Coldwater Conservation Plan
Upper Starrucca Creek Watershed

SUSQUEHANNA COUNTY, PENNSYLVANIA
MAY 2023

Prepared by the Susquehanna County Conservation District

This project was funded by a planning grant from the Coldwater Heritage Partnership.

Susquehanna County Conservation District

TROUT UNLIMITED

PENNSYLVANIA FISH & BOAT COMMISSION

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1.0 Acknowledgements

The Susquehanna County Conservation District (SCCD) is very grateful for the opportunity and resources that were provided through the Coldwater Heritage Partnership in support of the development of this Coldwater Conservation Plan for the Upper Starrucca Creek Watershed (USCW). This project was financed in part by a grant from the Coldwater Heritage Partnership on behalf of the Pennsylvania Department of Conservation and Natural Resources (Environmental Stewardship Fund), the Pennsylvania Fish and Boat Commission, the Foundation for Pennsylvania Watersheds, and the Pennsylvania Council of Trout Unlimited (TU). Thanks are extended to TU Pennsylvania Coldwater Habitat Program field biologists who completed fish surveying work throughout the USCW. The partnership between the SCCD and TU has yielded valuable data about naturally reproducing trout populations and water quality conditions. Final thanks to those landowners along Starrucca Creek and its tributaries who allowed access to collect the data.

2.0 Introduction

2.1 Scope

This plan is the result of efforts initiated by the Susquehanna County Conservation District (SCCD) to study USCW and its potential for supporting cold water organisms through 2021. This Coldwater Conservation Plan provides a description of the watershed; discusses the ecological and cultural highlights; discusses overall water quality currently documented in the watershed; identifies potential threats to the health of the cold-water ecosystems, and provides recommendations for both physical and conceptual steps that can be taken to further enhance the natural resources in USCW. Data collected through the development of this plan will serve as a baseline of data for future studies within the watershed and a resource for planning of future conservation management activities.

In 2021 the Susquehanna County Conservation District (SCCD) requested the assistance of TU's Unassessed Waters Program. TU staff and other volunteers assisted with conducting habitat, aquatic life connectivity and native trout population surveys throughout the USCW. Data collected through this partnership supports the goals of the Pennsylvania Fish and Boat Commission's Unassessed Waters Initiative. Funding for these particular surveys was generously provided through the Voluntary Wild Trout & Enhanced Waters Program fees collected with fishing licenses. (Home, n.d.) This data will support Wild Trout listings and be included in this document.

Documentation of wild trout streams is critically important for establishing the level of protections required for maintaining water quality variables such as water temperature, adequate macroinvertebrate habitat, and dissolved oxygen levels. The collaborative work that

was recently done could potentially grant additional water quality protections for the natural resources in this watershed of Susquehanna County.

2.2 Project Objectives

- Describe the geographical setting of the watershed.
- Collect and present data on native trout populations within the USCW
- Assess the current water chemistry and habitat of the watershed
- Assess the connectivity for aquatic organism passage on the main stem and its tributaries
- Identify activities and conditions that may negatively impact water quality
- Develop a plan that emphasizes conservation and protection of the water quality through specific actionable steps as well as general suggestions for stakeholders in the USCW
- Provide a list of potential partners and funding avenues to assist with the implementation of recommendations from this document.

2.3 Watershed Description

Starrucca Creek is a tributary to the Susquehanna River with headwater catchments that span multiple municipalities in Susquehanna and Wayne counties. The USCW is the headwaters for the greater Starrucca and is located on the north east of the Glaciated Low Plateau physiographic region of Pennsylvania. This section of the Appalachian Plateaus Province covers the majority of Susquehanna County. The 20.73² miles catchment of the Upper Starrucca span Ararat and Thompson townships in Susquehanna County and Preston Township in Wayne. The Creek was named after the small Borough of Starrucca located on the western edge of Wayne County.

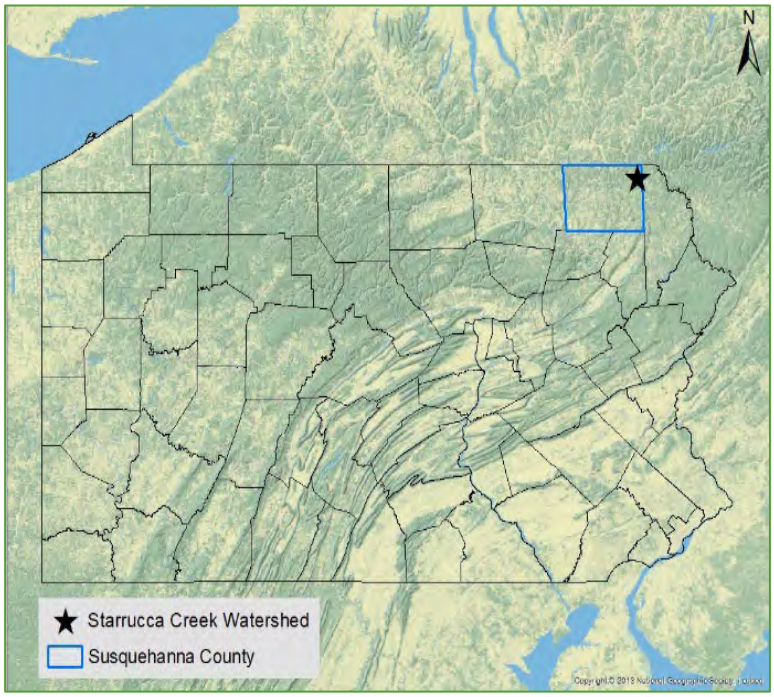


Figure 1 Starrucca Creek Watershed Location

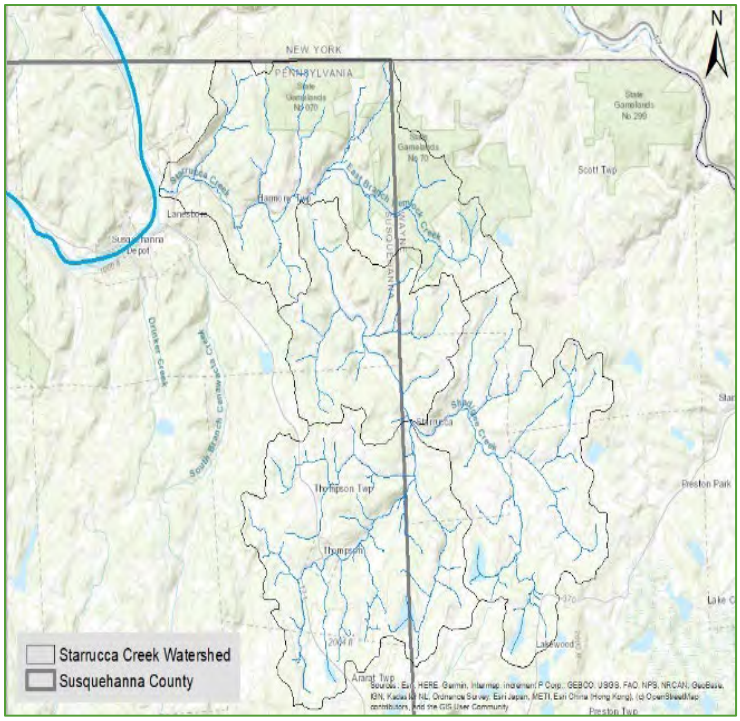


Figure 2 Stream Map Starrucca Creek Watershed

The entire watershed consists of four catchments identified at the HUC 12 scale. Starrucca Creek is the first fifth order stream to flow into the Susquehanna River as it enters Pennsylvania from New York. This makes it the largest tributary by area to reach the Susquehanna River where the river flows through Susquehanna County.

The highest density population within the watershed is located in the Borough of Thompson with a population of 306 (*Thompson, PA, n.d.*). Land use is primarily deciduous forest, agricultural and mixed forest. Forested landscape makes up 70.3 percent of the land use cover within the USCW. Less than ten percent of the total stream length flows through agricultural areas. Global Hydrologic Soil Groups (HSG) D and C represent 96 percent of soils in this watershed. (*Model My Watershed, n.d.*) This distribution is consistent with the number of natural wetlands, ponds and lakes that can be found throughout this watershed; See Figure 1 (Appendix A). (*National Wetlands Inventory, n.d.*) A history of industrial, recreational, and agricultural influences has also played a role in the number of manmade impoundments throughout this watershed.

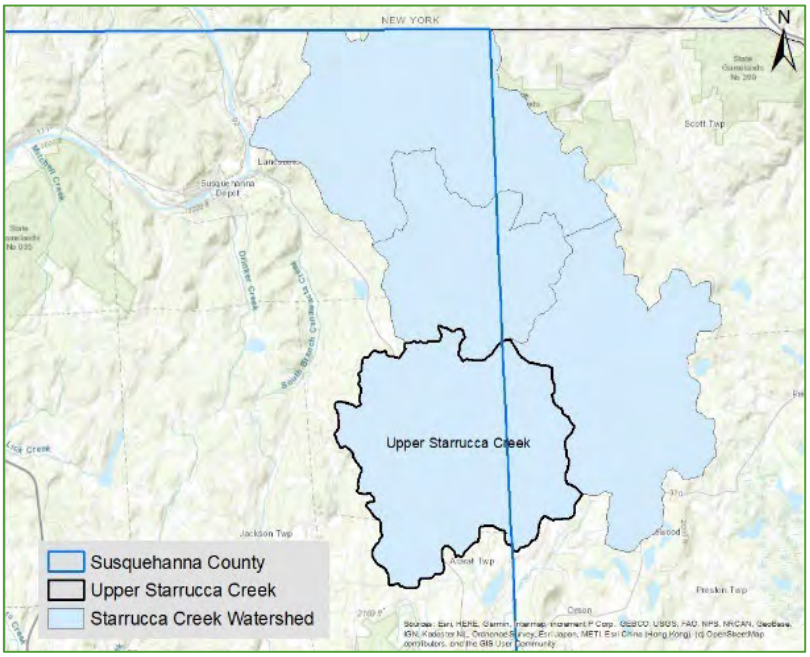


Figure 3 Upper Starrucca Creek HUC 020501011302 in relation to entire Starrucca Creek Watershed

2.4 Current Water Quality Status

Under the Pennsylvania Chapter 93 Designated Use, the entire Starrucca Creek and tributaries within the watershed are designated Cold Water Fisheries. (*25 Pa. Code § 93.9i. Drainage List I., n.d.*) Upper Starrucca Watershed originates from multiple wetlands in Ararat Township and covers a total of 15.73² miles in Susquehanna County and approximately 5² miles in Wayne County. From these wetlands Starrucca Creek flows in a northeasterly direction approximately 6.1 miles through Thompson Township before crossing the county line approximately 1.5 miles upstream from the confluence with Shadigee Creek near the Village of Starrucca. This reach of Starrucca and the unnamed tributary designated 32274 are considered to have an existing use designation of Exceptional Value (EV). The unnamed tributary 21665 that flows through the Florence Shelly Nature Preserve in Thompson Township has a designated use of Exceptional Value as well. This designation provides protections to all wetlands within that subbasin, including those which do not have any designated trout water classification by the Pennsylvania Fish and Boat Commission (PFBC).

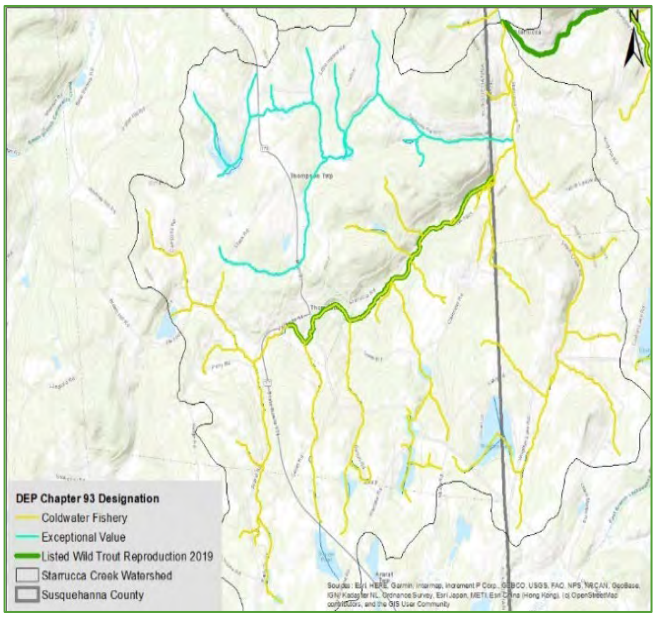


Figure 4 Chapter 93 Designations Upper Starrucca Creek Watershed

Figure 5 Chapter 93 impaired streams for pathogens

There are 5.3 stream miles upstream of the county line listed as Natural Reproduction Trout Steam by the PFBC. This reach does not meet the parameters to qualify as a Class A Trout Stream. Despite its protected status, 57% of the stream are listed as impaired due to pathogens through the Department of Environmental Protection Integrated Report program. This program provides data to the Environmental Protection Agency (EPA) that meets the requirements of the sections 305(b) and 305(d) of the federal Clean Water Act (CWA).

