Virginia Water Central

Virginia Water Resources Research Center Blacksburg, Virginia June--August 2000

Summer 2000 Rolled Up into One Expanded Issue

Abraham Lincoln, so I have read, once ended a letter by saying that, if he'd had more time, he could have written a shorter letter. Perhaps, then, he would have approved of our taking an extra two months to bring you *one*—not two—issues of *Water Central* this summer.

This issue has the regular *Water Central* items on pages 2—20. Our print edition also included a 12 page insert of information on the **Virginia Water Research Symposium 2000**, to be held November 7—9 in Richmond. If you are reading this issue on the Internet, please go to www.vwrrc.vt.edu/announcements/symp2000.htm to see the tentative program and registration instructions.

The late J. Paxton Marshall, to whom this issue is dedicated, was a good friend to Virginia, to Virginia Tech, and to me. I think no one better understood Honest Abe's point about taking time to write carefully.

–The editor

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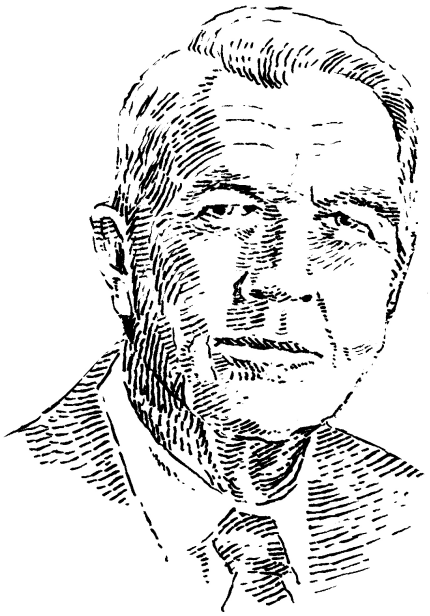
Virginia Water Research Symposium Program and Registration Form: www.vwrrc.vt.edu/announcements/symp2000.htm



J. Paxton Marshall

Precise in his writing,
a leader in his communities,
of unquestioned integrity in public service,
generous in his friendships, and
a model of reasoned judgment in action.

This issue of *Virginia Water Central* is dedicated to the memory of James Paxton Marshall, July 31, 1922—June 16, 2000; Virginia Cooperative Extension specialist in public policy, 1967—1995.

Virginia Tech
VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

FEATURE ARTICLE

Reflections on the Water in the 2000 Virginia General Assembly

In the last issue (April 2000) of *Water Central*, the Feature listed 125 water-related bills considered by the 2000 session Virginia General Assembly. Of these, 80 passed, 20 failed, and 25 were carried over to 2001.[1]

Each year, following our inventory of water legislation, *Water Central* asks a variety of Virginians their opinion of the most significant water-related bills from the previous legislative session. This year, we conducted a mail survey of 100 water professionals, state legislators, news reporters, and individuals or organizations chosen randomly from the *Water Central* mailing list. The survey asked recipients three questions: if they followed water-related legislation; if so, what specific bills interested them; and what bill or bills they considered *most* important. This article reports the choices and comments from the 48 people who responded. (Please see page 3 for additional survey details.)

Survey respondents who wished to remain anonymous are not identified in any way with their bill choices and comments. Other respondents who commented are identified by name, location, and affiliation if they represent an organization.

Many Measures Mentioned

Respondents identified 33 distinct bills or resolutions, here collectively called "measures." On the following page is a table listing the measures mentioned by at least one survey respondent. The list is in order of the number of people mentioning the measures, which is shown in the right column. House measures are identified as HB for bills and HJ for resolutions; Senate measures as SB or SJ. Identical House and Senate bills are listed as only one measure. Some survey respondents cited topics of interest but not specific bills; those topics are listed at the end of the table.

Of the 33 measures identified by survey resondents, 14 bills or resolutions were cited by one or more respondents as the *most important* water-related legislation of the session. In the table, the number of people doing so is shown in parenthesis in the right column. Most of these 14 measures passed, but two were carried over, and one failed.

Text continues on page 4

[1] The April 2000 *Water Central* incorrectly listed SB 613 and 616—bills #22 and #23 in the April list—as passed, when in fact these two bills were carried over. *Water Central* thanks Robert Taylor of the Va. Dept. of Health for pointing out our error.

Virginia General Assembly (2000) Water Measures Watched by 48 People Responding to June 2000 Survey*

Bill, resolution, or general topic (no specific bill) followed	# respondents following (with # citing as most important)
1. HB1170/SB684, Wetlands permitting—Passed	18 (15)
2. HB30, Budget bill—Passed	9 (6)
3. HB404/SB179, Monitoring for toxic substances in state waters—Passed	9 (4)
4. SB177, Permits and financing for small, private sewage systems—Passed	5 (2)
5. HB1282, Water reclamation and reuse—Passed	5 (1)
6. SB645, Water-quality monitoring and reporting—Passed	4 (1)
7. HB1306/SB664, Tax credits for riparian forest buffers—Passed	3 (1)
8. HB106/SB48, Sales tax exemption: Soil and Water Conserv. Districts—Passed	2 (1)
9. HB681, Local recycling and waste disposal—Passed	2
10. HB909, Methyl tertiary-butyl ether (MTBE) in public water supplies—Passed	2
11. HB1165, Freedom of Information Act; record exemptions—Passed	2
12. HJ149, Roanoke River Basin study—Passed	2
13. HJ161, Shenandoah Valley groundwater study—Passed	2 (1)
14. SB613, Va. Resources Authority and water-supply funds—Carried Over	2 (1)
15. SB616, Water-supply revolving fund—Carried Over	2 (1)
16. HB323, Claims related to water supply in a Fauquier Co. subdivision—Passed	1
17. HB552, Protection of farm and forest lands—Passed	1
18. HB600, Va. Land Conservation Foundation: grants to localities—Passed	1
19. HB624/SB296, Lake-level contingency plans—Passed	1
20. HB712, Natural Resources Policy Act—Carried Over	1
21. HB880, Effects of underground coal mining on surface water—Carried Over	1
22. HB945, Soil and water conservation dams—Passed	1 (1)
23. HB1164, Va. Land Conservation Foundation: membership, grants, geographic coverage—Passed	1 (1)
24. HB1217/SB712, Environmental laboratory certification—Carried Over	1
25. HB1305, Marine Habitat and Waterways Improvement Fund—Passed	1
26. HB1324, Open-Space Lands Preservation Trust Fund—Passed	1
27. HJ12, Chesapeake 2000 Agreement's development provision—Failed	1 (1)
28. HJ261, Farm and forest lands—Passed	1
29. HJ301, Virginia Naturally environmental education initiative—Passed	1
30. HJ372, Sustainable forestry initiative—Passed	1
31. SB705, Dumping of motor oil and anti-freeze—Failed	1
32. SJ79, Submerged aquatic vegetation study—Passed	1
33. SJ217, Urban best management practices study—Failed	1
Topic: Chesapeake Bay—tributaries, fisheries, water quality	3 (1)
Topic: Total Maximum Daily Loads (TMDLs)	2 (1)
Topic: Development-impact fees for facilities, including water-related facilities	1 (1)
Topic: Water utilities	1
Did not follow water-related legislation	15

*The recipients were in two groups:
1) 47 individuals or organizations chosen randomly from the *Water Central* mailing list, May 23, 2000;
2) 53 people selected intentionally from water-related state agencies; businesses; interest groups; news media; and the General Assembly, specifically the House Appropriations, Senate Finance, House Conservation/Natural Resources, and Senate Agriculture/Natural Resources committees.

The surveys were mailed May 23, 2000, from Blacksburg with a self-addressed stamped envelope enclosed and requesting a response by June 12. Forty-eight people responded.

