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Visual Assessment of Stream Bank Conditions at Prince William Forest Park

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Introduction

Prince William Forest Park, a unit of the National Park Service, preserves approximately 15,000 acres of Northern Piedmont forest near Triangle, Virginia. The park lies within two physiographic provinces, the Coastal Plain and the Piedmont, and straddles northern and southern climate zones. The park possesses a unique diversity of habitat, flora, and fauna, and protects approximately 70% of the Quantico Creek watershed. As part of the park's enabling legislation, ensuring the potability of the Quantico Creek has been a primary objective of the park.

Since 1995, Prince William Forest Park resource management staff have monitored water quality of the Quantico Creek watershed. This program has three components; water chemistry, fecal coliform quantification, and the Izaak Walton League of America's "Save Our Streams" (SOS) benthic macroinvertebrate monitoring. While the program provides biological and chemical data on Quantico Creek, it lacked sufficient information regarding the physical attributes of the stream channel. Stream morphology is a key parameter needed to properly document the health and condition of a watershed, so an all-encompassing, non-selective evaluation of the watershed's physical condition was needed. For this reason, a visual assessment program was created and implemented in 2004.

History

The land and water that are now part of Prince William Forest Park have weathered a fair amount of abuse. Before the park's creation in 1936, it had an established history of farming, logging, mining, and hunting. It is estimated that by 1815, 40% of the lands were being actively farmed, mainly with tobacco. After degrading and eroding the soil, tobacco gave way to subsistence farming which continued until 1942. Additionally, by 1800, logging had claimed most of the land once over. Two mineral mines existed within the park's boundary, a gold mine and a pyrite mine. While the Greenwood Gold Mine had little impact on the lands and waterways, runoff from the Cabin Branch Pyrite Mine affected the local aquatic ecosystem and acidic mine spoils prevented vegetation growth on site. Lastly, trapping was so prevalent that beaver, whose dams created slow-moving pools, were extirpated from the area, by the early 1800s. Nearly 200 years of these conditions altered the stream channel.

During the economic disparity of the 1930s, the federal government reclaimed and improved the impoverished lands to provide for recreation. Through well-thought-out conservation, the Chopawamsic Recreation Demonstration Area (RDA) was created in 1936, and served as the model for all other RDAs that followed. With a legislative name change and an agreement with the Quantico Marine Corps Base in 1948, Prince William Forest Park had the responsibility of ensuring the potability of the Quantico Creek. Over time, almost all

lands within the park have reforested. Today, nearly all of the reaches within the watershed possess a riparian buffer and slow-moving pools from beavers, which were reintroduced in 1958. However, rapid growth and development are threatening Quantico Creek. The additional impervious surfaces and increased stormwater runoff are down cutting stream channels, and creating lateral expansion and channelization.

Water quality monitoring

The goals of the park's water quality monitoring program are threefold: to determine the presence of organics and heavy metals, to protect visitor health and safety in recreational waters, and to determine the streams' ability to support life. Water chemistry analysis is conducted annually at 12 sites to test for pollutants such as phosphates, sulfates, and lead. Fecal coliform testing is conducted on an alternating weekly/biweekly basis at 5 and 12 sites, respectively. Bacterial levels are quantified through colony counts of filtered and incubated samples. During the summer of 2005, the park will transition from testing for fecal coliform to testing for *Enterococcus coli*. The SOS program is conducted yearly in three rotations of 32 sites, and monitors populations of benthic macroinvertebrates while evaluating basic site conditions. Even though the monitoring program has shown that the Quantico Creek watershed is relatively unimpacted and it has been used as a reference stream by the Environmental Protection Agency (EPA) and the Urban Biodiversity Information Project, more documentation of the streams was necessary. Using methods outlined in the U.S. Department of Agriculture–Natural Resources Conservation Service's (NRCS's) stream visual assessment protocol (SVAP; NRCS 1998), the resource management staff at Prince William Forest Park set out to capture the morphology and current physical condition of the second-order streams in the Quantico Creek watershed.

Methodology

The visual assessment program began in 2004, and collected baseline morphology information and data. Using the NRCS SVAP as the foundation of the programs, Prince William Forest Park resource management staff incorporated two additional tasks: georeferenced photo points and cross-channel profiles. This multifaceted project not only maximized efficiency in the field, but substantially increased the amount of data generated.

The first task conducted at every site was the collection of georeferenced photo points at 50-m increments along each second-order stream. This task was performed by taking a series of five photographs and collecting global positioning system (GPS) data from the middle of the stream channel. The five photographs were taken in the following order: downstream, perpendicular to the river right, upstream, perpendicular to the river left, and canopy. The GPS data were collected using a Trimble TSCe data logger and a Trimble ProXR base system. The following parameters were used to collect the GPS data: at least 30 readings generated and a position dilution or precision (PDOP) value no higher than 8.0.

