

# Research and Management Partnership for Stream Habitat Inventory in the Appalachians

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## Abstract

The U.S. Forest Service Center for Aquatic Technology Transfer (CATT) has worked with resource managers from the George Washington-Jefferson National Forest (GWJNF) since 1995 to collect and analyze stream habitat data from watersheds across the Forest. Data summaries are used for project-level analysis and monitoring and in revising or establishing the desired future condition of watershed-related attributes. To date, the CATT has inventoried 298 streams (624 stream kilometers) using basinwide visual estimation technique (BVET) habitat surveys. A typical inventory includes estimates and measurements of several habitat attributes, such as amount of large woody debris, in every habitat unit (e.g. pool, riffle) encountered. BVET surveys provide large amounts of data that can be compared within or between streams at scales ranging from stream reaches to drainage basins. In 1999, the CATT and the GWJNF began to enter all summary data into a geographic information system, making comparison between streams and watersheds much easier than in the past, and providing managers with a powerful tool to aid decision-making. The CATT and the GWJNF are working together to improve the functionality of the existing GIS and to anticipate incorporation of the BVET data into larger corporate databases such as the Forest Service's Natural Resource Information System.

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## Introduction

The George Washington-Jefferson National Forest (GWJNF) manages 1.8 million acres of land within eight major watersheds, primarily within Virginia (Figure 1). Over 2,300 miles of perennial streams, 1,000 of which are classified as 'trout waters,' flow through GWJNF managed lands in the Blue Ridge and Valley and Ridge physiographic provinces. In addition to providing a diverse fishery, Forest waters support over 100 species of freshwater fish and mussels, of which 26 are listed as threatened, endangered, or sensitive.

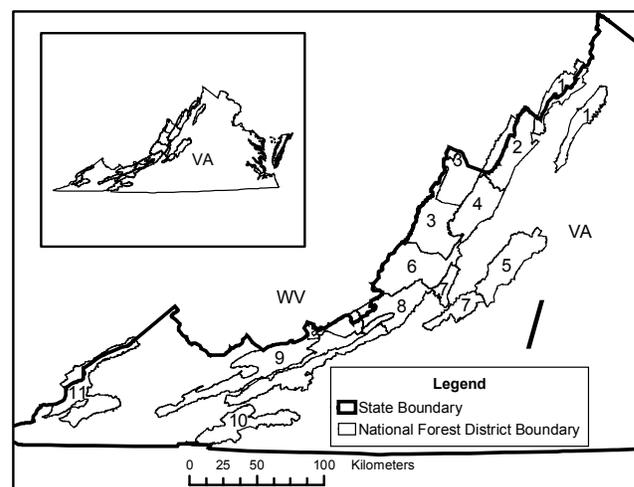


Figure 1. Location of GWJNF and associated ranger districts. 1 = Lee district; 2 = Dry River district; 3 = Warm Springs district; 4 = Deerfield district; 5 = Pedlar district; 6 = James River district; 7 = Glenwood district; 8 = New Castle district; 9 = New River Valley district; 10 = Mt. Rogers district; 11 = Clinch district.

Table 1. Total number of streams and stream kilometers surveyed on the GWJNF using BVET habitat surveys between 1995 and 2002, and number of streams with less than 125 total pieces of LWD per kilometer.

Ranger District	Year	Streams Surveyed		Less than 125 pieces per km <sup>1</sup>	
		(count)	(km)	(count)	(%)
Pedlar	1995	60	191	45	75
New Castle	1996	31	81	15	48
Glenwood	1997	39	102	22	56
Mt. Rogers	1998	61	150	19	31
New River Valley	1999-2000	24	100	9	38
Lee	2001	47	140	27	57
Dry River	2002	36	78	26	72
Total		298	624	163	55

<sup>1</sup> Streams with less than 125 pieces of LWD per km do not meet the GWJNF DFC for LWD.

