined by the presence of water in the soil profile or above the soil surface during certain times of the year. Bogs, marshes (both saltwater and freshwater), and swamps are three commonly recognized types of wetlands.

The *Virginia Code* (for example, in Sec. 62.1-44.3) defines "wetlands" as "areas that are inundated or saturated by surface or ground water at a frequency or duration sufficient to support, and that under normal conditions do support, a prevalence of vegetation typically adapted for life in saturated soil conditions…." To determine if a particular area is a wetland, Virginia regulatory agencies use the U. S. Army

Virginia Tech
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AND STATE UNIVERSITY

Corps of Engineers' *Wetlands Delineation Manual* of January 1987.

Tidal wetlands are associated with and affected by tidal waters (salt marshes, for example); **non-tidal wetlands** are found outside of any tidal influence. According to the Virginia Institute of Marine Science, there are 1,267,000 acres of vegetated wetlands in the 90 percent of Virginia that has been inventoried. About 191,000 acres are tidal; the remainder are non-tidal. The table below lists acreage of non-tidal wetlands in Virginia's major watersheds (the numbers include a very small percentage of tidal freshwater wetland acres).

Watershed	Wetland acres
Potomac-Shenandoah*	33,554
Chesapeake Bay-Atlantic Ocean	329,147
Rappahannock*	33,080
York*	99,168
James *	169,226
Chowan*	348,220
Roanoke*	60,048
New	1,822
Tennessee-Big Sandy	1,755

*National Wetlands Inventory incomplete for these watersheds.
Source: Virginia Institute of Marine Science Special Report, January 2000.

The Framework of Non-tidal Wetlands Regulation

Since 1972, the Virginia Marine Resources Commission (VMRC) has administered a *tidal* wetlands regulatory program; HB1170 revises and expands the state's regulatory oversight of *non-tidal* wetlands.[1] Prior to passage of HB1170, non-tidal wetlands in Virginia have had some protection from Section 404 of the federal Clean Water Act. Under Section 404, the U. S. Army Corps of Engineers issues permits for the discharge of fill material into "waters of the United States," which include adjacent wetlands. Since 1992, recipients of a Corps fill permit have also needed a Virginia Water Protection Permit from the state Department of Environmental Quality (DEQ). (Prior to 1992, a Virginia "certification" was required for a 404 permit.)

Two recent court actions, however, have limited the scope of the federal program. In January 1997, the U. S. District Court for the District of Columbia overturned regulations (issued by the Corps and the U. S. Environmental Protection Agency in 1993) by which the Corps regulated excavation projects affecting wetlands. This so-called Tulloch ruling limited the definition of fill and allowed certain wetland excavation and drainage activities to proceed without a permit. In the second case, *U. S. vs. Wilson* in December 1997, the U. S. 4th Circuit Court of Appeals restricted the Corps' regulatory authority over fill placement in *isolated* wetlands (wetlands not closely associated with a navigable waterway).

By limiting the federal non-tidal wetlands regulatory program, these two court decisions led to increased calls for state action. HB1170 was the Virginia General Assembly's response.

The Permitting Process and No Net Loss

In most wetlands permitting programs, applicants are expected to **avoid and minimize** placement of fill in a wetlands. Under the Section 404 program, **individual permits** receive detailed regulatory oversight to assure that the sequence of avoid-and-minimize has been followed. Moreover, when a permit is issued, **compensation** is required for any permitted loss of wetlands. The Corps also issues **general permits** that have less regulatory oversight and may be issued without requiring compensation. The Corps uses general permits when the activities are expected to have only minimal effects on a wetland, or when requiring compensation is considered infeasible or economically burdensome.

Under the new law, the Virginia Water Control Board is to develop general permits to cover the following categories of activities affecting non-tidal wetlands:

- activities of less than 0.5 acres;
- activities of utility and public-service companies;
- linear transportation projects (by the Virginia Department of Transportation or others);

[1] The text of HB1170, the 2000 non-tidal wetlands bill, is available on-line through the Legislative Information Service, http://leg1.state.va.us/.

- mining activities; and
- activities covered by nationwide or regional permits issued by the Corps.

Because a number of activities will proceed each year under general permits, accumulated annual losses could be significant if compensation were not required. In fact, compensation requirements have not been a condition of a Virginia *tidal* wetlands program permit when the fill area is small (typically a few hundred square feet). The VMRC program is widely regarded as successful, yet each year tens of acres of wetlands are lost without compensation. The Commonwealth now recognizes that no *net* loss will be secured only if compensation is required for wetland acres lost in activities permitted under the new general permits for non-tidal wetlands. Consequently, by October 2001 regulations will be issued to assure such compensation.

Compensation Strategies—Tools for Getting to No Net Loss

One way to replace losses of wetlands from permitted activities is **on-site compensation**: **creation** or **restoration** of functionally equivalent wetlands on, or adjacent to, the site where the fill permit was used. (Please see box on the following page for more on wetlands compensation.) But studies across the nation have found that on-site compensation for *small* fills rarely has resulted in ecologically successful wetlands. Therefore, **off-site compensation** can be ecologically preferable to on-site alternatives in some instances. The following sections describe the five currently used options for securing off-site compensation.

Applicant-sponsored Off-site Compensation

In this case, the permit recipient develops a compensation project off-site to compensate for the effects of just a single permit. At the time the permit is issued the applicant files a plan for the compensation, and the compensation usually is expected to start at the same time as the fill activity. Recipients of individual permits who are required to provide significant acres of compensation, but who do not have the available space for successful compensation on-site, often develop such off-site projects. The small size of the fills allowed under Virginia's general permits—0.5 acres—might make developing an off-site project for a single small fill too costly to consider.

Single-user Mitigation Banks

Under this option, public agencies or large-scale developers who anticipate needing several fill permits for future projects invest funds in wetlands-creation or -restoration projects. Their investment earns them wetlands "credits" that are deposited to a "bank account" after the projects have been certified as ecologically successful, or after the investor posts a financial assurance (like a performance bond). For a single-user bank to be a viable compensation option, the permit applicant must anticipate a large number of future projects that will require compensation and have the money to invest in wetlands projects.

The Virginia Department of Transportation has developed single-use mitigations banks. Utility and public-service companies, and some private-sector companies, in Virginia could also do so. But some of the other potential recipients of the new general permits likely will not be in a position to use this option.

Private Mitigation Credit Sales

In recent years entrepreneurs have invested private-sector capital to create or restore wetlands in order to produce mitigation credits. Permit recipients then buy the credits to satisfy their compensation requirements. With the sales transaction, the private credit-seller assumes the responsibility for the ecological success of the compensation. Private-sector credit projects have a good chance of ecological success, because before the credits can be sold the seller must pass through a multi-agency approval process. In addition, private sellers offer financial assurances of ecological success.

The supply of private-sector credits has grown in many areas of the nation, including in some Virginia watersheds. Research indicates that, for reasons related to the multi-agency review process and the nature of the market, credit prices are quite high and it is unlikely that private-sector credits will be available in all watersheds. As a result, some recipients of Virginia general permits will probably not have access to private-sector credits.

Continued after box on following page

Wetlands Compensation

Wetlands creation involves modifying upland or open water areas so that they have the *hydrology* (water location and movement) needed for a wetland. **Wetlands restoration** normally involves reversing drainage or other actions that alter the hydrology in areas that were formerly wetlands; typically such former wetlands have been in agricultural use. Restoration may also involve restoring wetlands *vegetation*. Creation of wetlands where no former wetlands existed is thought to be a more technically challenging task than restoration of former wetlands.

The science and technology of wetlands restoration and creation is advancing rapidly. Nonetheless, the success of any single wetlands creation of restoration site is hard to predict. For example, as the site develops, minor modifications in the hydrology might have significant effects on the wetlands functions that are secured. For this reason, "no net loss" demands that compensation wetlands either be ecologically successful before the permit is issued or that there be financial or other assurances that ecological success will be achieved in the future.

Whether the compensation is by creation or restoration, the use of *off-site* compensation poses some ecological questions. If a number of small wetlands are filled, can the ecological functions be replaced with a single large wetland? Should the compensation wetlands exactly replace the types of wetlands and functions lost from each permitted fill, or should the compensation restore those wetland types that will best contribute to a watershed's hydrology, water quality, and habitat diversity?

