GIS-Based Analysis of Streambank Erosion and Invasive Riparian Vegetation in Brodhead Watershed, Northeastern Pennsylvania

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1. Introduction:

The Brodhead Watershed has a drainage area of 285 miles in Monroe and a small portion of Pike Counties in northeastern Pennsylvania. The watershed includes five main streams; Brodhead, Paradise, McMichael, Pocono, and Marshall's Creeks. All runoff in this watershed eventually flows into Brodhead Creek, and then into the Delaware River near Delaware Water Gap, Pennsylvania.

Three 100 year floods have affected the watershed in the past three years. The water from these floods ripped through the Brodhead Watershed severely eroding the stream banks, endangering properties and private roads. The introduction of invasive vegetation in the watershed has led to the displacement of native growth and has depleted biodiversity. Species such as Japanese knotweed and Japanese barberry began to appear in smaller tributaries, and are now found throughout the watershed.

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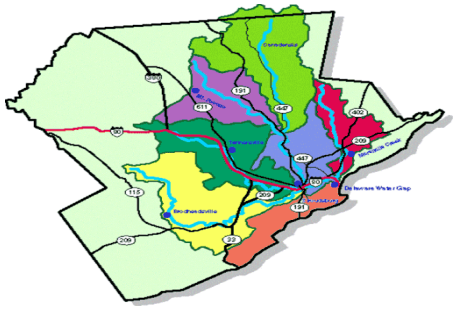

Figure 1: Map of the Brodhead Watershed, Monroe County, Pennsylvania (BWA.org).

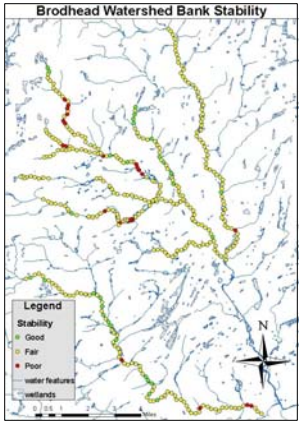

Figure 2: Brodhead Watershed bank stability map; each color indicates a specific stability level from good (green) to poor (red)

2. Methodology:

Bank Stability: The stability of these stream banks were calculated using the Pfankuch-Rosgen Channel Stability Evaluation Method. A GPS unit recorded waypoints every 250 meters. At each of these points, the upper banks, lower banks, and stream bed were assessed based on several criteria, each with a different numerical designation. Total channel stability is calculated as the sum of all of the criteria. High bank stability index correlates to a less stable bank, and is dangerous to properties in the vicinity.

Invasive Vegetation: The presence and density of invasive flora was noted using the Braun-Blanquette estimated density method. Both left and right banks were observed with canopy cover and soil moisture being noted.

Software: XY coordinate data was imported from the GPS unit into ArcMap software. This data was joined with DEM, bank stability, and invasive vegetation data to analyze the features of the river network and surrounding landforms.

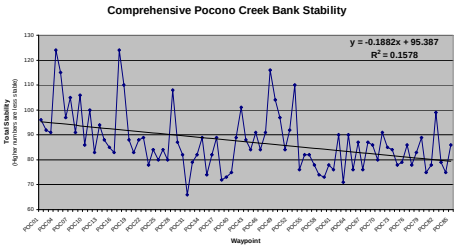

Figure 3: Comprehensive Pocono Creek bank stability which shows the positive correlation: stability increases upstream

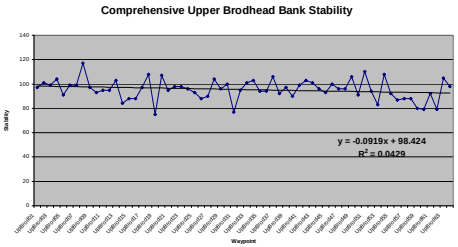

Figure 4: Comprehensive Upper Brodhead Creek bank stability which shows the positive correlation: stability increases upstream

3. Data Analysis:

Bank Stability: Preliminary analyses of the bank stability suggests that bank erosion is present in moderate to severe amounts throughout the Brodhead Watershed (Fig. 2). In most areas, sharp bends and meanders in the stream bed show excessive erosion. Preliminary analysis of bank stability showed values for the watershed ranging from excellent (0%), good (7.95%), fair (84.66%), to poor (7.39%). Stability index plotted against distance upstream reveals a positive correlation, which shows an overall increase in stable banks in headwater locations (Figs. 3,4).