Text contiued from page 2

Respondents Choose and Speak

The first seven bills listed above were followed by three or more people, as well as being cited by at least one person as the *most* important water-related measure of the session. Let's look at these seven in more detail.[2]

1. HB1170/SB684, Non-tidal Wetlands Protection Program.

Summary: This bill requires that those proposing to conduct certain activities in **nontidal wetlands** (wetlands away from the coast and which contain water only at certain times of the year) first obtain a Virginia Water Protection Permit from the Water Control Board. The Board must establish both *individual* and *general* permits for such activities, with the general permits applicable to activities affecting less than one-half acre of wetlands. The permits will require compensatory actions, known as **mitigation**, for adverse impacts to wetlands. Normal agricultural and silvicultural activities are exempt from the permit requirement.

The bill also directs the Water Control Board "generally to establish and implement policies and programs to protect and enhance the Commonwealth's wetland resources." The Board is to use a *regulatory* approach to achieve the goal of no net *loss* of state wetlands and a *voluntary* approach to achieve a net *gain*.

The bill also clarifies that wetlands are state waters under the State Water Control Law, and it requires the Water Control Board to seek a Clean Water Act/Section 404 "State Programmatic General Permit" from the U.S. Army Corps of Engineers.

Resondent Comments: This was "easily" the most important water-related legislation of the session, according to one respondent. Other respondents agreed. Del. Vic Thomas (D-17th) called it the most important water-related bill "of this year or any recent year." Sen. Patricia Ticer (D-30th said, "Without it, we could have lost much of our non-tidal wetlands under the Tulloch court decision." Kay Slaughter, at the Southern Environmental Law Center in Charlottesville, said the wetlands bill was "undoubtedly" the most important one passing this year. And citizen Susan Collins, of Prince George, called protection of existing wetlands "crucial because of their many ecological and economic benefits."

Robert G. Burnley, at the Virginia Economic Development Partnership in Richmond, noted the bill's "potential impacts on water quality, [by] stopping...practices which may reduce the state's wetlands acreage, *and*...on economic development." Ms. Slaughter spoke to the potential economic impacts as well: "It was important that this bill addressed many of the concerns [of] the business community, [and it] should be able to balance the need for wetlands impacts with the need to mitigate those impacts...."

Several people requesting anonymity also had comments on the wetlands bill:

- The bill "marked a signifcant change in policy-makers' willingness to address comprehensive wetlands protection...The results came after a strong grass-roots effort...from a...surprisingly diverse group" of supporters of the bill.
- The bill appeared to show a compromise among three general positions within the General Assembly: "development at all cost, some protection of the environment, or strong environmental protection."
- "In ways not yet understood" the bill may have "a very significant impact upon... development and land use."
- The bill "changes the regulatory structure for wetlands in a substantial way."
- Such a bill "has been needed for more than a decade, but [is] critical now, especially in lower Hampton Roads."

[2] The summaries presented are adapted from the Virginia Legislative Information System, an Internet-based source for the content and status of General Assembly legislation. Please see last page of this article for more information about this and other sources for learning about specific legislation.

2. HB30, Budget bill.

Summary: The budget bill makes appropriations for the 2000-02 biennium.

Respondent Comments: "[The] state budget!!" With that, Del. Robert Bloxom (R-1st) gives his choice of the most important water-related bill. It's hard to argue with him: no bill is effective unless the state appropriates money to implement or enforce its provisions. For some perspective, here are the *total* budgets (including non-water-related items) for the biennium for four of the most important natural-resource agencies in Virginia:
Dept. of Environmental Quality (DEQ): $270,781,611;
Dept. of Conservation and Recreation (DCR): $130,153,303;
Dept. of Game and Inland Fisheries (DGIF): $83,074,610; and
Marine Resources Commission (VMRC): $28,970,373.

Collectively, the six people (including Del. Bloxom) who cited the budget's significance to water resources mentioned several particular budget items:

- **Water Quality Improvement Fund.** This fund provides grants to local governments, soil and water conservations districts, institutions of higher education, and individuals for water-pollution prevention, reduction, and control programs. The fund has $28.85 million for Fiscal Year 2001: $16.85 to support the point-source pollution program, and $12 million for the nonpoint-source pollution program.
- **Citizen monitoring.** The Department of Environmental Quality's (DEQ's) budget includes $462,000 over the biennium for water-monitoring and clean-up efforts by citizens groups, including $252,000 for sediment clean-up in the Elizabeth River; $100,000 for the statewide Citizens for Water-quality Monitoring Alliance; $60,000 to the Friends of the Shenandoah group; and $50,000 to the Virginia Izaak Walton League's Save Our Streams program.
- **Total Maximum Daily Loads (TMDLs).** The DEQ's budget includes $1.3 million to support the work of developing TMDLs for the state's impaired waters.
- **BMP assistance.** The Department of Conservation and Recreation's (DCR's) budget includes $1 million of best management practices (BMPs) cost-sharing and $200,000 for BMP engineering.
- **Water-supply planning.** The DEQ's budget contains $850,000 to develop a statewide water-supply planning initiative.

3. HB404/SB179, Monitoring for toxic substances in state waters.

Summary: This bill increases requirements for the Water Control Board, the Department of Environmental Quality, and the Department of Health to monitor and report toxic substances in state waters, as follows:

<u>New requirements for the Water Control Board</u>
1) The Board's annual toxics report to the General Assembly should describe the segments of Virginia's waters "where there has been a commitment to conduct additional evaluation and monitoring of toxic substances."
2) Water segments identified in the state Water Quality Monitoring Plan are to be monitored at least once every three years, "contingent upon the availability of funding."
2) The Board is to review at least once every five years its technologies for toxic removal or remediation.
3) Citizens gain the right to petition the Board to include a water segment in the agency's monitoring plan; such an inclusion could result in the sampling fish tissue and sediments. The Board must respond to these petitions, but it is not *compelled* to include the requeted segments in the state water-quality monitoring plan. If the requested segment is not included in the plan, however, the Board must provide a written explanation of the petition denial.

New requirements for the departments of Environmental Quality (DEQ) and Health (VDH)

1) The DEQ must post on its Internet site results from fish-tissue and sediment monitoring for at least one year.
2) The DEQ and VDH must develop a memorandum of agreement "to ensure the timely exchange and evaluation of reliable water-quality and fish-advisory information between the two agencies."
3) The DEQ must develop a written policy identifying the circumstances and factors that would warrant an assessment of potential sources of toxic contamination.
4) The VDH must develop a written policy identifying the criteria used to determine whether toxic substances are present in levels high enough to warrant a fish-consumption advisory.
5) The departments' memorandum of agreement and written policies are to be submitted to the chairpersons of the General Assembly committees that have oversight of DEQ activities.

Respondent Comment: One respondent said that "increased monitoring by the State will affect the outcome of the 303(d) list of impaired waters and the Clean Water Act 305(b) reports, eventually affecting the total maximum daily loading studies, which may lead to effluent limitations and other additional regulations."

4. SB177, Small sewage treatment plants' financial assurance.

Summary: This bill requires owners of small, privately-operated sewage-treatment systems to obtain a pollution-discharge permit from the Water Control Board. (The systems addressed are those discharging between 1,000 and 40,000 gallons of effluent per day.) To obtain a permit, facility owners must file a plan for controlling, preventing, or containing any threat to public health or the environment if the facility ceases operation. Owners must also demonstrate the financial capability to terminate the facility properly. Penalties and cost responsibilities are identified for any owner "who ceases operations and knowingly and willfully fails to implement a closure plan…if such failure results in significant harm to human health or the environment.

Respondent Comment: "Dilapidated facilities…[going] into such decline without anyone being held accountable…could be a much under-estimated source of fecal coliform contamination in certain watersheds."

5. HB1282, Wastewater reclamation and re-use.

Summary: This bill requires the Water Control Board to "encourage and establish" requirements for reclamation and re-use of wastewater, as "an alternative to directly discharging pollutants" to state waters.

Respondent Comment: One respondent said that the bill could mean "significant changes to the equations for metting demands for water, by providing non-potable water where the use doesn't mandate potability. The key will be how fast the DEQ can come up with regulations to implement the law change."

