Undercut Banks and Trout Populations in the Saw Mill River

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Abstract:

Background: The Saw Mill River is an ailing ecosystem. This study compares trout populations in two sections of the Saw Mill River to determine what habitat features are best suited to hold a stable trout population.

Methods: Two predetermined sections of the Saw Mill River in Westchester County were surveyed ten times each to evaluate the populations of the various species living in the River. From these three sites a total of 6 species were collected using a seine net. The two sections of the Saw Mill River used in this study were as follows: Hawthorne Multiplex Cinema (41°05.821'N:073°48.665'W) and Rumbrook Park (41°02.886'N:073°49.530'W). Each of the three sections were predetermined and chosen according to their unique stream bank characteristics.

Results: A total of seven species of fish were collected from the Saw Mill River ecosystem. After population counts were taken over a one month period, abundance of trout was the highest in sections of the Saw Mill River with undercut banks. A 2 proportion Z test was used to analyze for differences in fish abundance within the three sampled sites. Since the data was not normally distributed, original population count numbers first had to be transformed to make their distribution approximately normal. Although trout were more abundant in sections of the river with undercut banks, a two sample Z test p=.3991 proved this data statistically insignificant.

Conclusions: In this study significance was not great enough to determine which sections of the Saw Mill River are best suitable to trout. In regard to the high environmental pressure placed on the stream by external factors such as heavy land use and population density, by completing this study the overall health and stability of the Saw Mill River was to be determined by looking at trout populations and overall species diversity.

Introduction:

The Saw Mill River is Westchester's southernmost tributary to the Hudson River. Its headwaters are located in New Castle, New York. From there, the river flows 20 miles through Westchester County eventually meeting with the Hudson River at Dock Street in Yonkers. The mouth of the Saw Mill River is tidal and receives an influx of water from the Hudson River. The river is at its widest at it's confluence with the Hudson River. It displays a distinct dendritic drainage pattern in its' upper coarse and a long narrow drainage basin in its southern reaches. The river follows a typical pattern of alternating pools and riffles. Upstream areas of the river are an average of 3-8 meters wide with a depth of less than 1 meter. The bottom of the river varies from mud and sand to cobble and boulder.

The Saw Mill River is a major natural resource in Westchester and a critical riparian corridor. The river provides some of the only remaining habitat in this part of the County for a wide range of plants and animals and this is why it is important to conserve and protect (Schmidt et. al, 1981). The northern reaches of the Saw Mill River flow through dense suburban development. The Saw Mill River Parkway runs along the bank of the river and crisscrosses it at several locations along its length. These developments have completely altered the natural course of the river and have led to erosion of the riverbank severely narrowing the area in which the Saw Mill River flows and thus increasing stream velocity. These urban developments have additionally led to flooding, pollution, habitat loss, and overall ecosystem degradation. The increased flow in which the water flows has led to the creation of undercut banks in the river. These are created when water flow erodes away at the banks of the river producing an underwater cavity.

In the past two decades scientific studies of warm water stream restoration and rehabilitation projects have been scarce (Osborne et al., 1993). This lack of guidance in stream and habitat restoration can be attributed to limited information on the effectiveness of various stream habitat restoration techniques (Reeves et al., 1991).

Study Area:

The stretches of the Saw Mill River studied ranged from a depth of 24-40 inches. Each of the sampling sites had moderate vegetation disruption. This could vary from invasive flora species to urban developments. River currents in each area ranged from slow moving pools to moderate riffles. Overhead shade was present at each location. The bottom varies from mud and sand to cobble and boulder.

Human population has been increasing at a steady rate from year to year and urbanization is a global trend. All of earth's ecosystems are now human impacted (Vitousek et al., 1997). Suburban development in areas around the river has led to a decrease in river diameter and has altered the Saw Mill River away from its natural course. The lower half of the Saw Mill River flowing through Yonkers has been completely placed underground. The river has become a concrete flume in which all its surrounding habitat has been completely wiped away. Only recently, have efforts been made to bring the river back above ground and to restore its natural habitat and ecosystem. By bringing the river back above ground, many flora and fauna native to the river can be reintroduced (Wyatt 1998). All in all, it is a premium on conservation priorities how to support the most species at the least cost (Myers et al., 2000).

