Journal of Ecological Research, **4**, 22-26 (2002)

EFFECT OF HEMLOCK ON FISH ABUNDANCE IN STANDING STONE CREEK

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ABSTRACT

The presence of hemlock trees along streams in south central Pennsylvania may be a beneficial factor to the abundance of fish. The introduction of the Woolly Adelgid has caused devastating defoliation of hemlock in this area. Due to the role of hemlock trees in the stability of creek and stream ecosystems, we hypothesized that fish abundance should be greater in sections of local creeks and streams with hemlocks than those without. No significant difference in fish abundance was found between sites with and without hemlocks on the East Branch of Standing Stone Creek in Huntingdon County, Pennsylvania. Small differences existed in fish abundance and species diversity may have been due to habitat selection and preference related to other physical characteristics of the stream.

Key words: abundance, fish, hemlock, woolly aldegids

INTRODUCTION

The Eastern Hemlock tree (*Tsuga canadensis*) is the official state tree of Pennsylvania. Its abundance in the state is important because it provides habitat for numerous animals and has positive effects on many of the state's mountain streams. It is an extremely long-lived, shade tolerant conifer that may grow densely alone or with other deciduous hardwood species. *Tsuga canadensis* creates important structural diversity at the stand and landscape level and provides habitat and cover for a variety of wildlife species. In the absence of major disturbance, *T. canadensis* stands are characterized by cool, damp climate, low light levels, and relatively stable forest decomposition. Currently, the infestation of hemlock by the woolly adelgid (*Adelges tsugae*) from Asia has caused a large depletion and decomposition of many hemlock forests throughout the New England states. This aphid-like insect has begun to migrate south into eastern Pennsylvania, and has recently made the move towards the central portion of the state. This increase in distribution has caused Pennsylvania to be at the forefront of a national effort to manage the bug with biological controls.

In the mid 1920's the Hemlock woolly adelgid (HWA) was introduced into North America and is thought to have entered Pennsylvania in the mid 1960's (Pennsylvania DCNR 2002). Since then, the HWA has been feeding upon New England's eastern hemlocks by sucking the sap from its needle's base. This increased loss of sap causes the tree to lose essential nutrients necessary for survival. Studies in

Connecticut revealed that wind, birds, deer, and humans could play an important role in the dispersal of hemlock woolly adelgid, *Adelges tsugae* (McClure 1990). Once the HWA establishes itself upon hemlocks, it can produce a near 95% fatality rate of the tree (Orwig and Foster 1998).

As a key native species of the state, the hemlock provides riparian forest cover and bank stability for headwaters streams. The hemlocks provide the shade cover during the warm seasons that enable many fish to survive this highly stressful period. Due to decreased hemlock abundance, streams develop problems that affect fish sizes and populations (Berube and Levesque 1998). The extrinsic effects that occur are increased water temperature and sediment runoff, along with decreased dissolved oxygen and lowered species diversity of coldwater aquatic communities. All of these factors are important to fish survival in coldwater creeks and streams. Without the presence of the Eastern hemlock, Pennsylvania's fish populations lose their chances of maximum survival.

The purpose of our study was to test the hypothesis that there would be more total fish in hemlock-covered stream and creek areas than in non-hemlock covered stream areas.

FIELD SITE

The East Branch of Standing Stone Creek (Huntingdon County, Pennsylvania) runs through areas with and without hemlock. The areas with heavier hemlock coverage also contained deeper holes and more structure in the runs, both of which are excellent for fish habitat. The Pennsylvania Fish and Boat Commission has classified this section of stream as a Class A trout stream. This classification means that the state's stocking program is unnecessary due to the natural reproduction of all fish present in that section. Due to the lack of stocked fish, all fish sampled can be considered native-born.

METHODS AND MATERIALS

We chose two sites to sample. The area upstream was chosen for its abundance of hemlock close to the stream, whereas the downstream section was chosen due its lack of hemlock. We divided each of the two sites into five 10-foot blocks by measuring and marking the bank (Fig. 1). At each block, a large net was stretched across at the downstream marker. The person operating the fish shocker started at the upstream marker and moved around in the block, going downstream. Besides the electro-shocker operator, two other people followed with medium to large size nets to catch the stunned fish that surfaced. In addition, the large net stretched across the downstream boundary served to catch any fish missed by the handheld nets. The fish were deposited in separate buckets and at the end of each block, identified and quantified.

In addition, at each site (hemlock and non-hemlock), we measured pH, dissolved oxygen content, and conductivity with meters, and stream flow rate, depth and width morphometrically (see Table 3). A two-sample t-test was used to determine if the mean fish abundances at the two sites differed.