6. SB645, Water-quality monitoring.

Summary: This bill increases both the number of water-quality monitoring stations and the frequency of sampling by at least five percent annually, with priority given to those water bodies for which there is "credible evidence showing impairment of the water body." Currently, monitoring and sampling are to be expanded so that the sampling effort will ultimately be representative of all river and stream miles in the state, but no statute requires expansion by a specific percentage annually. The stipulated expansion is contingent upon the appropriation of adequate funding.

No respondents commented on this bill.

7. HB1306, Riparian buffers tax credit.

Summary: This bill establishes a non-refundable income tax credit to individual or corporate owners of **riparian land** (land abutting a waterway) who "forbear harvesting timber on certain portions of the land near the waterway for 15 years." The amount of the credit is equal to 25 percent of

the value of the timber in the buffer, up to $17,500 (with a recapture provision if the timber is harvested before the end of the 15-year period). The State Forester is to develop guidelines and to certify individual plans of qualifying taxpayers.

Comment: Steve Mallette, of Locustville, said that this is "the first…credit provided to landowners that recognizes the financial contribution landowners have been providing for water quality [and] habitat protection."

Miscellaneous Comments

•From Neal Kilgore, of the Va. Division of Soil and Water Conservation: Three kinds of bills are important to "address long-term [water] priorities for the state:
1) bills that provide equitable funding across the state;
2) bills that address a broad range of issues, not just agriculture; and
3) bills that address water-quantity issues."

•From C. L. Tucker, of Powhatan: The Land Conservation Foundation [the subject of HB 600 and HB1164] is "probably the best tool available to help set aside in perpetuity pieces of land that will otherwise be developed, compromised, or destroyed."

•From an anonymous respondent: "It is important to require developers to show that there are adequate resources…and public facilities before they're allowed to build, so as not to put unncecessary strain on available water resources."

•From an anonymous respondent: SB613 and SB616, both carried over to 2001, "would kill the water-supply program—very dangerous legislation." [*Ed. note*: Presumably the respondent meant the water-supply *funding* program. SB613 would allow the Va. Resources Authority to pledge funds in the Water Supply Assistance Grant Fund as security for bonds of the Authority. SB616 would transfer administration of the Va. Water Supply Revolving Fund from the Board of Health to the Housing and Community Development Department.]

Conclusion

This article has mentioned only about one-fourth of the water-related legislation considered in the 2000 General Assembly. Further, it has dealt in detail with only a few bills. For ways to learn more about other recent legislation on water or any other topic, please see the suggestions in the box below.

The sample of opinion here is not based on a statistically valid survey. *Water Central* did not randomly sample the whole state, and our results obviously do not include the opinions of people who chose not to return their survey. Consequently, these results do not completely represent the state or even the people who received the survey. Rather than that difficult goal, we sought instead only to increase the amount of conversation about water-related issues in Virginia—to let more people have *a* word, not the *last* word.

For More Information on Virginia Legislation

Citizens can get a copy of any bill or resolution from the Legislative Bill Room, (804) 786-1895 (you will need to know the bill or resolution number). Internet users can find legislation easily. For every bill, the Legislative Information System (Web-site: leg1.state.va.us/) provides the full text, a summary, and a complete record of action on the bill; bills are indexed by subject, number, and committee.

One can also use the Legislative Information System Web-site for *budget* information. People without Internet access can get a copy of the budget from the Bill Room (see phone number above), or at one of the 13 state-depository libraries; call the Library of Virginia in Richmond at (804) 692-3562 to learn the location of the nearest state depository.

People without Internet access can request additional information on legislation or the budget by calling the Legislative Information *Office*: (804) 698-1500 for the House, (804) 698-7410 for the Senate.

Finally, don't overlook the time-honored method: call your local delegate or senator.

The opinions expressed in this article are not necessarily those of the Virginia Water Resources Research Center. Water Central is grateful to all the people who responded to the survey.

SCIENCE BEHIND THE NEWS

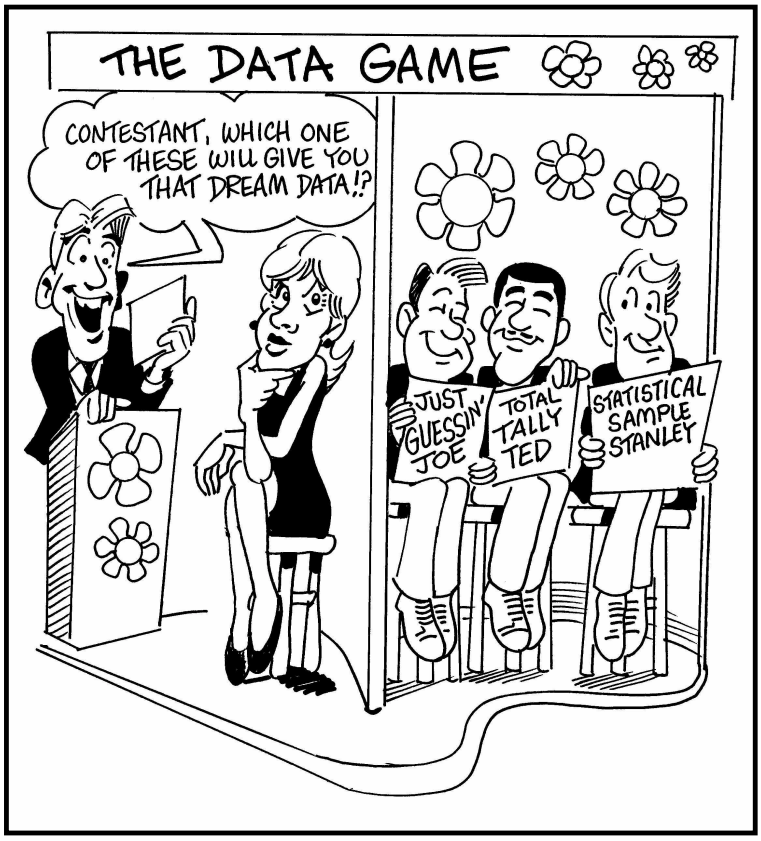
When Numbers Talk, They Speak Statistics

Have you ever been asked, "How's the water around here?" One might answer with an anecdote, such as "One time I got sick after swimming at the lake," or "*My* tap water tastes pretty good." Even if true, those observations would say little about the larger situation of "around here." To answer that question, one needs more information than is provided by isolated individual cases.

The science of **statistics** provides the concepts and tools for getting and using reliable information to help answer scientific questions. Proper use of statistics makes scientific studies more reproducible, comparable, and valid. Statistics also offers techniques for presenting scientific results more meaningfully. Statistics gives us a "systematic way to check out anecdotal evidence.... The science of statistics is there to teach us how to make honest, verifiable statements from data."[3]

Data, specifically *numerical* data, are the focus of statistics; statistics, then, is "the science of collecting and analyzing numerical data."[4] This article explores some key aspects of statistics—randomness, probability, and gathering data—and shows connections between these topics and Virginia's water-quality management efforts.

Will our cartoon character choose wisely? As you'll see, that statistical guy gives her a lot to consider.



Randomness and Probability

If you play Virginia's Lotto game—pick a combination of six numbers, choosing from the numbers between 1 and 42—would you ever play 1-2-3-4-5-6? Wouldn't it be very unlikely for combination to come up?

Yes, indeed! In fact, the odds for that particular combination being picked are about 7.1 million to one—same as the odds for *any* single combination. As long as the selection is done properly, each ball has an equal chance of being picked, so an ordered sequence of numbers is no less likely than a sequence with no pattern. In fact, even the previous week's winning combination is just as likely—or unlikely—to recur as any other combination. This is because the lottery balls are chosen by a **random** process.

Random outcomes—that is, outcomes selected by a random process—do not show any pattern in the short run, but they do show a pattern over many repeated trials. In the Lotto drawing, for example, the outcome of any individual event (that is, which set of six numbers will be picked) is not predictable. The long-term pattern is predictable, though: each six-number combination will occur an average of once every 7.1 million times.