Whatever the form of compensation and however these questions are answered, in practical terms "no net loss" demands adequate agency resources to monitor compensation projects, a party responsible for having adequate funds to initiate a compensation project and maintain it over time, and a means to protect and maintain the site as a wetland in the future.

Continued from previous page

Fee Payment Program

Under this option, permit recipients pay a fee based on a schedule or based on reference to some specific but *not yet initiated* restoration project. The fees are accumulated in a fund administered by a fee program administrator. At a future date, the administrator is responsible for spending the accumulated fees on a single compensation project or on several smaller projects. Fee programs are attractive because they are relatively simple to set up and so can provide permit recipients with a readily available off-site compensation option.

In a fee program, the choice of how best to spend the funds is not governed by a formal plan for a given watershed; rather, the fee administrator is to use his or her "best professional judgment" (along with that of people at other, appropriate agencies) to assure that the funds are directed toward projects that might best meet the needs of the watershed. Fee programs are not required—as private-sector credit programs are—to pass a multi-agency review process to meet certain quality assurances for the individual sites. Instead, the permitting agency seeks quality assurance by choosing fee administrators (typically non-governmental organizations) with a demonstrated commitment to, and record of, success in environmental protection and restoration programs.

The Virginia Wetlands Restoration Trust Fund is one of the more active fee programs in the nation. The Norfolk District of the Corps has selected the Nature Conservancy of Virginia as its partner in the fee program. The Corps allows payments to the fund to secure compensation for minor fills that might otherwise go uncompensated, or if *on-site* compensation has a poor chance of ecological success. Fees are based on cost calculations made by the Corps; the Nature Consevancy proposes compensation projects and monitors them for success; and private contractors complete site development. In its five-year history, the fund has earned about $4 million and has been the catalyst for projects costing $1.5 million.

State Revolving Fund for Credit Development

Virginia could create a new wetlands-compensation fund such as the one existing in North Carolina. The North Carolina Wetlands Restoration Program was created to simplify meeting wetlands-compensation requirements and to achieve a net gain of wetlands in that state. The state is responsible for developing watershed plans to identify the areas where restoration actions would be of high priority and of greatest ecological value. Restoration activities are now underway in a number of watersheds. To start the program, the state provided $6 million to the North Carolina Wetlands Restoration Fund (WRF), with additional funds to be provided in future years. In addition, the state's Department of Transportation is paying $2.5 million annually (for seven years) for plan development. With the fund now in operation, a recipient of a wetlands-fill permit can satisfy compensation requirements by paying of a fee to the WRF. The collected fees are used to repay the WRF for wetlands restorations that were implemented with the initial state allocation. The state is currently (October 2000) evaluating its fee schedule to assure that fees are adequate to recover the costs of the restoration projects.

Initial capital for such a fund in Virginia could come from the Virginia Water Quality Improvement Fund and be supplemented with the federally funded State Revolving Loan Fund. Also, as was done in North Carolina, the state transportation department might help to capitalize the fund in anticipation of using the fund to compensate for its projects. The new fund, once capitalized, would invest in wetlands restoration in watersheds across the Commonwealth to secure the goals of the new Virginia non-tidal wetlands legislation.

The restoration and creation work could be contracted out using a competitive bidding process that would draw in the expertise of the private-sector credit sellers. Successful bidders might be asked to conform to ecological quality-assurance criteria now required of private credit-sellers in the multi-agency review process. The winner of each contract would be paid upon completion of the project after ecological success is documented or if financial assurances are proffered. Managers of the new fund would take responsibility for selling the credits created by the program to recipients of general permits. The payments required of the permit applicants (the "fee") could be tied to the costs of securing the successful restoration or creation. As fees were collected, the fund would be repaid and new projects initiated.

The Choice

Let's review the advantages and disadvantages of the off-site compensation options presented above.

- Single-user banks might be used by some of the recipients of the new Virginia general permit, but such banks may be impractical in many cases.
- Purchases from private credit-sellers operating in Virginia can offer acceptable compensation, but private sellers are not present in all watersheds at this time.
- The state could use the Virginia Wetlands Restoration Trust Fund as its fee program. To do so, Virginia would need to become an active partner with the Corps to determine how fees would be set and how funds would be allocated.
- Virginia could adopt a revolving-fund program analogous to the one in North Carolina. Funds to capitalize such a program are available and the funds could be repaid with the collected fees. A competitive bidding process could tap the expertise of the private sector in ecologically sound wetlands compensation. The state could draw upon the accomplishments of the Nature Conservancy in land management to assure long-term success of the compensation wetlands. Finally, such a program could be financed and structured so that the ecological success of the compensation wetlands—and no net loss—were secured *before* fills proceed under general permits.

—By Leonard Shabman

Water Central thanks Carl Hershner, Virginia Institute of Marine Science, for providing information for this article.

For Further Reading

The October 1999 issue of *Water Central* (For the Record, p. 15) has a list of sources of information and data on wetlands. Please contact the Water Center for a paper copy, or view the issue at our Web-site, www.vwrrc.vt.edu.

The Water Center has for loan a 19-minute video entitled "Use of Constructed Wetlands for Stormwater Runoff,"produced by Cornell

University. Please call (540) 231-5624 or send e-mail to water@vt.edu to borrow the video.

The Congressional Research Service's September 1, 2000, issue brief for Congress on wetland issues (IB87014) is an excellent reference. It is available on-line at www.cnie.org/nle/wet-5.html, or by contacting the National Council for Science and the Environment at (202) 530-5810.

"Wetlands Banking for Sound Mitigation? Yes Virginia" is an article in the May-June 1999 issue of *National Wetlands Newsletter*, published by the Environmental Law Institute, (202) 939-3800.

"Does Wetland Mitigation Work in the Long-term?" is an article in the September-October 1998 issue of *Land and Water*, published by Land and Water, Inc., (515) 576-3191.

Issues of defining and delineating wetlands are analyzed in the National Research Council's 1995 report, *Wetlands: Characteristics and Boundaries*, National Academy Press, Washington, D.C.

Finally, for research-oriented readers, "An Analysis of Palustrine Forested Wetland Compensation Effectiveness in Virginia" (a 1991 Ph.D. dissertation by Robert Atkinson) is available at the Virginia Tech library, (540) 231-6170. The library's Web-site (which includes their on-line catalog) is www.lib.vt.edu/.

TEACHING WATER

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, Science, and For the Record sections. *Water Central* welcomes readers' comments on whether the articles actually do, in fact, help teachers with the standards listed or with others. Abbreviations: C/T-computer technology; ES-earth science; LS-life science; BIO-biology.

Feature—Wetlands Issues
Science SOLs: ES.9, BIO.9.
Social Studies SOLs: 12.7, 12.8, 12.15, 12.16.

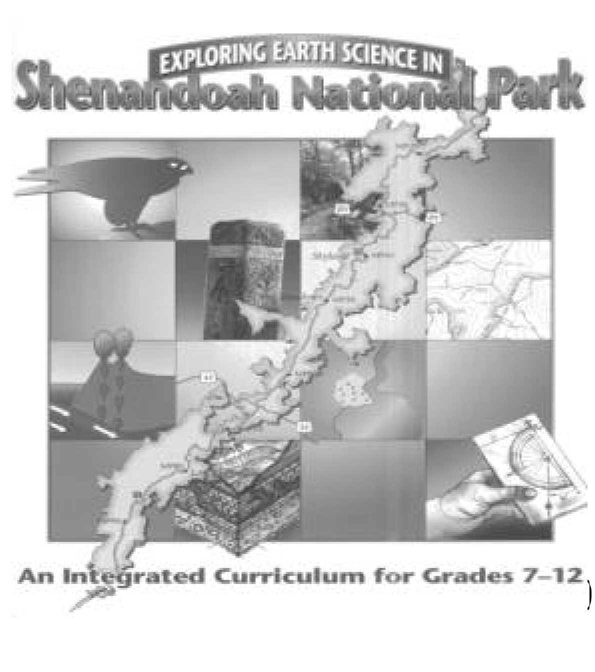
Science—Aquatic Plants
Science SOLs: 4.4., 4.5, 4.8, 5.5, 6.9, 6.11, LS.4, LS.7, LS.9, LS.12, ES.7, ES.9, BIO.5, BIO.7, BIO.9.