2.5 Natural Resources and Watershed Highlights

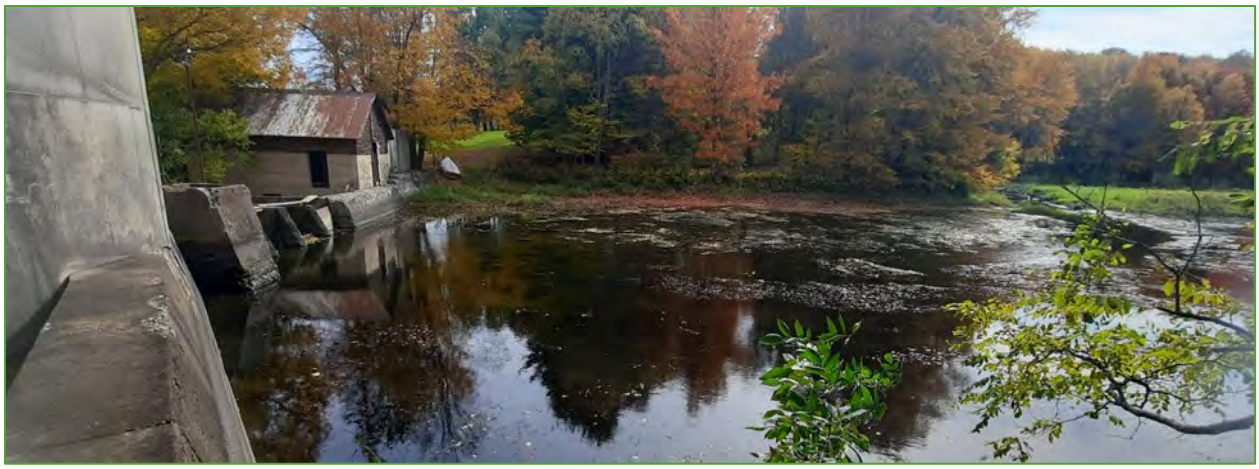


Figure 6 Spencer Mill Dam Pond on Starrucca Creek in Thompson Borough

The Borough of Thompson has been a witness to Starrucca Creek's wonder since its founding in 1876 but the stream's potential to generate power was developed years prior. The Spencer Milling Company gristmill was constructed on Starrucca Creek in what would later become the Thompson Borough. Over the years the building has had multiple businesses run out of it and recently had been used as an Agway. The mill dam it's self is made of concrete and the streambanks from the outflow have been also been lined with concrete and stone for over 280ft downstream. The impoundment created by the mill dam has filled in with sediment over the decades creating a shallow pond that fluctuates in size with rain.

The Florence Shelly Nature Preserve located in Thompson Township is 380 acres of conserved property containing a glacial pond, hemlock stands, expansive wetlands, and a floating bog. This conservancy is owned and managed by Pennsylvania Chapter of the Nature Conservancy. The stream that flows through this property drains from the most northern catchments of the watershed into Starrucca Creek. This tributary makes its way out of the preserve flowing east over what has become known as Buck Run Falls.

Figure 7 Welcome sign at parking area for Florence Shelly Preserve

Native trout were found in the reach of stream between the bottom of the falls and the confluence with Starrucca Creek. Buck Falls and the hemlock dominated riparian forests around it are situated along a section of the Delaware & Hudson (D&H) Rail Trail. This striking natural feature brings in recreational notoriety for trail users and out of town visitors alike. The D&H Rail Trail offers 19 miles of recreational trails between the trailhead in Ararat Township and the New York state line. Much of the trail intersects and provides creek access throughout the entire Starrucca Creek Watershed.

Figure 8 Buck Run Falls

The Friends of Starrucca Creek is a local watershed group that have annually worked within the watershed to help remove rubbish to beautify and prevent potential pollution. Partnering with the Pennsylvania Environmental Council to host the annual clean up, the group have removed massive amounts of trash and debris from not only upland areas within the watershed but even within the creek itself. Below is a before and after picture showing the results of the hard work that they have dedicated to improving the waterways.

Figure 9 Before and after pictures of massive trash and rubbish site on Starrucca Creek

3.0 Methods

3.1 Aquatic Organism Passage

The North Atlantic Aquatic Connectivity Collaborative (NAACC) is a network of individuals from universities, conservation organizations, and state and federal natural resource and transportation departments focused on improving aquatic connectivity across a thirteen-state region, from Maine to Virginia. The NAACC has developed common protocols for assessing road-stream crossings (culverts and bridges) and developed a regional database for these field data. The information collected will aid in the identification of high priority bridges and culverts for upgrade and/or replacement.

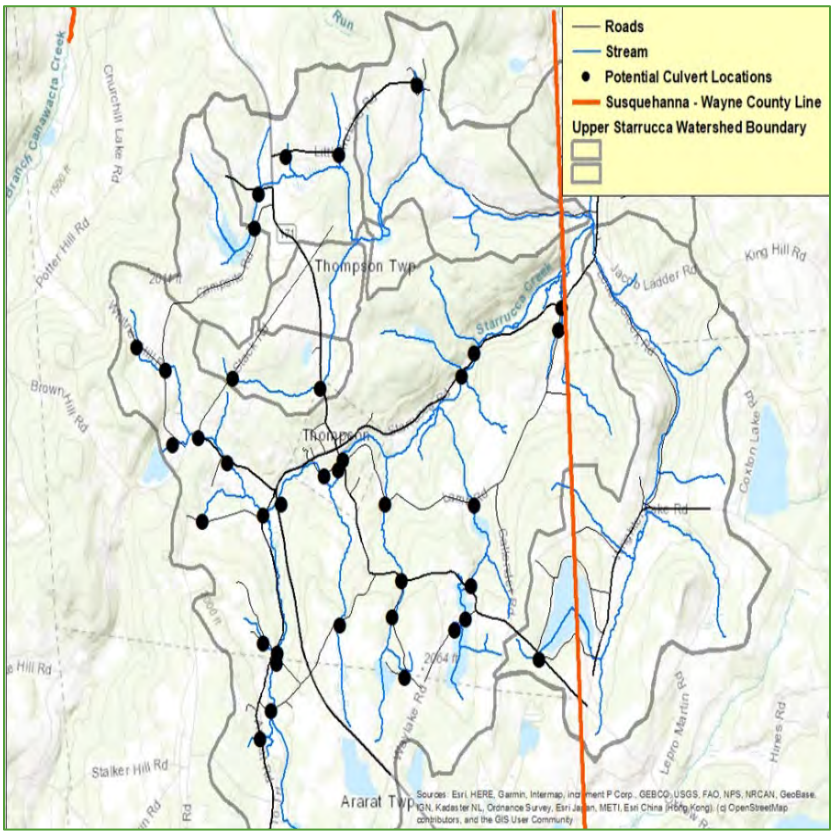


Figure 10 NAACC data base of potential road-stream crossing points prior to field assessment

Assessments were overseen or completed by Lead Observers, or more highly certified field staff, certified by NAACC. General information was collected at each site including; latitude and longitude, road name, township name, date, name of certified field staff, stream name, road type, crossing type, crossing material, and number of cells. Road stream crossing assessments consist of physical measurements of crossing dimensions, photos of the crossing, stream channel up- and down-stream of crossing, and observations of crossing and stream conditions. Assessments were completed using either paper field forms or digital PDF forms completed on electronic devices. Measurements were taken using stadia rods and surveyor's tape and were recorded in tenths of feet.

Measurements consisted of inlet/outlet dimensions, length of crossing, water depth at the inlet/outlet, and roadfill height (if roadfill is present). Additional observations include a visual assessment of the alignment of the structure relative to the stream channel, general crossing condition, type of inlet/outlet grade (ie. perched, inlet drop, outlet freefall, at stream grade, etc.), flow condition (ie. dry, typical low-flow, moderate flow, etc.), size of tail water

scour pool, structure substrate type and percent coverage, and comparison of water depth and velocity relative to natural stream conditions. Other information that can be collected but is not required in order to calculate aquatic passability includes slope of structure using an inclinometer and bankfull measurements. Bankfull measurements were taken in undisturbed stream reaches out of the range of influence of the structure.

Assessments are saved on electronic devices or digitized from paper forms after surveys are completed. Assessment forms were uploaded to the NAACC database and GPS locations were matched to existing crossings identified by GIS analysis or assigned to a new crossing if one was not recognized by the GIS analysis. Once forms are uploaded, they must be approved by L1 or higher certified staff to be finalized. Once assessments are uploaded and approved, passability scores are calculated and posted to the online database. Survey information and calculated passability scores can be viewed at www.streamcontinuity.org/.

3.2 Fishery Assessments

Funding for the fishery samples completed for this CHP was generously provided by the PFBC through the voluntary trout stamp program. When purchasing a fishing license, anglers are asked to contribute an additional donation to the Wild Trout fund. Those donations go directly into surveys like these to protect additional wild trout waters throughout the commonwealth.

Figure 11 Trout Unlimited intern Willie Cosner conducting electroshock fish survey at crossing 89619 on unnamed tributary. Brook trout were documented here.

Data collection methods followed the PFBC's "*Sampling Procedures for Unassessed Trout Waters Sampled by non-PFBC Entities*" (PFBC, 2010) protocol. Physical, chemical, and fishery data were collected at each survey location. Latitude and longitude of the starting point for each survey were recorded in decimal degrees using a handheld GPS unit. Site length measurements of the surveyed stream reach were measured in meters using a hip chain or range finder. Site lengths were approximately 100 meters and ended at a natural break point to minimize fish movement beyond the survey area. Stream width

measurements (wetted width) were made approximately every 20 meters of the survey reach and up to 5 widths were recorded at each site to calculate the mean site width.

Fishery data were collected using backpack electrofishing gear. Specifically, all surveys were completed using the Smith-Root, LR-24 backpack electrofisher. Pulsed DC was used at all sites. Electrofishing proceeded upstream from the beginning of each sample site. All fish observed by the field crew were identified to species in the field and a subjective abundance rating was assigned to each species based on PFBC protocol. During electrofishing surveys, all salmonid species were collected and measured to the nearest millimeter (total length). Each individual trout was then assigned to a 25 mm size class. Biomass estimates were obtained using the Pennsylvania state mean weight for the length group of each trout captured. A more detailed explanation of the methods used can be found in "*Sampling Procedures for Unassessed Streams in Pennsylvania*" (PFBC, May 1, 2011). All data collected as part of this effort has been submitted to the PFBC.

3.3 Field Chemistry

Water chemical data was collected in the field and included the following parameters: water temperature (o C), pH (standard units), total alkalinity (mg/L), and specific conductance (µmhos). All equipment was properly calibrated prior to measurement and EPA approved protocols were followed where appropriate. The data captured collected in the field during fisheries survey work can be found in Table 3. (Appendix C).

3.4 Habitat Assessment

Habitat quality was assessed by TU and SCCD staff at points throughout the watershed utilizing the Pennsylvania Department of Environmental Protection *Draft Instream Comprehensive Evaluation Survey protocol* (PA DEP 2009). In stream and riparian habitats were assessed by assigning a score between 1 to 20 based on quality and descriptors that fell into

Figure 12 Natural plunge pool habitat and forested riparian area observed during habitat assessment

four categories. See Figure 1 (Appendix D) for a copy of the field data sheet used for habitat assessment. Habitat parameters assessed were: Instream Cover(Fish), Epifaunal Substrate, Embeddedness, Velocity/Depth Regimes, Channel Alteration, Sediment Deposition, Frequency of Riffles, Channel Flow Status, Condition of Banks, Bank Vegetative Protection, Grazing or other Disruptive Pressure, and Riparian Vegetative Zone Width. The cumulative scores of observed conditions indicate weather habitat is considered "Optimal" 240-192; "Suboptimal" 180-132; "Marginal" 120-72; or "Poor" 60 or less. Areas where habitat is influenced by wetland conditions can have reduced habitat scores as the assessment method is designed to assess streams.