GWJNF resource managers recognize the importance of monitoring and evaluation in the management of aquatic resources. Stream habitat data are needed to ensure that effective standards and guidelines are established to provide habitat for the persistence of species as directed by the National Forest Management Act of 1976, and to meet the requirements of Federal environmental laws, including the National Environmental Policy Act, Clean Water Act, and Endangered Species Act. To this end, the GWJNF has engaged in a collaborative partnership with the U.S. Forest Service, Southern Research Station, Center for Aquatic Technology Transfer (CATT) to collect, analyze, and report stream habitat data.

Since 1995, we have collected over 600 kilometers of habitat data on 298 wadeable streams within 7 GWJNF ranger districts (Table 1). The underlying methodology used to collect habitat data has remained consistent, allowing us to compare results both within and between watersheds. However, the types of data collected and the tools used to collect and report them have changed in response to changing Forest needs and technological developments. Our purpose here is to describe the continuing evolution of BVET habitat survey data collection, analysis, and reporting processes within the context of the GWJNF stream monitoring program.

## Methods

In 1995, we collaborated with resource managers from the GWJNF to develop a standard stream habitat survey based on visual estimation methods (Hankin and Reeves 1988). The basinwide visual estimation technique (BVET) habitat survey allowed

us to collect data on a pre-selected set of habitat attributes in an entire watershed. The original habitat survey included attributes to quantify the total surface area in pools and riffles, water depths, quantity of large woody debris (LWD), and bankfull channel and riparian widths. In 1998, the GWJNF requested that we add attributes to describe substrate composition, distribution of channel types (Rosgen 1996), channel gradient, and water temperature.

Here, for the sake of simplicity, we will limit our methods, results, and discussion to the inventory of LWD using BVET habitat surveys in GWJNF streams.

## Field work

The BVET habitat survey is performed by a two-person crew using visual estimation techniques (Doloff et al. 1993). The crew enters the stream at a recognizable location, such as the Forest boundary, and proceeds upstream recording habitat attributes. The crew divides the stream into individual habitat unit types (e.g. riffle, pool), records the location (distance from survey start point) of each habitat unit, and records visual observations of habitat attributes such as the amount of LWD within the bankfull stream channel in each individual habitat unit. LWD are recorded in one of four size categories during the survey (Table 2). Data are recorded electronically on field data loggers.

Table 2. LWD size classes used during BVET habitat surveys in GWJNF streams.

Size Class	Length (m)	Diameter (cm)
1	>1 and < 5	10-55
2	>1 and <5	>55
3	>5	10-55
4	>5	>55

### Data analysis and reporting

Since a typical survey includes hundreds of individual habitat units (pools and riffles), basinwide habitat surveys quickly generate large amounts of data. Although it is possible to summarize BVET data by hand, it is not practical. Between 1995 and 1998 we used commercial statistical software packages to analyze BVET data but as the surveys evolved we needed an analysis tool that provided more flexibility. In 1999, we began analyzing BVET data with spreadsheet based software that is more easily manipulated in response to changing data collection methods and reporting needs.

Since 1995, we have prepared and delivered annual hard-copy and electronic media reports that provide basic data summaries; for example, see Duty et al. (2002). The reports include both tabular and graphical presentations of various analyses for all stream habitat attributes surveyed. For example, in the case of LWD, we calculate the number of pieces of LWD per kilometer for each stream and present the data in a table with results from all other streams for data comparison. We also include a figure showing the distribution of LWD along the entire length of the stream.

Geographic information systems (GIS) are now widely used in data analysis and interpretation in fisheries data. GIS combines spatial data, such as stream location, with descriptive attribute information, such the amount of LWD, to provide a powerful analysis tool. Several pre-requisites must be met to develop an effective GIS, including: 1) consistent data collection methods over time, and 2) collaboration with qualified professionals to develop the GIS tool. Once entered into the GIS, data become dynamic, making it relatively easy to compare data within or between watersheds over time.