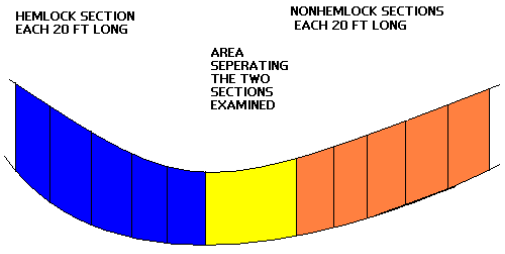

Figure 1. Area of study and quadrants used

RESULTS

Fish abundance did not differ significantly between the hemlock and non-hemlock sites. (t = –1.15, df = 7, P = 0.287), although there were more species found at the hemlock site than the non- Hemlock site (see Tables 1 & 2).

Table 1. Numbers of individuals of several fish species found in each of five quadrants of a non-hemlock and hemlock site along the East Branch of Standing Stone Creek, Pennsylvania.

Non-Hemlock Area				
1st Quadrant	**2nd Quadrant**	**3rd Quadrant**	**4th Quadrant**	**5th Quadrant**
1 black nosed dace	8 black nosed dace	1 brown trout	5 black nosed dace	6 tessellated darters
1 long nosed dace		1 tessellated darter	2 tessellated darters	11 black nosed dace
		1 cut lips minnow		
		5 black nosed dace		
				Total 42 fish

Mean 8.4 fish per quadrant

Hemlock Area				
1st Quadrant	**2nd Quadrant**	**3rd Quadrant**	**4th Quadrant**	**5th Quadrant**
4 fall fish	7 spot fin shiner	5 black nose dace	3 white sucker	7 black nose dace
1 black nosed dace	1 white sucker	1 spot fin shiner	1 brown trout	1 brown trout
7 spot fin shiner	6 black nosed dace	4 white sucker	2 black nose dace	2 spot fin shiner
1 white sucker	2 tessellated darter			1 fall fish
	1 fall fish			2 creek chub
	1 rosy face shiner			
				Total 60 fish

Mean 12 fish per quadrant

Table 2. Summary of fish collected at a non-hemlock and hemlock site along the East Branch of Standing Stone Creek, Pennsylvania

	Non- Hemlock Area	**Hemlock Area**
	30 black nosed dace	21 black nosed dace
	1 brown trout	2 brown trout
	9 tessellated darter	2 tessellated darter
	1 long nosed dace	6 fall fish
	1 cut lips minnow	14 spot fin shiner
		2 white sucker
		1 rosy face shiner
		2 creek chub
Total Species	5 species	8 species

Table 3. Environmental characteristics of a hemlock and non-hemlock site along the East Branch of Standing Stone Creek, Pennsylvania

Hemlock	pH	O2	O2 %	Temp (deg C)	Depth (m)	Flow rate (m/s)
1	6.78	10.61	90.1	7.5	0.47	0.125
2	6.81	10.62	89.6	7.6	0.485	0.154
3	6.66	10.66	89.4	7.7	0.395	0.2
4	6.74	10.6	89.8	7.5	0.595	0.25
5	6.82	10.3	87.6	7.4	0.31	0.286
Mean	6.762	10.558	89.3	7.54	0.451	0.203
Stdev.	0.064962	0.146014	0.9848858	0.114017543	0.10638374	0.066317419

Non-Hemlock	pH	O2	O2 %	Temp (deg C)	Depth (m)	Flow rate (m/s)
1	6.98	10.73	90.5	7.6	0.32	0.435
2	6.99	10.72	90.1	7.6	0.33	0.476
3	6.74	10.77	91.5	7.6	0.41	0.526
4	6.6	10.75	91.3	7.5	0.30	0.435
5	6.98	10.81	91.9	7.6	0.42	0.455
Mean	6.858	10.756	91.06	7.58	0.356	0.4654
Stdev.	0.178662	0.035777	0.7402702	0.04472136	0.08613942	0.037885353

DISCUSSION

Our results failed to support our hypothesis that there would be a greater abundance of fish in a stream section where there were hemlock trees compared to a control section without. No significant difference was found between the hemlock and non-hemlock sections. Furthermore, the slight difference that was found was most likely due to other uncontrolled habitat differences. The section with hemlock trees had deeper water and more vegetative cover than did the non-hemlock section. Certain fish were associated with deeper water (e.g., chubs), whereas others were more often found in shallower water (e.g., darters) (see Page and Burr 1991). Our comparison may have also been affected by our having scared away or missed finding some fish. Further research with better control for habitat differences is needed. Research done in summer months may be more likely to find a difference, since the shade from the hemlocks would create a greater temperature difference. Studies on more streams and larger individual stream sections will decrease the likelihood of random error, and may find a difference where this study did not.

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