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The Channel Conditions of Upper Glade Run: A Geomorphic Assessment at the 65th Annual Conservation Camp

By
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Statement of Purpose

In 2005 Conservation Camp participants establised baseline dimension pattern and profile conditions and began a long-term study to monitor the stream channel behavior of Upper Glade Run. Upper Glade Run is within the boundaries of Camp Caesar, a 4-H camp approximately 4.5 miles north of Cowen, West Virginia. The major focus is to monitor a section of the channel that has been altered by the removal of a significant amount of riparian vegetation. The monitoring continued in 2006 and will proceed until the summer of 2008.

Contact the WV Save Our Streams Coordinator by e-mail at: tcraddock@wvdep.org to request the 2005 report.

Introduction

Fluvial geomorphology is the study of landform evolution related to rivers. Although most streambank studies or projects do not require an intensive, geomorphic analysis of the reach, any project that potentially affects natural river processes requires a basic understanding of the fluvial geomorphology principals.

A basic concept in fluvial geomorphology is that stream channels tend toward an equilibrium state in which the input of mass and energy to a specific system equals the outputs from the same system. A corollary to this condition is that the internal forms of the system (such as channel morphology) do not change in the transfer of mass and energy. The term “stream-channel equilibrium” refers to the relative stability of the channel system and its ability to maintain its morphological characteristics over some period of time and range of flow conditions. In reality, perfect equilibrium does not exist in natural streams. However, natural streams do tend to develop channel sizes and shapes that accommodate their own typical discharge levels and character and quantity of sediment supplied by the watershed. These streams are said to be in a state of dynamic equilibrium.

Streams respond to alterations (such as a change in hydrologic regime due to human activity) by modifying their size, shape and profile.

Why is Vegetation Important to Channel Stability?

Both upland and riparian vegetation affect the geomorphology of stream channels. Vegetation plays a key role in stabilizing streambanks, dissipating energy and in maintaining a stable channel form. The growth of riparian vegetation in and adjacent to the channel **on both sides**, augments floodplain formation, increases hydraulic roughness, reduces erosion and promotes sediment transport. Upland vegetation slows hill slopes erosion, and both upland and riparian vegetation contribute woody debris to the stream system.

In the early summer of 2005 riparian vegetation was removed from the lower portions of Upper Glade Run. This picture shows a section of the stream the following year. There was very little recovery. The plants observed were mostly herbaceous and included Wood Nettle, Spiked Loosestrife, Milkweed, Joe-Pye-weed, Goldenrod and a variety of grasses. In the foreground and on the left of the picture there is some recovery of woody vegetation, mostly Rhododendron. In prior years, several additional woody varieties such as Red Maple, Silver Maple, Smooth Alder and Hemlock were also present.

The Assessment Methods

Characterizing Existing Channel Conditions

The initial characterization of the study reach is based on measured bed and bank profiles and maps or aerial photographs that show channel form. The project is described in terms of channel dimensions, profile, and materials (streambed composition).

Channel Classification

A classification of the channel can aid in visualizing and describing the study site. The Rosgen classification system is the most extensive and widely applied. The Rosgen approach divides streams into eight major types based on number of active channels, presence of a floodplain, width/depth ratio and entrenchment ratio. Each major type is then subdivided, based on the channel slope and dominant type of bed and bank materials. To date, this system for stream classification is probably the most comprehensive and useful, provided that practitioners have a strong geomorphologic background.

This study uses a modified method based loosely upon the Rosgen classification system to assess the study reach. Measurements and field observations used in the initial phases of this study include the following:

- Pebble counts
- Channel cross section
- Photographs
- Sketches
- Longitudinal profile

Results and Discussion

Pebble Counts

In a stream that is in a state of dynamic equilibrium, there is generally little overall change in the composition size of the materials present; and if the stream is adequately moving its sediment load through the watershed. Low water conditions, changes in the channel dynamics, loss of riparian buffers are just some of the factors that increases erosion and sedimentation, and will likely cause changes in composition, which are sometimes dramatic.

Pebble counts were collected in 2005 and 2006 using a zigzag pattern. Particle sizes were recorded using the general size classes of silt/clay (< .062 mm); sand (.062–2 mm); fine gravel (3–24 mm); coarse gravel (24 – 64 mm); cobble (65–255 mm); boulder (256–2048 mm); and bedrock (> 2048 mm). Percentages a particle indices and D50s are reported in the Table 1.

Table 1. Pebble count percentages

2005					
Silt 0	Sand 33	Fine Gravel 42	Coarse Gravel 6	Cobble 7	Boulder 12
2006					
Silt 7	Sand 14	Fine Gravel 14	Coarse Gravel 23	Cobble 28	Boulder 14
2005			2006		
Particle Index = 2.24 D50 = 7			Particle Index = 2.93 D50 = 28		

Table 2 uses a relative percent difference (RPD) statistic to compare the above percentages, D50 and the particle index.