At 100-m increments, a cross-channel stream profile was performed, except in those areas where water depth exceeded 1 m. The width of the base flow, the width of the active channel, and the depth of the stream were recorded. A transect was set up by stretching a field tape across the width of the active channel, beginning with the higher of the two banks.

The tape was leveled using a hanging level, and the distance, between the leveled tape and the stream bank or bed, was measured at 0.5-m increments. The procedure was repeated until the peak of the opposite bank was reached.

The final task, conducted at 100-m increments with no exception, was the collection of data required by the SVAP. There are ten basic aspects to be assessed and five optional ones. For this project, the ten basic assessments were used, along with two of the optional parameters. Data collected addressed channel condition, hydrological alteration, riparian zone, bank stability, water appearance, nutrient enrichment, barriers to fish movement, instream fish cover, pools, invertebrate habitat, canopy cover, and riffle embeddedness. All data were input into a data dictionary for the Trimble TSCe data logger.

The repeatable methods used were carefully documented to allow for future comparisons. The georeferenced photo points produce an accurate, visual representation of stream conditions, and precisely geopositioned locations. The cross-channel profile provides a current, baseline physical morphology of the stream channel, and the SVAP grades the current condition of the stream channel. While field data collection is complete, no statistical analysis has been performed.

Results and discussion

For the second-order streams of the Quantico Creek watershed, 529 sites were established at 50-m increments. A total of 529 georeferenced photo points were established, and 224 cross-channel profiles and 246 assessments using the SVAP were created. The photo points produced a total of 2,645 photographs, which are currently being processed; this involves reducing the size of the photo, labeling them, checking their quality, and examining the order of each picture taken. Once this is completed, the photos will be grouped together and imported into Microsoft PowerPoint. The photos will also be tied their respective GPS data and imported into an ESRI geographical information system (GIS) product. The cross-channel profiles, which are currently being processed, will be used to determine which reaches are laterally expanded or deeply incised. The data from each of the profiles are being converted into a graphical display that will allow for a better visualization of the morphology. SVAP data show that nearly 100% of the land use in the park is forest, and that that dominant substrate of the streams is nearly equally split between sand, gravel, or boulder. The assessments also show that within the Quantico Creek watershed, there are 11 sites in "excellent" condition, 86 in "good" condition, 130 in "fair" condition, and 19 in "poor" condition.

A brief analysis of the collected information yielded various trends that were more or less applicable to all sites within the specific condition class. Among "poor" condition sites, the base flow is usually very shallow, and the stream channel is very narrow. These sites are commonly found upstream from recent blown-out dams or downstream from newly built dams. Deep pools are absent, canopy cover is under 50%, a drop structure can be found within three miles of the site, and water appearance is considerably cloudy. Among "fair" condition sites, the base flow is still somewhat shallow, but the active channel is much wider than "poor" condition sites. The substrate is usually boulder, and there is a good amount of healthy debris in the stream. More fish cover is available and water appearance is less cloudy.

However, these sites still lack deep pools and stable banks.

Among "good" condition sites, the physical characteristics continue to improve. The active channel is usually wide with an average base flow. The substrate is almost always cobble (large gravel, small boulder) and again there is healthy debris present. Banks are now stable, and water appearance is less cloudy. However, these sites continue to have barriers to fish movement, and riffles are well embedded into the stream bed. Lastly, among "excellent" condition sites, an average base flow is found within a wide stream channel. These sites often have an equal mix of substrates, usually sand and cobble. The sites grade very high in almost every category assessed. However, the lack of deep pools and/or the presence of barriers to fish movement still exist.

By examining the ratings by stream, differences between the second-order streams can be determined. All of the "poor" condition sites are found on Quantico Creek, with nearly all of the sites lying within the headwaters region. However, approximately three-fourths of the remaining sites are rated in "good" condition. Nearly all of the "excellent" condition sites are found along the South Fork of Quantico Creek. However, approximately three-fifths of the remaining sites are rated as being in "fair" condition, and two-fifths in "good" condition. Without statistical analyses, which will be performed at a later date, one can not make a clear distinction as to which stream is in better physical condition.

Conclusion

The visual assessment of stream channel conditions project at Prince William Forest Park has been a success. The initial field work captured needed data and currently provides baseline knowledge of the stream conditions. However, more field work is needed. During the summer of 2005, this program will be used to access first-order streams and tributaries within the park. With the conclusion of the project, Prince William Forest Park will have succeeded in creating a well-rounded water quality monitoring program that encompasses the biological, chemical, and physical parameters of the Quantico Creek watershed.

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