3.6 Stream Temperature Monitoring

Figure 13 Temperature logger housing deployed on tributary 32264

Data collected related to thermal fluctuations throughout the watershed can help with planning future conservation efforts and provide insight into how current conditions are impacting native trout populations. SCCD staff utilized the protocols provided in the *Stream Temperature Monitor Handbook for Trout Unlimited Chapters (2018)* to develop its program for this project. Temperatures were recorded using HOBO Pendant Data loggers. Before deployment these loggers were calibrated according to the manufacturer's instructions. None of the loggers displayed any variances of more than .5°F. Protective housings were constructed using PVC piping and caps drilled with holes to allow water to flow through freely. The loggers were secured within the housing with wire and anchored at desired sites. Each logger was set to capture a temperature data record every hour. A picture of the housing and logger can be seen below. At the time of deployment, the logger serial number; depth; surrounding habitat; canopy cover; time of day; and temp of water was recorded Table 1 (Appendix F).

Stream temperature monitoring logger locations were assigned a site ID based on the location of the stream in the watershed. Sites on Starrucca Creek were given increasing numerical designations the further away from the wetland complex at the top of the watershed while sites on unnamed tributaries were assigned IDs based on their reach listings. The locations were chosen in consideration of multiple impoundments and above and below confluences to help identify how the main branch's temperature profiles throughout the year were influenced. Limited public access and expansive forested tracts did influence the placement of temperature logger sites. Landowners were contacted prior to temp logger installation and when possible SCCD staff did install logger housings. The temperature recordings displayed as a line graph in Figure 32 in 4.4; Figure 2 (Appendix F). Temperatures of 68 F and 75 F are displayed on the graphs with a black line and a red line. These indicate temperatures that are stressful and potentially fatal for trout respectively. Figure 3 (Appendix F) displays three locations where water temperatures exceeded the optimal range for trout during the sampling period.

Figure 14 PVC housings for temperature loggers

4.0 Observations

4.1 Culvert Assessments

TU and SCCD completed assessments in 22 road stream crossings in the USCW in October and December 2021. Culvert survey ID and AOP rating are in Table 1 (Appendix E). Figure 16 below shows locations and AOP ratings of culverts assessed in relation to the roads and streams. A total of 9 crossings were found to have full AOP, six crossings had reduced

Figure 15 Crossing 92241 Culvert pipe with eroded surrounding crossing base

AOP, and seven had No AOP. All bridges that were assessed received a Full AOP rating. Three crossings that received a Full AOP rating were box culverts. Only one round culvert received a Full AOP rating**.**

Crossing 92241 located on PA-1001 was found to have reduced AOP, however the passability score was 0.712. This crossing consists of two elliptical culverts and was noted to be in poor condition. One of the culverts was blocked and caving in, leaving only one culvert to pass water. Erosion was evident at the inlet and outlet. The unnamed tributary (32299) was found to have naturally reproducing populations of brook trout during surveys for this project.

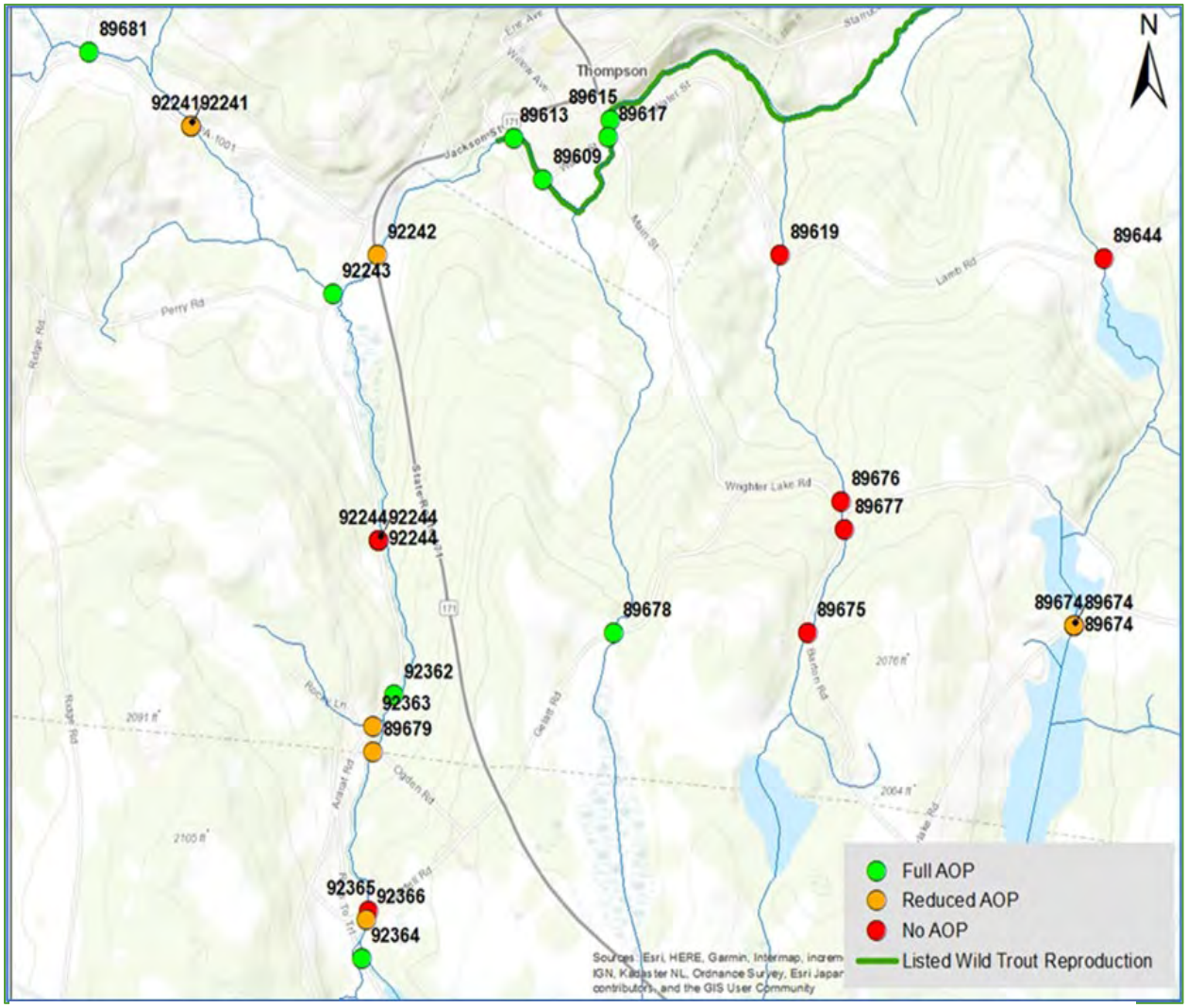


Figure 16 Culvert locations and Results Map

Figure 17 Crossing 92244 consisting of three elliptical pipes

Crossing 92244 was located on the main stem of Starrucca Creek and was an old driveway and received an AOP rating of no AOP and a passability score of 0.477. This crossing consisted of three elliptical pipes with varying heights under a trail/driveway. During lower or higher flows passability could be even more reduced. Eroded bank material on either side of this crossing was observed during assessment.

Crossing 89679 on Ogden Road received a Reduced AOP rating with a passability score of 0.482. This crossing was noted to be in poor condition in relation to the roadway. A large sediment wedge has formed at the inlet of this crossing causing erosion and water to flow into the crossing at many angles (Figure 28 section 4.3). There is evidence of the water over topping the road. Flows were moderate at the time of this survey and the outlet could pose a greater obstacle to fish passage at lower or higher flows.

Figure 18 Crossing 89679 at Ogden Road with scour pool

Crossing 89619 on Lamb Road was found to have No AOP and a passability score of 0. This is a round culvert pipe with a large outlet drop. This crossing is on unnamed tributary 32296 which was found to have naturally reproducing populations of brook trout during surveys for this project.

Crossing 92365 located on Sartell Road near the intersection with the D&H rail trail received an AOP rating of No AOP and a passability score of 0.507. There is a large scour pool at the outlet of this culvert, and it is in poor condition. Brook trout were documented at a site upstream of this crossing.

Crossings 89619, 89644, 89675, 89676 and 89677 all received No AOP ratings but were located where trout were not documented and/or where habitat was not suitable/typical for trout streams (i.e. beaver ponds) and therefore are not discussed in detail.

4.2 Fishery Survey Results

TU sampled 33 streams in the Starrucca Creek watershed during August and September 2021. Tables 1 and 2 below summarize the results of the fishery surveys. Eighteen sites in this watershed had trout, 10 streams contained only brook trout, two contained only brown trout, and the remaining six sites contained brook and brown trout. 125 trout were encountered during these surveys. While trout were documented, some sites did not have qualifying populations of trout to be listed as wild trout. Figure 19 is a map that shows where trout were documented and if the site qualifies to be considered for a Naturally Reproducing Wild Trout Stream designation. Other species captured in this watershed included blacknose dace,

Common Name	32269	32289	32296	32298	32299	Buck Run Site 1	Buck Run Site 2	Buck Run Site 3	Buck Run Site 4	Calendar Creek 32282	Starrucca Creek Site 1	Starrucca Creek Site 2
Brook Trout			3	2	2				2	3	3	3
Brown Trout									2		1	
Blacknose Dace	1	3		3	4	3	3	4	3		4	3
Longnose Dace							2		2		3	
Sculpin Spp.							4		3	4	4	
Brown Bullhead	1		2						2			
Bluegill	1											
Creek Chub		3			4	2	3	4	3	3	4	
Pumpkinseed	3		1									
Chain Pickerel					1							
Cutlips Minnow							2					
Largemouth Bass	2											
Yellow Perch									1			

Table 1. Species occurrence and relative abundancies for fish documented through the fishery surveys in Upper Starrucca Creek. Relative abundancies assigned based on PFBC Unassesed Waters Initiative. 1 = Rare, 2-8 = Present, 9-32 = Common, >33 = Abundant.

longnose dace, bluegill, sculpin spp., white sucker, brown bullhead, common shiner, creek chub, pumpkinseed, chain pickerel, cutlips minnow, yellow perch, pumpkinseed, and largemouth bass. Only five sites were found to be dry at the time of sampling.

TU assisted by SSCD staff completed 14 surveys on stream reaches that had not yet been surveyed in Starrucca Creek. Two streams 32267 and 32268 were found to be dry at the time of the surveys. TU completed additional sites within Starrucca Creek that are outside of the focal area of this project. A complete list of sites surveyed in Starrucca Creek and summarized results are listed in Table 1 (Appendix B).

Unnamed tributary 32269 was surveyed downstream of route 171 upstream of a wetland complex. Habitat at this site was mostly flat and swampy. No trout were documented at this site. Blacknose dace (Rhinichthys atratulus), brown bullhead (Ameiurus nebulosus), and bluegill (Lepomis macrochirus) were found to be rare, largemouth bass (Micropterus salmoides) were present and pumpkinseed sunfish (Lepomis gibbosus) were common.

Size Classes (mm)	UNT 32296	UNT 32298	UNT 32299	32264 Buck Run Site 4		Calendar Creek	Starrucca Creek Site 2	Starrucca Creek Site 1	
	BRT	BRT	BRT	BRT	BRN	BRT	BRT	BRT	BRN
25-49									
50-74						3	3	2	
75-99		1		2		4	1	5	
100-124	2	1				2	6		
125-149	7	2		2	1		7		
150-174	1		1	3	1		2	1	
175-199			1	1			2	2	1
200-224			1						
225-249									
250-274			1						
275-299					1				
TOTAL	10	4	4	8	3	9	21	10	1

Table 2 Size distribution and species of trout at sampling locations

Unnamed tributary 32289 was surveyed downstream of the Lamb Road crossing (Crossing ID 89644) Table 1 (Appendix E). No trout were documented at this site. The stream around Lamb Road is being heavily impacted by the culvert and beaver dam upstream. Blacknose dace and creek chub were found to be common at this site (Table 1).