Table 2. Comparison of the 2005 and 2006 pebble count percentages

Materials	2005	2006	RPD
Silt + Sand	33	21	29.6
Gravel	50	37	29.9
Cobble	7	28	120.0
Boulder	12	14	15.4
Particle Index	2.24	2.93	26.7
D50	7	28	120.0

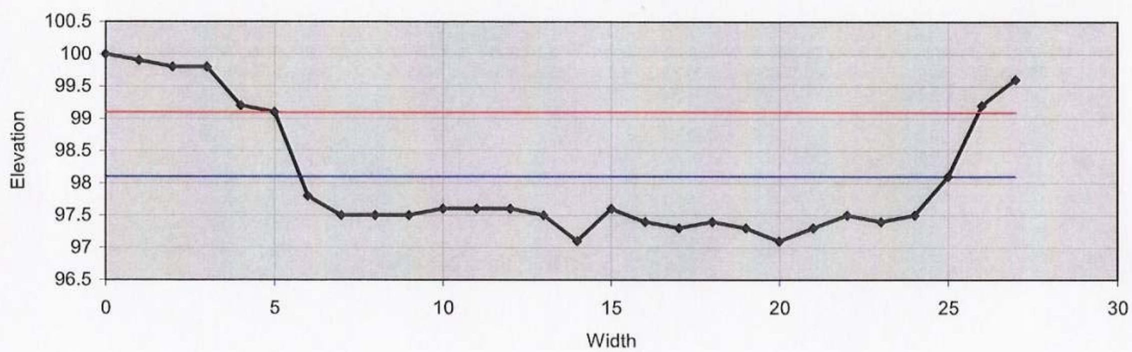
RPD of > 30 are considered to be significant

Channel Dimension (Cross-Section)

Channel cross section reflects the two-dimensional view of the channel, typically viewed in the downstream direction. Points collected from a surveyed cross section should at a minimum contain floodplain elevation, top of bank, bank toe, bank full, water surface elevations and thalweg. Typical dimensions measured from a channel cross section include top and bank full width, bank height, bank slope and channel depth. By convention, the right and left banks reflect the sides of the channel as viewed in the downstream direction.

Measurement of the channel cross section at a riffle is the key ingredient in channel classification and provides a wealth of information regarding the current condition of the channel. At the initial study phase a relatively stable riffle cross section was surveyed for classification purposes. Figure 1 shows this same cross section measured again in 2006. Table 3 compares the cross-section measurements from 2005 and 2006.

Figure 1. Graph of the Upper Glade Run riffle cross section



Bankfull Dimensions	
12.3	x-section area (ft.sq.)
19.2	width (ft)
0.6	mean depth (ft)
1.0	max depth (ft)
19.9	wetted parimeter (ft)
0.6	hyd radi (ft)
30.1	width-depth ratio

Flood Dimensions	
20.9	W flood prone area (ft)
1.1	entrenchment ratio
---	low bank height (ft)
---	low bank height ratio

Materials	
28	D50 Channel (mm)
120	D84 Channel (mm)
---	threshold grain size (mm):

Bankfull Flow	
---	velocity (ft/s)
---	discharge rate (cfs)
---	Froude number

Flow Resistance	
0.056	Manning's roughness
0.42	D'Arcy-Weisbach fric.
4.4	resistance factor u/u*
1.6	relative roughness

Forces & Power	
---	channel slope (%)
---	shear stress (lb/sq.ft.)
---	shear velocity (ft/s)
---	unit strm power (lb/ft/s)

Table 3. Comparison of the 2005 and 2006 cross-section measurements

Dimensions and ratios	2005	2006	RPD
Cross sectional area (feet^2)	21.0	12.3	52.1
Width (feet)	18.4	19.2	4.3
Mean depth (feet)	1.1	0.6	58.8
Width-depth ratio	16.1	30.1	60.6
Flood prone width (feet)	26.0	20.9	21.7
Entrenchment ratio	1.4	1.1	23.1

In 2005 this section of Upper Glade Run classified as a B type channel, but there was a change to an F channel type in 2006.

Type B channels have a broad valley but not a well developed flood plain. These channels are moderately entrenched with moderate to steep slopes. Type B channels are often rapid dominated streams with step/pool sequences. Bank heights are typically low if the channel is stable. This stream type is quite resilient to moderate changes, especially if riparian buffers remain intact.