For the Record—Aquatic Life Information
Computer Technology SOLs: C/T5.3, C/T8.4.
Science SOLs: 4.8, 6.11, LS.11, LS.12, BIO.9.

Attention Earth-science Explorers!

The National Park Service, United States Geological Survey, and teachers have created a curriculum package that explores the geology of Shenandoah National Park's Blue Ridge Mountains. In "Exploring Earth Science in Shenandoah National Park—An Integrated Curriculum for Grades 7-12," students address real problems and concerns. They learn how professionals go about gathering, developing, and using information and how to judge the value of the results. The curriculum was developed by teachers and field-tested by students; it is aligned with both national science standards and the Virginia Science Standards of Learning.

The park is hosting workshops to make this curriculum available. Attendance at a workshop is necessary to acquire the curriculum book (a black-and-white version of the book's cover is shown below). Two-day workshops cost $150.00 per person (covering lodging, food, and curriculum materials); one-day workshops are available for $75.00 per person. Recertification points are available. For more information or to set up a workshop date, call the park's education office at (540) 999-3489.



SCIENCE BEHIND THE NEWS . . .

Plants Don't Stop at the Water's Edge

In 1634, William Wood described Boston as "very pleasant, hem'd in on the South-side with the Bay of Roxberry" and with "marshes on the backe-side...."[2] The bay and marshes Wood mentioned were among the "great reaches of mudflats and salt marshes, which were covered by tides at high water, known as the Back Bay." By the late 1800s, the area was "an unsavory sedimentation basin for all the sewers of Roxbury...and the receptacle of any pollution...in the waters of Muddy River."

In the 1870s, Frederick Law Olmstead devised a plan for "converting the noxious flats of the Muddy River into a healthy and decorative park known as the Back Bay Fens, skirted on the east by an avenue designated as the Fenway." When the Boston Red Sox built a baseball stadium in the area in 1912, it was, understandably, called Fenway Park.

Today, of course, you won't find aquatic plants growing in Fenway Park. But if you go to a real **fen**—a moist area with mineral-rich water—aquatic plants will definitely be in the "line-up." Aquatic plants and their many habitats are part of the action in various current water issues. This article aims to give you a front-row view of what aquatic plants are, where they're found, how they're adapted to wet places, and why they're important to Virginia.

What is an Aquatic Plant?

The answer to this question starts with another: what is a plant? That's not as obvious as you may think. Two large groups of organisms that many people would call plants are the algae and the fungi. But in a fairly well-accepted biological classification scheme, both these groups rate their own "kingdom" and are *not* placed in the Plant Kingdom. That leaves as "true" plants the *liverworts, hornworts, mosses, ferns, gymnosperms* (cone-

bearing trees and shrubs) and *angiosperms* (flowering plants). Ferns, gymnosperms, and flowering plants have specialized tissues for transporting water and minerals; consequently, they are called **vascular plants**. About 2,700 of Virginia's approximately 3,000 plant species are vascular plants. This article deals only with vascular aquatic plants.[3]

Categorizing vascular plants as *aquatic* has complications, too. Different plant species exist along a continuum between extreme dryness and extreme wetness. Most vascular plants prefer conditions between these two extremes, and so they overlap the categories people devise. Nevertheless, good working descriptions do exist for aquatic vascular plants. Here are two:

- "An aquatic plant...is normally found in nature growing in association with free-standing water whose level is at or above the surface of the soil."[4] In this context, "normally" implies that the plant requires such conditions to grow well and reproduce.
- "[As] a definition of the marsh and aquatic [plant] group..., I can think of nothing better than those plants which a typical terrestrial

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[2] Quotations about Boston are from Walter Whitehill (1968), *Boston: A Topographical History*, Harvard Univ. Press, Cambridge, Mass.

[3] For more on algae, please see the August 1998 issue of *Water Central*, pp. 9—13.

[4] Donald Reimer, 1993, *Introduction to Freshwater Vegetation* (p. 48). See References for full citation.

[plant specialist] usually does not collect for fear of getting his feet wet."[5]

For this article, I use three categories of vascular plants based on preference or tolerance for submergence or flooding: **aquatic**, **semi-aquatic**, and **non-aquatic**.[6]

Aquatic plants require partial or total submergence during some part of their life cycle to survive and grow optimally. True aquatic plants have three common growth habits: *submerged* aquatic plants live and grow completely underwater or just reaching the surface; *emergent* aquatic plants have upper stems and leaves protruding from the water, with lower stems and roots below the surface; and *floating* aquatic plants have leaves floating on the surface (they may or may not be attached to the sediments). The following are common examples of these three types:

- submerged: Coontail and Eelgrass;
- emergent: Cattail and Common Arrowhead;
- floating (attached): Water Lily;
- floating (unattached): duckweeds.

Semi-aquatic plants grow and thrive in terrestrial environments but have structural or physiological adaptations to flooding. They are able to grow in saturated soil, such as the soil found in wetlands or in areas directly beside water bodies, known as **riparian** areas.

Non-aquatic plants cannot tolerate *frequent* or *prolonged* submergence. Many trees, shrubs, and other plants that can grow in uplands can also grow in wetter areas if they are submerged only occasionally and only for short periods of time.

Life as an Aquatic Plant

Land vs. Water

As any Virginia gardener in a typical July knows, land plants sometimes run short of water. While aquatic plants normally don't have this problem, they do share with land plants the challenges of getting adequate *light*, *carbon dioxide*, *heat*, and *nutrients*.

Light is a crucial issue for aquatic plants. One author has stated, "Of all the major environmental parameters, the two that differ most between terrestrial and submerged environments are water and light…."[7] Even with the sun directly overhead, less than 50 percent of the light reaching a water surface penetrates one meter deep, and it can be as little as five percent. Light reaching the surface is reduced on its way to submerged plants by the water itself, by sediments suspended in the water, by phytoplankton (floating, microscopic algae), and finally by algae that grow on the surface of submerged plants.

In addition, water and the materials it contains affect not only the *quantity* of light but also the *quality*—that is, the relative intensity of different wavelengths. Light quality is just as important as quantity for plants' ability to grow, as you can see if you try to raise houseplants under only incandescent light bulbs, which, regardless of how bright they are, do not mimic the light quality of sunlight.

Along with getting enough light, getting adequate atmospheric gases—particularly carbon dioxide—is also a larger problem for aquatic plants than for terrestrial plants. On the other hand, aquatic plants face *less* drastic daily temperature changes, and their cells can *more* easily get dissolved nutrients. The following chart summarizes differences in the conditions aquatic and terrestrial plants face.

Aquatic ← ← ←	**→ → → Terrestrial**
Water abundant	Water limited
Light reduced underwater	Light more readily available
Gases limited	Gases abundant
Small daily temperature change	Large daily temperature change
Nutrients more readily available	Nutrients less readily available

As a group, aquatic plants share certain adaptations that allow them to survive their water-rich environments. (Some of the same adaptations, though, make aquatic plants unable to survive for very long if completely exposed to air.) The following sections describe some common aquatic-plant adaptations.

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[5] Ernest Beal, 1977, *Manual of Marsh and Aquatic Vascular Plants of North Carolina*, (p. 1). See References for full citation.

[6] My categorizations are based on unpublished writing by Nancy Mason Mignone, 12/18/91, as a student in Virginia Tech's "Aquatic Vascular Plants" course.

[7] Reimer, 1993 (p. 25).

Flexible Structures. Submerged and floating leaves, stems, and other structures are supported by water. As a result, submerged and floating aquatic plants do not need rigid structural tissue (such as the wood and bark of trees), and this lack of rigid tissues allows floating and submerged plants to move with water currents or waves. In addition, many submerged plants are made less resistant to water movement by the presence of thin or finely divided leaves.

Less Leaf-surface Covering. Plants on dry land have to reduce water loss from leaves and other surfaces. One common way of doing so is by having a waxy cuticle, or film, over the leaf surface. Not facing a water-loss problem, submerged plants have little or no waxy cuticle on their leaves. The upper leaf surfaces of floating plants, however, tend to have a waxy cuticle to reduce drying and to helps floating leaves shed water and avoid being submerged.