A random outcome's long-term pattern is indicated by the outcome's **probability**. The probability of a random outcome is always

[3] Teresa Amabile, video series *Against All Odds: Inside Statistics*. See details in References section.

[4] *Oxford Dictionary and Thesaurus, American Ed.*, Oxford Univ. Press, 1996. The word "data" is plural; "statistics," is singular when it refers to the field of statistics but plural in other cases.

between 0 (indicating the outcome *never* happens) and 1 (the outcome *always* happens). A commonly used example is flipping a coin—the probability of getting heads is 0.5 (one chance in two) on every flip; the probability of getting tails is the same. No one knows whether a given flip will be head or tails, but we do know that the long-term frequency of each outcome is 0.5. "The idea of probability is that randomness is regular in the long run."[5]

Suppose, however, you flip a coin 10 times and it's heads each time. What is the chance of it being heads the next time? It's still 0.5.[6] Previous flips do *not* affect the probability of a given flip, nor do they give any information about subsequent flips, because the events are **independent**. For independent, random outcomes, the so-called "law of averages" is a myth: While random outcomes have a long-term pattern, that pattern does *not* necessarily show up in the short term. Independence of random outcomes is why, after a couple has three female children in a row, their odds of having a boy are still 50:50; and why having a "500-year storm" one year doesn't guarantee there won't be another one the following year.

When random outcomes are not independent of one another, they are dependent or **correlated**. Scientific studies frequently aim to detect if any correlation exists between random outcomes or the factors that affect such outcomes. Many studies of the Chesapeake Bay, for example, seek to identify factors correlated with the Bay's water quality, shellfish production, or other variables of interest.

Perhaps the key idea to remember about random variables, and randomness itself, is that things are random only in the context of how they are observed. Take the coin example again: unless the outcomes result from a *fair flip* with a *fair coin*, the results will not be random, and the probability of a heads or a tails will be altered.

A more relevant example comes from Virginia's water-quality monitoring program. According to the *1998 Water Quality Assessment (305b) Report*, prior to 1998 most monitoring stations were chosen based on the location of point-source dischargers (such as wastewater treatment plants). Recently, however, the Department of Environmental Quality "has included random stations [in order to] produce a more accurate and balanced portrayal of the state's overall water quality…." Adding more randomness to the monitoring method will change the probability of finding the true range of water-quality values in the state.

When the process of making observations is not random, the data generated will have some type of **bias**, a source of *consistent, systematic error*. Bias is a key consideration in gathering data, our next topic.

Gathering Data

Two fundamental data-gathering methods are **observation** and **experimentation**. For scientific and statistical purposes, observation is not just looking around; it involves careful measurement and recording. Scientific experiments include observation but have one fundamental difference from purely observational studies: an experimenter manipulates certain factors. This is known as applying a **treatment**; experimental results compare the response of treated objects to that of untreated objects (also known as the **controls**).

Whether by experimentation or by observation, a scientist gathers data in order to learn something about a particular **population** of objects or phenomena. The population of interest might be large (all Virginia streams) or small (the kinds of algae growing in a single pond), but it is always the *total* group about which one seeks information.

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[5] David Moore, *Statistics: Concepts and Controversies*, 1991 (p. 339). See details in References section.

[6] The probability of getting two heads in a row to start with, however, is not 0.5, but 0.5 x 0.5, or 0.25 (1 chance in 4). The probability of getting 10 heads in a row is 0.5 times itself nine times, or 0.001 (1 chance in 1000). The probability of *any* sequence of independent random outcomes is the *product* of the outcomes' individual probabilities.

"Hmmm...different opinions...lots of numbers...uncertainty about what it all means... Those reporters need some statistics!"

An individual member of a population is called a **unit**. Studying populations involves studying the number, characteristics, or actions of units. Typically, such features *vary* within a population, both over space and over time, so scientists refer to them as population **variables**.[7] When scientists study features of population units selected at random, they are studying **random variables**.

In gathering data about a population, a scientist aims for *accuracy* and *precision*. **Accuracy** is how close a measurement is to the actual value of the object or phenomenon being measured. If, for example, 500 fish inhabit a stream section, and "Total Tally Ted" counts 499 fish in the stream section, Ted's data would be very accurate.

Precision, comparatively, is how close measurements of the same object or phenomenon are *to one another* (when sampled by the same method, at the same or a comparable time, and under the same conditions). For example, if Ted counts the fish in the stream section three times, and gets results of 490, 492, and 491, his measurements are very precise (even though not as accurate as in the previous example). Precision indicates how consistent and repeatable the measurement methods are, and repeatability is an important aspect of scientific validity.

Sampling

Rather than observing or measuring a whole population, scientists normally observe a **sample**, a portion of the population. A **sample statistic** is a number that characterizes a sample. In so doing, a sample statistic *estimates* some characteristic of the population from which the sample was taken.[8] The whole field of statistics is largely the study and practice of using samples and sample statistics to make valid inferences about populations.

People choose to sample, rather than trying to measure a whole population, for three good reasons:
1) sampling is faster and less expensive;
2) in some cases, measurement destroys the objects being studied (for example, sampling fish usually results in the fishes' death), so a total count would be senseless;
3) sampling may actually be more accurate than total count. As one author puts it, "a careful sample of an inventory of spare parts will almost certainly give more accurate results than asking the clerks to count...500,000 parts in a warehouse."[9]

Here's a sampling situation related to Virginia's water resources. Virginia has over 49,000 miles of free-flowing rivers and streams. The state uses sampling to monitor the water quality of this population of stream miles. For example, the information on stream water quality in Virginia's *1998 Water Quality Assessment (305b) Report* came from a sample of 19,260 stream miles. On the other hand, Virginia has much smaller numbers of public lake acres and estuarine-water square miles, so the state did almost total counts in assessing those resources for 1998 (93 percent of lake acres and nearly 100 percent of estuarine waters were assessed).

The value of sample data depends on the data's accuracy and precision, because these factors determine how much the sample data tell us about the larger population. Accuracy and precision of sample data depend, of course, on a researcher properly performing whatever observation or measurement methods are being used. But even before a

[7] For example, in a population of dragonflies, age, size, and color will all vary somewhat among units. Number of legs, however, is not a variable, as all normal individuals will have six legs.

[8] Population characteristics are often referred to as population **parameters**. Sample statistics are estimations of population parameters.

[9] Moore, p. 7 in *Statistics: Concepts and Controversies*. See References for complete citation.

single measurement is recorded, the applicability of the sample relative to the population is largely determined by the **sample's statistical design**, that is, how one selects the units to be sampled.

Various sample designs exist, and the choice depends on the researcher's objectives, the money and time available, and the degree of accuracy and precision desired. For an introduction to statistics, the most fundamental design to understand is a **simple random sample**, in which *every unit has the same chance or probability of being chosen for the sample.* Such as sample is unbiased; its results tend to be repeatable; and its precision increases as the sample size (number of units sampled) increases.[10]

Virginia's stream-monitoring program currently is facing a sampling-design question. Recall, from the previous section on randomness and probability, that, prior to 1998, the state chose monitoring sites based on the judgment of water-quality professionals, in order to show water-quality trends at specific locations. That method of site selection was acceptable for that objective; it is not appropriate, however, if the objective is to characterize the state's water quality *generally*. To do that, the state must introduce randomness into its selection of monitoring sites.

Experimental Design

As noted above, in experiments some units receive treatments and others—the controls—do not.[11] The treatment is manipulation of a variable, a factor that is presumed to affect the outcomes being investigated. One measures the treatment's effect in an experiment, but the real question is its effect in the larger population of interest. The **experiment's statistical design** is the plan for ensuring that the experimental data allow valid conclusions about that larger population.

A statistically minded experimenter has these goals:
1) a sufficiently large sample of experimental units from the population;
2) no or limited bias; and
3) control of extraneous variables, so that they do not affect the experimental units, or at least so that the probability of an effect is equal for all units.

