

Results of a survey of the Davidson River in Pisgah National Forest, NC

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Abstract. The Pisgah Chapter of Trout Unlimited monitors the water quality of the Davidson River in Pisgah National Forest in an attempt to keep the stream a premiere angling destination. A survey of the Davidson River in Pisgah National Forest was conducted to provide baseline chemical and biological data at a time when the river is suspected to be in good health. The survey included the identification of macroinvertebrates and the collection of water chemistry data (including dissolved oxygen, pH, conductivity, total dissolved solids, temperature and other parameters). The survey utilized the North Carolina Biotic Index and genus-level identifications of macroinvertebrates, which were collected using a modification of the Standard Qualitative Method used by the North Carolina Department of Environment and Natural Resources. The river was determined to be of excellent condition in all nine sections. Biotic index values indicated that the section of the river downstream of the state fish hatchery dam suffered from some disturbance during the study.

Introduction

The Davidson River Project (DRP), an effort implemented by the Pisgah Chapter of Trout Unlimited (PCTU), exists in part to provide baseline data of the Davidson River for purposes of evaluating water quality and determining areas of the Davidson that require reparation projects or new management protocol. Data collected by PCTU is supplied to the personnel of Pisgah National Forest, where it is interpreted by professionals in order to make management decisions. Some of these decisions call for physical improvements to the river, wherein volunteers from Trout Unlimited and other groups aid in costs and labor.

The Pisgah Chapter has utilized a number of scientific assessment techniques in this effort. While habitat and substrate surveys have been conducted within the entire stretch of the river within Pisgah National Forest, biological surveys of benthic macroinvertebrates have also been incorporated. Beginning in September 2002, Pisgah Chapter members have volunteered to provide biological monitoring data by adopting one of the nine sections of the Davidson River and conducting samples in this section twice each month for a year. These section managers collect macroinvertebrates using a standard kick-net technique, and identify the organisms to the order-level. An abbreviated version of the North Carolina Biotic Index (NCBI), the Order-level NCBI was used to create biotic index values (Marchal 2003).

Macroinvertebrate data is vital to this project for a number of reasons. Because the purpose of the DRP is to, "keep the Davidson healthy," the importance of water quality and a balanced ecosystem is vital. Because many species in the Davidson River ecosystem rely on benthic macroinvertebrates as a food item (trout included), these populations are an important component of the Davidson. Additionally, because certain types of macroinvertebrates are intolerant of pollution, the use of macroinvertebrate biotic indices provides an insight to the level of disturbance within the system. While the

data provided by volunteer section managers has provided much year-round information on the macroinvertebrates of the Davidson River, it has been determined that genus and species identifications of macroinvertebrates can supply more accurate data (Lenat and Resh, 2001). It was decided by the Membership Board of PCTU that a survey of the Davidson River utilizing more rigorous identifications would be necessary to accompany the order-level year-round data collected. In addition, the collection of water chemistry data would also be incorporated, so that information in addition to that of biological factors would be known.

Materials and Methods

Study Sites

In an effort to best make the data created by this study comparable to the year-round data collected by section managers, the nine sections of the Davidson River defined by PCTU were also used in this study. Within each section a survey site was defined, which may or may not have been the exact site used by the DRP section managers (Table 1). Sites were selected to be characteristic of the substrates, light penetration, width and depth of their respective sections. Each station was sampled five times, resulting in 45 total surveys.

Survey Methods

In most respects, the macroinvertebrate samples of this study followed the standard qualitative method used by the North Carolina Department of Environment and Natural Resources (NCDENR) Division of Water Quality (Standard Operating Procedures for Benthic Macroinvertebrates, 2001). This approach is useful in providing a multi-habitat approach at aquatic sampling, a characteristic unavailable to surveys utilizing only a kick net technique (Lenat, 1988). While the NCDENR approach utilizes a 10-step approach, this study utilized one of 7-steps. This approach included one kick net sample, three sweep net samples, one leaf pack sample, two fine mesh rock and/or log samples and visual samples. Another difference in the methods of this survey and those conducted by NCDENR was in the preservation of species. Instead of preserving nearly every organism collected, all macroinvertebrates collected were compared to a reference collection in the field. Organisms that could be identified in this way were released, while new species and those difficult to identify (such as dragonflies, order odonata), were all preserved and identified using a dissecting microscope in the lab. Macroinvertebrates were identified to genus when possible. All organisms were recorded on a data sheet modeled after that used by NCDENR (Appendix I).