Internal Spaces. Floating and submerged plants have an extensive system of air spaces and canals that allow the plants to store and transport gases. The intricacy of the system increases the amount of internal surface area available to the plant for gas exchange (such as absorbing carbon dioxide).

Creative Pollination. Land plants rely on wind and animals to transfer pollen to female flower parts. Aquatic plants, in most cases, have to accomplish pollination via water. Aquatic species have developed various pollination adaptations, such as stamens (male flower parts) that detach and float to the surface, then release pollen that sinks back down to the submerged pistils (female flower parts); or pistils that are tongue-shaped or filamentous to capture drifting pollen.

Vegetative Reproduction. In general, aquatic plants are more able than land plants to reproduce from stem fragments or other vegetative parts. Many aquatic plants actually *rely* on this ability, because successful pollination is not easy for aquatic plants. This vegetative-reproduction capacity enables some alien aquatic species to spread widely.

More Water is Only Part of the Story

Not only do land and water differ in the conditions they present to plants, but different aquatic habitats also can present plants with markedly different conditions. In fact, one author has stated, "[T]he only thing [aquatic habitats really] have in common is an abundance of water."[8]

What makes aquatic habitats different? If we ignore continental-scale differences like climate, four main types of influences create the wide range of environmental conditions under which Virginia's aquatic plants live: salinity; water movement; morphology of the water body; and the land and land uses in the watershed.

Salinity. The difference between fresh water and salt water is measured by salinity: the total concentration of eight major ions, or "salts," in the water (for example, ions of calcium, magnesium, and sodium). The average salinity for seawater is approximately 3.5 percent; the salinity of fresh waters varies, depending on the surrounding watershed, but the average for lakes and rivers worldwide is about 0.01 percent. **Brackish** water has salinities between these values.

Just as is true with fish and other aquatic animals, aquatic plant species are adapted to a certain range of salinity. For example, Widgeon Grass prefers the lower Chesapeake Bay where the salinity ranges from about 1.8 to 3.0 percent. Less-salt-tolerant Eurasian Watermilfoil, however, is found in the middle and upper Bay, where salinity ranges from 0 to 1.8 percent.[9]

In an estuary like the Chesapeake Bay, salinity can change in response to variation in the amount of freshwater reaching the estuary via its tributaries. For example, in the drought year of 1999, the Bay received less freshwater, resulting in saltier conditions and changes in conditions for aquatic plants.[10]

Water Movement. A fundamental fact of life for an aquatic plant is whether the plant is living in moving water or in relatively still water. Moving-water, or **lotic**, environments include streams and rivers, areas under tidal influence, and coastal areas influenced by waves. Standing-water, or **lentic**, habitats are lakes and ponds.

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[8] Reimer, 1993 (p. 7).

[9] The publications by Hurley and Orth, cited in full in the References section, are the source of these salinity ranges and plant preferences.

[10] Karl Blankenship, "Bay's Grass Beds Helped by Drought, Rebounded in '99," *Bay Journal*, June 2000.

Water movement aids aquatic plants by mixing the water with the atmosphere, which is the plants' primary source of carbon dioxide and an important source of heat. Water movement also helps distribute materials and heat *within* the water body. On the other hand, the physical force of moving water presents plants with a problem. Plants with weak roots (such as Common Elodea), or no roots at all (such as Coontail), typically will not grow in areas with a lot of water movement; strongly rooted Sago Pondweed, however, can be found in such areas.

Morphology. The morphology of a water body refers to the size, shape, and depth of the water body. These three features determine how much area plants have to colonize: surface area for floating plants, shallow areas for submerged plants, and near-shore areas for emergent plants. In lakes, morphology also greatly influences water movement.

Land and Land Uses in the Watershed. The land surface below a water body is called the **substrate**. It consists of **sediments** lying over bedrock. Sediments are a mixture of rocks, sand, silt, and clay, plus plant and animal remains in various stages of decomposition. The structure and composition of sediments depend on the type of water body, its location, the characteristics of its surrounding watershed, and its history.

As does soil for land plants, an aquatic substrate provides rooted aquatic plants with attachment points and a source of nutrients. Aquatic species have different sediment preferences, due to the sediments' physical structure, chemical composition, or both. In the Chesapeake Bay, for example, Redhead Grass is found on silt-mud sediments, while Eelgrass is associated with sandier sediments.

Aquatic Plants in Virginia

Virginia is home to more than 3,000 species of vascular plants (including native species and those that are not native but have been found in the wild). Of these, some 694 (about 23 percent) are aquatic or semi-aquatic species of three general types: ferns and fern allies, 18 species; gymnosperms, 3 species; and flowering plants, 673 species. Virginia's flowering aquatic plants occur in 81 different plant families. By far, the most represented families are the sedges (155 species) and the grasses (93 species).[11] These plants live in many watery habitats, including those in the following table.

Bay/estuary	Peaty pine barren
Bog	Pond (and margin)
Cove	River (and margin)
Depression	River flood plain
Ditch	Shore
Lake/reservoir (and margin)	Spring
	Stream
Marsh (freshwater)	Streambank
Marsh (brackish)	Swamp
Marsh (salt)	Wet soil
Mud flat (tidal or freshwater)	Wet woods

Perhaps the most talked-about aquatic plants in Virginia currently are submerged aquatic plants in the Chesapeake Bay. The box on page 11 lists 24 submerged plants commonly or occasionally found in the Bay.[12]

Why Aquatic Plants Get Attention

Positive Attention: Ecological Functions

All living things need energy, materials, and suitable places to carry out vital processes and behaviors. In most ecosystems, vascular plants are essential to providing these three necessities to other organisms. The same is true for most aquatic ecosystems, where aquatic and semi-aquatic vascular plants carry out many ecological functions.[13] Aquatic plants' specific impacts depend on particular plants and habitats, but in general aquatic plants commonly carry the following functions.

Food for Animals. Aquatic plants directly or indirectly provide food for many animals, particularly mammals, birds, fish, and many invertebrates, such as shellfish and insects. Different aquatic plant species differ, however, in their value as wildlife food. Eurasian Milfoil, for example, is less valuable

Continued after box on next page

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[11] The estimates of plant numbers and the list of habitats are based on the 1995 checklist of aquatic and wetland plants by Duncan Porter, Virginia Tech Department of Biology.

[12] Often called "Bay grasses," none of these plants is actually a member of the Grass Family.

[13] An important exception is oceans, where algae are the main producers of energy and oxygen.

Aquatic Plants in the Chesapeake Bay and its Tributaries

<u>10 commonly found</u>
Eelgrass
Widgeon Grass
Common Elodea
Coontail
Eurasian Watermilfoil
Horned Pondweed
Redhead-grass
Sago Pondweed
Southern Naiad
Wild Celery

<u>14 occasionally found</u>
American Pondweed
Curly Pondweed
Hydrilla
Leafy Pondweed
Muskgrasses: three species, no distinguishing common names
Naiads: Northern, Slender, and *Najas minor* (no common name)
Slender Pondweed
Water Chestnut
Water Stargrass
Water-weed

Source: *Distribution of Submerged Aquatic Vegetation in the Chesapeake Bay--1996*, by Robert Orth, Virginia Institute of Marine Science.

Continued from previous page
for waterfowl than Widgeon Grass.[14] Of course, animals that feed on plants in turn often become food for other animals. In addition, while some animals feed directly on the plants, other animals find their food harbored among plants' leaves or roots.

Oxygen. Through photosynthesis, aquatic plants produce and release the oxygen that all aquatic animals need.

Habitat. Besides providing places where some animals find food, plants provide animals with places to rest, hide from predators, and breed. For algae and certain animals that attach to surfaces, plant leaves greatly increase the surface area available.

Nutrient cycling. Nutrients in the water and sediments are absorbed by aquatic plants, stored in plants' living tissue, and ultimately released back into water or sediments when dead plants are decomposed.

Erosion and sedimentation. Rooted aquatic plants reduce the energy in waves and currents, thereby reducing shoreline erosion. By slowing water movement, plants increase the deposition of sediments carried by water. Aquatic plant roots also help keep sediments in place. By these functions, aquatic plants tend to increase water clarity and light penetration.

