Microhabitat Selection of Trout in Two Pennsylvania Streams

Lori Smith
Honors Project 2011

Introduction:

Within Pennsylvania, there exists a variety of threats to stream ecosystems. Agricultural activities, urbanization, and natural gas exploration are a few examples. The possible repercussions that these threats can have on streams are exponential including effects on aquatic life, water quality, and habitat. Fishery managers have long recognized the close relationship between habitat availability and trout population dynamics. Furthermore, it has been shown that necessary habitats such as minimum stream flows, low-velocity and deep refuge, foraging sites, overhead cover, and spawning gravels are vital in order to maintain healthy trout populations . In addition, water quality conditions and benthic macroinvertebrate populations also play a large role in maintaining healthy trout populations.

Study Area – Two Streams were used in this study (Big Bear Creek and Ogdonia Creek).

Big Bear Creek:

Big Bear Creek, a tributary to Loyalsock Creek, is a third order stream nestled in a 17 m² watershed. The stream itself runs approximately 5.2 miles, and has been in part the property of the Dunwoody Sportsmen's Club since 1884. However, prior to 1999 the stream suffered from severe bank erosion, sediment deposition and channel widening as a result of hurricane events and poor road management practices. Therefore in order to combat this issue, in 1999, the U.S. Fish and Wildlife Service in cooperation with the Dunwoody Sportsmen's Club decided to use the streams as a pilot project for Natural Stream Channel Design (NSCD). The purpose of NSCD is to restore a stream to its natural condition and achieve even distribution of riffle, run, pool areas through the use of habitat restoration structures. The project took over four years to complete, covered four miles and 200 structures were placed into the stream.

Pre-restoration:


Post -restoration


Ogdonia Creek:

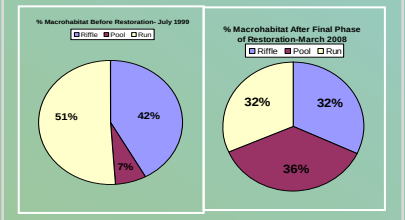
The second stream used in this study is a stream known as Ogdonia Creek.. Similarly to Big Bear Creek, Ogdonia Creek is a third order stream and also a tributary to Loyalsock Creek. Ogdonia Creek located approximately eight miles north of Big Bear Creek. However, unlike Big Bear Creek, Ogdonia Creek does not have restoration structures as part of the NSCD and is a natural, non-restored stream.


Project Purposes:

This study compared habitat and trout populations on the restored Big Bear Creek and the non-restored Ogdonia Creek. There were two main objectives of this study and they are as follows: 1.) to determine microhabitat selection of brown versus brook trout, and determine habitat selection of trout within Natural Stream Channel Design stream versus the non-restored stream; 2.) to assess water quality and habitat conditions, as well as fish, benthic macroinvertebrate, and periphyton densities..

Microhabitat Measurements:

One of the major objectives of the NSCD implemented in Big Bear Creek was to achieve even distribution of riffle, run and pool areas also known as microhabitats. Microhabitats provide important environmental niches for fish and benthic macroinvertebrates. Results from a previous study conducted by Nichole Rhodes, a former Lycoming College student, shows pre and post restoration results of microhabitat measurements completed on Big Bear Creek.



Pre-restoration -1999 Post-restoration – 2008

In conducting microhabitat measurements on both streams in 2010, similar results to that of post-restoration were seen. An even distribution was found at both streams. This even distribution is important in providing different species and size class of fish with their respective habitats.

Area (m²) of Microhabitats -2010

Big Bear Creek	
Riffle (m²)	402.62 ± 109.6
Run (m²)	453.51 ± 90.5
Pool (m²)	219.33 ± 39.5

Ogdonia Creek	
Riffle (m²)	443.03 ± 132.06
Run (m²)	592.34 ± 27.7
Pool (m²)	390.64 ± 94.3

Microhabitat Surveys:

Microhabitat surveys were conducted through a series of snorkeling surveys. Surveys were conducted between September and October 2010. A 200 meter reach was snorkeled among two sites at both streams. While snorkeling trout were identified and size class, species, and dominant substrate (at fish's position) were visually estimated. After visual estimates were completed a marker was placed in the water indicating the fish's location. Later measurements of fish depth (m), focal point velocity (m/s) (velocity at the fish's eye), mean velocity (m/s), distance to structure (m) were taken for each fish located. An Independent t-test statistic and Wilcoxon Rank Sum test was used to assess whether there was significant difference in habitat preference of trout.


Students completing snorkeling surveys


Visual marker indicating fish's position in water

Results indicated that there was no significant difference in habitat selection among brook trout and brown trout, and among trout in the two varying streams (ie. Big Bear Creek versus Ogdonia Creek). Both brook and brown trout were found to select for similar habitats in both streams.