A Hach brand water chemistry test kit was used to collect water chemistry data. Parameters included in this survey included: dissolved oxygen (using a digital titrator and powder reagents); conductivity, salinity and total dissolved solids (using a

Table 1. Study site locations. All study sites were located within Pisgah National Forest, each within a specific section of the river (as described by members of PCTU).

Site/ Section	Coordinates	Description of Location
1	N35°16.45/ W82° 42.55	Nearby first fishing pull-off on 276.
2	N35°16.89/ W82° 43.22	Near the Art Loeb Trailhead off 276.
3	N35°17.06/ W82° 43.76	Between Pisgah Ranger Station and the English Chapel off 276.
4	N35°17.23/ W82° 44.93	Near a fishing pull-off between Avery Creek and picnic area off 276
5	N35°17.09/ W82° 45.67	Near picnic area before Coontree off 276.
6	N35°17.42/ W82° 46.59	Near Looking Glass Trailhead.
7	N35°17.08/ W82° 47.93	Downstream from fish hatchery dam off Forest Service 475.
8	N35°17.06/ W82° 48.21	Off of the Davidson River Trail off Forest Service 475.
9	N35°16.95/ W82° 49.04	Just upstream from Cove Creek off Forest Service 475.

conductivity probe); pH (using a pH probe); nitrates (using a spectrophotometer and powder reagents). Water temperature and air temperature was determined using a LaMotte brand thermometer. This information was noted on the same data sheet as the macroinvertebrates. Visual estimations of stream width and depth, bank height, bank angle, flow conditions, turbidity and flow conditions were also included on the data form. Location information was also recorded, including coordinates given by a Magellan Blazer GPS unit.

Biotic Index

Water quality ratings were derived from macroinvertebrate data using the NCBI. This biotic index uses the pollution tolerance of North Carolina's macroinvertebrates to calculate a water quality value by computing the average pollution tolerance of all of the macroinvertebrates collected in a survey (Lenat, 1993). Macroinvertebrates identified to genus were given tolerance values according to the NCBI. Those identified to family or order were given tolerance values of the mean tolerance value of all species in their group in North Carolina, though the vast majority of macroinvertebrates were identified to genus. In addition, the NCBI accounts for the ecoregion of the survey location and the season the survey was conducted. This information is used to calculate a numeric water quality value, which can be interpreted into a water quality rating (Table 2).

Table 2. Criteria for North Carolina Biotic Index in the mountain ecoregion (Standard Operating Procedures for Benthic Macroinvertebrates, 2001). Water quality scores can be translated into water quality ratings as follows: 5 is excellent, 4.9-4 is good, 3.9-3 is good-fair, 2.9-2 is fair, and 1.9-1 is poor.

Water Quality Score	Biotic Index Value	Seasonal Corrections
5	<4.00	Winter/Spring: add 0.5 Fall: add 0.4 (apply before determining water quality score)
4.6	4.00-4.04	
4.4	4.05-4.09	
4	4.10-4.83	
3.6	4.84-4.88	
3.4	4.89-4.93	
3	4.94-5.69	
2.6	5.70-5.74	
2.4	5.75-5.79	
2	5.80-6.95	
1.6	6.96-7.00	
1.4	7.01-7.05	
1	>7.05	

Other sources of Data

In addition to the data supplied by this study, the data of other studies was referenced to ensure accuracy. This includes water quality values for the Davidson River from NCDENR macroinvertebrate surveys using the NCBI and water chemistry data from the Volunteer Water Information Network (VWIN). All of this information was created from measurements and surveys conducted within Section 1 of the Davidson River. In addition, for the inventory of macroinvertebrates of the Davidson River, data from my undergraduate thesis project was included.