These positive ecological impacts make aquatic and semi-aquatic plants a significant factor in many water-resource issues nationwide. In Virginia, such plants are key components of efforts to restore the Chesapeake Bay, in wetlands preservation and management, and in efforts to improve water quality by better management of riparian areas. The following "bulleted" items reveal the emphasis Virginians are putting on aquatic and semi-aquatic plants in these three areas of water-resource management.

<u>Submerged aquatic vegetation (SAV) in the Chesapeake Bay</u>

•"Historically, more than 200,000 acres of grasses grew along the shoreline of the Chesapeake Bay. By 1984, a survey of Bay grasses documented only 37,000 acres in the Bay and its tributaries. Declining water quality, disturbance of grass beds, and alteration of shallow water habitat all contributed to the …decline. The absence of grasses translates into a loss of food and habitat for many Bay species…Bay grasses have rebounded steadily since the low point in 1984. In 1998, 63,495 acres of grasses were documented."—Chesapeake Bay Program, *Chesapeake Bay: Introduction to an Ecosystem*, April 2000, p. 20.

•"RESOLVED by the Senate, the House of Delegates concurring, That the Virginia delegation to the Chesapeake Bay Commission continue its study of the most effective means for protecting submerged aquatic vegetation."—2000 Virginia General Assembly, SJR79.

•"New permit programs are being developed by the Virginia Marine Resources Commission, as

[14] The names of submerged aquatic plants often reflect preference by certain waterfowl—Widgeon Grass, for example (a widgeon is a type of duck).

well as by Maryland agencies, so officials can monitor where [SAV] replanting operations are taking place—and whether they are successful. Right now, officials admit, they don't know how many restoration projects are under way."—*Bay Journal*, Sept. 2000.

Wetland Plants

•"Two-thirds of the nation's commercial fish and shellfish depend on wetlands as nursery or spawning grounds."[15]

•In 1998, the Virginia General Assembly made wetlands, along with riparian buffers, eligible for exemption from local taxation: "Wetlands, as defined herein…and riparian buffers, as defined herein,…are hereby declared to be a separate class of property …The governing body of any county, city or town may…exempt or partially exempt such property from local taxation."[16]

•Southwestern Virginia wetlands contain "a disproportionate number of listed endangered or threatened vascular plant species… ."[17]

Riparian Buffer Zones

•The Virginia Riparian Buffer Implementation Plan, adopted in July 1998, seeks "to ensure, to the extent feasible, that all streams and shorelines in the Commonwealth will be protected by an adequate riparian buffer."[18]

Virginia has committed to *restoring* 610 miles of riparian areas by 2010.

•The Virginia Conservation Reserve Enhancement Program's goal is to restore 35,000 acres of buffer over 15 years (by 2015). Riparian species planted should be native and are expected to enhance species diversity, provide wildlife food and habitat, benefit stream ecology, and improve water quality.

•The 2000 Virginia General Assembly enacted HB 1306, the Riparian Buffer Tax Credit. It provides a non-refundable tax credit to individual or corporate owners of timber-producing riparian land who forego timber-harvesting for 15 years.

Negative Attention: Invasive or Over-abundant Aquatic Plants

Just as with terrestrial weeds, an "aquatic weed" is an aquatic plant growing where, or to an extent, the somebody does not want. Writing for the American Water Works Association, Bill Harvey described the essence of problems with aquatic plants:

> "…While the necessity of aquatic vegetation is clearly understood, the character, quantity, and quality of certain types of aquatic vegetation can cause competition in an ecosystem…In most situations, problems associated with aquatic plants develop when exotic aquatic plants are accidentally or intentionally introduce into disturbed habitats."[19]

Aquatic plants, when growing out of place or in excessive abundance, can interfere with aquatic recreation, fisheries management, navigation, and irrigation. Two plant examples, Giant Salvinia and Hydrilla, illustrate problems aquatic plants can cause.

Giant Salvinia is a floating aquatic plant native to Brazil. A federally listed "noxious weed," it has been causing problems recently in several southern and southwestern states. It can spread thick mats of vegetation across lakes, ponds, and slow-moving water, doubling in size within a week under certain conditions. Such growth can block light from reaching other plants, make water more stagnant, choke

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15 Chesapeake Bay Program, 2000, *Chesapeake Bay: Introduction to an Ecosystem*, p. 18. See References for full citation.

16 *Va. Code*, Sec. 58.1-3666. The *Code* defines "wetland" as "an area that is inundated or saturated by surface or ground water at a frequency or duration sufficient to support, and that under normal conditions does support, a prevalence of vegetation typically adapted for life in saturated soil conditions…." The Code defines "riparian buffer" as "an area of trees, shrubs or other vegetation, subject to a perpetual easement permitting inundation by water,…at least thirty-five feet in width, adjacent to a body of water, and managed to maintain the integrity of stream channels and shorelines and reduce the effects of upland sources of pollution..."

17 Douglas Ogle, 1998, "The Wetland Communities of Southwest Virginia." See References for full citation.

18 Virginia Riparian Forest Buffer Panel, 1998. See References for full citation.

19 Bill Harvey, "Hydrilla: A Midsummer's Nightmare" *Opflow*, Vol. 25/No. 6 (June 1999).

intakes of irrigation systems or treatment plants, clog outboard motors, and cover open water that waterfowl need.

Hydrilla is a submerged aquatic plant originally found mainly in Africa. It has key adaptations for invading aquatic-plant habitat:
•reproduces from vegetative fragments, such as from a single whorl of leaves;
•grows rapidly (up to two inches per day);
•uses available nutrients efficiently;
•requires less available light than some native plants, allowing it to grow deeper and begin photosynthesis earlier in the day; and
•can withstand drying out, increasing its ability to survive transport from one body of water to another on boats or boat trailers.

Texas provides an interesting look at two sides of a Hydrilla invasion. Introduced in the late 1960s, the plant has since spread throughout the eastern half of the state. It has reportedly blocked irrigation canals, disrupted flow in utility cooling reservoirs, and impeded fishing, swimming, and boating. But, on the other hand, in some reservoirs that previously lacked aquatic plants Hydrilla has provided needed habitat and improved water clarity.

Many other aquatic plants have earned the label of "weed" or "invasive plant." For example, the New England Interstate Water Pollution Control Commission recently listed Curly Pondweed, Eurasian Watermilfoil, Fanwort, and Water Chestnut, along with Hydrilla, as problem-causing invasives in New York and New England.

Less Common, But Hopeful, Attention: Varied Uses for Aquatic Plants

While excessive growth of invasive aquatic plants can result in people trying to remove them, several potential benefits give people reasons for using, harvesting, and even cultivating certain aquatics. Here are brief comments on four areas of past, present, or potential uses.

Biological Water Filtration. Some emergent and floating plants are used to reduce the concentrations of nutrients in treated wastewater. The plants absorb the nutrients and use them for their own growth; eventually the plants are harvested for other uses (such as animal feed) or for disposal.

Human Food. Water lilies were cultivated in ancient Egypt, and various species of aquatic plants (such as Chinese Water Chestnut) are still used in some Asian and African countries. In the United States, aquatic plants used for food include Wild Rice, Watercress, Water Chestnut, and arrowheads (called "Delta Potatoes"). Water Velvet, though not used *directly* for food, has been cultivated for hundreds of years in some Asian countries, including China, for use as a natural manure in rice paddies. The plant, through a symbiotic relationship with a blue-green alga, is able to make use of atmospheric nitrogen; it can, therefore, tap and store nitrogen that is not directly available to most other plants.

Fiber and Structural Material. Ancient Egyptians used Papyrus, a type of sedge, as a source of pulp for paper. Various peoples have used semi-aquatic grass species (such as Giant Reed and bulrushes) for pulp, thatch-roofs, floor mats, wall partitions, fences, musical instruments, and boats. Closer to Virginia, in the early 1900s Eelgrass, a submerged species common in the Chesapeake Bay, provided a popular housing insulation nicknamed Cabot's' Quilt (its inventor was related to John Cabot). The material was also useful in soundproofing, having reportedly been used, for example, in Rockefeller Center in New York City.