Invasive Vegetation Presence: The three prevailing invasive species found in the watershed are shown with maps generated using ArcMap software (Fig. 5 - 7). Japanese barberry (*Berberis thunbergii*) was found throughout the watershed with patches observed in almost every stream, and hot spots observed in a few areas in the upper watershed (Fig. 5). Japanese barberry was present at 61% of sites, with an average density of 1.6 on a 1-4 scale. Japanese knotweed (*Polygonum cuspidatum*) occurred the most and was the densest of the invasive species, although the southwestern portion of the watershed had few occurrences of knotweed (Fig. 6). Japanese knotweed was present at 59% of survey sites with an average density of 2.3. Multiflora rose (*Rosa multiflora*) was found throughout the watershed in abundant numbers, but few very dense areas were observed (Fig. 7). Multiflora rose was found at 61% of sites with an average density of 1.7. Other prominent invasive vegetation such as Japanese stiltgrass (*Microstegium vimineum*) was found at 49% of sites with an average density of 1.9. Stiltgrass was found to be denser in the southern areas of the watershed, and hotspots were more common. Garlic mustard (*Alliaria petiolata*) was observed scattered throughout the southern areas of the watershed. In the northern reaches, garlic mustard was rare with scattered plants growing in the northern most areas. Garlic mustard was found at 31% of sites with an average density of 1.4.

Figures 5 – 7 illustrate the four following levels of plant density: **0.5 – 1** = Rare, single plants, **1.1 – 2** = Small patches, easily counted, **2.1 – 3** = Large patches, **3.1 – 4** = Dense, continuous stretches

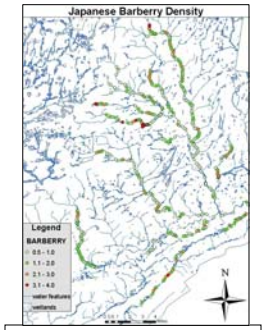

Figure 5: Brodhead Watershed barberry densities

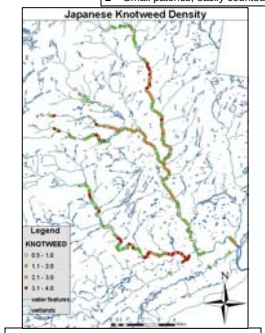

Figure 6: Brodhead Watershed knotweed densities

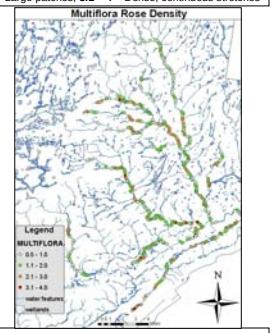

Figure 7: Brodhead Waterhsed Multiflora rose densities

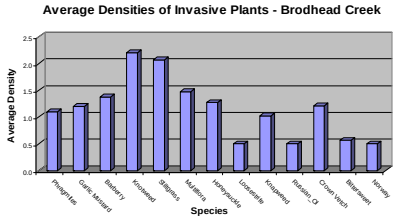

Figure 8: The number of times a specific invasive plant was observed throughout Brodhead Creek.

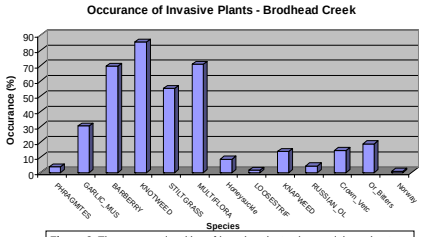

Figure 9: The average densities of invasive plants observed throughout Brodhead Creek. **1**= Rare, single plants, **2**= Small patches; easily counted, **3**= Large patches, **4**= Dense, continuous stretches

4. Conclusion:

Bank stability: Results indicate that 1) the banks along the Brodhead Watershed have been subjected to significant erosion due to flooding events 2) this erosion has created instability in stream banks that endangers private property as well as municipal and state roads 3) future floods will cause extensive damage if no measures are taken to stabilize these banks

Invasive Vegetation Presence: Results indicate that 1) exotic plants are replacing native species in riparian areas throughout the Brodhead Watershed 2) densities of this vegetation will continue to rise as these populations continue to spread throughout other areas of the watershed

References: BWA, http:/www.brodheadwatershed.org (access on 09/13/2007)