Lindquist Farm Project

In December, 2009 members of Bucks County Trout Unlimited planted the last of 1000 trees along Watson Creek on the Lindquist Farm in Buckingham Township. With these trees in the ground the chapter's largest stream restoration project in its history was completed. The project included removal of a dam, stabilization of 450 feet of eroding streambank, a riparian buffer planting of native trees on 1,500 feet of Watson Creek and stream temperature monitoring within the project area. This project was funded by the National Fish and Wildlife Foundation's Delaware Estuary Program (www.nfwf.org).

Watson Creek is one of the two main tributaries to Mill Creek, Lahaska Creek is the other; both flow through the limestone geology that traverses Central Bucks County. Streams that drain underlying formations of limestone are usually characterized by cold water conditions due to substantial groundwater contributions to base flow. Many of Pennsylvania's premier wild trout fisheries are located in regions with underlying limestone. Wild brown trout are present in Watson Creek.

The Lindquist Farm Project had its origins in the chapter's Mill Creek Habitat Restoration Plan completed in 2006 (click on the link above to read the plan). The formulation of the plan involved BCTU members walking the stream corridors of most of the watershed to complete a visual assessment of stream conditions. Some of the factors considered during this assessment were, bank stability, riparian buffer condition, barriers to fish movement and in stream fish cover. The Lindquist Farm was one of five stream reaches identified in the assessment as priorities for restoration.

Stream Temperature Monitoring

From August 6, 2009 to October 10, 2009 water temperature monitoring on the project reach was conducted using HOBO Water Temp Pro automated temperature sensors. Three sensors were installed; one each at the extreme upstream and downstream ends of the 1500 foot project reach and one in the approximate middle of the reach. The sensors recorded water temperature every thirty minutes during the study period. Table 1 shows the highest, lowest and average temperatures for each monitoring station.

Table 1. Low, High and Average Temperatures

Station	Low temperature	High Temperature	Average Temp.
Upper	51.852 F	72.826 F	63.058 F
Middle	51.809 F	73.256 F	63.120 F
Lower	51.630 F	73.861 F	63.062 F

The scientific literature suggests that the preferred temperature range for brown trout is 54 to 66 degrees F. At about 70 degrees F, trout species in general suffer a reduction in the ability to compete with other fish species for food and resources. Lethal temperatures for trout in general are 73 to 79 degrees F (with brown trout mortality at the upper end of this range). For the discussion that follows, only data collected for the period from August 6 to August 31 will be reviewed. After August 31, at all three monitoring stations, there were no instances of temperatures of 67 F or higher, which could be characterized as well within the tolerance range for brown trout.

At 70 degrees F competition stress begins to occur in trout. Table 2 summarizes the percentage of readings 70 F or higher for each monitoring station from August 6 – 31.

Table 2. % Readings 70 F or higher, August 6-31

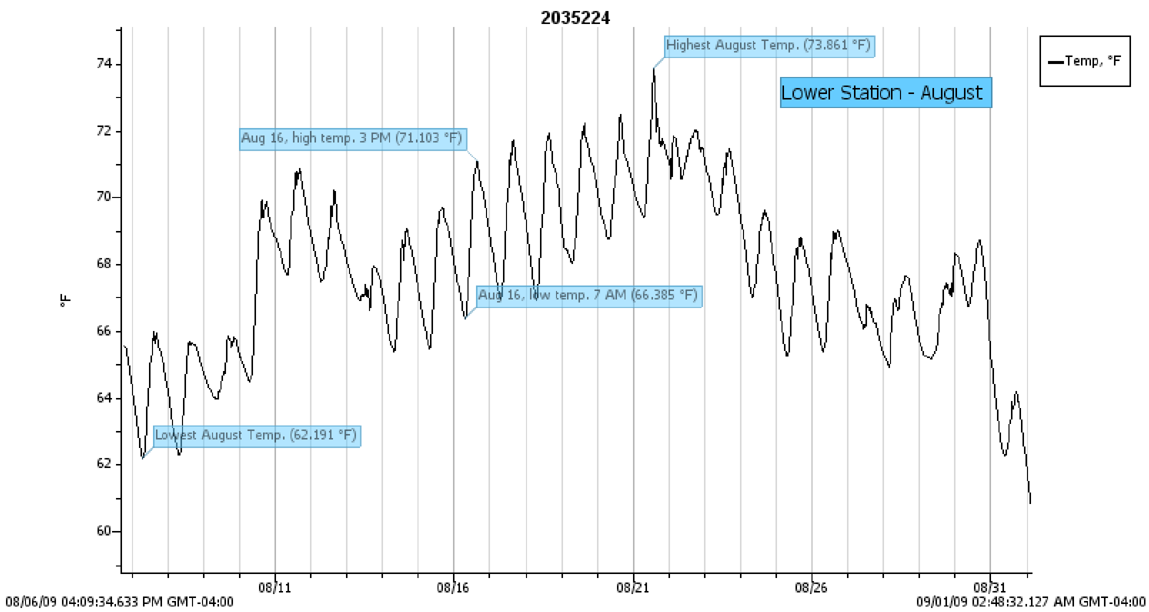
Station	% Readings 70 degrees F or higher
Upper	17.75 %
Middle	19.6 %