Results

Macroinvertebrate Data

In all, 44 macroinvertebrate genera were identified in the study, and an additional 8 other organisms were collected and identified to either family or order. Most of these genera are represented in the listing of macroinvertebrates for the Davidson River from NCDENR (French Broad River Basin 2003 Report, 2003). An updated inventory of the macroinvertebrates of the Davidson (including results from this study and that of NCDENR surveys) is shown in Appendix II.

The use of the NCBI produced biotic index values between 1.81 and 4.64, with all ratings within the “excellent” category with the exception of three samples, one of Section 1, one of Section 4 and one of Section 7 (Table 3). As a general trend, upstream sites yielded better ratings than downstream sites (Figure 1). This trend did not apply to Sections 4 and 7, however, which were given a lower mean biotic index value than the section immediately downstream. The biotic index values for Section 7 were considerably farther from that of Section 6. Biotic index values did not vary greatly throughout the summer. While slight variations did occur within the survey, these do not suggest any certain trend. In the sample conducted by NCDENR of the Davidson within

Table 3. Biotic Index Values for benthic macroinvertebrate surveys using the NCBI. Shaded values indicate values not defined as “excellent”.

Section	Survey 1	Survey 2	Survey 3	Survey 4	Survey 5	Mean
1	3.72	4.15	3.33	3.79	3.88	3.77
2	3.88	3.27	3.68	2.73	3.7	3.45
3	3.14	3.89	2.82	3.26	3.25	3.27
4	4.04	3.41	3.79	2.91	2.96	3.42
5	3.62	3.89	3.04	3.02	3.01	3.31
6	2.72	3.17	2.61	2.52	3.41	2.89
7	3.88	4.64	3.76	3.5	2.93	3.74
8	2.74	2.9	1.93	1.81	2.21	2.32
9	2.29	2.05	1.93	2.03	2.13	2.09