Animal Feed. Most aquatic plants are of limited value as animal feed. Relative to traditional feed crops, they have limited nutritional value, poor palatability, and poor digestibility and are also relatively costly to process into animal feed. Various species of submerged plants from the Chesapeake Bay have been tried as animal feed, but these efforts have not been notably successful. On the other hand, duckweeds are a valuable source of animal feed, as their growth rates and protein content may equal or exceed those of soybeans.

Water and Plants Reflect One Another

Distinguishing the "aquatic-ness" of a given plant species is inexact at best. As a group, vascular plants' biological preferences and tolerances range all along the scale of conditions from submerged to saturated to dry. Moreover, many individual species can live under different degrees of wetness.

Whatever the conditions of a water body, some aquatic or semi-aquatic plants will normally be found in or near the water body.

By their presence, the plants will reflect the existing combination of water quantity and quality factors. In turn, the plants will exert an ongoing influence on the chemical, physical, and biological features of their aquatic home.

—By Alan Raflo.

Water Central *thanks botanist Nancy Mignone; Gary Moore (Va. Department of Conservation and Recreation); and Erik Nilsen, Duncan Porter, and Tom Wieboldt (all of the Virginia Tech Biology Department) for providing information for this article.*

Scientific Names of Plants Mentioned

(* indicates plant not found wild in Virginia)

American Pondweed (*Potamogeton nodosus*)
Bald Cypress (*Taxodium distichum*)
Bulrushes (Many species of *Scirpus*)
*Chinese Water Chestnut (*Eleocharis dulcis*)
Common Arrowhead (*Sagittaria latifolia*)
Cattail (*Typha latifolia*)
Common Elodea (*Elodea canadensis*)
Coontail (*Ceratophyllum demersum*)
Curly Pondweed (*Potamogeton crispus*)
Eelgrass (*Zostera marina*)
Eurasian Watermilfoil (*Myriophyllum spicatum*)
Fanwort (*Cabomba caroliniana*)
Giant Reed (*Phragmites australis*)
*Giant Salvinia (*Salvinia molesta*)
Horned Pondweed (*Zannichellia palustris*)
Hydrilla (*Hydrilla verticillata*)
Leafy Pondweed (*Potamogeton epihydrus*)
Muskgrasses (*Chara braunii*, *C. zeylanica*, and *Nitella flexilis*)
Naiads: Northern (*Najas flexilis*); Slender (*N. gracillima*); Southern (*N. guadalupensis*)
*Papyrus (*Cyperus papyrus*)
Redhead-grass (*Potamogeton perfoliatus*)
Sago Pondweed (*Potamogeton pectinatus*)
Sedges (Many species of *Carex* and other genera)
Slender Pondweed (*Potamogeton pusillus*)
Smaller Duckweed (*Lemna minor*)
Water Chestnut (*Trapa natans*)
Water Hyacinth (*Eichhornia crassipes*)
Water Lily (*Nymphaea odorata*)
Water Stargrass (*Heteranthera dubia*)
Water Velvet (Species of *Azolla*)
Watercress (*Nasturtium officinale*)
Water-weed (*Egeria densa*)
Widgeon Grass (*Ruppia maritima*)
Wild Celery (*Vallisneria americana*)
Wild Rice (*Zizania aquatica*)

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Further Reading on World Wide Web

The Web-sites of the U. S. EPA's Chesapeake Bay Program and of the Virginia Institute of Marine Science (VIMS) have a substantial amount of information on submerged aquatic vegetation in the Chesapeake Bay. For the Bay Program: www.chesapeakebay.net/; for VIMS: www.vims.edu/bio/sav/index.html.

The Center for Aquatic and Invasive Plants at the University of Florida, has a photo gallery, information on some 70 plants, and other resources. Located at http://aquat1.ifas.ufl.edu.

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 October 28. Unless otherwise noted, all localities mentioned are in Virginia. Summaries by guest writer David Mudd.

In Virginia...

•The National Rural Water Association has ranked Virginia 15th in the country for the effectiveness of its safe drinking-water program. The organization gauged each state's effectiveness by analyzing Safe Drinking Water Act compliance reports submitted to the U. S. Environmental Protection Agency (EPA) over the past four years. The study is available on the Association's Web-site, www.ruralwater.org/. (08/31/00)

•The Virginia Department of Environmental Quality (DEQ) is proposing **new standards for dissolved oxygen** for some state waters. According to the proposal, at certain times of the year natural events in these waters—such as reduced flows and decomposition of vegetation—lead to dissolved oxygen levels below standards. The department wants allowances for such natural variation. The last of three public hearings on the matter is scheduled for December 8th, with comments accepted until December 22nd. For more information, contact Elleanore Daub at (540) 698-4111, or go to the DEQ Web-site at www.deq.state.va.us/water/wqstnd.html.

•The U.S. Geological Survey (USGS) is trying to get **a better look at a 56-mile wide crater** created some 35 million years ago when a comet or asteroid plummeted into the Atlantic Ocean near what is now the mouth of Chesapeake Bay. In Summer 2000, the USGS drilled a deep hole just inside the rim of the crater near Hampton and began setting off tiny explosions—equivalent to shotgun blasts or slightly stronger—to help construct a seismic reflection of the rim. One goal of the work is to gain a better understanding of the crater's effect on groundwater in the region. (*Water Online News*, 09/08/00)

•The Chesapeake Bay Foundation's annual **State of the Bay** report was published in September. On a scale of 1—100, the Bay scored 28, the same as last year's score. To generate the score, the Foundation rates 13 factors, including populations of several shellfish species; the number and health of herons; several water-quality measures ; and the extent of submerged vegetation, wetlands, forested buffers, and open lands. Current conditions are compared to the conditions the Foundation estimates would have been seen 400 years ago (before European settlement); those hypothetical conditions are assigned a score of 100. Believing the Bay might eventually reach a score of about 70, the Foundation hopes to see a 50 by 2010. To request a printed copy of the report, phone the Foundation's Annapolis headquarters at (410) 268-8816; or read it on-line at www.cbf.org. (*Washington Post* and *Baltimore Sun*, 09/21/00; *Bay Journal*, October 2000)

•Several large municipal water systems in the region—including Washington, D.C., Norfolk, Virginia Beach, and Portsmouth—have **changed their methods for purifying drinking water**. The systems switched in October from chlorine to a chlorine-ammonia mix called **chloramine**. The switch brings these municipalities into compliance with tougher national standards imposed by the EPA to address concerns over possible cancer-causing effects of some of the by-products of chlorination. Chloramine brings its own complications, though. The ammonia may affect kidney-dialysis patients as well as aquarium fish, so officials are recommending home filters for anyone concerned about such effects. (*Virginian-Pilot*, 10/03/00 and *Washington Post*, 10/11/00)

•In August, the Atlantic States Marine Fisheries Commission passed a resolution completely **restricting for at least six months the catch or sale of Spiny Dogfish** (a type of shark) from all state and federal waters between Maine and Florida. Over the past decade, Spiny Dogfish's popularity in French cooking and in Britain's fish-and-chip eateries has led to over-fishing, according to the Commission. Virginia took in an estimated 392,000 pounds of the fish in 1998, up from zero pounds only eight years earlier. The Commission has reported a 50-percent drop in the presence of mature female Dogfish in the Atlantic since 1989 and said 1997 was the worst breeding year ever recorded. (*Virginian-Pilot*, 08/28/00)

•In another matter before the Atlantic Fisheries Commission, Virginia has agreed to **stricter limits on Horseshoe Crab fishing** in state waters. Conch fishers use Horseshoe Crabs as bait. After resisting for some time the quota suggested by the Commission, the Virginia Marine Resources Commission agreed in October to accept a cap this year of 152,000 crabs, less than half its requested quota of 355,000. Virginia did secure the commission's approval for **quota trading**, under which Virginia fishers could take more than the accepted state limit as long as another member state agrees to restrict its take accordingly. (*Washington Post*, 10/25/00)

In addition to their use as bait, **Horseshoe Crabs' blood chemistry** makes them valuable to medical labs. Their blood has a coagulant used by labs to detect bacteria that may foul certain drugs and contaminate devices such as pacemakers. The animals used for this purpose are often released after the blood is drawn, but an estimated 15 percent don't survive the experience. A current study at the Virginia-Maryland Regional College of Veterinary Medicine is seeking ways to reduce that mortality rate, along with better ways to monitor Horseshoe Crab populations. (*Summer-Fall 2000 Newsletter*, Va.-Md. Veterinary College)

…and Outside of Virginia

•While most people are content to wait for the ferry **to get from Martha's Vineyard to Nantucket**, Australian James Pittar proved there's another way—**he swam**. He's the first person known to have completed the 14-mile stretch between the Massachusetts islands, a record all the more remarkable because Pittar's legally blind. Kayakers using whistles kept him on course. (*Christian Science Monitor*, 07/25/00)

•In May the National Drought Policy Commission urged Congress to pass a **National Drought Preparedness Act**. The Commission's report, *Preparing for Drought in the 21st Century*, suggests measures to increase drought education, promote research into monitoring and prediction, encourage better drought planning, establish assistance programs that reward conservation, and set up a council to coordinate drought programs administered by federal and state agencies. The report is available on-line at www.fsa.usda.gov/drought.finalreport/.