To accomplish these goals, the experimenter uses *randomization* and *replication*.

Randomization means that one randomly selects the units, randomly assigns them to treatment and control groups, and even uses a random order for making measurements. These steps eliminate or reduce biases (known or unknown) that would make the experimental results less representative of the larger population.

Replication means that more than one experimental unit is tested under each condition (treatment vs. control).[12] Replication is necessary because things vary randomly, even under the same conditions. It follows, then, that we should expect to observe some variation among all units treated alike in an experiment—among all control units, and among all treated units.

Given random variation, how can experimenters tell if a difference between a treated unit and a control unit is due to the treatment, or to random variation? The answer, they can't *without replication*. Without replication, only one comparison is possible, between one control and one treated unit. Any difference observed could be due to random variation, and we have no way to tell. *With replication*, though, more than one comparison is possible; the more comparisons one makes, the better one can judge whether observed differences are a real treatment effect or just the result of random variation.

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[10] In practice, a simple random sample is often too expensive, so people use variations, such as *stratified* random sampling and *systematic* random sampling. Consult a basic statistics text for explanation of these or other sampling designs.

[11] Even in observational studies one tries to control variables as much as possible by taking measurements under comparable conditions. For example, a water-quality monitor would want to use the same measurement method from one observation to the next.

[12] Replication is not the same as *repeated measurements* on a single experimental unit.

Stanley Summarizes

To illustrate some of this article's main ideas, we call upon our cartoon character Statistical Sample Stanley. Recall the opening question, "How's the water around here?", and the two anecdotal answers, one about becoming sick after swimming and the other about the taste of tap water. While you were reading this article, Stanley decided to check out those anecdotes by gathering some data, statistically. Here's what he did.

Anecdote #1: "One time I got sick after swimming at the lake." Stanley knows water contaminated with bacteria can make swimmers sick, so he asked this question: "Are there harmful bacteria in the lake during swimming season?" His *population* of interest was the lake water during swimming season, and he wanted to take samples to give him information about the population.

Stanley designed a *random sampling* program to check lake water for bacteria. As with any study, he had practical considerations: he was able to sample only eight spots in the lake on any one day, and he was able to sample only six days during the season. People swim and boat all over the lake, and the lake is not large, so he *randomly selected* six sample locations. Swimming season is April—September, so again he *randomly selected* eight days during this period on which to sample. Then he made his observations: the measurements of bacteria levels. At the end of the season, he had statistically useful data on the lake's water quality.

Anecdote #2: "My tap water tastes pretty good." Stanley wondered, "Do *all* the residents think their water tastes good?" He knows "good" is subjective and hard to measure out of any context. So Stanley asked a related question that he could test: "Do the residents of this town think the tap water tastes *as good as the locally best-selling bottled water*?" (Note that Stanley makes the assumption that people generally like the taste of the locally best-selling water.)

Stanley designed an *experiment* to answer this question. He *randomly selected* 100 people (his *experimental units*) from the town (everyone that lives in town is hooked up to the water line). Each person was told they would compare the taste of a brand of bottled water to local tap water. Unknown to participants, Stanley randomly assigned the people into two groups of 50. People in one group—the *treatment group*—got one glass of bottled water and one of tap water. People in the other group—the *control group*—got two glasses of the same bottled water. Stanley had 50 *replicates* both of the treatment and of the control.

People rated their samples of water as follows: unknown #1 was better, unknown #2 was better, or there was no difference. Stanley will see how many people out of 50 rated the tap water was at least as good as the bottled water. (He can use his control group to see how many people out of a *random* group of 50 would rate identical water differently.) When he finishes his analysis, he won't know if the tap water tastes good in general, but he can reasonably say whether it tastes as good as a good-tasting bottled water.

Note, however, that Stanley has not yet actually analyzed his results, nor has he drawn any conclusions. That's because he's waiting for you! Describing data and its variation, and making statistical inferences from data, are the topics in Part 2 of Science Behind the News' jaunt through statistics. Look for it in the December 2000 issue of *Water Central*.

References and Further Reading

Moore, David S. 1991. *Statistics: Concepts and Controversies, 3rd Ed*. W. H. Freeman & Co., New York (439 pages). The most helpful reference consulted for this article.

Porter, Theodore M. 1986. *The Rise of Statistical Thinking, 1820-1900*. Princeton University Press, Princeton, N.J. (339 pages). Discusses how statistical concepts developed among the physical, biological, and social science.

Smith, Eric P. 2000. "Sampling and Monitoring Design for 305(b) Program—Combining Probabilistic and Judgmental Sampling"; and
Smith, Eric P., *et al.* 2000. "Assessing Violations of Water Quality Standards Under Section 303(d)

of the Clean Water Act." Both in *Fiscal Years 1999 and 2000 Report of the Water Quality Academic Advisory Committee*, Special Report SR18-2000, Va. Water Resources Research Center, Blacksburg (68 pages).

🗍 Tietjen, Gary L. 1986. *A Topical Dictionary of Statistics*. Chapman and Hall, New York (171 pages). This is a useful, but advanced, reference ("one level below the professional statistician," in the author's words).

🗍 U. S. Environmental Protection Agency. 1996. *Volunteer Monitor's Guide to Quality Assurance Project Plans*. Publication EPA841-B-96-003. EPA Office of Wetlands, Oceans, and Watersheds, Washington, D. C. (59 pages). This free publication has good introductory information on precision and accuracy.

📽 "Against All Odds: Inside Statistics" (1989). By Annenberg/CPB in association with the American Statistical Association, this series (26 half-hour programs on 13 video cassettes) explains what statistics is, what its main tools are, and how these tools are used to answer scientific and public-policy questions. It's entertaining and gives many real-life case studies (Program #10, for example, discusses research on the Chesapeake Bay). May be available at your local library. To enquire about purchase: phone (800) 532-7637; Web-site http://www.learner.org/. (Mailing address is Annenberg/CPB Collection, P. O. Box 4069, Santa Barbara, CA 93140.)

📽 "Polling and Statistics" (1997). By Films for Humanities and Sciences, this program examines polling prior to the 1992 British elections and why the polls predicted the outcome incorrectly. 25 minutes. May be available at your local library. To enquire about purchase: write P. O. Box 2053, Princeton, NJ 08543-2053.

–By Alan Raflo

Water Central thanks Jeffrey Birch and George Terrell, both of the Virginia Tech Statistics Department, for their assistance with this article.

TEACHING WATER
For Virginia's K-12 teachers

This Issue and the Virginia Standards of Learning

In this section, *Water Central* suggests Virginia Standards of Learning (SOLs) supported by this issue's Feature and Science articles. We welcome readers' comments on whether the articles actually do, in fact, help teachers with the standards listed or with others that we have not listed.

Abbreviations: BIO - biology; CH - chemistry; ES - earth science; LS - life science.

Feature—Reflections on the 2000 Virginia General Assembly
Science SOLs: 6.11, LS.12, ES.7;
Social Studies SOLs: 7.2, 7.4, 12.7, 12.8, 12.13.

Science—Statistics
Math SOLs: 5.16, 6.20, 7.17, 8.12;
Science SOLs: 6.1, 6.2, LS.1, ES.1, ES.2, BIO.1, CH.1.

If You'd Rather Be Fishing While Teaching...

The Virginia Department of Game and Inland Fisheries wants to help you make fishing a part of your science, recreation, health, or physical education program. **Teach'n Fishing Workshops** offer an introduction to the department's new Sportfishing and Aquatic Resource Education Curriculum. The six-hour workshops prepare formal and non-formal educators to offer information on fishing skills, responsible fishing, and aquatic resources to students or to community groups.

For more information, contact Dana Roberts at (804) 367-0141;
email: droberts@dgif.state.va.us;
Web-site:
www.dgif.state.va.us/fishing/sarep/index.html.

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 July 31. Unless otherwise noted, all localities mentioned are in Virginia.