Unnamed Tributary 32296 to Starrucca Creek was surveyed downstream of the Lamb Creek Road crossing (Crossing ID 89619). Ten brook trout (Salvelinus fontinalis) were documented throughout the survey and it was noted some trout were missed (Table 2). Brown bullhead and pumpkinseed sunfish were also documented in this reach. In-stream habitat was noted to be good for trout but also steep. The culvert at the top of this reach was documented to have No AOP and is discussed in detail in the Culvert Assessment section.

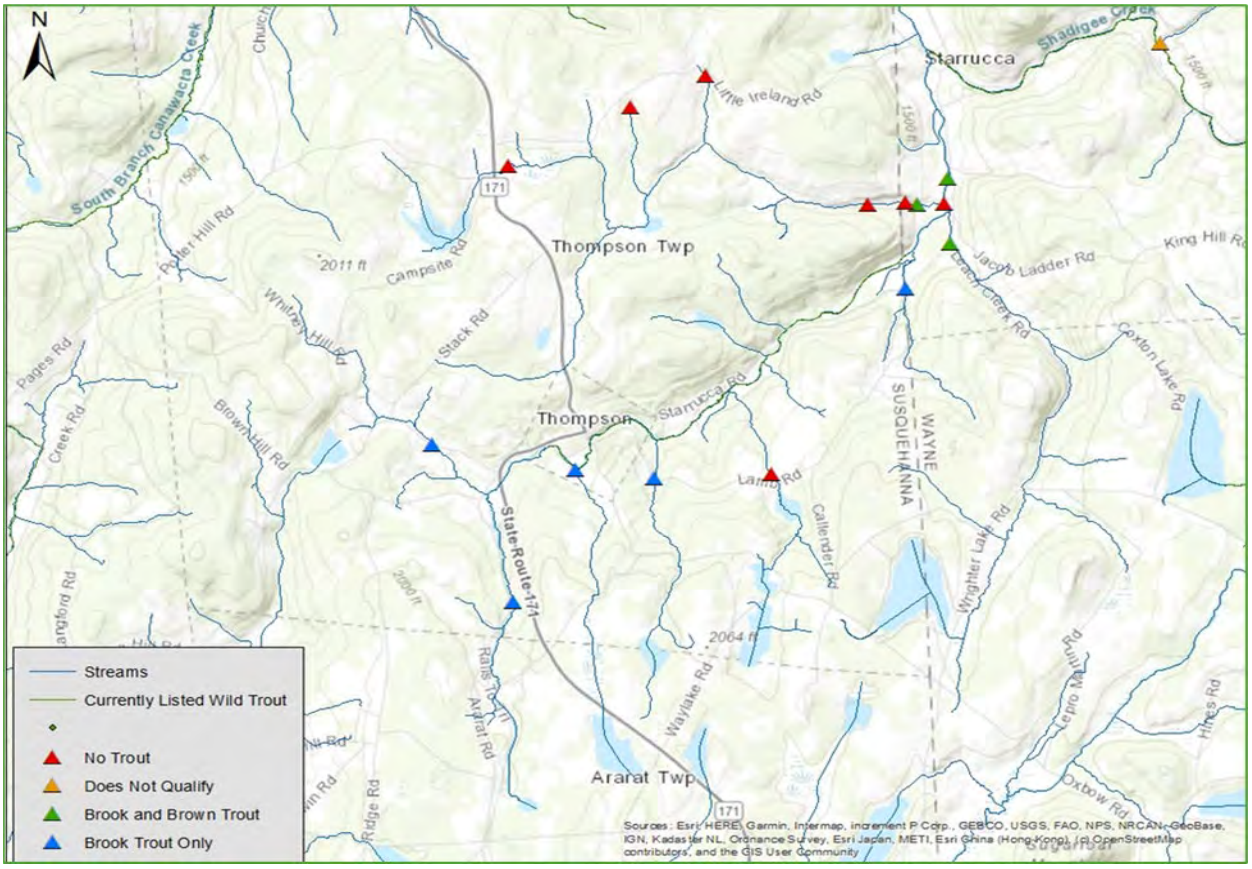


Figure 19 Fishery Survey Locations Color Coded for Trout Presence

Unnamed Tributary 32298 to Starrucca creek was surveyed very close to the confluence with Starrucca Creek accessed behind the withdrawal pond for Thompson Fire Company. Four brook trout were documented at this site, making it eligible for a Wild Trout listing through PFBC. In addition to brook trout, blacknose dace were also found to be common at this site (Table 1). Observers noted this site to be small, with an average wetted width of <1.6 meters and was one of the coldest streams (15.6 C) at the time of the fishery surveys Table 1 (Appendix C).

Unnamed Tributary 32299 to Starrucca Creek was sampled both upstream and downstream of the crossing on State Route 1001 north of Thompson (Crossing ID 92243, Figure Appendix E). This location was chosen for the survey due to a large wetland complex near the

confluence of Tributary 32299 and Starrucca Creek making it unsuitable for a backpack electrofishing survey. Four brook trout were documented at this site, making it eligible for a Wild Trout listing through PFBC. Blacknose dace and creek chub (Semotilus atromaculatus) were both found to be abundant at this site and a single chain pickerel (Esox niger) was documented.

Buck Run (Tributary 32264 to Starrucca Creek) was surveyed in four locations. Brook trout and brown trout (Salmo trutta) were documented at Buck Run Site 4 which is downstream of a large waterfall, Buck Run Falls (Figure 20). Trout documented here will warrant a Naturally Reproducing Trout listing from PFBC. In addition to the trout species, blacknose dace, sculpin spp, (Cottoidea) and creek chub were found to be common. Brown bullhead and longnose dace (Rhinichthys cataractae) were found to be present and one yellow perch (Perca flavescens) was documented (Table 1).

Figure 20 Trout Unlimited Team conducting Fish Survey around Buck Run and Starrucca Creek confluence

Buck Run was also sampled at the mouth (Buck Run Site 1) where no trout were documented. Other species at this site included blacknose dace which were common and creek chub which were present Table 2 (Appendix B). Buck Run Site 2 was located immediately upstream of Buck Run falls. No trout were documented at this site. Sculpin spp. were abundant, blacnose dace and creek chub were common, longnose dace and cutlip minnow (Exoglossum maxillingua) were found to be present. Buck Run was also sampled further upstream of the falls (Buck Run Site 3). No trout were documented at this site. Other species documented at this site include blacknose dace and creek chub which were both abundant.

Calendar Creek (Tributary 32282 to Starrucca Creek) runs along the Susquehanna and Wayne County border. Calendar Creek was surveyed upstream and downstream of the Starrucca Creek Road crossing near the intersection with Calendar Creek Road. Brook trout

were found to be common and were documented both upstream and downstream of the Starrucca Creek Road (Table 1). Sculpin spp. were abundant and creek chub were common.

Figure 21 Brook and Brown Trout documented during fish survey

Starrucca Creek main stem was sampled in two locations. The most upstream fishery survey location was Starrucca Creek site 2, located along Ararat Road across from the Lambertson's Daylilies. 21 brook trout were documented at this site, the most of any site surveyed in the watershed (Table 2). Blacknose dace were also found to be common at this site. Starrucca Creek was also sampled downstream of Buck Run just downstream of the current Wild Trout Listing. Both brook and brown trout were documented. One brown trout was documented as well as 10 brook trout (Table 2). Other species included blacknose dace, sculpin spp. and creek chub which were abundant, and longnose dace which were common.

Survey data were submitted to PFBC in fall of 2021. Since then, all of the waters where qualifying numbers of trout were documented have been proposed for listing. PFBC plans to further investigate the extent of trout in the upper watershed with hopes of listing the entire main stem of Starrucca Creek in Susquehanna County. The size class distribution and species of trout documented in Upper Starrucca Creek can be found in Table 2. The water chemistry data collected at the time of the fishery survey work can be found in Table 1 (Appendix C).

4.3 Visual Habitat Assessment

Habitat assessments conducted through the watershed revealed a majority of suboptimal habitat. While sampling locations were primarily focused on areas where the potential for human impacts could be documented, these surveys provided information about how threats to water quality were impacting the stream's overall health. These assessments also provided information for where conservation efforts would be most beneficial.

A summary of the data collected during the habitat assessments can be found in Table 1 (Appendix D). There were three sites where habitat was assessed that scored poor. All three site assessment scores were influenced by wetland habitat. Specific disruptive pressures were documented and will be discussed in the recommendations section of this plan.

Figure 22 Optimal habitat assessment

The beginning of the watershed for the main branch is a complex of wetlands and connecting stream channels that interact with surrounding forests and the D&H Rail Trail. There are two water bodies at the very beginning of this watershed. One is a 12-acre Forested Shrub Wetland classified as a PFO1E in the National Wetland Inventory, and the other is a manmade pond known as Roberts Pond. An assessment of the outflow from the wetland showed optimal overall habitat at this location Figure 22. Assessment of the stream channel between impoundments along the Rail Trail documented optimal riparian habitat but sub-optimal overall scores due to siltation of stream substrate. Figure 23.


Figure 23 Sub optimal habitat assessment location at the top of Starrucca Creek Watershed

Flowing downstream from these wetlands Starrucca Creek is impounded by multiple beaver dams as it flows paralleling the D&H Rail Trail. This area has multiple habitats classified as both emergent and forested shrub wetlands also listed on the National Wetland Inventory. Habitat was assessed at points along the rail trail where Starrucca Creek parallels and crosses the rail trail via culverts. Some of the lowest habitat assessment scores were recorded in this section. Disruptive pressures, vegetated riparian habitat,

sediment loading, and channel alteration assessment scores reflect recent trail maintenance activities that have potential for long term negative impacts to instream habitat and overall water quality. Habitat was assessed at points along the rail trail where Starrucca Creek parallels and crosses the rail trail via culverts. Some of the lowest habitat assessment scores were recorded in this section. Disruptive pressures, vegetated riparian habitat, sediment loading, and channel alteration assessment scores reflect recent trail maintenance activities that have potential for long term negative impacts to instream habitat and overall water quality. At the site of trail maintenance adjacent to the first beaver dam impoundment below Roberts Pond, an area where trail comb material was excavated to build up the trail base seemed to have constant standing water with an increased concentration of nutrients leading to an algal growth Figure 24.

Figure 24 Nutrient rich ground flow along trail maintenance location

Figure 25 Rail Trail maintenance resulting in degraded habitat scores

Figure 26 Forested Emergent Wetland created by beaver dam along Rail Trail

Figure 27 Forested riparian habitat loss to development

Figure 28 Ogden Road culvert causing stream to back up and erode new channel

Assessments further down the watershed revealed improved overall habitat scores; however, potential threats and causes for lower habitat scores were observed and documented. Sediment sources observed while assessing habitat included sites with storm water conveyance ditches (Figures 29 & 30), unstable banks around the 171-bridge Figure 3 (Appendix E), and eroding banks due to under sized or failing culverts. Large amounts of sediments have been deposited in the channel behind the Spencer Mill Dam that have the potential to migrate during high water events and cause sedimentation of substrate

Figure 29 Ararat Road ditch

Figure 30 Ogden Road Ditch

downstream Figure 3 (Appendix E). At one culvert crossing on Ogden Road, the stream channel had split into two after a high-water event and subsequent debris jams (Figure 28). Sedimentation of stream substrate was observed around this location.

Disruptive pressures observed included losses of shrubby and forested riparian habitat in residential areas of the Thompson Borough, channel constriction due to armored banks Figures 5&6 (Appendix E) , loss of riparian habitat due to development (Figure 27), and improper placement of stream debris from culvert maintenance.

4.4 Temperature Monitoring

Through this study ten temperature data loggers were deployed throughout the USCW. The temperature profiles from July to November for each of the locations are displayed in Figure 31. Five loggers were on the main stem of Starrucca Creek and five were deployed on tributaries.