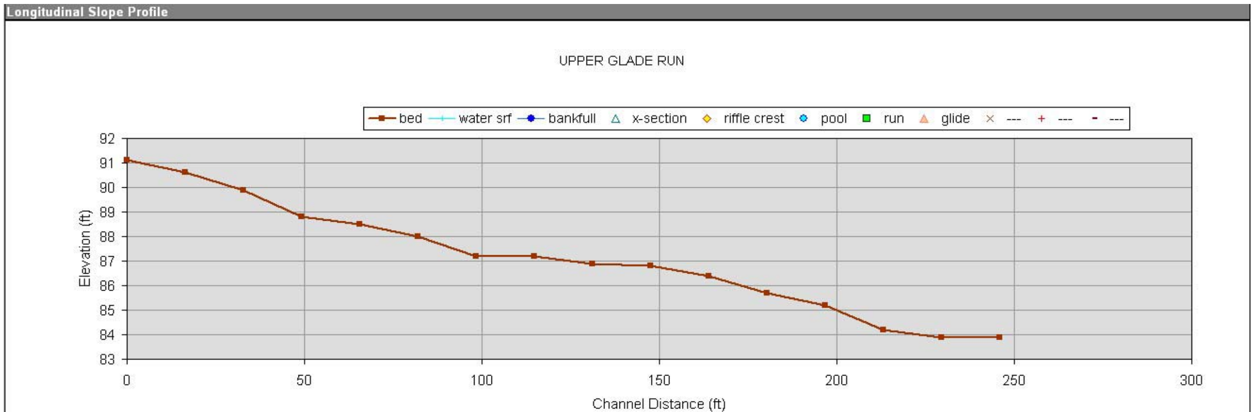
Type F channels are usually deeply entrenched. These stream types are typically working to create a new floodplain at a lower elevation and will often evolve into C and then E stream types. This evolutionary process leads to very high levels of bank erosion, bar development, and sediment transport.

Longitudinal Profiles

Channel slope is defined as the vertical fall of a stream over a given distance. It is typically reported as a percentage (ft/ft) or as feet of drop per mile (ft/mile). Longitudinal profiles depict slope trends on a stream reach. The most accurate means of determining the slope of the channel bed is by surveying the channel thalweg elevation (the deepest point in the channel bed) over a given distance.

Figure 4. Longitudinal profile

Longitudinal Slope Profile



	slope (%)	slope ratio	length (ft)	length ratio	pool-pool spacing (ft)	p-p ratio
reach	2.9	---	246.0 (13.4 channel widths	---	---	---
riffle	---	---	---	---	---	---
pool	---	---	---	---	---	---
	---	---	---	---	---	---
	---	---	---	---	---	---

notes	cross section ID	bed feature	incremental data		Benchmark Elevation 100				depth		user defined									
					Turning Points			FS		FS	FS	FS	FS	azimuth	ELEV	ELEV	ELEV	ELEV	ELEV	ELEV
			distance	station	BS	HI	FS	bed	water	bankfull				AZ	bed	water srf	bankfull	---	---	---
back sight to benchmark					0	100														
			0	0		100		8.9							91.1					
			16.4	16.4		100		9.4							90.6					
			16.4	32.8		100		10.1							89.9					
			16.4	49.2		100		11.2							88.8					
			16.4	65.6		100		11.5							88.5					
			16.4	82		100		12							88					
			16.4	98.4		100		12.8							87.2					
			16.4	114.8		100		12.8							87.2					
			16.4	131.2		100		13.1							86.9					
			16.4	147.6		100		13.2							86.8					
			16.4	164		100		13.6							86.4					
			16.4	180.4		100		14.3							85.7					
			16.4	196.8		100		14.8							85.2					
			16.4	213.2		100		15.8							84.2					
			16.4	229.6		100		16.1							83.9					
			16.4	246		100		16.1							83.9					

Table 4. Percent slope comparison of the 2005 and 2006 longitudinal profiles

2005	2006	RPD
1.5	2.9	63.6

Conclusions and Summary

Upper Glade Run is a rather unique system due to the hydrologic influences exerted by the two-acre lake at its headwaters. This lake was built more than 50 years ago for recreational purposes but in many ways has behaved as a flood control structure for most of the watershed.

Runoff is reduced through lake influences and by healthy upland forest and excellent riparian vegetation in the upper part of the watershed. Extreme high flows are rare, but they do occur especially from locally heavy downpours. Only on rare occasions are flows high enough to overtop the banks. In addition, since much of the channel is similar in dimension, pattern and profile throughout the watershed, few changes have occurred (based upon historical data from aerial photographs). This is not been the case in the lower portion of the drainage.

The study portion of Upper Glade Run has historically been somewhat incised due to structural encroachments and sporadic human influences; however, the riparian vegetation has remained consistent and relatively undisturbed.

In the spring of 2005 the vegetation was removed, which will likely cause further and faster degradation to this portion of the channel. Long term monitoring will capture these changes and help us to better understand the interrelationships that maintain a stable stream channel system.

Thus far we see dramatic changes from just two years of surveys. The channel character has changed and the stream is evolving differently than anticipated, probably due to the removal of vegetation. We anticipate some recovery if natural vegetation is allowed to return. However, if the channel continues to incise and erode the streambanks, the structures close to the stream could be at risk.

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