Lower	20.25 %

Moving downstream through the project reach, there is a clear gradient of increasing instances of water temperatures that are stressful to trout. The upper monitoring station was sited at the extreme downstream end of a long forested reach, just upstream of the project reach which has no forested buffer other than a few scattered trees that range from approximately 15 to 30 feet tall. As direct solar radiation (i.e. sunlight) is the primary contributor to daily increases in stream temperature, it is likely that the increase in temperatures downstream through the project reach are at least partly the result of more sunlight reaching the stream due to a lack of a forested buffer. Increasing water temperature resulting from lack of forested buffer is cumulative to a certain extent. In areas lacking shading from a forested buffer, it is likely that stream temperature will increase continuously in the downstream direction. Of course, stream temperatures should begin to decrease if the stream once again begins to flow through a forested reach, as is the case with the Lindquist Farm project reach, though we did not monitor for this.

As the Lower Monitoring Station was at the downstream end of the project reach it is not surprising that the highest temperatures were recorded there. Figure 1 shows a detail of the data recorded at this station from August 6 – 31.

Figure 1. Lower Station - August data



The highest temperature recorded during the study period, 73.861 F, occurred at this station at 2:00 PM on August 21. In comparison, the highest temperatures recorded at the Middle and Upper Stations were also on August 21, 73.256 F at 2 PM at the Middle Station and 72.826 F at 4 PM at the Upper Station. From August 14 to 21 there is an increase in both the minimum and maximum daily temperatures recorded at this station. This increase is possibly an indication of the cumulative effect of direct sunlight on stream temperatures. The effect of these daily temperature fluctuations on trout is unclear; some studies indicate that daily fluctuations better enable trout to withstand temperatures above their preferred upper limits while others have found no such correlation. Using August 16 as an example, there is a 4.718 F difference in the high and low temperatures for that day.

While it is difficult to state with certainty all the causes affecting the temperature regime within the project reach and its effects on Watson Creek's trout population, there does seem to be a clear indication that the lack of forested buffer within the reach does play a role in increasing water temperatures in the reach. As the trees that were planted along the project reach grow, reduction of stream temperatures should result.

Riparian Buffer Planting

The project area is a reach of Watson Creek that flows through former pasture; it had little existing riparian buffer, mostly non-native herbaceous vegetation (see photos 1&2). Stream banks were severely eroding throughout much of the reach (see photos 3 & 4) and a dam impeded fish passage (see photo 5). The reach lacked many of the factors that are known to be important for a healthy stream ecosystem: forested riparian buffer, stable vegetated stream banks, lack of large woody debris in the stream and a dam that contributed to isolation of fish populations in the watershed.