In Virginia…

•Recent studies by Robert Jonas of George Mason University indicate that **bacteria levels in the Chesapeake Bay** are unusually high. Bacteria numbers can reach 20 million per milliliter (ml) of water in the Bay, compared to 1—8 million per ml in other estuaries. (A liter, which equals about 1.1 quarts, contains 1000 milliliters.) Bacteria consume oxygen as they decompose organic materials, so Jonas and other scientists are interested in how bacteria levels relate to efforts to improve dissolved oxygen levels in the Bay. (*Bay Journal*, April 2000)

•**"Pass the Paddle"** is a nationwide relay designed to bring attention to North American river systems. The first leg began April 1 on the Potomac River in Virginia. From there, the paddle has been traveling by water, air, and land on a 25,000-mile journey that ends in Washington, D.C. on October 7. The event is part of "Rivers 2000," an educational and promotional campaign sponsored by the River Management Society. (Rivers2000 Web-site, www.rivers2000.org, 4/5/00)

Meanwhile, **another river-awareness challenge** started in July. On the 31st, Mimi Hughes began the second 125-mile leg of her attempt to swim the entire Tennessee River. She swam her first 125 miles in 1999 and expects to complete the whole distance—652 miles—by 2004. She hopes to encourage Tennessee Valley residents to protect the river. (*TVA River Neighbors* newsletter, August 2000)

•In March the Va. Dept. of Environmental Quality (DEQ) published its 1999 data on **mercury levels in fish** in the South River and the South Fork-Shenandoah River (into which the South River flows). Mercury contamination, originating at a Du Pont plant in Waynesboro, was discovered in the South River in the early 1970s. A fish-consumption advisory is in place for the South River from Waynesboro to Port Republic (Rockingham County) and for the S. F. Shenandoah from Port Republic to the Page-Warren county line.

The DEQ sampled Rainbow Trout, Rock Bass, Smallmouth Bass, and White Sucker from the South River (46 total fish); and Channel Catfish, Redbreast Sunfish, Redhorse Sucker, and Smallmouth Bass from the Shenandoah (67 total fish). Most samples were taken in July and September. In the South River, one fish was above 1.0 part per million (ppm), which is the federal Food and Drug Administration's "action level" for mercury in the edible portion of fish. In the Shenandoah, 12 fish were above the level. The range in the South River was 0.10—0.99 ppm; in the Shenandoah, 0.22—2.50 ppm. Newport Landing (Page County) had the highest readings, including an average of 1.1 ppm for 10 Smallmouth Bass sampled on Sept. 13. (Va. DEQ Web-site, www.deq.state.va.us, 4/11/00)

•Mathews County is now the home of the **Mathews Blueways Water Trails**, a 90-mile trail system along the county's waterways and Chesapeake Bay shoreline. The trails are open to any shallow-water craft, with 15 public-access points. For more information: Neil Webre, (804) 725-4125; e-mail: blueways@eudoramail.com. (*Bay Journal*, May 2000)

•Due mostly to Hurricanes Dennis and Floyd, Virginia suffered the **fourth-highest monetary loss due to catastrophes** among all the states in 1999. Virginia's had $485 million in property and casualty claims paid. North Carolina's had $928 million in losses (the second-highest), also due largely to damage from hurricanes. (*Natural Hazards Observer*, May 2000)

•There's **good and bad water-quality news about the Elizabeth River** in southeastern Virginia. At an April 2000 conference in Norfolk, sponsored by the Elizabeth River Project, participants reported such examples of good news as 32 acres of wetlands restored, 16,000 oysters being grown, and 40 abandoned ships removed from the river bottom. At the same time, however, there were also reports of persistent problems. For example, 91 percent of fish sampled in 1999 from the southern branch of the river—in the area's industrial zone—had cancers or pre-cancerous lesions. A major problem is the contamination of sediments in parts of the river with toxic metals (such as lead, zinc, and copper) and with carcinogenic, petroleum-based

compounds. A marine biologist from Old Dominion University summarized the situation by saying that the river still has the most problems of any Chesapeake Bay tributary, but it also is "improving in more ways" than any other river in the Bay watershed. (*Associated Press*, 4/29/00)

•In May, the U. S. Environmental Protection Agency (EPA) began a **significant wetlands-related enforcement action** in the Hampton Roads area. Claiming that 10 area property-owners and developers violated (non-criminally) the Clean Water Act by draining wetlands and allowing materials to wash into water bodies, the agency is seeking restoration of about 2,300 acres of non-tidal wetlands. The areas in question are in Chesapeake, Newport News, Suffolk, and Virginia Beach. (*Virginian-Pilot*, 5/9/00)

•The **Va. Dept. of Conservation and Recreation (DCR) approved 34 out of 95 grant requests for Fiscal Year 2000**. The awards come from Virginia's Water Quality Improvement Fund and the federal Clean Water Act's Section 319 program. Requests for nearly $13 million were received, with $2.52 million available. Grant amounts ranged from about $11,000 (Big Walker Soil and Water Conservation District no-till drill) to $250,000 (stormwater quality pond for Norfolk). (From the DCR Web-site, www.state.va.us/~dcr/sw/, June 2000)

•In June, **bacterial contamination and new source-water standards** forced the city of Roanoke to suspend use of a spring that had supplied 3.5 million gallons per day (about 20 percent of the daily use). The contamination was at the source water (the spring), and not in treated water. The city will build a new treatment facility to meet new standards, and officials expect to use the spring again by early 2002. (*Roanoke Times*, 6/6/00)

•**Governmental entities are the subject of 31 percent of enforcement caseloads** by the Va. Dept. of Environmental Quality. The cases range from minor oversights to actions serious enough to have been referred for criminal prosecution, and some of the violations have persisted for years. In response, the 2000 Va. General Assembly passed HB2178, which requires that laws, regulations, and policies applicable to permit holders be consistently enforced regardless of whether the permit holder is a public or private entity. (*Virginian-Pilot*, 7/3/00, and Va. Legislative Information System, leg1.state.va.us/, 7/6/00)

•**Smyth County** has been awarded **$445,500 in grants and loans for public-water lines** to 58 households now using springs and wells. Twenty of the households have been using a contaminated private spring. The Smyth County project is one of 113 projects in 41 states being funded through the federal "Water 2000" initiative; Smyth was the only Virginia locality to receive money at this time. Begun in 1994, Water 2000 seeks to assist rural communities with serious drinking-water problems. Nationwide, an estimated two million people have serious drinking-water problems, including some 700,000 without running water. (*Smyth County News & Messenger*, 7/12/00)

•In July, the **Nature Conservancy purchased 44 acres of land along the Clinch River** in Russell County. The $26,000 purchase adds to another eight acres that the group previously bought to help protect the area's freshwater mussel habitat. This part of Virginia has one of the most diverse freshwater mussel communities in the United States, including several rare and endangered species. (*Associated Press*, 7/25/00)

•**A revised multi-state agreement on the Chesapeake Bay** was made official on June 28. The agreement is among the members of the Bay Program Executive Council: the governors of Maryland, Pennsylvania; and Virginia, the mayor of Washington, D.C.; the administrator of the U. S. EPA; and the chairperson of the Chesapeake Bay Commission, representing state legislators. The Chesapeake 2000 agreement sets a timetable from 2000 to 2012 for goals regarding nitrogen reduction, introduction of non-native species, submerged aquatic vegetation, airborne contaminants, land development, and other issues. (*Bay Journal*, July-August 2000)

•**Nine oyster reefs** are being constructed **in the Rappahannock River** by the Va. Marine Resources Commission. The one-acre reef structures will be surrounded by 25 acres of oyster shells. The work, part of the state's Oyster Heritage Program, will cost about $384,000. Completion of some of the reefs was expected by Summer 2000. (*Bay Journal*, July-August 2000)

•In June, the **Va. Marine Resources Commission prohibited crabbing in a 600-square-mile area** of the Chesapeake Bay. The prohibition runs from June 1—September 15 each year, corresponding to the Blue Crab spawning season. Creation of the sanctuary, which had been recommended by specialists at the Va. Institute of Marine Science (VIMS), seeks to protect an estimated 40 percent of spawning Blue

