Probabilistic Monitoring: Determining the quality of Virginia's waters

If Virginia's streams and rivers were stretched end to end, they would circle the Earth twice. So determining the overall quality of Virginia's waters is a challenge, given their extent and the time and cost of water monitoring. Undeterred, DEQ's Probabilistic Monitoring Program is tackling this task.

With support from the U.S. Environmental Protection Agency, DEQ has been working on this effort since 2000, funded in part by $589,000 in competitive grants from EPA. About 20 people from DEQ's central and regional offices participate on the team.

Monitoring water quality

DEQ collects water quality information at each monitoring site at least twice, once in the spring and once in the fall. The program has monitored chemical, biological and habitat conditions at 280 sites. Staff members use laboratory analysis of water and sediment samples to monitor chemical parameters such as nutrients and metals. They conduct biological tests by counting the number and type of insects in streambeds, for example, and study sediment size to assist in determining habitat conditions.

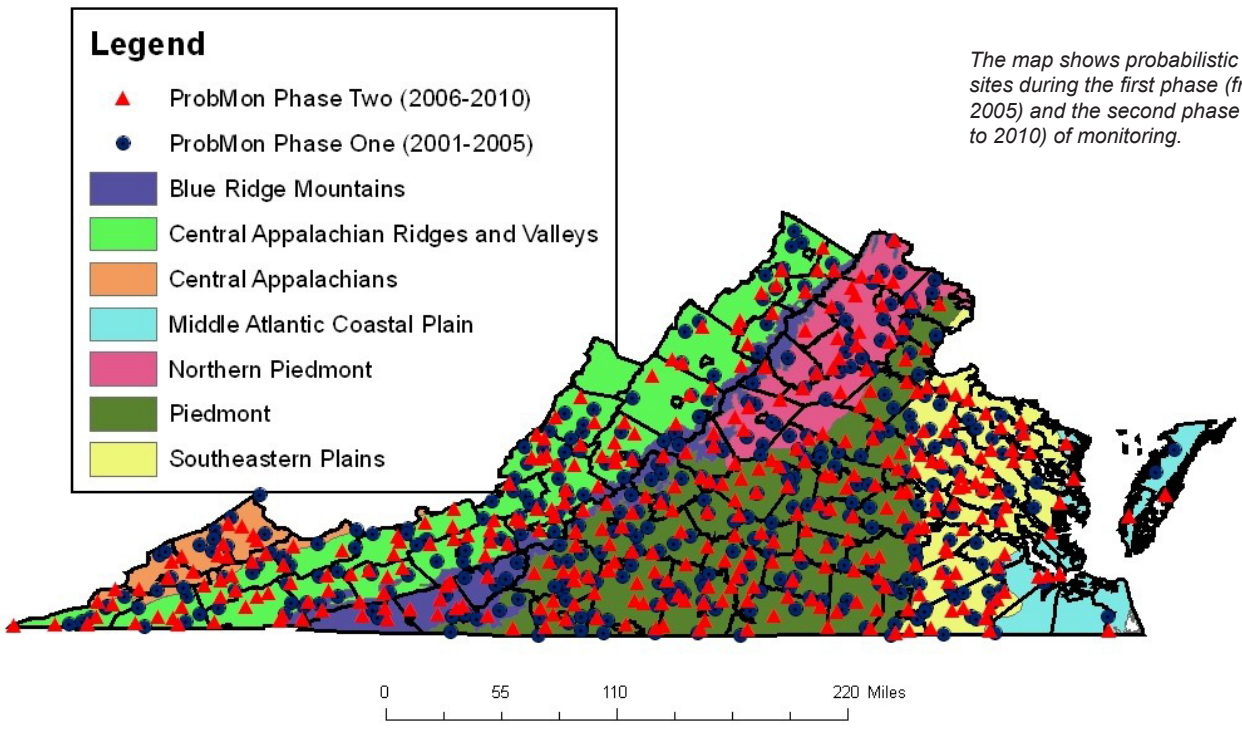
Monitoring results

Based on five full years of water quality data and a few hundred monitoring sites, the program has determined that most of Virginia's freshwater streams are not contaminated with elevated levels of nutrients (nitrogen and phosphorus), bacteria or toxic chemicals, and have banks with enough vegetation to help prevent excess pollution. In addition, just under half provide conditions that allow aquatic communities to thrive.

Much like the health of a person, the health or quality of a stream depends on many factors, and these are just a few. The team is also working on other factors like what percentage of streams suffer from excess sediment (too much damages animal and plant habitats) and whether it is due to natural conditions or human influences.

By 2008, the Probabilistic Monitoring program, or ProbMon for short, expects to have enough monitoring information to decide how good the water quality is in Virginia. Eventually the ProbMon program will be able to determine the quality

Probabilistic monitoring sites in Virginia's watersheds



The map shows probabilistic monitoring sites during the first phase (from 2001 to 2005) and the second phase (from 2006 to 2010) of monitoring.

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of Virginia's waters as well as how they are improving over time by comparing their first five years of data (from 2001 to 2005) to their second five years of data (from 2006 to 2010). This approach could also be applied nationwide, and EPA has supported probabilistic monitoring and encouraged states to implement it since the early 1990s.

Using statistics to determine water quality

So, with data from just several hundred locations, how can the program begin to make conclusions about all of Virginia's streams and rivers, and expect to answer the principal question, how good is water quality in Virginia?

In short, the answer is statistics, making the probabilistic part of the water monitoring important. At its most basic level, probabilistic monitoring is a method used to gather water quality information from hundreds of stream locations across Virginia. Water monitoring sites are randomly selected by a computer software program designed for the task. The randomness ensures that the sites (and therefore the results) are not biased or skewed. This method allows the program scientists to draw highly probable conclusions about the quality of Virginia's waters.

The analysis can be compared to a poll asking Virginians for whom they would vote for governor. The pollster would ask the question to a sample of Virginians from across the state to account for the cultural, political and economic differences of each region.

Likewise, the probabilistic monitoring program monitors streams across Virginia to account for differences such as stream type and conditions, and topography.

A DEQ biologist collects insects and other aquatic animals from the bottom of the South Fork Shenandoah River.

In the end, the pollster can predict what percentage of Virginians would vote for each candidate based on a representative sampling of people. By monitoring a number of conditions at each site, the program is essentially polling the streams for their water quality and can draw conclusions with a high degree of accuracy.

Metals and toxics monitoring

Probabilistic monitoring is also being used by other programs. For example, DEQ was able to compile the first statewide distributions of toxic chemicals and metals in waterways by using probabilistic monitoring data. This information is being used to identify locations of excess metals in sediments and toxic chemicals in the water, and help establish the degree of contamination.

More information is available on the ProbMon website at www.deq.virginia.gov/probmon.

Result Highlights

Much like the health of a person, the health or quality of a stream depends on many factors. These factors represent parts of the answer to the question, how good is water quality in Virginia? Below is a sample of what the program knows so far about freshwater streams in Virginia:

Percentage of stream kilometers that have good, fair or poor stream banks:

70 % ~ good
20 % ~ fair
10 % ~ poor

Percentage of stream kilometers that have good, fair or poor conditions for aquatic communities:

43 % ~ good
15 % ~ fair
42% ~ poor

Percentage of stream kilometers that have acceptable or unacceptable levels of PCBs :

98 % ~ acceptable
2 % ~ unacceptable

Percentage of stream kilometers that have acceptable or unacceptable levels of bacteria:

88 % ~ acceptable
12 % ~ unacceptable