PHOTO 1

PHOTO 2

PHOTO 3

PHOTO 4

PHOTO 5

The riparian buffer restoration involved planting over 1000 native trees, 400 native shrubs and 200 native wildflowers. All the plants used in the buffer restoration are native to the Piedmont physiographic province. To aid in survival of the trees, each was protected with a tree shelter to protect them from damage by deer (both browsing and antler rubbing by bucks) and a rodent guard was installed at the base of each to protect from voles gnawing on the bark (see photos 6, 7 & 8). Restoration of a forested riparian buffer will contribute to a healthier stream in a number of ways. The buffer will filter pollutants from runoff before it reaches the stream. It will shade the stream and help reduce water temperature. Colder water carries more dissolved oxygen than warmer water and so can support a more diverse fish and aquatic macroinvertebrate community. The trees will be an immediate source of leaf matter in the stream which is an important energy source for the food web. After leaves fall or are blown into the stream chemicals within them begin to leach out and contribute to Dissolved Organic Matter (DOM) in the stream ecosystem. DOM is an important energy (food) source for microbes that form the base of the food web. Once in the stream and now characterized as Coarse Particulate Organic Matter (CPOM), leaves are invaded by bacteria and fungi; this is important for the aquatic macroinvertebrates that feed by shredding leaf matter as the bacteria and fungi increase the nutritional value of the leaves. Many species of mayflies, stoneflies and caddisflies are “shredders”. Having been shredded and subject to physical abrasion in the stream, the CPOM becomes Fine Particulate Organic Matter (FPOM) and is now an energy source for a different set of aquatic organisms.

PHOTO 6

PHOTO 7

PHOTO 8

In the long term the trees planted will be a source of woody debris in Watson Creek. Woody debris can be twigs, larger branches and downed trees that all create in-stream habitat for aquatic life. For example a collection of branches will trap leaves and so create a feeding ground for the shredders described above. When a large tree falls into the stream it will often result in a scour pool forming downstream of it and so creates habitat for trout and other fish. As the project area lacked existing woody debris and the trees that were planted will not be a source of large woody debris for many decades, some woody debris in the form of “root wads” was incorporated into the restoration plans. A root wad is a 10 to 12 foot section of tree trunk with the roots still attached. The root wads used had trunks from 12 to 24 inches in diameter and were salvaged from building construction sites. The root wads that were installed will perform many functions that contribute to the health of Watson Creek. They will trap CPOM, create overhead cover and scour pools for trout and were installed to help stabilize some of the eroding banks in the project area (see photos 9 & 10).

PHOTO 9

PHOTO 10

Streambank Stabilization

The stabilization of 450 feet of eroding streambank in the project area will greatly reduce the amount of sediment entering Watson Creek. Sediment is the number one pollutant in rivers and streams in the United States. Too much sediment affects the stream in a variety of ways. Many of the stream macroinvertebrates live in the interstitial spaces of pebbles and cobbles on the stream bottom. Too much sediment can fill these spaces (substrate embeddedness) and so reduce the diversity of the stream macroinvertebrate community. Trout require areas of clean gravel free of sediment in which to spawn. Trout eggs are deposited and develop in the interstitial spaces of the substrate; these spaces provide protection from predators and water flowing through the spaces provides oxygen to the eggs. Pollutants, especially phosphorous, can also bond to sediment particles and so remain in the stream for longer periods. Two different methods were used to stabilize banks. The use of root wads as described above was used on about 100 feet of streambank. Approximately 350 feet of bank was graded from vertical to a less severe slope, a native seed mix of wildflowers and grasses was put down and then covered with erosion fabric (see photos 11 & 12). It was then planted with various native shrubs and herbaceous plants including, willow, red-twig dogwood, ninebark, alder, joe-pye weed and cardinal flower. As these plants grow their roots will stabilize the bank and they will remove pollutants, especially nitrogen and phosphorous, before they reach the stream. Of course, these plants will also provide habitat for birds and terrestrial insects.

PHOTO 11

PHOTO 12

Dam Removal

The dam that was removed will allow fish passage upstream and downstream and will restore the natural process of sediment transport downstream. It will especially allow trout to gain access to higher quality spawning habitat, colder water and a gravel/cobble substrate, in upstream reaches of the watershed (see photo 13).

PHOTO 13

Conclusion

The Lindquist Farm Project will improve water quality in the immediate project area and in both downstream and upstream areas. The project area will have improved physical habitat for trout and aquatic macroinvertebrates. Colder water, more DOM, CPOM and FPOM, less sediment and other pollutants will have a positive effect in the immediate project area and will result in improved water quality downstream. The dam removal will now allow fish passage and sediment transport. With the Lindquist Farm Project complete, Bucks County Trout Unlimited looks to continue its work and implement more stream restoration projects to improve water quality in the Mill Creek watershed.

We would like to thank all our partners whose assistance made this project possible:
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