Crab females. According to VIMS research, the number of mature, female Blue Crabs in Virginia's part of the Bay has decreased by 70 percent since 1988. (*Bay Journal*, July-August 2000)

…and Outside of Virginia

•A National Academy of Sciences report claims that **marine life in over one-third of U. S. coastal areas is being damaged by surface runoff of nitrogen and phosphorus**. The April 2000 report said that severe environmental harm is occurring in 44 out of 139 areas examined, including along the coasts of Maryland and North Carolina. (*Associated Press*, 4/5/00)

•The U. S. EPA's Office of Research and Development is examining **technologies to clean up soil and water contaminated by methyl tertiary butyl ether, or MTBE**. MTBE has been the most widely used of a type of gasoline additive—known as an oxygenate—that reduces emissions from automobiles. It also, however, has caused widespread groundwater problems due to its tendency to move rapidly through soil and its slow bio-degradation rate. Two apparently promising techniques involve using air pressure to remove MTBE from water, and using carbon to adsorb MTBE, which can then be skimmed from the water surface. The Research Office's recommendations are to go to the EPA Office of Water by the end of 2000. (Inside EPA's *Water Policy Report*, 4/12/00)

Meanwhile, a bill was introduced July 27 in Congress that would **ban the use of MTBE** as an oxygenate within four years of passage. In the interim, states would be able to petition to be exempt from the current requirement that gasoline contain at least two percent oxygenates. The bill was introduced by Robert Smith (R—NH), chairman of the Senate Environment and Public Works Committee. Much of the debate over the legislation concerns how it would affect the use of ethanol as an oxygenate in place of MTBE. (Inside EPA's *Water Policy Report*, 7/31/00)

•In March, the U. S. EPA's Assistant Administrator for Water Charles Fox requested the EPA's water-related offices to develop **a new strategy for dealing with waterborne disease-causing organisms**. The strategy is supposed to assess existing programs to ensure that they collectively address waterborne, microbial pathogens. Mr. Fox called for a draft strategy to be ready by the end of 2000. (Inside EPA's *Water Policy Report*, 4/12/00)

•**Robowell**. Is it the latest futuristic character played by Arnold Schwarzenegger? No, it's a **robotic groundwater monitoring system**, patented by U. S. Geological Survey (USGS) scientists in Massachusetts. The machine can regularly measure water levels and groundwater quality at monitoring wells, then let a human operator know if a measurement indicates a change in local water quality. (*Water Online*, www.wateronline.com, 5/9/00)

•On April 7, **111,000 gallons of oil spilled into a tributary of Maryland's Patuxent River** from a cracked pipeline owned by the Potomac Electric Power Company. About one-third of the oil soaked into the marsh where the cracked pipeline runs, but the rest overtopped a containment boom and flowed into the river during an April 8th storm. Over 400 birds and mammals were killed or injured by the spill. In mid-May, although some oil spots were still visible, company and government officials declared the emergency over and said that long-term restoration work would begin. (*Baltimore Sun*, 5/18/00)

•In May, **Crescent Resources, Inc**., the land management division of Duke Energy, said it **will permanently bar development along about 200 miles of streams** in 14 counties in North and South Carolina. The streams are in the Catawba River watershed. The company will sign conservation easements that are to be at least 50 feet wide and will prohibit residences and clear-cut logging, while allowing selective timber cutting. Crescent also pledged $500,000 to help other landowners who might wish to preserve their streamside land, a move that could affect up to an additional 100 miles of streams. (*Charlotte Observer*, 5/24/00)

Meanwhile, on June 24, an estimated **3.7 million gallons of raw sewage spilled from into a Catawba River tributary** from the Charlotte-Mecklenburg Utilities system. A power surge disabled an alarm that would have alerted utility staff to rising wastewater levels. State officials said the spill was among the five or ten largest in of the year. The state was to decide later whether or not to fine the local utility. (*Charlotte Observer*, 6/27/00)

• A **West Virginia high-school student** represented the United States as a **finalist for the 2000 International Stockholm Junior Water Prize**. Ashley Mulroy was to compete with finalists from 20 other countries for the

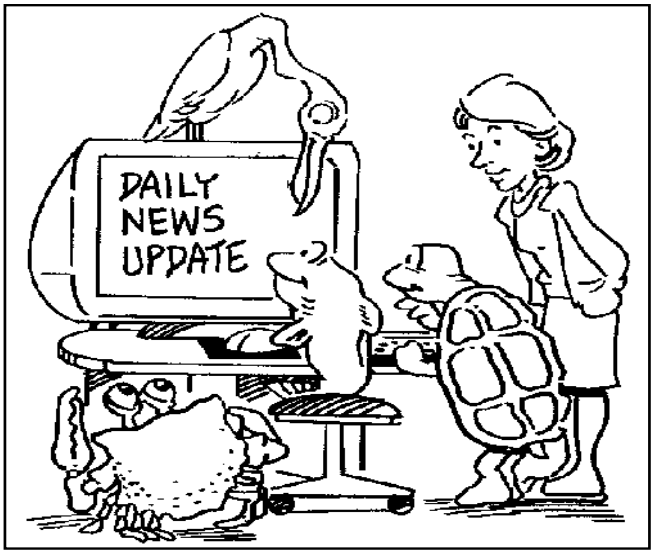
prize, to be awarded on August 15. Ms. Mulroy's research was a study of contamination of public drinking-water supplies with commonly used antibiotics, and the possible correlation of such contamination with drug-resistance by coliform bacteria. (News release, Water Environment Federation, Alexandria, Va., 6/15/00)

•The **Association of State Drinking Water Administrators** is arguing that states do not have the resources to cope with all the regulations due under the 1996 amendments to the Safe Drinking Water Act. The Association raised its concerns in testimony before Congress in April and in written comments to the U. S. EPA in June. (Inside EPA's *Water Policy Report*, 6/21/00)

•In a April report, the North Carolina Dept. of Environment and Natural Resources said that statewide **1,142 lagoons containing liquid manure have been abandoned** by farmers going out of business. Thirty-nine cases were an immediate environmental threat. The report said it would take $30 million to clean up all of the inactive lagoons. (*Charlotte Observer*, 6/21/00)

Meanwhile, Smithfield Foods, Inc., based in Virginia, reached agreement with the North Carolina Attorney General's Office to **eliminate open-air hog-waste lagoons** on its 276 N.C. farms by 2005. The agreement covers about 70 percent of the state's hog-production capacity. The company also pledged $65 million over the next 25 years to support development of alternative technology and related environmental projects. (*Charlotte Observer*, 7/28/00)

•In a **sample of Brown Bullhead catfish taken in 1996 from the Anacostia River** in Washington, D.C., 50 to 60 percent of the fish had liver tumors, believed to be due to contaminated sediments. Such problems in the Anacostia are already well known—the District has a fish-consumption advisory in place—but this is reportedly the first quantitative survey. (*Bay Journal*, July-August 2000)



Did you know that you can follow water-related news at the Water Center's Web-site (www.vwrrc.vt.edu)?

•Finally, many localities have encountered problems of **combined sewer overflow**: when heavy rains cause storm sewers to overflow into the sanitary sewer system. But one street in Charleston, West Virginia, has a particularly nasty situation. On Wertz Avenue, a combined-sewer overflow often results in bloody wastewater coming out of manholes. The wastewater comes from a nearby sausage factory. "Sometimes when it rains, you see the blood shoot up out of the ground," one long-time resident was quoted as saying. (*Charleston Daily Mail*, 7/18/00)

N O T I C E S

On the Public Calendar

•**Sep. 16**—Cave Board, 1 p.m., Dept. of Conservation and Recreation, Staunton. For more information: (804) 786-1712; e-mail: pco@dcr.state.va.us.