Mean +/- Std. Dev.and α = 0.05			
	Brook Trout N = 12	Brown Trout N = 20	P-value
Parameter			
Depth (m)	0.362 +/- 0.126	0.389 +/- 0.185	0.6229
Mean Velocity (μ/s)	0.183 +/- 0.179	0.134 +/- 0.124	0.4159
Focal Velocity (μ/s)	0.155 +/- 0.236	0.095 +/- 0.155	0.4380
Distance to Structure (m)	0.350 +/- 0.272	0.400 +/- 0.465	0.6790

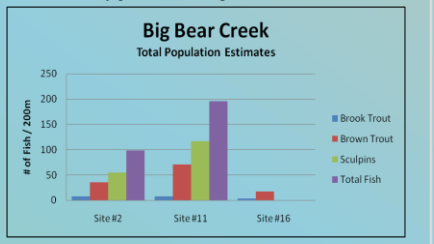
P-value was greater than 0.05 therefore no significant difference was present.

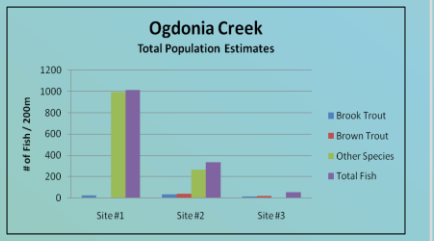
Quality and Conditions Assessment, and Population Estimates:

Between August 2010 and February 2011 water samples were collected to determine water quality. Habitat assessments were also completed in accordance to EPA's Rapid Bioassessment. In addition, fish benthic macroinvertebrate and periphyton densities were assessed. In order to assess microhabitat availability, habitat measurements were taken.

Water quality and benthic macroinvertebrate densities were assesssed on three sites from each stream. Results from water chemistry indicated good water quality conditions. pH was greater than 6.51 between both sites,. Mean alkalinity was 40.8 ppm for Ogdonia Creek and 20.6 ppm for Big Bear Creek. Mean conductivity was greater than 61.0 μ/S for Ogdonia Creek and 33.0 μ/S. According to the Hilsenhoff Family Biotic Index, both streams indicated very good water quality with the possible presence of organic pollution. Family Biotic Index score was 4.0 for Big Bear Creek and 3.8 for Ogdonia Creek. More than 80% of periphyton collected were dominated by *Coccneis sp*. Results from habitat assessments indicated good habitat conditions at both streams (Big Bear Creek = 170/200; Ogdonia Creek = 155/200).

Fish population estimates were completed between August and September 2010. Mean trout density per hectare was 420 at Big Bear Creek and 328 at Ogdonia Creek. Solely at Big Bear Creek, mean brown trout densities persisted over mean brook trout densities with brook trout density per hectare being 60 and brown trout density per hectare being 359. However at Ogdonia Creek, mean brook trout density per hectare was 179 compared to mean brown trout density per hectare being 149.





Three fish species were found at Big Bear Creek (Brook trout, brown trout, and slimy sculpins). Whereas, at Ogdonia Creek blacknose dace, longnose dace, fallfish, and smallmouth bass were found in addition to the same species found at Big Bear Creek.

Acknowledgements:

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Genetic Analysis of Brown Trout in Two Pennsylvania Streams

Lori Smith
Honors Project 2011

Project Purposes:

This study compared the genetic DNA of brown trout from two populations. The purpose of this study was to access genetic variation of brown trout among two populations (ie. Big Bear Creek and Ogdonia Creek, Northcentral, PA).

Study Area – Two Streams were used in this study (Big Bear Creek and Ogdonis Creek).

Big Bear Creek:

Big Bear Creek, a tributary to Loyalsock Creek, is a third order stream nestled in a 17 m² watershed. The stream itself runs approximately 5.2 miles, and has been in part the property of the Dunwoody Sportsmen's Club since 1884. However, prior to 1999 the stream suffered from severe bank erosion, sediment deposition and channel widening as a result of hurricane events and poor road management practices. Therefore in order to combat this issue, in 1999, the U.S. Fish and Wildlife Service in cooperation with the Dunwoody Sportsmen's Club decided to use the streams as a pilot project for Natural Stream Channel Design (NSCD). The purpose of NSCD is to restore a stream to its natural condition and achieve even distribution of riffle, run, pool areas through the use of habitat restoration structures. The project took over four years to complete, covered four miles and 200 structures were placed into the stream.

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Ogdonia Creek:

The second stream used in this study is a stream known as Ogdonia Creek.. Similarly to Big Bear Creek, Ogdonia Creek is a third order stream and also a tributary to Loyalsock Creek. Ogdonia Creek located approximately eight miles north of Big Bear Creek. However, unlike Big Bear Creek, Ogdonia Creek does not have restoration structures as part of the NSCD and is a natural, non-restored stream.


Introduction:

Through previous research on the two study streams some initial goals for this study were established. The intital goals of the genetic analysis were to determine the strain of brown trout that persited in both streams. Based on the morphology, it was hypothesized that the Von Behr strain, also known as the German Trout, made up the brown trout of Big Bear Creek. This was contrary to the Loch Levan strain that was believed to make up the brown trout of Ogdonia Creek. The German brown trout is described as being brightly colored with bright red spots, particularly on the lateral line, pronounced dark brown and black spots on the opercula and sides, black and white margins on the anal and dorsal fins, and rarely exceeding 12 inches in length. Whereas the Loch Leven brown trout is described as a silvery gray with black spots, no red ones, and can exceed lengths of 12 inches.