The GWJNF recognized the potential for interpreting their BVET habitat survey data with a GIS. Their stream habitat dataset had become so large that comparisons between streams and districts

could not be easily compared using hard-copy reports. A GIS could provide relatively quick answers to questions such as: ‘How many streams within the GWJNF do not meet our desired future condition (DFC) for amount of LWD?’ and ‘Are streams that do not meet the DFC clustered into small areas or are they scattered across the Forest?’ In 2001, the GWJNF contracted with the Conservation Management Institute (CMI) at Virginia Polytechnic Institute and State University to develop a GIS tool that could answer such questions. The resulting GIS incorporates several spatial data layers such as ranger district boundaries and streams locations, which are linked to attribute tables containing summaries of BVET habitat survey results. We have begun to use this tool to analyze and interpret BVET habitat survey results in a spatial context.

### Wilderness watershed: An example

Hogback Creek is a second order stream located within the St. Mary’s River Wilderness in the Pedlar Ranger District. The U.S. Forest Service Southern Research Station performed a BVET habitat surveys on the stream in 1989 and we performed a second survey in 2002 (Moran et al. 2003). We surveyed an additional 60 streams on the Pedlar Ranger District in 1995. The results of the Hogback Creek and additional Pedlar Ranger District surveys allow us to demonstrate some of the many ways in which the GWJNF uses BVET data to examine stream conditions.

We will use the Hogback Creek and Pedlar Ranger District surveys to show: 1) variation in LWD distribution within a single stream during a single survey, 2) variation in LWD amount within a single stream during multiple surveys, 3) variation in LWD amount in multiple streams within a single ranger district, 4) variation in LWD amount across watersheds and ranger districts.

### Results

#### Single stream, single survey

In 1989, we found a total of 87 pieces of LWD per km in Hogback Creek. The LWD consisted mostly of pieces less than 5 m in length and 10 to 55 cm in diameter (size 1) (Figure 2). The total amount of LWD was below the GWJNF DFC. There was very little LWD in the lower 350 meters of the stream (Figure 3).

### Single stream, multiple surveys

We found over twice as much total LWD per km in 2002 as in 1989 (Figure 2). In 2002, the LWD once again consisted mostly of pieces less than 5 m in length and 10 to 55 cm in diameter. The total amount of LWD was greater than the minimum GWJNF DFC and LWD was more evenly distributed throughout the stream in 2002 (Figure 3).

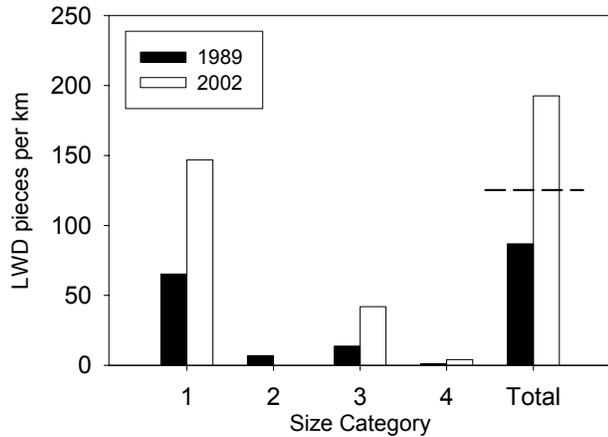


Figure 2. Amount of LWD per km in Hogback Creek in 1989 and 2002. See Table 2 for a description of LWD size categories. Total is the sum of all four size categories. Dashed line indicates GWJNF DFC for total LWD (125 pieces per km).

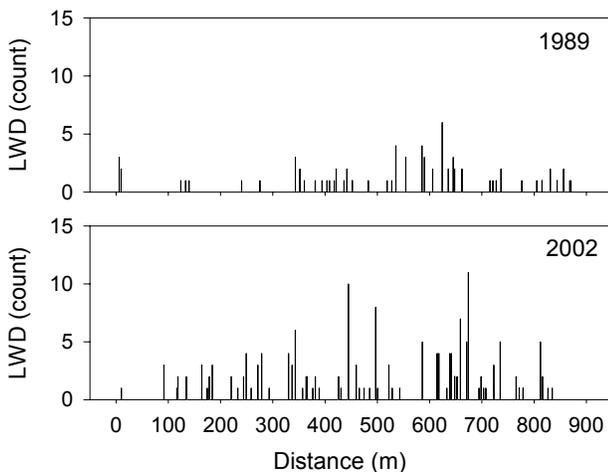


Figure 3. Distribution of LWD in Hogback Creek in 1989 and 2002. Distance is number of meters from downstream end of survey. Count is sum of all four LWD size categories.