•Maryland has completed its first comprehensive **survey of freshwater streams in the state**. The study assessed 8,800 stream miles by looking at 1995-1997 data on fish, reptiles, amphibians, and aquatic invertebrates from 1,000 monitoring sites. The results are not good, according to Maryland Secretary of Natural Resources Sarah J. Taylor-Rogers, who said, "In a word, [the streams'] condition is stressed." Ten percent of the state's streams are considered healthy, 50 percent unhealthy, and 40 percent not unhealthy but showing signs of stress. To request a copy of the report, contact Ann Smith at (410) 260-8611; e-mail: asmith@dnr.state.md.us.. A summary is available on-line at www.dnr.state.md.us. (*Washington Post*, 09/25/00)

•At the American Chemical Society's annual meeting in Washington, D.C., last August, Paul Waters of American University reported on **a gasoline additive that he claims reduces harmful auto emissions by 70 percent**, boosts engine power by 10 percent, and increases mileage by 20 percent. The additive, called **polyisobtutylene**, possibly could replace MTBE (methyl tertiary butyl ether), currently the most widely used gasoline oxygenate. (MTBE has been the cause of numerous groundwater contaminations nationwide.) The additive is being tested in several states and in Japan, China, and Ireland. (*Washington Times*, 08/25/00)

•**American Shad** are running the length of the **Susquehanna River** once again. With the completion of a fish ladder in June at the York Haven Dam just south of Harrisburg, Penn.—one of four now in operation on the river—the species can return to waters that haven't seen their kind in nearly a century. Shad decline in the Susquehanna since the 1800s (one report claims that 15 million were caught over four days in a single seine at the river's mouth in 1827) is attributed in large part to over-fishing, but dams have also contributed by blocking the return of the migratory fish to their spawning waters. In the mid-1980s, governmental and private groups began restocking rivers and the Chesapeake Bay. By that time, construction of the ladders on the Susquehanna had begun as well, and the numbers of Shad passing through those ladders is on the rise. A record 36 million Shad were stocked in the Bay and its tributaries in 2000. (Alliance for the Chesapeake Bay's *Bay Journal*, September, 2000)

•In a bigger-fish story, the Tennessee Valley Authority (TVA) and several partners have reintroduced 800 young **Lake Sturgeon** to the French Broad River in Tennessee. The species, which grows to seven feet or longer, was nearly eliminated from the Tennessee basin by pollution, over-fishing, and habitat changes. TVA claims that improvements in water quality and flows now make it possible for Lake Sturgeon to survive and, it is hoped, establish a self-sustaining population. Plans call for releasing more young sturgeon over the next eight to ten years. (*TVA River Neighbors*, September, 2000)

•In September, Frederick County, Maryland, passed an **ordinance regulating the location of large hog farms in the county**. The ordinance prevents operations with more than 1,000 hogs from locating within a half-mile of residential areas or within a mile of waterways designated scenic, and it calls for yearly inspections of large operations by county officials. It's the first ordinance of its kind in the state. (*Washington Post*, 09/15/00)

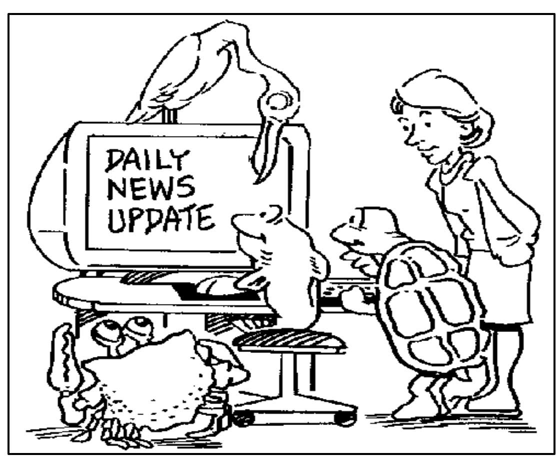
•In September, the U. S. Senate voted to study the advisability of independent reviews of the policies and activities of the U. S. Army Corps of Engineers. The vote followed publication of a *Washington Post* series that raised a number of issues about the Corps review of water projects. The vote quashed an effort by Sen. Russell Feingold (D-Wisc.) to pass an amendment requiring immediate independent reviews of all Corps analyses of major water projects around the nation. The two sponsors of the successful amendment promised to hold hearings next year on the issue. (*Washington Post*, 09/22/00)

•Maryland and federal environmental authorities are concerned about a series of **sewage system problems in Baltimore** that have led to spills of more than 15 million gallons of raw sewage since July. Like many large U. S. cities, Baltimore depends on an aging system of tunnels, pipes, and storm sewers. City officials say maintaining the system grows more difficult as pipes age and demand increases, but state and federal officials—as well as some civic groups in the city—have questioned whether the city has committed enough resources to keep the system operating as well as it should, no matter its age. The city has spent $100 million on upgrades to the system in the past ten years and plans to spend $100 million more by 2007. (*Baltimore Sun*, 09/22/00)

•In September, scientists discovered the worst outbreak of **fish disease in North Carolina's Neuse River** in at least three years. The state's Division of Water Quality said 42,000 fish died in one weekend in areas of the lower Neuse, near New Bern, from a disease that caused bloody lesions. The microbe *Pfiesteria* has been blamed for similar large kills in the past, but scientists determined it was not the culprit in this recent outbreak. Testing continued. (*Raleigh News and Observer*, 09/28/00 and 09/29/00)

•The October 11 **spill of 210 million gallons of coal slurry** from a mine sediment pond in southeastern Kentucky has been called one of the worst ecological disasters ever in the southeastern United States. The slurry—a mixture of water and by-products of coal processing, including toxic metals—covered bridges and lawns, smothered aquatic organisms, and fouled municipal water pipes as it made its way into the Big Sandy River and the Ohio River. Its effects may last for years. Even so, as one federal official said, it could have been worse: In 1972, a similar spill killed 125 people along Buffalo Creek in the same part of Kentucky. Questions are now being raised about building slurry ponds above abandoned mine shafts, as the operator of the mine where the spill occurred had done. A 1997 study by the federal Mine Safety and Health Administration identified 219 slurry ponds nationwide as "potential problems." (*Washington Post*, 10/28/00)

•Finally, here's a comment about **the power of time and biology**. The Chesapeake Bay Foundation has placed some 1.5 million oysters into the Bay and its tributaries in recent years, trying to restore this key organism in the Bay ecosystem. Oysters are filter-feeders, and at one time the Bay contained enough of them to filter all of its water in about five days; the number now remaining take more than a year. In a recent news article, one Bay Foundation fisheries scientist had this to say about the oyster restoration effort: "We recognize that our one million oysters are a drop in the bucket. But when they spawn, that's what is going to fill the bucket." (Hampton Roads *Daily Press*, 08/03/00)



Don't forget: You can follow water-related news on-line with at www.vwrrc.vt.edu.

N O T I C E S

On the Public Calendar

•**Dec. 13**—State Water Control Board, 9:30 a.m., General Assembly Building, Richmond. For more information, contact Cindy Berndt via the Va. DEQ Central Office in Richmond at (804) 698-4000, or toll-free in Virginia, (800) 592-5482.

