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Chesapeake, Pennsylvania State University

Taking Stock of Riparian Forest Cover

GIS Streamlines Inventory of Riparian Forest Buffers in Chesapeake Bay Watershed

Though ecologists and landowners have long appreciated the value of riparian zones—areas adjacent to water bodies—the challenge has been identifying riparian areas to protect or restore. A collaborative effort by five research groups—three at the Pennsylvania State University (the Land Analysis Laboratory, the Cooperative Wetlands Research Center, and the Environmental Resources Research Institute), plus the Chesapeake Bay Program's Nutrient Subcommittee and the Virginia Department of Forestry—produced a method to evaluate the extent of forest cover adjacent to all streams, rivers and shorelines in the Chesapeake Bay watershed. Their geographic information systems (GIS) approach used existing data readily available from federal and state agencies. The goal was to produce information useful for broad-scale targeting and decision-making policy and to provide a watershed-scale assessment of riparian forest buffer status.

Figure 1.
A Forested Riparian Buffer Zone

The condition of a riparian buffer—the areas adjacent to a stream, river, or water body—greatly influences the water quality of all water bodies and wetlands. Forested riparian zones reduce the delivery of non-point source pollution to waterways and water bodies, an issue of great concern to anyone interested in the ecological health of the Chesapeake Bay Watershed, and the Commonwealth of Virginia. (The focus on the reduction of non-point source pollution was enhanced when the 1972 Clean Water Act was amended in 1987 with section 319 that called for plans to control such sources of pollution.)

Forested buffers also reduce the sediment load carried into streams and water bodies while protecting shorelines and stream banks from erosion. Buffers enhance habitat diversity, increase food supply for stream micro- and macro-organisms, and moderate stream and water-body temperatures. Properly established and maintained buffers can also help lessen the severity and recurrence of flooding.

Creating a Riparian Inventory

Both the Chesapeake Bay Program and the Commonwealth of Virginia Department realized they needed an inventory of the current status of riparian buffers before they could

Figure 2. **EMAP Land Cover Data for the Chesapeake Bay**

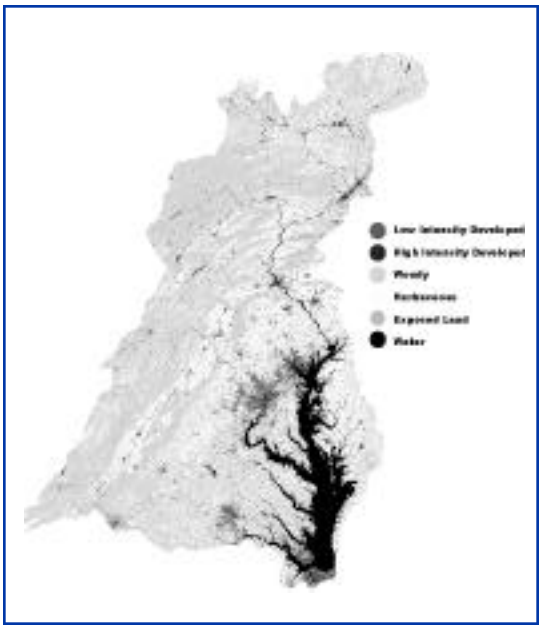


Figure 3. **Hydrology for the Chesapeake Bay**

target protection and restoration efforts. Relying on geographic information systems (GIS) for quick and accurate results, they decided to 1) use satellite-derived land cover data to inventory buffer conditions within 100 and 300 feet of each stream in the Chesapeake Bay, 2) prepare statistical summaries of riparian forest buffer conditions within sub-watersheds, states and the entire Chesapeake Bay Watershed, and 3) conduct an accuracy assessment of the inventory through comparison with aerial photo analysis and field verification.

Acquiring Data

The first step in creating the new inventory was to assemble three types of data:

- **Land cover data** from the EPA's Environmental Monitoring and Assessment (EMAP) on major land cover categories such as developed land, forest, herbaceous vegetation, exposed soil and water. (See Figure 2)
- **Hydrology data** on streams and water bodies, provided by the Chesapeake Bay Program. (See Figure 3)
- **Watershed boundaries** corresponding to EPA 8-digit and 11-digit Hydrologic Unit Codes (HUC), obtained from the Chesapeake Bay Program and the USDANatural Resources Conservation Service.

An Automated Method

Because there are over 115,000 miles of streams within the Bay watershed and the project results were needed quickly by the Chesapeake Bay Program Office, program coordinators developed an automated method to conduct the riparian inventory using the compiled GIS data layers. All data were organized within ESRI's (Environmental Systems Research Institute) ArcINFO GIS software.

For each area of interest, an automated algorithm divided streams into segments, then identified buffer conditions extending 300 feet on both sides of the stream at the mid-point of each segment. For a riparian zone to be considered buffered by forest for 300 feet on a side, all of the 50-foot intervals must be listed as forested in the land cover data. To be considered buffered for 100 feet on a side, the first two intervals on a side must be listed as forested.

Accuracy Assessment

Because the automated GIS method is new, the data were validated by comparing them to data from both aerial photography interpretation and field verification using:

- Aerial photographs of randomly selected quarter-quadrangles throughout the study areas. Buffer widths for streams within the photographs were determined using a magnifying stereoscope that allows pseudo-3D viewing. The streams were divided into four categories depending on how much buffer existed: < 10', 10' - 100', 100' - 300' and > 300'.
- Field verification sites randomly selected from throughout all physiographic provinces within study areas. Trained personal visited each site and assessed buffer cover and width.