An important part of determining biodiversity in streams is to look at taxa, richness, and species diversity (Karr et al., 1999). By looking and collecting data on these three points we can help determine the overall health of the Saw Mill River. Generally, the more species diversity there is, the better the overall health of the ecosystem (Redford et. al., 1994). To do this, simple models based on population, such as netting, may be useful in describing habitat quality on large scales (Milner et al. 1998). Thus it can be concluded that seine netting is a method that can be used to collect significant and accurate data in our research.

Generally, rivers with the most natural stream flow are the healthiest and support the greatest species diversity (Milner et al., 1995). However, other past studies have shown that rivers with undercut banks have more biodiversity than rivers in absence. In these studies river embankments with artificially made banks and/or undercut banks have had the most significant species diversity (Reeves et al., 1991). Limitations in these past studies must be taken into account, however, as research in these studies has focused on areas of limited human use (Redford and Richter, 1999). This is in contrast to the increasing rate of urbanization as a global trend and with many streams and rivers, such as the Saw Mill River, which are located in areas with high population density.

Species in the Saw Mill River such as Rainbow Trout can only survive under certain conditions. Any significant deviation from these conditions can be fatal to populations in the river. Due to the low depth of the Saw Mill River (average 1 meter) the water can reach temperatures exceeding 70 degrees Fahrenheit. Many cold water species such as the Rainbow Trout can survive only in water temperatures below 60 degrees Fahrenheit (Crisp et al., 1993). In these lethal conditions trout may seek artificial or undercut banks (Mitchell et al., 1998). Undercut banks and the surrounding overhanging forage can provide the necessary shade and

flowing cool water needed for the trout to survive through high water temperatures (Benke et al., 1990).

The Saw Mill River has experienced a significant loss in biodiversity and habitat in the past 20 years. The loss of these species has been attributed to poor water quality (Schmidt and Samaritan, 1984). This poor water quality can be credited to runoff from the Saw Mill Parkway and external sources of pollution.

Whether trout in the Saw Mill River have a preference for these undercut banks due to the shade, shelter, and cover they provide from predators is to be determined. In addition, habitat heterogeneity and substrate provided by plants found on undercut banks may allow for a larger population of trout in the Saw Mill River (Reid et al., 1998).

Two sections of the Saw Mill River have been studied mainly to determine if there is a correlation between undercut banks and trout populations. A secondary objective is to determine whether sections of the Saw Mill River with undercut banks will provide for more species diversity than sections of the River without these banks.

Methods:

Two sites on the Saw Mill River were selected for sampling based on stream bank characteristics. These two stretches of the river were picked by physically scouting sections of the river. To allow for a complete scope of bank environments criteria were as follows: one section must have natural stream flow with no undercut banks and a gradual sloping bank, and the second section must have undercut banks present. The first site selected, Rumbrook Park (41°02.886'N:073°49.530'W), was a section of approximately 100 meters with moderate/ gradual sloping banks. The second selected site, the Hawthorne Multiplex Cinema (41°04.821'N:073°48.665'W), was a section of approximately 100 meters in length with undercut banks and vertical sloping banks. Once these two sites were selected for use in research, other environmental factors in each site were taken into account such as shade, water depth, and bank vegetation cover. (See Table 1) These environmental factors were then ranked on a qualitative scale from 1-5 with 1 being nonexistent and 5 being abundant.

Prior to research,a non-lethal 20 foot x 1.5 meter seine net had to be obtained and collectors of the data had to be trained to properly seine for fish. Training consisted of a seine netting course taught in the nearby Hudson River. These nets were used to gather fish populations in the two predetermined sections of the Saw Mill River.

The seine net was placed across the width of the Saw Mill River within the predetermined section of the stream being researched. Once the seine net was in placed the net was allowed to sit for 10 minutes without disturbance. This will allow for fish species that may have been spooked away from the immediate area to accommodate to the net and to return back to the section of the stream they were previously in. The two netters would then enter the stream at the opposite end of the predetermined area approximately 100 meters away from the seine net.

From this point the two netters would simultaneously walk toward the location of the seine net downstream. Sticks would be used to splash the water causing the fish to be spooked downstream towards the net. The netters would keep walking until they reached the seine net. Once the seine net was reached, the fish spooked into the seine net were then corralled by bringing the two opposite ends of the seine net together. Sampling was initiated on September 12, 2012 and terminated on September 27, 2012. All specimens were identified and counted. Other data such as length, weight, sex, and food habits were not accounted for. This study specifically looked for brown and rainbow trout of no specific gender or age. Once the population count of trout and other species was taken in the predetermined areas, all fish were released quickly and without harm back into the river. All fish were handled properly and returned to the river within minutes, allowing the fish to swim away safely minimizing adverse side effects.