•**Dec. 15**—House Committee on Conservation and Natural Resources (considering carry-over legislation), 1 p.m., Gen. Assembly Bldg., Richmond. For more information, contact Hudaidah Bhimdi at (804) 698-1540.

•**Dec. 19**—Commission on the Future of Virginia's Environment, 2 p.m., Gen. Assembly Bldg., Richmond. For more information, contact Brian Taylor at (804) 698-7450.

Source Water Protection Symposium

The American Water Works Association will hold the symposium January 28—31, 2001, in Savannah, Ga. Early registration is due by January 8. For more information, phone (800) 926-7337; Web-site www.awwa.org.

Maryland's Streams are in the Movies

"Maryland's Streams: An Undiscovered Realm" is a 30-minute video by the state Dept. of Natural Resources (DNR). Copies are available for $10. Phone (410) 260-8611; e-mail: asmith@dnr.state.md.us.

The Status of Virginia's Oysters, 1999

This 36-page publication is available from Va. Sea Grant. For more information, phone Sea Grant at (804) 982-5965; e-mail: phf7b@virginia.edu (Pauli Fitzgerald).

CORRECTION FROM THE PREVIOUS ISSUE OF *WATER CENTRAL*

Challenged by readers who argued that Abraham Lincoln did not actually say what was attributed to him on page 1 of the June-August 2000 issue, *Water Central*'s Historical Tidbits Division went to work. We stand corrected: Lincoln did *not* first say that, if he had more time, he'd write a shorter letter. Neither did Mark Twain, as our challengers maintained. In fact, according to the *Oxford Dictionary of Humorous Quotations* (1995), it was French philosopher Blaise Pascal (1623-1662) who said, "I have made this [letter] longer than usual, only because I have not had the time to make it shorter."

At the Water Center

For more information about any item below, call the Water Center at (540) 231-5624; e-mail: water@vt.edu; or visit www.vwrrc.vt.edu

Oyster Reef Communities in the Chesapeake Bay (CD-ROM), is now available for loan from the Water Center. This CD includes sections on oyster reef ecology, oyster-related research, and ways to learn more about oyster reefs in the Bay and become involved in restoration. Written for educators and the general public.

New Scientific Paper: Thomas J. Burbey, Tamim Younos, and Eric T. Anderson. Hydrologic analysis of discharge sustainability from an abandoned underground coal mine." *J. American Water Resources Association*, Vol. 36, No.5: 1161-1172. Reprints are available.

Conference Announcement: "An International Symposium on Integrated Decision-making for Watershed Management", hosted by Virginia Tech and co-sponsored by the U. S. EPA and the Water Center. **January 7—9, 2001**, in Chevy Chase, Md. The goals of the symposium are to present the state of the art in decision-making processes and decision-support tools, and to identify priority needs for improving and facilitating decision making for watershed management. For more information: www.conted.vt.edu/watershed.htm; e-mail: bosch@vt.edu (Darrell Bosch).

New Research Projects:

•The Va. Tech Service-Learning Center and the Water Center have received a Corporation for National Service grant to study **water quality problems in the Stroubles Creek watershed**. For more information: Tamim Younos at the Water Center, tyounos@vt.edu).

•William Cox, Professor of Civil and Environmental Engineering at Va. Tech, is leading a new **water-supply planning** study funded by the Va. DEQ through the Water Center. The researchers seek to establish a framework for an expanded state role in water-supply planning. The intent is to enhance the ability of state government to anticipate water-supply problems and conflicts, evaluate alternative responses in a timely manner, and provide the basis for state government to assist local governments' water-supply planning and implementation.

FOR THE RECORD

Sources for Selected Water Resources Topics

Aquatic-life Information Sources

How many species of fish are found in the James River? What kinds of amphibians inhabit the different parts of Virginia? What species of freshwater mussels are endangered in Virginia? These are some of the innumerable questions one could ask about current conditions for aquatic life—fish, amphibians, birds, insects, plants, and many other organisms. The following are a few sources of information nationwide and in Virginia.

(The symbols before the sources listed indicate how one can get information: 🕸 = on the source's World Wide Web site; 🗍 = from publications by the source; ☎ = from people at the source.)

🕸 🗍 ***The Status and Trends of Our Nation's Biological Resource*** is published by the U. S. Geological Survey, Biological Resources Division. The 1000-page/two-volume report is available for $98 from the U. S. Supt. of Documents, (202) 512-1800 (stock # 024-001-03603-7). The report is also available on-line at http://biology.usgs.gov/ (click on "Publications" under "Science").

🕸 **National Biological Information System (NBII)**; Web-site: www.nbii.gov. According to the NBII Web-site, this system is "a gateway to [the enormous wealth of biological data on the Web]...organizing [the information] according to topic and discipline...." The Web-site also includes an **Image Gallery** of plants and animals.

🕸 ***Waterfowl Population Status***, published annually since 1994 by the **U. S. Fish and Wildlife Service**, Dept. of the Interior, Washington, D.C. Available on-line at http://migratorybirds.fws.gov. The agency's main Web-site, www.fws.gov/, has information on a long list of topics (such as "aquatic nuisance species" or "seabird mapping").

🕸 **The Virginia Fish and Wildlife Information Service**. This Web-based system has classification, biological, and geographic information on the major groups of aquatic and terrestrial animals in Virginia. Located on the Va. Dept. of Game and Inland Fisheries Web-site at www.dgif.state.va.us/wildlife/index.cfm (click on "Wildlife Information Online").

Especially For Rare/Endangered Species

🕸 ☎ **Natural Heritage Programs**.

Natural heritage programs provide information on rare organisms and ecological communities. The Natural Heritage Network (Web-site: www.heritage.tnc.org/) helps state and regional programs standardize and share their information. Virginia's program is the Division of Natural Heritage, Va. Dept. of Conservation and Recreation, Richmond, (804) 786-7951; Web-site: www.state.va.us/~dcr/vaher.html.

🗍 ***Virginia's Endangered Species***, Karen Terwilliger, ed., 1991. Va. Dept. of Game and Inland Fisheries (VDGIF), Richmond; 672 pages. Focusing mainly on about 250 specific organisms, the book also has good general information on Virginia's biological habitats and communities, including aquatic groups. Larger libraries may have a copy, or you can order a copy ($40 soft-cover, $70 hard-cover) from McDonald and Woodward in Granville, Ohio, (800) 233-8787.

A shorter source of similar information is the *Field Guide to Virginia's Endangered Species*, available for $15 from VDGIF's Wildlife Diversity Division, (804) 367-8999.

🕸 **Association for Biodiversity Information**. NatureServe™ is an on-line encyclopedia for "conservation information on 50,000 plants, animals, and ecological communities in the United States and Canada," according their Web-site, www.natureserve.org/. The site has organisms' scientific and common names, geographic distribution, and other information.

Upcoming "For the Record" Schedule

Issue 15 – Water Maps: Types and Sources
Issue 16 – Groundwater Information Sources
Issue 17 – Coastal/Marine Information Sources
Issue 18 – Drinking-water Information Sources
Issue 19 – Water-quality Information Sources
Issue 20– Water-quantity and Hydrologic Information Sources

Schedule subject to change

Virginia Water Central

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Water Central staff: Alan Raflo, editor; George Wills, illustrator.

Attention Web-crawlers!

Water Central is available on the Water Center's Web site, **www.vwrrc.vt.edu**. If you prefer to read the newsletter there, *instead of* receiving a paper copy, please send your e-mail address to water@vt.edu, and we will notify you when a new issue is posted.

YOU GET THE LAST WORD

Please answer the following questions to let us know whether the newsletter is meeting your needs. Please mail this page to the Water Center address listed in the box to the left, or e-mail your responses to water @vt.edu. Thank you.

1. Would you rate the content of this issue as good, fair, or poor?

2. Would you rate the appearance as good, fair, or poor?

3. Would you rate the readability of the articles as good, fair, or poor?

4. Is the newsletter too long, too short, or about right?

5. Do the issues come too frequently, too seldom, or about right?

6. Please add any other **comments** you wish to make.

Virginia Water Resources Research Center
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