### Multiple streams, single district

In 1995, streams on the Pedlar Ranger District ranged from 3 to 369 total pieces per km, with an average of 104 pieces per km, below the GWJNF DFC (Figure 4). In 1989, Hogback Creek had approximately the average amount of LWD found in other Pedlar Ranger District streams, but by 2002 it had increased to near the 90<sup>th</sup> percentile (Figure 4).

### Multiple streams, multiple districts

Overall, 55% of streams surveyed were below the DFC for LWD in GWJNF streams (Table 1). The Mt. Rogers Ranger District had the lowest percentage (31%) of streams below 125 pieces per kilometer and the Pedlar Ranger District had the highest percentage (75%).

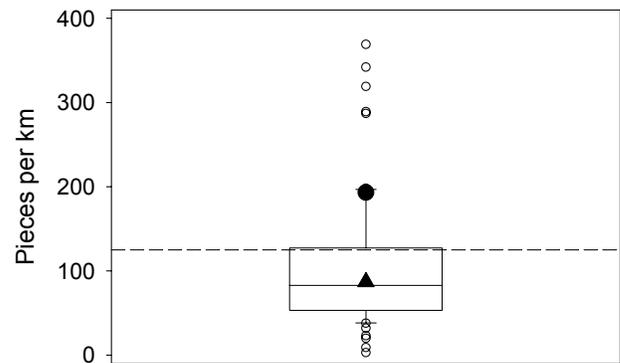


Figure 4. Amount of LWD per km in all Pedlar Ranger District streams surveyed in 1995 (boxplot), Hogback Creek in 1989 (closed circle), and Hogback Creek in 2002 (closed triangle). Dashed line indicates GWJNF DFC for total LWD pieces per km. Bottom and top of box represent 25<sup>th</sup> and 75<sup>th</sup> percentiles, solid line represents median value, whiskers represent 10<sup>th</sup> and 90<sup>th</sup> percentiles, open circles show complete range of data.

### Discussion

The LWD results demonstrate the myriad ways that BVET habitat surveys can be analyzed to provide stream habitat information. For example, we can use a single survey on a single stream to locate areas in need of LWD addition. Multiple surveys on the same stream show changes in stream conditions over time. These changes may then be traced to specific causes. In the present example we suspect that the dramatic increase in the amount of LWD in Hogback Creek is related to increased tree damage and deaths related to a 1990s infestation of the watershed by

gypsy moths (*Lymantria dispar*) and a present day infestation by hemlock woolly adelgid (*Adelges tsugae*). Surveys can also be compared across ranger districts or entire Forests to help allocate resources to the areas in greatest need. In addition, such data can be linked to a GIS to analyze stream habitat conditions in the context of past or proposed future land uses.

The numbers of ways in which BVET habitat data may be analyzed and presented are limited only by the amount of time available and the reporting tools available to the analysis team. Hard copy reports are important tools for presenting summary information to biologists, administrators, and the public on an annual basis. A GIS tool centralizes results contained within hard-copy reports, provides for relatively easy comparisons over space and time, and can also incorporate other spatial data layers such as timber cuts, road crossings, etc. to provide a better planning tool and clearer interpretation of results.

The GWJNF has already made use of its Forest-wide analysis capabilities. The Forest used BVET data to assess status of streams when preparing their new Land Resource Management Plan that provides direction for Forest management over the next decade.

In the near future the majority of the BVET habitat data we have collected will be incorporated into the natural resources information system (NRIS), a corporate database intended to house all Forest Service natural resource related data. This will allow even greater potential for spatial and temporal data analysis as we will be able to compare data collected on the GWJNF to BVET habitat survey data collected from watersheds in other National Forest across the country.

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