Aggregate counts of fish species were first analyzed to determine fish abundance in the two sections (See Figure 1). The fish count data collected in this study was interval data and parametric tests were used to analyze for differences in fish abundance within the two sampled sites. Since the data was not normally distributed, original population count numbers first had to be transformed to make their distribution approximately normal. Since zeros were included in the data a constant of 1 was added to each number. Then the square root of each number was taken. For example, a count of 3 would result in a final value of 2. (See Figure 2) After the transformation of the data set a 2 proportion Z test was used to test for statistical significance (See Figure 3).

Site	Depth (in)	Shelter	Bank Slope	Bank Cover	Shade
Rosedale Nursery	24-36 in	3	Gradual	1	2
Rumbrook Park	28-40 in	4	Moderate	4	4
Hawthorne Multiplex Cinema	24-36 in	5	Undercut	3	5

Table 1 Qualitative Characterization of Saw Mill River Sites

1	2	3	4	5
Non-existant	Rare	Present	Common	Abundant

Table 2: Qualitative Characterization Scale

Results:

A total of 7 species were collected in the Saw Mill River. Two of the species (yellow perch and common carp) were left out of the study due to the fact that they were only present at the Hawthorne Multiplex Cinema. A total of 2667 total fish were caught in this study representing a total of 4 families (Table 2). The most speciose section was at the Hawthorne Multiplex Cinema. 7 species were caught at this one site over a one month period. Of these 7 species, only 3 of the species were collected at the other location. Within the 7 caught species, 2 species of trout were caught at the Hawthorne Multiplex Cinema (Rainbow and Brown). These data suggests that trout species are more abundant in areas of the Saw Mill River with undercut banks. These data were statistically analyzed using a two proportion Z test. The rounded mean of the transformed data of the number of trout caught in each location were first determined (Figure 3). A proportion was then created using the rounded total population count of trout at each location. This proportion was statistically analyzed to determine the significance of the population counts at both locations. From this test it was determined that $P1>P2$, $p= .423042405$ (Figure 3). Analysis for significance showed that $p> 0.05$. In this study the analysis for significance showed that although trout were more abundant at the Hawthorne Multiplex Cinema, significance was not great enough to suggest a correlation between the probabilities of trout to be located in sections of the Saw Mill River with undercut banks rather than sections of the Saw Mill River lacking in this stream bank feature. Future studies in this topic need to take into account the effect of increased trials in fish population gathering. In this study each site was sampled ten times for a total of 20 trials. To allow for more accurate significance values, there should be more trials for population counts in sections of the Saw Mill River. The number of

Figure 1. Fish Population Abundance

	Fish (n)			
	Trout	Dace	Sucker	Sunfish
Hawthorne Multiplex Cinema				
	1	0	1	0
	3	20	10	4
	0	20	5	0
	2	100	3	0
	0	100	4	0
	3	100	4	0
	3	100	10	0
	2	100	30	0
	0	100	50	1
Total:	14	640	117	5
Rumbrook Park				
	0	100	75	0
	0	100	30	1
	0	150	55	0
	0	150	60	0
	0	125	45	0
	0	150	30	2
	0	175	33	0
	0	150	25	0
	0	150	25	0
	0	175	15	0
Total:	0	1425	393	3

Figure 2. Transformed Population Abundance Values

	Fish (n)			
	Trout	Dace	Sucker	Sunfish
Hawthorne Multiplex Cinema				
	1.41	1	1.41	1
	2	4.58	3.32	2.24
	1	4.58	2.24	1
	1.73	10.04	1.73	1
	1	10.04	2.24	1
	3	10.04	2.24	1
	3	10.04	3.32	1
	2	10.04	5.57	1
	1	10.04	50	1.41
Rumbrook Park				
	1	10.04	8.72	1
	1	10.04	5.57	1.41
	1	12.29	7.48	1
	1	12.29	7.81	1
	1	11.22	6.78	1
	1	12.29	5.57	1.73
	1	13.27	5.83	1
	1	12.29	5.11	1
	1	12.29	5.11	1
	1	13.27	4	1

trials needed for $p < 0.05$ is currently unknown and open to conjecture. Furthermore, long term studies are needed to analyze why trout prefer sections of the Saw Mill River with undercut banks. Among the possibilities are easier access to prey, shade, and shelter. Similarly this section of the Saw Mill River contained the greatest abundance of sunfish.