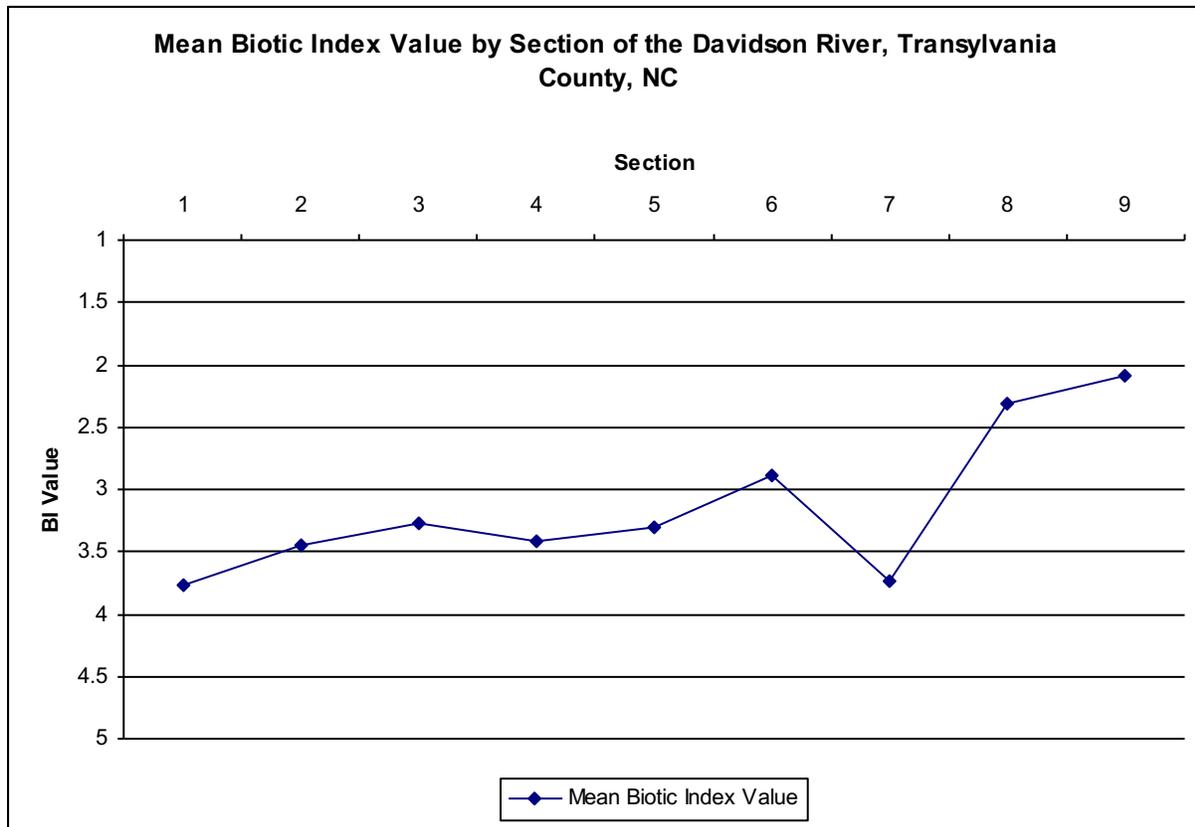


Figure 1.

Section 1 in July of 1997, a biotic index value of 3.77 was calculated using the NCBI (French Broad..., 2003). This value matches identically that which was granted from the mean biotic index value of section one established in this study. Biotic index values for each survey, along with a record of the macroinvertebrates collected at each sample are given in Appendix III.

Water Chemistry Data

Water temperature was fairly steady within each site throughout the study and from site-to-site, with section means averaging from 15.7 to 18.1. Dissolved oxygen levels were of a favorable level, with section means ranging from 8.8 to 11.98. Section means of conductivity values ranged from 11.9 to 16.2. Total dissolved solids were fairly similar for all sections; section means ranged from 6.0 to 7.0. As expected, pH values of the Davidson were of an acidic nature, with section means ranging from 5.93 to 6.70. Mean values by section for these parameters are shown in Table 4. Nitrate levels were found to be of only trace amounts, after sampling each section once for this parameter the test was discontinued. Salinity levels were 0.0 for every survey. Water chemistry parameter levels for each survey are included in Appendix III.

The water chemistry data from this survey mirrors closely that of surveys conducted by VWIN. The mean conductivity level in the summer months for 2002 and 2003 was 14.83 and the mean pH was 6.4 (Mass et al, 2003).

Discussion

Both biotic index values and water chemistry values indicate that the Davidson River within Pisgah National Forest is in excellent condition. Each section is capable of supporting populations of trout, and continuing to serve as a top destination for anglers. The survey was successful in providing baseline data at a point in which the river system is in good health, so that if macroinvertebrate populations and water chemistry parameters change somewhat it can be determined whether or not a reevaluation of management protocols is necessary.

While the Davidson River is in excellent condition, the biotic index values of Section 7 do indicate a significant disturbance in this section. This could be a result of where the study site for this section is located (downstream of the state fish hatchery dam). It is possible that the hatchery dam has some effect on the macroinvertebrate population, resulting in a shift from an abundance of more pollution intolerant organisms to that of more pollution tolerant ones. While the effluent of the dam is released in Section 7, the study site for the section was upstream of this release. This means that it is doubtful that the effluent has any effect on the study site for Section 7. The effluent does not seem to have any negative effect on the macroinvertebrate population of Section 6, located just downstream. A closer investigation of Section 7, with emphasis on the hatchery dam and effluent, may determine why this section does not follow the trend of all other sites (upstream is of better quality of downstream). In addition, while this study does not indicate that the hatchery's effluent impacts the quality of the Davidson, a close investigation of this feature may be of a benefit.

Table 4. Mean water chemistry values by section.

Section	Water Temp (Celsius)	DO (mg/L)	Conductivity (μS)	TDS (mg/L)	pH
1	17.6	10.82	12.52	6.2	6.68
2	18.1	8.46	13.02	6.2	5.93
3	17.8	9.22	12.42	6.4	6.69
4	16.8	11.52	12.62	6.0	6.70
5	17.3	10.00	13.64	6.2	6.66
6	15.7	10.12	12.60	6.2	6.54
7	16.7	11.98	11.90	6.0	6.87
8	16.0	9.86	15.46	6.8	6.28
9	16.8	8.8	16.42	7.0	6.48

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