•**Sep. 19**—Soil and Water Conservation Board, 9 a.m., Pocahontas State Park, Chesterfield. For more information: (804) 786-1712; e-mail: pco@dcr.state.va.us.

•**Oct. 4, 18, and 31**—Advisory committee for wetlands permitting program, 9:30 a.m., Dept. of Environmental Quality Piedmont Office, Richmond. For more information: Ellen Gilinsky, (804) 698-4375; e-mail: egilinsky@deq.state.va.us.

•**Oct. 16**—Board on Conservation and Development of Public Beaches, 11 a.m., William and Mary College, Williamsburg. For more information: (804) 786-1712; e-mail: pco@dcr.state.va.us.

Notices continue next page

Fall's the Time to Meet and Confer!

•**Roanoke River Watershed 2000 Conference**. Friday, September 8, 2000; 10 a.m.—4:30 p.m. Virginia's Explore Park, near Roanoke. For more information: Bill Modica, (540) 387-2782.

•**Governor's Conference on Greenways and Blueways**. October 1—3, 2000, Virginia Beach. For more information: (804) 798-6362; e-mail: vagovconf@aol.com; Web-site: www.state.va.us/~dcr/prr/trailcnf.htm.

•**Annual Water Works Operations Conference**. Oct. 5—6, 2000, Staunton. For more information: Carmel Costa, (804) 744-1345; e-mail: costac@co.chesterfield.va.us; Web-site: www.vaawwa.org/.

•**Annual International Conference on Contaminated Soils, Sediments, and Water**. Oct. 16—19, 2000, Univ. of Massachusetts., Amherst. For more information: Denise Leonard, (413) 545-1239; Web-site: www.aehs.com.

•**Annual Wetlands Regulatory Workshop**. Oct. 30—Nov. 3, 2000, Atlantic City, N.J. For more information: Ralph Spagnolo, (215) 814-2718, or Frank Reilly, (540) 286-0072.

"Drinking Water: Understanding a Resource"

This 16-page publication focuses on Nebraska but has very good information for other states, too. Available for the cost of mailing from University of Nebraska-Lincoln Water Center/Environmental Programs, (402) 472-3305; e-mail: sress1@unl.edu.

National Water Quality Reports

•The U. S. EPA's 1998 report to Congress on the nation's water quality is available on-line at www.epa.gov/ow; or calling (800) 490-9198 (request publication EPA841-R-00-001).

•*The Atlas of America's Polluted Waters* has maps of impaired waters in each state. Available on-line at www.epa.gov/owow/tmdl/atlas/index.html; or call (513) 489-8190 (request publication EPA 840-B-00-002).

Friends Keep Friends Safe on the River

The brochure "River Safety on the Rappahannock" is available from the Friends of the Rappahannock. It includes a map with distances and rapids; tips on using river gage information; and a river-safety checklist. Available on-line at www.crrl.org/for; for a paper copy, call (540) 373-3448; e-mail: cleanriver@pobox.com; or visit the group's office at 3219 Fall Hill Ave., Fredericksburg.

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 our Web-site, www.vwrrc.vt.edu.

William R. Walker Graduate Research Fellow Award Winner

Kimberly Alice Powers, Civil & Environmental Engineering, Virginia Tech.

New Publications

(Virginia citizens may receive one free copy of any Water Center publication. There is a charge for additional copies, for photocopying out-of-print publications, and for out-of-state requests.)

•*Fiscal Years 1999 & 2000 Report of the Water Quality Academic Advisory Committee*, SR18-2000, May 2000 (also available on-line).

•*Proceedings of the 1999 Virginia Water Research Symposium*, May 2000.

•"Stream Health: Relating Stream Biota to Stream Water Quality." Paper presented at the National Monitoring Conference, Austin, Texas (photocopies available).

Research Seed Grant Recipients ($5,000 each)

•Roseanne Ford, Chemical Engineering, Univ. of Virginia: "Response of a subsurface microbial community to the introduction of ground-water contaminants."

•Jerome Maa, Physical Sciences, Va. Institute of Marine Science: "Using supersonic waves to measure marine sediment properties."

•Madeline Schreiber, Geological Sciences, Va. Tech: "The impact of organo-arsenic additives in poultry feed on water quality."

•Mark Widdowson, Civil and Environmental Engineering, Va. Tech: "Evaluating processes that control natural attenuation of nitrate in natural waters."

•Christine Anderson-Cook, Statistics, Va. Tech: "Efficient statistical designs for water contaminant mixture experimentation of normal and non-normal responses."

•G. V. Loganathan, Civil and Environmental Engineering, Va. Tech: "GPS enhanced radar precipitation estimates for real time applications."

New Research Project

"Development of TMDL Plans for Benthic Degradation for Six Impaired Stream Segments in the James River, and Potomac and Shenandoah River Basins, Virginia." Funds for this project come from the U. S. EPA and the Va. Dept. of Environmental Quality. For more information, contact Tamim Younos at the Water Center.

FOR THE RECORD
Sources for Selected Water Resources Topics

Federal Water Regulations

However one explores the topic of federal regulations concerning water, one finds long lists. First is the long list of areas covered by federal regulations: drinking water safety, water quality in the nation's water bodies, use of navigable waters, wetlands activities, interstate transportation on waterways, certain dams and dam-related activities, and *many* others. Second is the list of federal agencies that develop, issue, and implement water-related regulations; some of them are listed in the box below. Third is the list of federal laws that the regulations are designed to implement; the U. S. Environmental Protection Agency alone issues regulations under more than a dozen major acts of Congress. Last is the biggest list of all: the huge number of regulations themselves.

Fortunately, good tools and resources exist, especially via the Internet. In fact, it's a fairly manageable task to track down at least the general areas of regulation and which apply to specific government agencies.

This page covers two main tasks: finding existing regulations and following proposed regulation.

Internet Sites of Some Federal Agencies that Issue Water-Related Regulations

Environmental Protection Agency
www.epa.gov/epahome/laws.htm

Army Corps of Engineers
www.usace.army.mil

Fish and Wildlife Service
www.fws.gov/

Dept. of Agriculture (especially the Forest Service)
www.usda.gov/

Federal Energy Regulatory Commission
www.ferc.fed.us/

National Oceanic and Atmospheric Administration (especially the National Marine Fisheries Service)
http://www.noaa.gov/

Finding Proposed Regulations

Federal Register. Published daily, this records all proposed and newly approved regulations. Paper copies are available at many public libraries; subscriptions cost about $700 per year. The on-line *Federal Register* is available at www.access.gpo.gov/nara. Detailed information about this publication and how to use it is available on-line at www.nara.gov/fedreg/.

For prices and ordering information for paper or microfiche versions, call the **GPO Access User Support Team** at (202) 512-1800, M—F, 8 a.m.—4 p.m.; e-mail: info@fedreg.nara.gov.

Finding Existing regulations

The *Code of Federal Regulations* (CFR) compiles the rules published in the *Federal Register*. The CFR is very large, of course, but it is divided into 50 titles covering broad areas. Title 40, for example, is "Protection of the Environment" and contains many of the regulations administered by the EPA.

Internet users should go to the GPO Access Web-site: www.access.gpo.gov/nara/cfr/index.html. At this location is an index of, and links to, all the CFR titles. Another productive route is to use the alphabetical list of *agencies* with pertinent CFR titles; find this at this address: www.access.gpo.gov/nara/cfr/parallel/alphabetical_list.html.

Contact the GPO Access User Support Team, at the phone number and e-mail address listed above, for paper copies of CFR titles (for a charge) and for assistance in using either the *Federal Register* or the CFR.

Happy regulation hunting!

Annabelle Fusilier assisted in compiling this page.

Upcoming "For the Record" Schedule

2000
October – Aquatic-life Information Sources
December – Water Maps: Types and Sources

2001
February – Groundwater Information Sources
April – Coastal/Marine Information Sources
June – Drinking-water Information Sources
August – Water-quality Information Sources

Schedule subject to change

Virginia Water Central

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