Table 2. Species of Fish Collected in the Saw Mill River (Total Species = 5)

Family Cyprinidae (Minnows)	Longnose Dace *Rhinichtus cataractae*
Family Cenrarchidae (Sunfishes and Black Bass)	Pumpkinseed Sunfish *Lepomis gibbosus*
Family Catostomidae (Suckers)	White Sucker *Catostomus commersoni*
Family Salmonidae (Salmon and Trout)	Rainbow Trout *Salmo gairdneri* Brown Trout *Salmo trutta*

Figure 3. Two Proportion Z Test Trout

	Rounded Avg 10 Samples	Rounded Total Species Count	P1>P2
Hawthorne Multiplex Cinema	Avg. =2	16	p= .423042405
Rumbrook Park	Avg. =1	10	p= .423042405

The relative abundance of calculations indicated that Rumbrook Park had the greatest species abundance for white sucker and blacknose dace (See Figure 1). These data suggest that these two species have no preference for undercut banks. Further studies are needed to analyze what habitats and stream bank features these fish species are most attracted to.

Although the Saw Mill River appears to be a somewhat diverse ecosystem, some species that are quite common in other Westchester streams have been eliminated from the Saw Mill River. These species include fall fish (Semotilus corporalis) and the cutlips minnow (Exoglossum maxillingua). Previous studies have listed this species as present in the Saw Mill River (Greely et al., 1936). Current efforts, including those in this study, to collect this species have not been successful. This has been attributed to poor water quality (Schmidt and Samaritan, 1984).

In a previous study of the Saw Mill River conducted in 1989 only 4 species of fish were collected at the Hawthorne Multiplex Cinema (Sanders et al., 1989). Out of these 4 collected species no trout were collected at this time. In this study, 7 species of fish were collected in this area. Species diversity has increased in this area of the Saw Mill River. New species to the area include the rainbow trout, brown trout, yellow perch, and common carp. From this increase in number of species it can be determined that there has been an increase in species biodiversity in the Saw Mill River (Karr et al., 1999). Increased biodiversity signifies increased stability in river ecosystems (Redford et al., 1999).

Conclusion/Discussion:

A total of 7 fish species have been detected in this study. All 7 of these species were present at the Hawthorne Multiplex Cinema. This has been an increase in number from previous studies conducted on the Saw Mill River such as the Longitudinal Distribution of Fishes in the Saw Mill River (Guillory et al., 1977). This indicated greater biodiversity in the Saw Mill River and a more stable ecosystem despite many constant pressures (high population density, loss of flora and fauna) (Wyatt 1998).

Parametric analysis and a two proportion Z test for statistical analysis has shown that although areas of the Saw Mill River with undercut banks hold a greater trout population than areas lacking in this stream bank feature more sampling is needed to determine if there is truly a correlation between undercut banks and trout populations in the Saw Mill River. Brown and Rainbow Trout had the greatest abundance at the Hawthorne Multiplex Cinema. This site also had the greatest species diversity out of the 2 sections of the river being studied. Rumbrook Park had the greatest abundance of white suckers and blacknose dace. Further studies are needed to determine what habitats these species are most suitable with.

Simple techniques based on population, such as netting can be useful in describing habitat on large scales (Milner et al., 1998). The sampling method chosen to collect species in this study was netting with a 20’x1.5 m seine net. As a result this study is subject to human error. Although the seine net has weights on the bottom and floats on the surface to block all fish from passing, it is possible that fish were lost during the corralling process. This is especially true of small fish such as the longnose dace and fast swimming fish such as the rainbow and brown trout. A more effective method for fish sampling would be electroshock fishing.

Even rather well-planned research can sometimes produce ambiguous results. To better prove the favorability of undercut banks to trout populations a study of longer time period should be conducted (Shields et al., 1998). Future studies on this topic must include more population count trials in their data collection. Additionally, seasonal changes in small streams may cause trout to seek different microenvironments (Bash et. al., 2002). This study was completed during the month of September. Future studies may strive to include data points in other seasons of the year.

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