Von Behr

Loch Levan

Through historical stocking records it is known that the Dunwoody Sportsmen's Club began stocking the Von Behr strain in Big Bear Creek in the early 1900's. However, the Fish and Boat Commission, who were responsible for previous stocking on Ogdonia Creek, used the Loch Levan Strain more heavily.

Field Methods:

Adipose fin clippings were taken from 10 brown trout from both streams, for a total of 20 clippings and preserved in 95% denatured ethanol to be processed for genetic analysis. The adipose fin was the selected because it has been found to affect the trout the least if removed.

Lori taking fin clip

Lab Methods:

Genomic DNA analysis was completed at the U.S. Fish and Wildlife's Northeast Fishery's Center's Population Ecology Branch. Genomic DNA was extracted from adipose fin clip tissue using the Purgene DNA extraction kit (Gentra Systems, Inc., Minneapolis, MN) following the manufacturer's guidelines. The selection of primers for microsatellite analysis was based on previous research completed by the Northeast Fishery Center. A total of fourteen microsatellites were combined into three multiplexes for PCR amplification. Microsatellites are specific loci or regions of DNA. An ABI Prism 3100 Genetic Analyzer was used for capillary electorphoresis.

PCR amplifier

ABI Prism 3100

Three programs were used to analysis the data. The Hardy-Weinberg Equilibrium test was accomplished through the program Genepop. The program Geneclass was used to complete a maximum likelihood assignment test which used to determine the probability of an individual being classified back into the population from which it was collected. Finally, BIOSYS-1 was used to construct a proportion shared tree for both populations analyzed.

Results:

The observed heterozygosity of the two populations was similar to the expected thus samples showed conformance to Hardy-Weinberg Equilibrium. Mean heterozygosity per locus was 0.625 ± 0.066 for Big Bear Creek and 0.638 ± 0.042 for Ogdonia Creek. Results of pairwise estimates ($\alpha = 0.05$) indicated a significant difference ($\alpha < 0.0001$) in allele frequencies among the two populations (ie. Big Bear Creek and Ogdonia Creek). The maximum likelihood assessment test which determined the probability of a removed individual having the same frequency of alleles as other individuals within the same population yielded a 90% assignment . Eighteen out of twenty individuals correctly identified with their original population. This proved that enough genetic differences were present between the two populations that individuals could correctly identify with their rightful populations 90% of the time.

Maximum Likelihood Assignment Test:

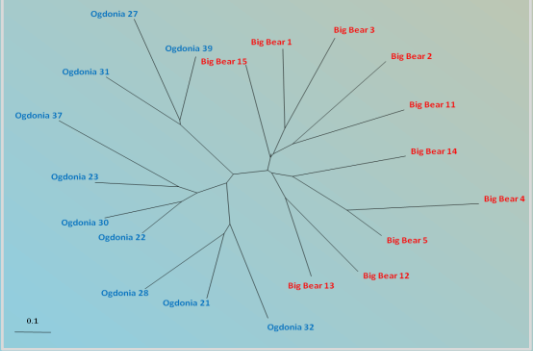
1	LORI-001 [BIG BEAR CREEK]	Big Bear Creek
2	LORI-002 [BIG BEAR CREEK]	
3	LORI-003 [BIG BEAR CREEK]	
4	LORI-004 [BIG BEAR CREEK]	
5	LORI-005 [BIG BEAR CREEK]	
6	LORI-011 [BIG BEAR CREEK]	
7	LORI-012 [BIG BEAR CREEK]	
8	LORI-013 [BIG BEAR CREEK]	
9	LORI-014 [BIG BEAR CREEK]	
10	LORI-015 [BIG BEAR CREEK]	
11	LORI-021 [OGDONIA CREEK]	Ogdonia Creek
12	LORI-022 [OGDONIA CREEK]	
13	LORI-023 [OGDONIA CREEK]	
14	LORI-027 [OGDONIA CREEK]	
15	LORI-028 [OGDONIA CREEK]	
16	LORI-030 [OGDONIA CREEK]	
17	LORI-031 [OGDONIA CREEK]	
18	LORI-032 [BIG BEAR CREEK]	
19	LORI-037 [BIG BEAR CREEK]	
20	LORI-039 [OGDONIA CREEK]	

18 individuals on 20 correctly identified (90.00%)

Results (cont.):

A proportion shared tree was also constructed displaying the proportion of genes shared by all individuals among both populations. As seen below, the two populations distinctly grouped separately from one another. The distinct grouping of populations indicates that each individual shared the most similarities in genes with other individuals within their population.

Proportion Shared Tree:



Discussion:

Although, the results of the genetic analysis were not conclusive in determining which strain, the Von Behr or Loch Levan strain, inhabits each study stream. Due to the distinct genetic variation seen between the two separate populations some predictions can be drawn. The high genetic variation among the populations indicates that two separate and distinct populations do exist. Moreover, if samples from known strain trout are acquired there may be a strong likelihood that prediction about each population may be met.

Acknowledgements:

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