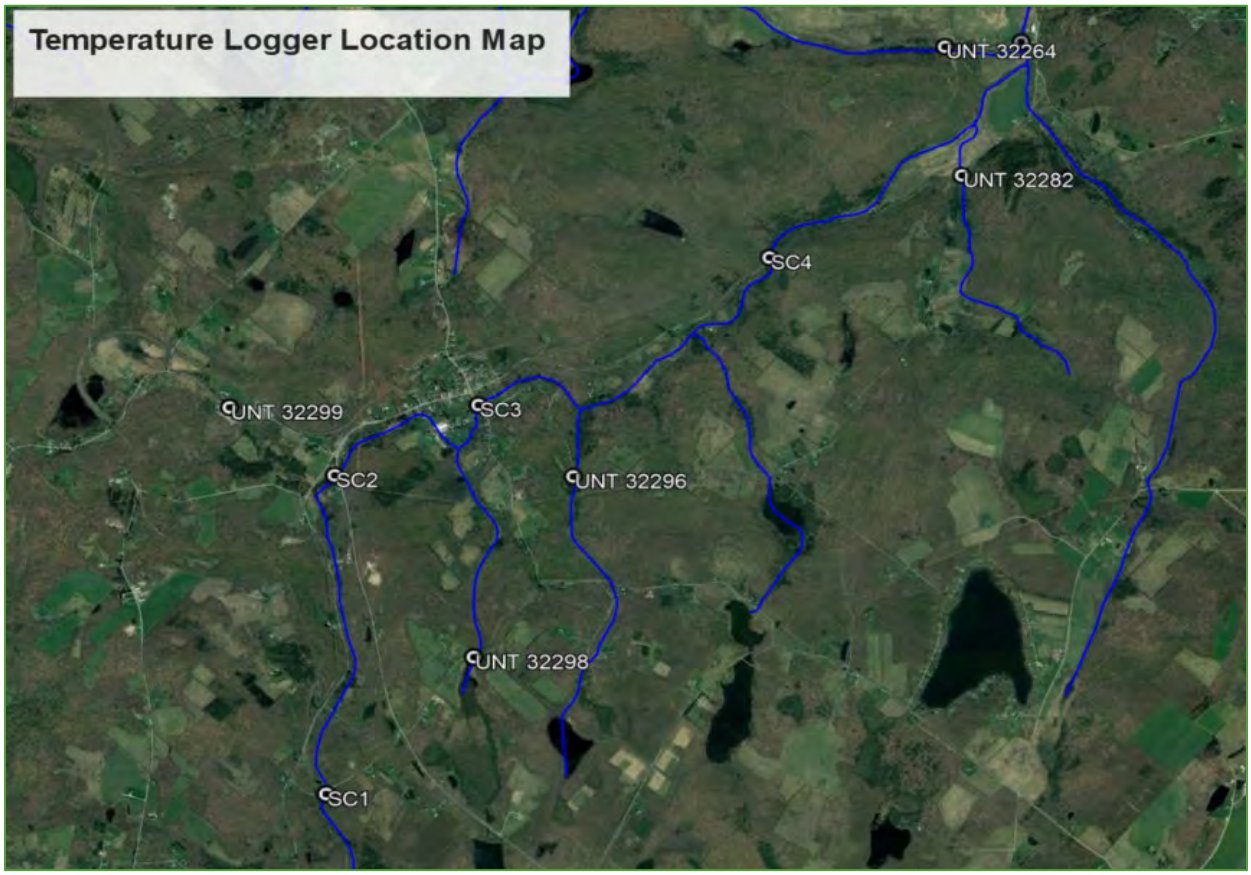


Figure 31 Locations of Temperature Logger points

Figure 2 (Appendix F) shows the temperature profiles for the loggers on main branch and tributaries of Starrucca Creek. The point with the highest recorded temperature was captured at UNT32298. This temperature was 83.043°F and was recorded August 13th.

Figure 32 displays the temperature profiles recorded on points along the main stem of Starrucca Creek. This graph shows that during the summer of 2021, water temperatures in the main stem of Starrucca Creek were capable of supporting trout. While every point along the creek did at some point reach a temperature that could put stress on trout, SC1, SC2 and SC3 were the only points where warmer water temperatures were sustained longer than a day.

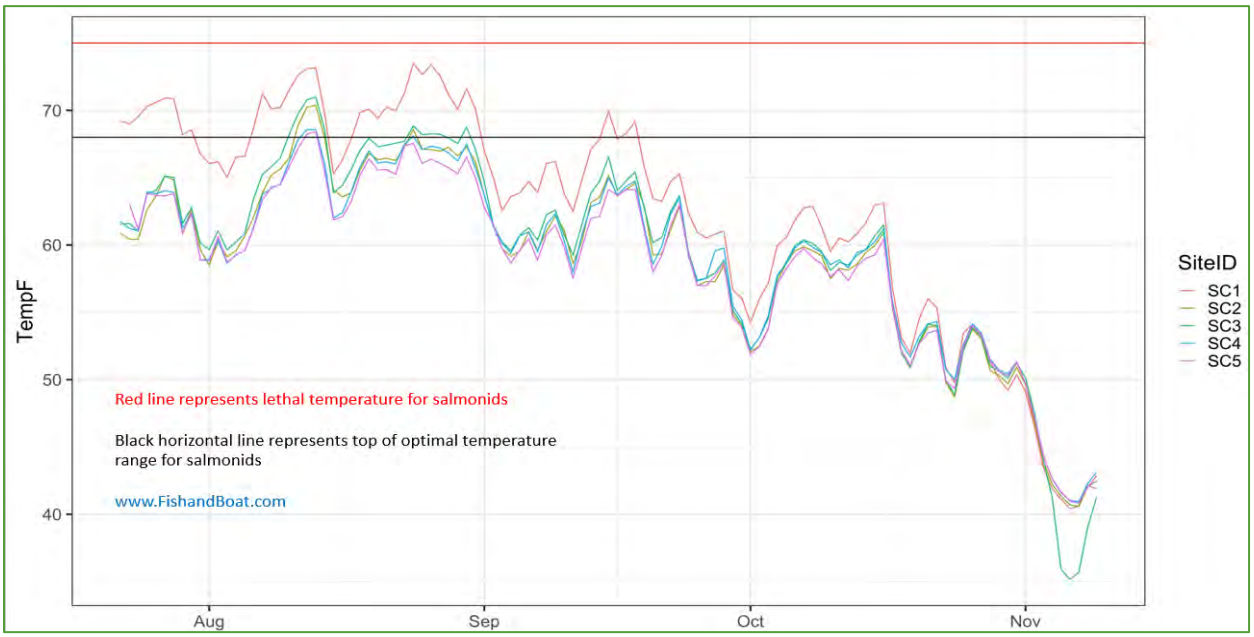


Figure 32 Temperature profiles at points along Starrucca Creek main stem

Water temperatures recorded downstream from the wetlands on Starrucca Creek and unnamed tributary 32298 were on average higher than temperatures lower in the watershed. Table 1 (Appendix F) lists the location and habitat of the area just upstream from the temperature logger at crossing ID 89678. The shallow beaver dam and lack of forested or shrub habitat in the resulting beaver dam could be contributing to the cause of high temperatures being recorded.

Figure 4 (Appendix F) shows the location of the temperature loggers throughout the watershed in relation to the current extent of listed naturally reproducing trout streams and reaches that are non-attaining. Temperature data recorded shows that the reaches of streams where trout were found are capable of supporting populations through the hottest points in the summer season of 2021.

5.0 Recommendations

- Promote the conservation of forested and riparian habitat in the upper reaches of the watershed. Where trail maintenance activities come in contact with Starrucca Creek, minimal disturbance of rail trail bed comb material and wetland habitat is recommended. Installation of flow control structures such as Clemson levelers could be installed in areas where there has been historical trail deterioration from high water events. This would mitigate the risk of trail damage, reduce the need for expensive maintenance, and allow for wildlife to thrive in wetland habitats created by beavers.

- Remove the Spencer Mill Dam on Starrucca Creek in the Thompson Borough to reconnect almost two miles of the main stem of Starrucca Creek. With this type of project there will be a need for restoration of riparian habitat to prevent the loss of sediment stored behind the dam.

- Have Friends of Starrucca Creek register as a 501c3 nonprofit organization to create new opportunities to seek funding for conservation work throughout the watershed.

- Continue water quality monitoring program within the USCW and expand monitoring to include study of macroinvertebrates, nutrient loadings, flow data, and continued water temperature data.

- Recommend and follow up on the prompt redesignation of the USCW as naturally reproducing trout waters with the Pa Fish and Boat commission.

- Replace the culverts that scored poor or reduced AOP on the main stem of Starrucca Creek above the mill dam and those on tributaries 32299 and 32296.

- Investigate the causes and sources of the pathogens that cause the creek to be listed as impaired in Chapter 93. Seek funding to address Thompson Borough sewage treatment system issues.

- Adopt ordinances that restrict development and deforestation of riparian areas along the main stem of Starrucca Creek and its tributaries by the municipalities within the watershed.

- Utilize the County's Dirt, Gravel & Low Volume Roads program to address deteriorated culverts and roadways contributing sediments to surface waterways that have been identified in this study.

- Work with PennDOT to stabilize culvert inlets and bridge abutments where erosion is contributing sediment to stream channels that have been identified in this study.

- Identify a funding source to conserve the water fall and surrounding area along tributary 32264 and create designated access for public recreation.

- Restore riparian habitat along Starrucca Creek in Thompson Borough.

- Further monitor nutrient levels at site along rail trail where ground flow seemed to accommodate increase algal growth.

- Promote NAACC culvert protocols and Chapter 102 regulations to municipal entities responsible for maintenance of culverts.

- Expand study area into eastern catchments over the Wayne County line. See if Wayne County Conservation District has any data on this specific watershed.

5.1 Potential Funding Opportunities and Partners

Coldwater Heritage Partnership

- Coldwater Implementation Grant
- Coldwater Conservation Plan Grant for Middle and Lower Starrucca Creek Watershed

Eastern Brook Trout Venture

- Annual habitat conservation and restoration grant

Pennsylvania Department of Environmental Protection

- Growing Greener Plus Grant Program

Pennsylvania Fish and Boat Commission

- State Wildlife Grants Program

Pennsylvania Department of Environmental Conservation of Natural Resources

- Riparian Habitat Restoration Grants

U.S. Fish and Wildlife Service

- Bring Back the Native Fish Program

- National Fish Passage Program

Pennsylvania Trout Unlimited

- Eastern Brook Trout Habitat Initiative
- TU Headwaters Youth Program
- Embrace A Stream (EAS)

Susquehanna County Conservation District

- Countywide Action Plan (CAP)
- Dirt and Gravel Road Program

Wayne County Conservation District

5.2 Summary and Conclusion

The study of the USCW and this resulting cold water conservation plan has accomplished the objectives laid out at the beginning of this document. The findings of this project will serve as a resource to the public for future conservation of the cold-water habitat that supports diverse and valuable natural resources in this watershed. While there are ample opportunities for conservation activities within this watershed, the data collected has shown the Upper Starrucca Creek to be a resilient and viable habitat capable of supporting the natural reproduction of Pennsylvania's state fish the Brook Trout. The data has also shown that the watershed serves as a nursery for naturally reproducing trout both above and below the limits of what is currently listed as capable of doing so. Improving the abilities of these trout populations to migrate throughout the watershed and thereby increase the potential for improved genetic diversity is highly weighted in this conservation plan. The recommendations section of this plan can serve as a guide for future work but at its core this plan is a working document and can be expanded to include new data or conservation efforts. Any partners in this watershed interested in future conservation efforts can contact the Susquehanna County Conservation District regarding questions about this plan or guidance for achieving these recommendations.