Results of the Automated GIS Method

The GIS assessment revealed that 34% of streams within the study area have 300 feet or more of forest buffer on both sides and 40% of the streams in the watershed have

Table 1.

Variability in buffer conditions among the Bay states was less than 12% in all buffer categories. Generally, Pennsylvania showed the greatest amount of buffering; New York the least. The Pennsylvania results may be artificially high due to the variability in the streams data layer. The Pennsylvania streams data included intermittent streams whereas the other states'hydrology data sets did not consistently include intermittent streams.

Buffering	Total Stream Length		Both sides buffered>300'		Both sides buffered>100'		At least 1 side buffered>300'		At least 1 side buffered>100'		Both sides buffered<100'	
State	miles	%	miles	%	miles	%	miles	%	miles	%	miles	%
Delaware	1091	100%	326	30%	572	52%	558	51%	638	58%	453	42%
Maryland	16756	100%	4487	27%	8032	48%	7658	46%	9050	54%	7706	46%
New York	8015	100%	2006	25%	3744	47%	3699	46%	4353	54%	3662	46%
Pennsylvania	47585	100%	17720	37%	26938	57%	26750	56%	30450	64%	17135	36%
Virginia	34381	100%	11971	35%	17857	52%	18216	53%	20056	58%	14316	42%
West Virginia	4956	100%	1840	37%	2582	52%	2671	54%	2913	59%	2042	41%
Chesapeake Bay	112784	100%	38350	34%	59725	53%	59552	53%	67469	60%	45314	40%

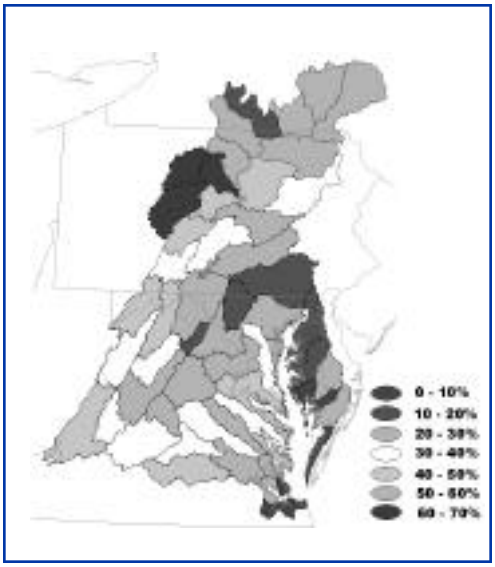
buffers of less than 100 feet on both sides. (Table 1 summarizes data for the Bay watershed and portions of each state within the Bay watershed). Significant variability in buffering conditions among sub-watersheds was noted (Figure 4). Correlations between buffering conditions and stream order, topography, landscape position and physiographic province were noted.

Results of the Accuracy Assessment

The automated method produced median results for all watersheds that were within 8 to 15% of those obtained by aerial photo interpretation. For large-scale projects, the automated method is a significantly better method to produce inventories of riparian forest buffer conditions compared to manual methods. This method is much faster and provides repeatable and consistent results.

In the project for the Chesapeake Bay, inland wetlands and coastal wetland areas showed very low forest buffering. However, these areas need to be uniquely considered since they provide significant environmental benefits both in terms of water quality and wildlife habitat.

Figure 4. **Percent of Watersheds Buffered on Both Sides > 300'**



Virginia Application

RGIS–Chesapeake Penn State is currently conducting an improved analysis for the Virginia Bureau of Forestry. To better analyze buffer conditions, additional and improved GIS data layers are being used as well as National Wetland Inventory (NWI) data. In addition, the Virginia analysis is evaluating buffer-fragmentation conditions that significantly impact the effectiveness of riparian buffers on stream quality.

Uses of This Data

The data produced for the project funded by the Chesapeake Bay Program office has been distributed by them to the member states and to numerous local and regional groups that value the information provided by the inventory. The data produced for Virginia's Department of Forestry is currently undergoing quality control and has yet to be distributed. Results were used by the Chesapeake Bay Program Office to help prioritize subwatersheds for streambank mitigation projects including forest restoration.

About RGIS

The National Consortium for Rural Geospatial Innovations–Chesapeake Penn State is located on the campus of The Pennsylvania State University in University Park, PA. It is a USDA program designed to promote the use of geospatial information and technologies by communities in rural America. RGIS is dedicated to helping communities understand the concepts and benefits of using geospatial data as well as assisting them in all aspects of GIS development.

Acknowledgements

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For More Information:

Surf to http://lal.cas.psu.edu or contact Dr. Rick L. Day, Penn State RGIS-Chesapeake, 116 ASI Building, Department of Crop and Soil Sciences, University Park, PA 16802; (814) 863-1615 or RDay@psu.edu. Direct data requests to the Chesapeake Bay Program Office, 410 Severn Avenue, Annapolis, MD 21403; (800) Your Bay.

Additional Sources

Day R.L. and R. Brooks. 1997. Chesapeake Bay Riparian Forest Buffer Inventory Final Report. The Pennsylvania State University. University Park, PA

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