Appendices

A: Watershed Description

Type	NLCD Code	Area (km^2)	Coverage (%)	Active River Area (km^2)
Open Water	11	0.92	1.72	0.9
Perennial Ice/Snow	12	0	0	0
Developed, Open Space	21	3.05	5.69	1.08
Developed, Low Intensity	22	0.38	0.72	0.2
Developed, Medium Intensity	23	0.09	0.16	0.05
Developed, High Intensity	24	0.02	0.03	0.01
Barren Land (Rock/Sand/Clay)	31	0.02	0.04	0.01
Deciduous Forest	41	33.59	62.76	5.09
Evergreen Forest	42	0.4	0.74	0.19
Mixed Forest	43	3.66	6.83	1.36
Shrub/Scrub	52	0.3	0.56	0.03
Grassland/Herbaceous	71	0.11	0.2	0.04
Pasture/Hay	81	8.26	15.44	1.46
Cultivated Crops	82	0.03	0.05	0
Woody Wetlands	90	2.18	4.08	1.05
Emergent Herbaceous Wetlands	95	0.52	0.97	0.41
Total		53.52	100	11.87

Table 1 Land Use Data for Upper Starrucca Creek Watershed

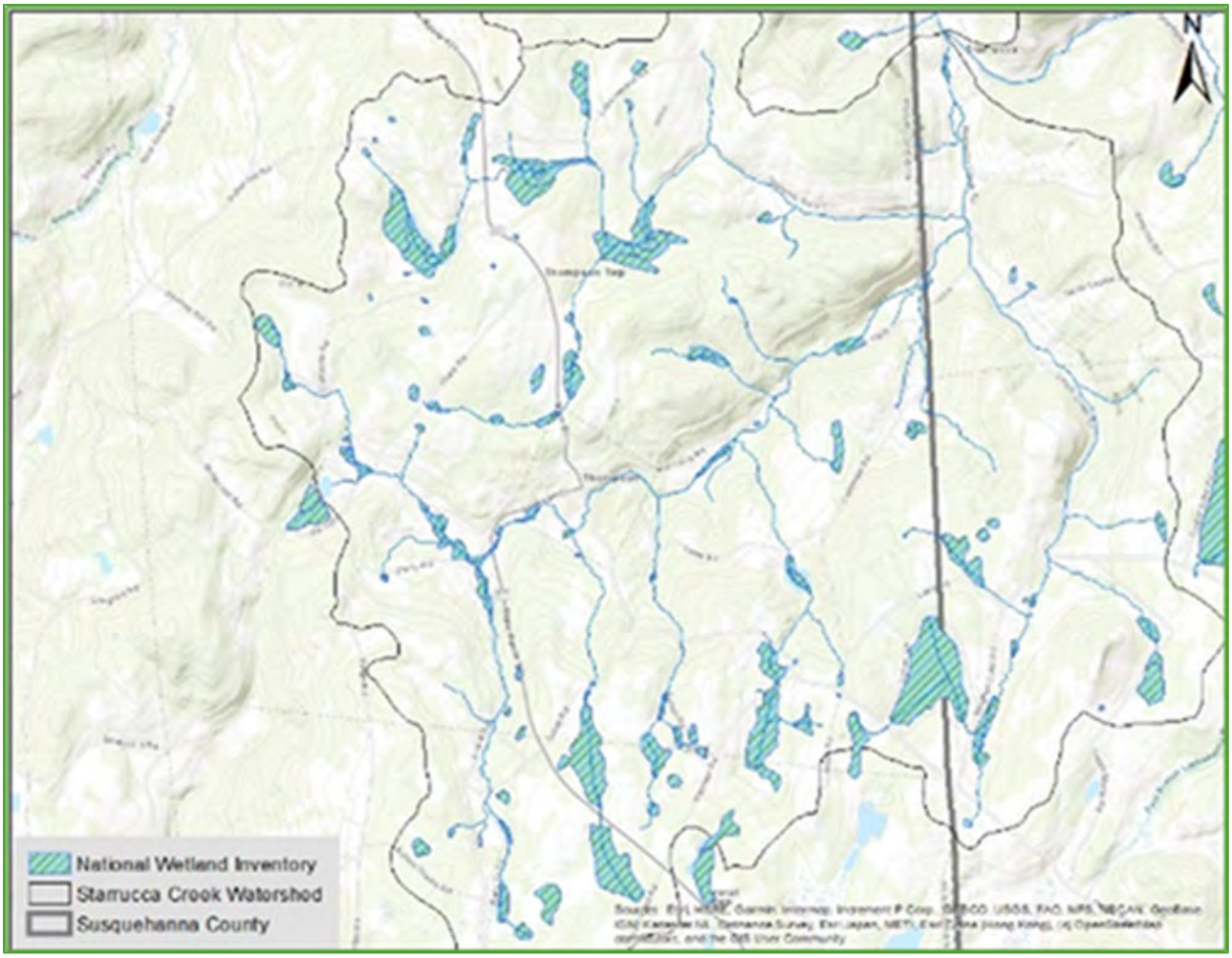


Figure 1 National Wetland Inventory wetlands and impoundments distribution in Upper Starrucca Creek Watershed.

B: Fishery Survey Data

Stream Name	Tributary To	Latitude	Longitude	Dry	brook trout
Starrucca Creek Site 3	North Branch Susquehanna River	41.95586	-75.55542		
32235	Shadigee Creek	41.89137	-75.43442		
32236	Starrucca Creek	41.89273	-75.42597		✓
32299	Starrucca Creek	41.86235	-75.53216		✓
Calendar Creek	Starrucca Creek	41.87765	-75.47654		✓
32296	Starrucca Creek	41.85909	-75.50606		✓
32298	Starrucca Creek	41.85986	-75.51532		✓
Starrucca Creek Site 4	North Branch Susquehanna River	41.84695	-75.52269		✓
32197	East Branch Hemlock Creek	41.95919	-75.47515		✓
32226	Starrucca Creek	41.90907	-75.47606		✓
32194	East Branch Hemlock Creek	41.96259	-75.49492		✓
32253 Site 1	Shadigee Creek	41.86180	-75.42514		✓
Buck Run	Starrucca Creek	41.88583	-75.47514		✓
Starrucca Creek Site 1	North Branch Susquehanna River	41.88848	-75.47164		✓
Leech Creek	Starrucca Creek	41.88208	-75.47133		✓
32230	Shadigee Creek	41.90168	-75.44669		✓
32219	Starrucca Creek	41.92412	-75.49592		✓
32220	Starrucca Creek	41.92667	-75.48876		✓
32289	Starrucca Creek	41.85951	-75.49232		
32264 site 1	Starrucca Creek	41.88594	-75.47208		
32264 site 2	Starrucca Creek	41.88603	-75.47657		
Starrucca Creek Site 2	North Branch Susquehanna River	41.96669	-75.57339		
32267	Starrucca Creek	41.89847	-75.50005	✓	
32264 Site 3	Starrucca Creek	41.88587	-75.48091		
32268	Starrucca Creek	41.89539	-75.50888	✓	
32269	Starrucca Creek	41.88970	-75.52321		
32212	Starrucca Creek	41.94786	-75.51313	✓	
32221	Starrucca Creek	41.92625	-75.48173	✓	
32223	Starrucca Creek	41.93232	-75.47066	✓	
32232	Shadigee Creek	41.90743	-75.43682		
32250	Shadigee Creek	41.87602	-75.43231		
32253 Site 2	Shadigee Creek	41.85915	-75.42515		

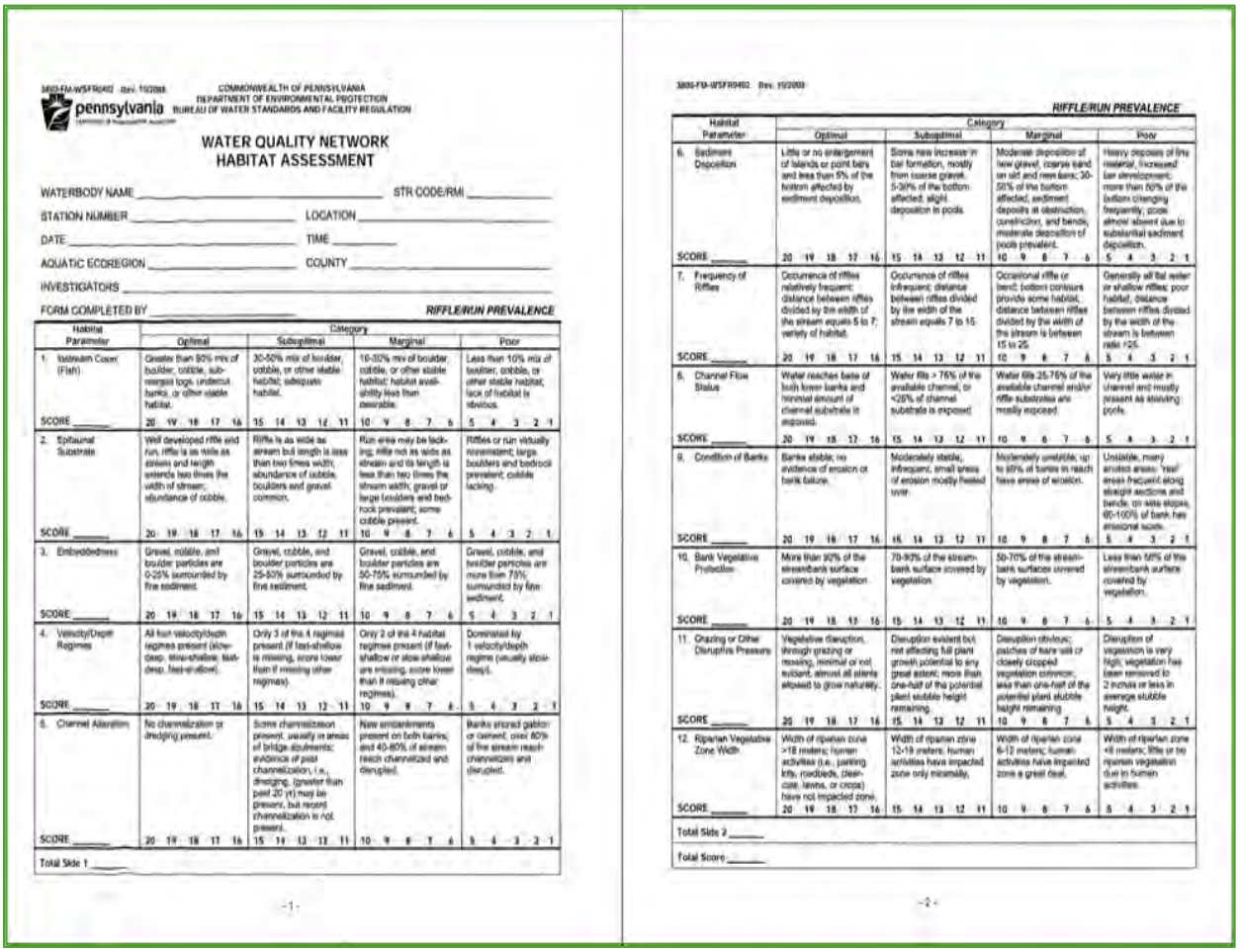
Table 1 Fishery survey results showing location and if trout were present

C: Water Chemistry Data

WRDS / Stream Name	Water Temp (°C)	pH	Conductance (µ)	Alkalinity (mg/L)
32267	Dry	Dry	Dry	Dry
32268	Dry	Dry	Dry	Dry
32269	14.8	6.7	48.9	12
32289	21.4	6.83	58.8	22
32296	14.8	7.55	79.9	22
32298	15.6	7.39	89.1	30
32299	16.5	7.5	82.3	23
32264 (Buck Run) site 1	16.5	7.57	77.3	28
32264 (Buck Run) site 2	16	7.43	70.5	30
32264 (Buck Run) Site 3	12.7	7.59	86.1	24
32264 (Buck Run) Site 4	16.2	7.53	70.1	30
32282 (Calendar Creek)	18.1	7.16	59.9	36
Starrucca Creek Site 4	16.2	7.48	78	32

Table 1 Water chemistry data collected during fishery surveys

D: Visual Habitat Assessments



3800-FM-WSFR0402 Rev. 10/2000 COMMONWEALTH OF PENNSYLVANIA
pennsylvania DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATER STANDARDS AND FACILITY REGULATION

WATER QUALITY NETWORK
HABITAT ASSESSMENT

WATERBODY NAME _____ STR CODE/RMI _____
STATION NUMBER _____ LOCATION _____
DATE _____ TIME _____
AQUATIC ECOREGION _____ COUNTY _____
INVESTIGATORS _____
FORM COMPLETED BY _____

RIFFLE/RUN PREVALENCE

Habitat Parameter	Category: Optimal	Suboptimal	Marginal	Poor
1. Instream Cover (Fish)	Greater than 50% mix of boulder, cobble, sub-mergeo logs, undercut banks, or other stable habitat.	30-50% mix of boulder, cobble, or other stable habitat; adequate habitat.	10-30% mix of boulder, cobble, or other stable habitat; habitat avail-ability less than desirable.	Less than 10% mix of boulder, cobble, or other stable habitat; lack of habitat is obvious.
SCORE _____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
2. Epifaunal Substrate	Well developed riffle and run; riffle is as wide as stream and length extends two times the width of stream; abundance of cobble.	Riffle is as wide as stream but length is less than two times width; abundance of cobble, boulders and gravel common.	Run area may be lack-ing; riffle not as wide as stream and its length is less than two times the stream width; gravel or large boulders and bed-rock prevalent; some cobble present.	Riffles or run virtually nonexistent; large boulders and bedrock prevalent; cobble lacking.
SCORE _____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
3. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
SCORE _____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
4. Velocity/Depth Regimes	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow).	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score lower than if missing other regimes).	Dominated by 1 velocity/depth regime (usually slow-deep).
SCORE _____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
5. Channel Alteration	No channelization or dredging present.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	New embankments present on both banks; and 40-80% of stream reach channelized and disrupted.	Banks shored gabion or cement; over 80% of the stream reach channelized and disrupted.
SCORE _____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Total Side 1 _____				

-1-

3800-FM-WSFR0402 Rev. 10/2000

RIFFLE/RUN PREVALENCE

Habitat Parameter	Category: Optimal	Suboptimal	Marginal	Poor
6. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from coarse gravel; 5-30% of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, coarse sand on old and new bars; 30-50% of the bottom affected; sediment deposits at obstruction, constriction, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE _____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
7. Frequency of Riffles	Occurrence of riffles relatively frequent; distance between riffles divided by the width of the stream equals 5 to 7; variety of habitat.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream equals 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is between ratio >25.
SCORE _____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
8. Channel Flow Status	Water reaches base of both lower banks and minimal amount of channel substrate is exposed.	Water fills > 75% of the available channel, or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE _____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
9. Condition of Banks	Banks stable; no evidence of erosion or bank failure.	Moderately stable; infrequent, small areas of erosion mostly healed over.	Moderately unstable; up to 60% of banks in reach have areas of erosion.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; on side slopes, 60-100% of bank has erosional scars.
SCORE _____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
10. Bank Vegetative Protection	More than 90% of the streambank surface covered by vegetation.	70-90% of the stream-bank surface covered by vegetation.	50-70% of the stream-bank surfaces covered by vegetation.	Less than 50% of the streambank surfaces covered by vegetation.
SCORE _____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
11. Grazing or Other Disruptive Pressure	Vegetative disruption, through grazing or mowing, minimal or no evident, almost all plants allowed to grow naturally.	Disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	Disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Disruption of vegetation is very high; vegetation has been removed to 2 inches or less in average stubble height.
SCORE _____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
12. Riparian Vegetative Zone Width	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters; little or no riparian vegetation due to human activities.
SCORE _____	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1
Total Side 2 _____				
Total Score _____				

-2-

Figure 1 DEP Habitat assessment sheet used

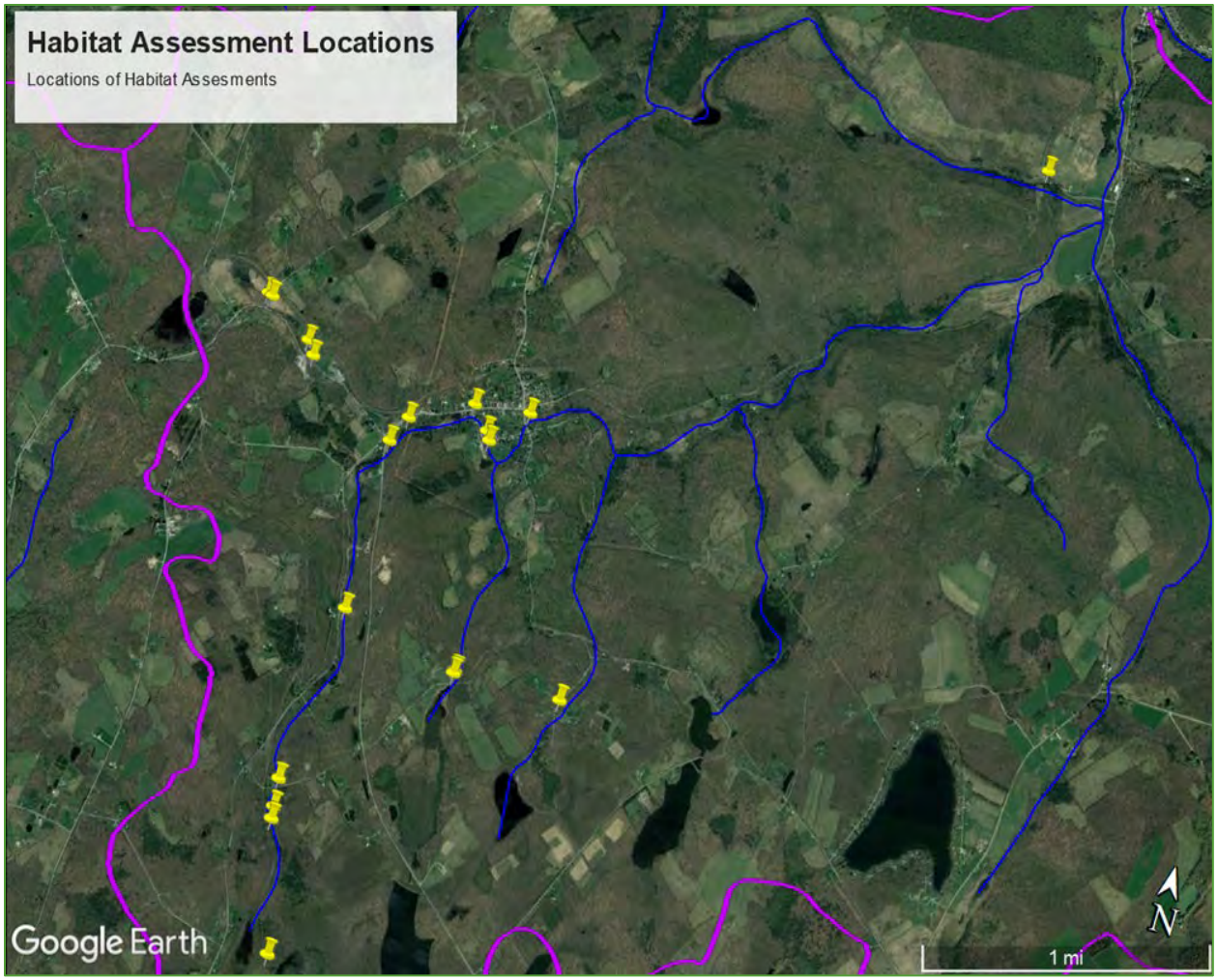


Figure 2 Map of habitat assessment locations

Location	Waterbody Name	Total Side 1	Total Side 2	Total Score	Note
41.83628 -75.52401	Starrucca Creek	20	36	56	West side of Trail maintenance site Ph6.59 Temp2.7 TDS 72.3
41.83596 -75.2352	Starrucca Creek	23	39	62	East side of Trial maintenance site
41.864884 -75.53722	Unnamed Trib	23	69	92	Upstream from Stack road Wetland Next to NE Equine
41.86479 -75.53682	Unnamed Trib	42	81	123	NE Equine Center Runoff entering culvert upstream from culvert
41.86225 -75.51816	Starrucca Creek	69	79	148	Below Mill Dam
41.86214 -75.53213	Unnamed Trib	73	78	151	Section upstream from bad condition culvert & Temp logger site Penn DOT
41.85867 -75.52402	Starrucca Creek	67	89	156	Below Big Bridge Eroding banks around bridge Temp 2.8 Cond 94.1 pH7.43
41.84719 -75.5134	Starrucca Creek	73	87	160	Wetland below culver & Temp Logger
41.86093 -75.5166	Starrucca Creek	76	96	172	Reach adjacent to Thompson Borough Hose Company Building
41.84704 -75.51346	Unnamed Trib	85	90	175	Temp 61.9° Cond 73.8 pH 6.45 Up from culvert beaver dam influenced
41.83848 -75.5244	Starrucca Creek	69	107	176	Temp 61.2° Cond 69.7 pH 7.01 Camp Bridge culvert upstream from Temp Logger Location
41.5137.57 -753058.31	Starrucca Creek	79	98	177	Section next to demolished building foundation
41.86224 -75.51365	Starrucca Creek	84	106	190	Water St Bridge
41.84738 -75.50475	Unnamed Trib	77	114	191	T&J Tree Farm Temp 61.7° Cond 22.9 pH 6.87
41.88628 -75.47726	Unnamed Trib	85	106	191	Unnamed Trib below culvert on Gellat Rd down from beaver dam
41.88628 -75.47726	Unnamed Trib	85	106	191	Buck Falls Crossing Temp3 pH6.67 TDS85.9
41.84864 -75.5234	Starrucca Creek	86	113	199	Section along Lampbertons Lilly Farm
41.86271 -75.51359	Starrucca Creek	89	111	200	Downstream from bridge temp logger location small unmapped trib upstream from temp logger site
41.86291 -75.53288	Unnamed Trib	86	115	201	Section upstream adjacent to PennDOT Property
41.86032 -75.52306	Starrucca Creek	83	120	203	Section Below Cesspool
41.82926 -75.52117	Starrucca Creek	93	133	226	Top Of watershed Temp 56° Cond 24.1 pH 6.52

Table 1 Summary of visual habitat assessments. Color coded Red= Poor; Orange= Marginal; Yellow= Sub-Optimal; Green= Optimal

Figure 8 Sedimentation source at 171 Bridge location

Figure 1 Impoundment from the Spencer Mill Dam in Thompson Borough

Figure 7 Armored banks and loss of forest and shrubby riparian habitat in Thompson Borough

Figure 8 Starrucca Creek main stem below the Spencer mill dam in Thompson. Channel restriction due to armored banks.

E: Culvert Assessment & NAACC Data:

Survey ID	Aquatic Passability Score	AOP Rating	Barrier Evaluation	Structure Type
89609	0.929	Full AOP	Insignificant barrier	Bridge with Abutments
89613	0.826	Full AOP	Insignificant barrier	Bridge with Abutments
89615	0.951	Full AOP	Insignificant barrier	Bridge with Abutments
89617	0.986	Full AOP	Insignificant barrier	Bridge with Abutments
89619	0.000	No AOP	Severe barrier	Round Culvert
89644	0.347	No AOP	Significant barrier	Round Culvert
89674	0.475	Reduced AOP	Moderate barrier	Round Culvert
89674	0.475	Reduced AOP	Moderate barrier	Round Culvert
89674	0.475	Reduced AOP	Moderate barrier	Round Culvert
89675	0.612	No AOP	Minor barrier	Box Culvert
89676	0.000	No AOP	Severe barrier	Round Culvert
89677	0.332	No AOP	Significant barrier	Round Culvert
89678	0.673	Full AOP	Minor barrier	Box Culvert
89679	0.482	Reduced AOP	Moderate barrier	Round Culvert
89681	0.756	Full AOP	Minor barrier	Round Culvert
92241	0.712	Reduced AOP	Minor barrier	Elliptical Culvert
92241	0.712	Reduced AOP	Minor barrier	Elliptical Culvert
92242	0.910	Reduced AOP	Insignificant barrier	Bridge with Abutments
92243	0.945	Full AOP	Insignificant barrier	Bridge with Abutments
92244	0.478	No AOP	Moderate barrier	Elliptical Culvert
92244	0.478	No AOP	Moderate barrier	Elliptical Culvert
92244	0.478	No AOP	Moderate barrier	Elliptical Culvert
92362	0.928	Full AOP	Insignificant barrier	Bridge with Abutments
92363	0.701	Reduced AOP	Minor barrier	Round Culvert
92364	0.776	Full AOP	Minor barrier	Box Culvert
92365	0.508	No AOP	Moderate barrier	Round Culvert
92366	0.530	Reduced AOP	Moderate barrier	Round Culvert

Table 1 Table Culvert survey locations, AOP scores and barrier evaluations. (Gray cells show multiple structures at the same crossing ID).

F: Temperature Data

Site ID	pH	Temp F°	Date	Time	Habitat Type	Shade
UNT 32264	7.46	70.2	7/15/21	16:20	Run	Some
SC1	6.81	78.3	7/15/21	16:13	Pool	Complete
UNT 32298	6.11	74.7	7/15/21	14:57	Pool	None
SC2	7.05	69.6	7/15/21	13:24	Run	Some
SC3	7.22	70	7/15/21	14:06	Run	Complete
SC4	7.6	67.5	7/15/21	15:30	Pool	Some
SC5	7.59	61.5	7/23/21	10:43	Run	Complete
UNT 32282	7.57	60.1	7/23/21	11:16	Pool	Complete
UNT 32299	7.33	68.5	7/15/21	12:51	Run	Complete
UNT 32296	7.33	63	7/15/21	15:30	Pool	Complete

Table 1 Data recorded at the time of deployment of temperature loggers

Figure 1 Impoundment from beaver dam upstream from logger on UNT 32298

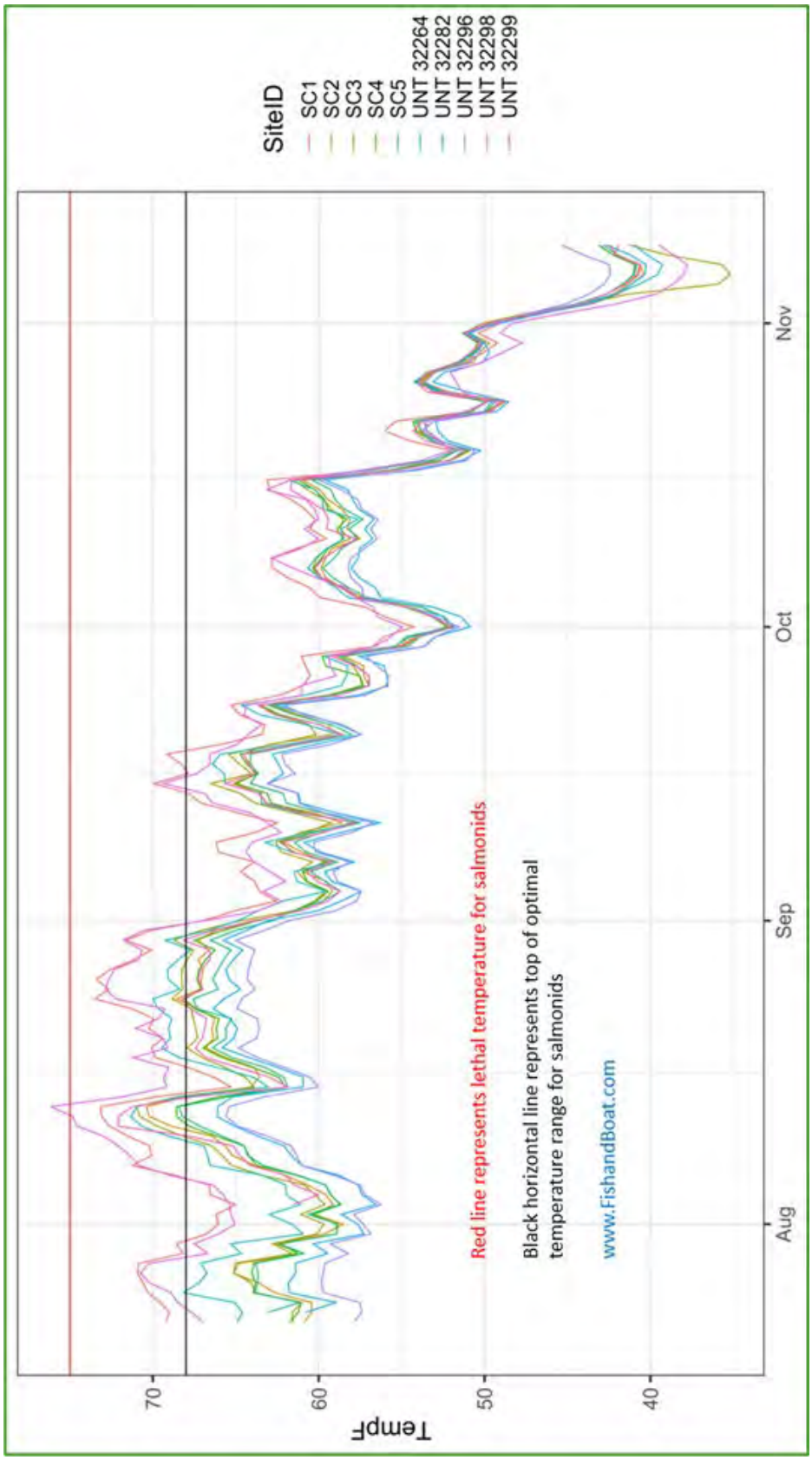


Figure 2 Temperature recordings of all loggers over 4-month span

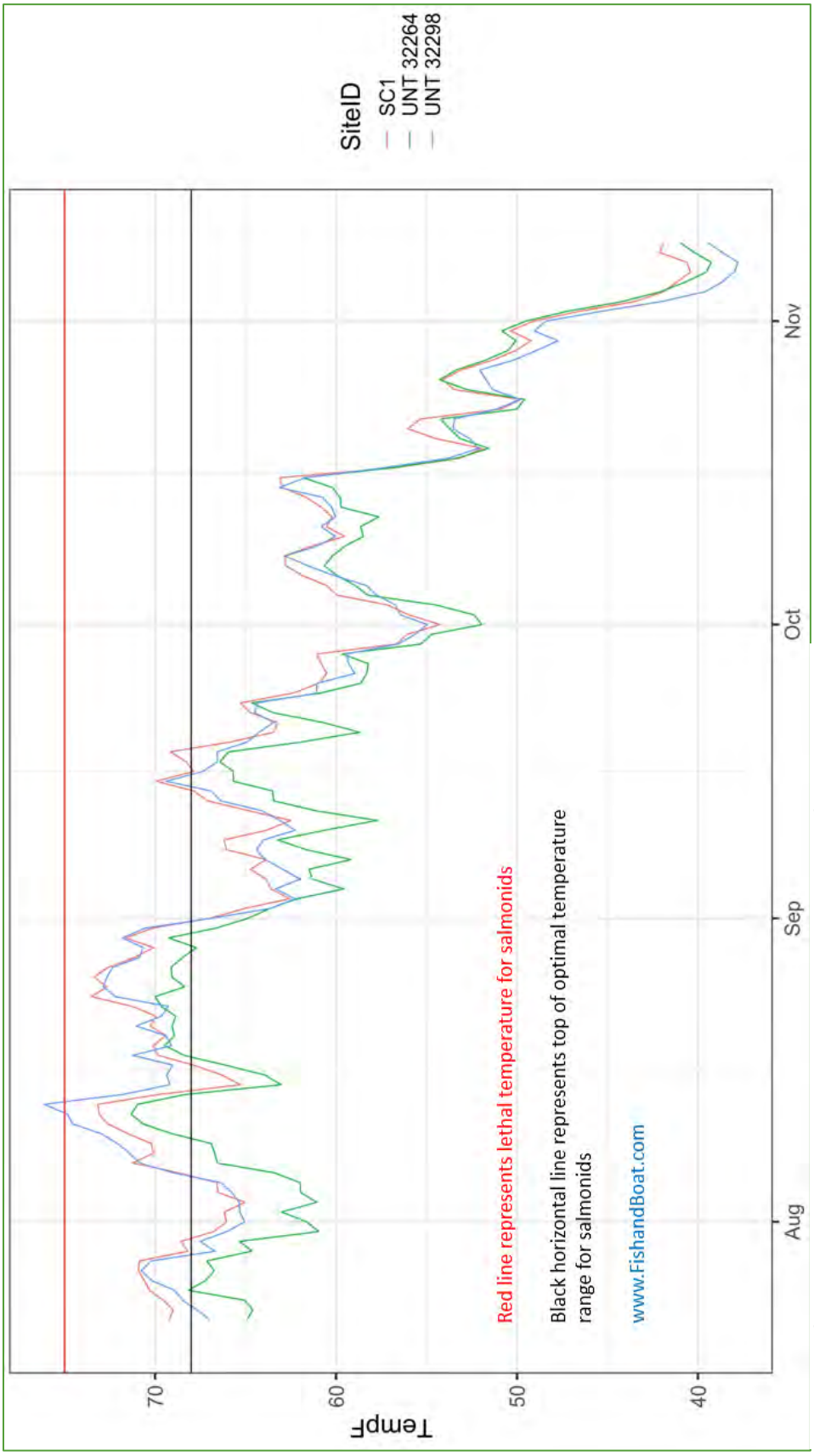


Figure 3 Data for three locations that exceeded optimal water temperatures for trout

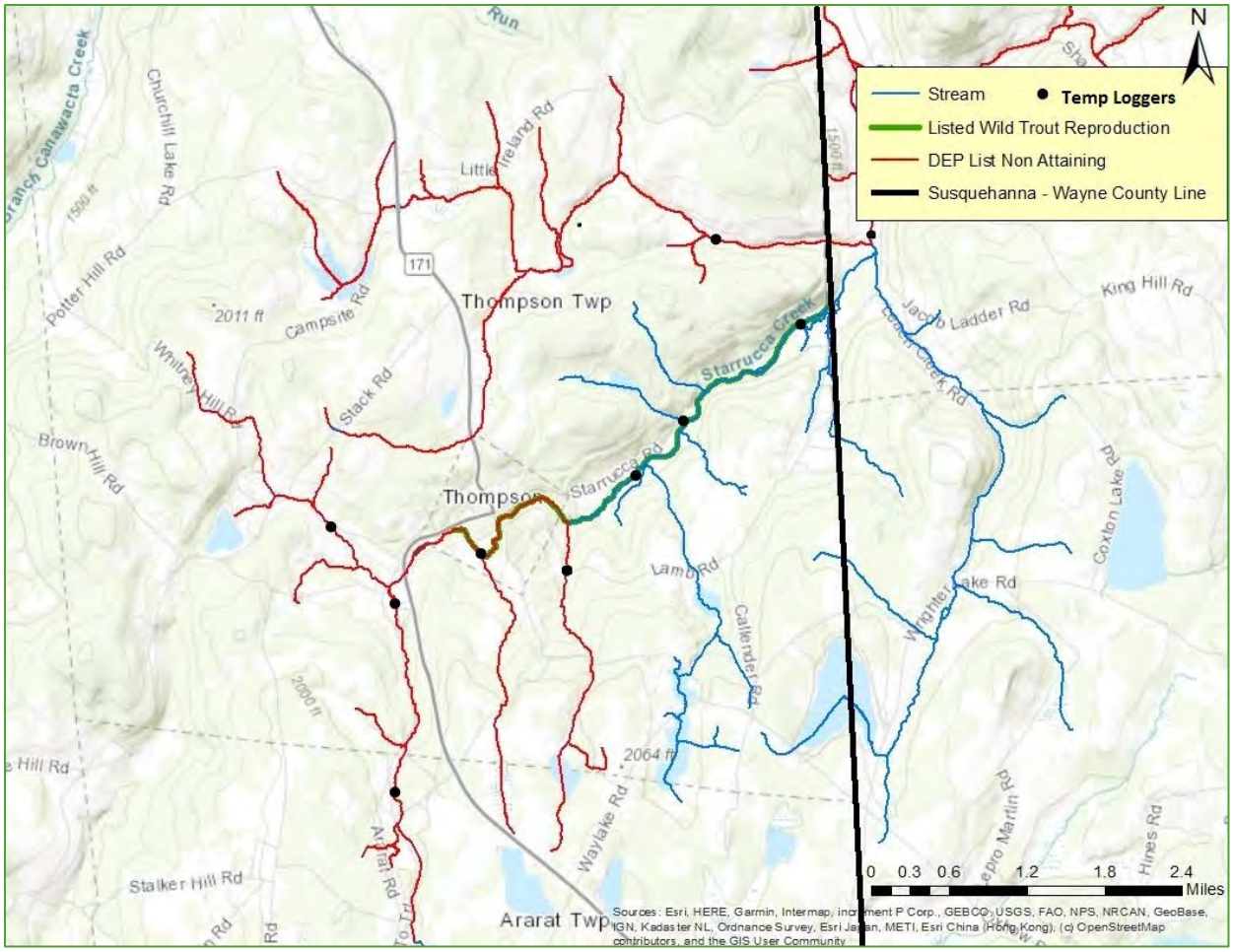


Figure 4 Map of temperature loggers in relation to streams listed as naturally reproducing and non-attaining

files

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