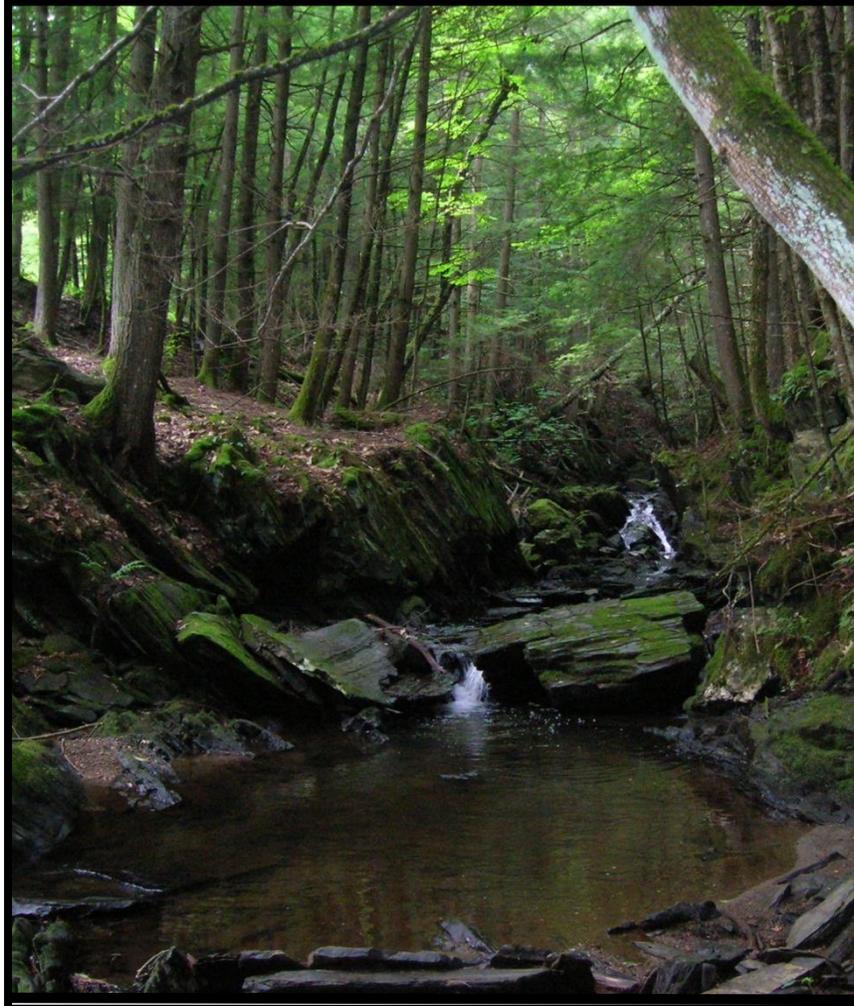


Bath, New Hampshire:

Brook Trout Report & Recommendations for Conservation



Undergraduate Thesis

Emma Lundberg, Southern New Hampshire University

New Hampshire Fish & Game Department

June – 2012

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Acknowledgments

The process of developing this report has been a long one. I have been blessed with so much help from my supervisors at the New Hampshire Fish and Game Department (NHFGD), as well as my advisor at Southern New Hampshire University.

I'd like to thank Fisheries Biologists, Benjamin Nugent and Matthew Carpenter from the NHFGD for their continued support over the past few years. Being able to work with these talented biologists and have their continuous guidance has given me the ability to learn, and subsequently apply that knowledge in a practical form. Without their help this report would not have been possible.

I'd also like to thank Dianne Timmins (Fisheries Biologist), Andrew Schafermeyer (Fisheries Biologist) and Judy Tumosa (Aquatic Educator), from the NHFGD. Their constant support throughout the report process has been an enormous help. I would especially like to thank Judy for offering this amazing opportunity, helping me through the process and keeping me up-to-date for the duration of the project. I'd also like to give Dianne additional thanks for her assistance with report editing and layout.

I would like to thank the NHFGD and all of the volunteers who helped to accumulate the water quality, habitat, and fish data from the Bath, New Hampshire site locations.

Finally, I would like to thank my wonderful advisor, Dr. Michele Goldsmith, for not only her support, but for believing in me and directing me in all of my efforts, not only in this thesis, but in all things throughout my college years.

I hope that this report and the recommendations that follow have a positive impact on the conservation and preservation of brook trout populations throughout the watersheds in the town of Bath, New Hampshire.

Brook Trout Overview

Brook trout (*Salvelinus fontinalis*) are the only native stream dwelling trout species located in the eastern United States. The brook trout's range reaches from eastern Canada south to northwestern Georgia. This species requires cold, clean water to survive. Brook trout are extremely sensitive to environmental changes and habitat alterations. This sensitivity has made



Figure 1. Brook trout found in Bath, NH 2011.

brook trout a particularly important indicator species. They thrive in small streams and larger rivers within forested watersheds where suitable temperatures and habitat exist. Poorly designed stream crossings, storm runoff from roads, and the removal of streamside vegetation can impact water quality and degrade their habitat in cold water streams. Poor water quality and other environmental perturbations can force brook trout and other sensitive species out of their local habitats. These population declines can serve as early warning signs of a reduction in the overall health of the aquatic ecosystem. Conservation and rehabilitation methods must be implemented along the eastern brook trout's entire range to halt further population declines of this indigenous species. (Hudy et al. 2006)

Many cooperative partnerships have been established with the intent to collect data and advocate for the health and well-being of brook trout. One such partnership is the Eastern Brook Trout Joint Venture (EBTJV), one of the partnerships under the umbrella of the National Fish Habitat Partnership (NFHAP). It was established to protect, restore and enhance brook trout habitat throughout its native range (Maine to Georgia). State, federal and private organizations have worked together to compile distribution, population, and status information on brook trout and identify key threats to their survival. The EBTJV developed conservation strategies that are currently being implemented at all levels – local, regional, and range-wide (EBTJV 2011). Assistance from local community members provides additional data, in the form of localized knowledge on brook trout populations and their habitat, as well as volunteer hours. This collaboration enhances conservation and management efforts. The work completed in the town of Bath would not have been possible without the assistance received from dedicated volunteers at this level. This study will enable the town of Bath to implement the recommendations developed for the protection of headwater streams identified in their Natural Resource Inventory (2012).

Variables such as land use (both current and historical), water quality, fragmentation, and the presence of exotic species must be examined locally to evaluate the condition of, and potential threat to, wild brook trout habitat and population health. This study was conducted to assess the current status of fish habitat, water quality and brook trout populations within headwater streams in the town of Bath. This will enable researchers and residents to better understand stream conditions and design specific restoration and/or conservation strategies in Bath. Without knowing the current condition of the wild brook trout populations and their habitat, it is difficult to develop successful, site-specific projects that will conserve those populations. Strategies for the protection of intact populations and the restoration of impacted populations must be employed in order to slow or reduce the severity at which brook trout population declines are occurring (Hudy et al. 2008).

An initial brook trout status assessment was completed for the EBTJV to indicate the presence of wild brook trout throughout their geographic range (Hudy 2006). Available brook trout

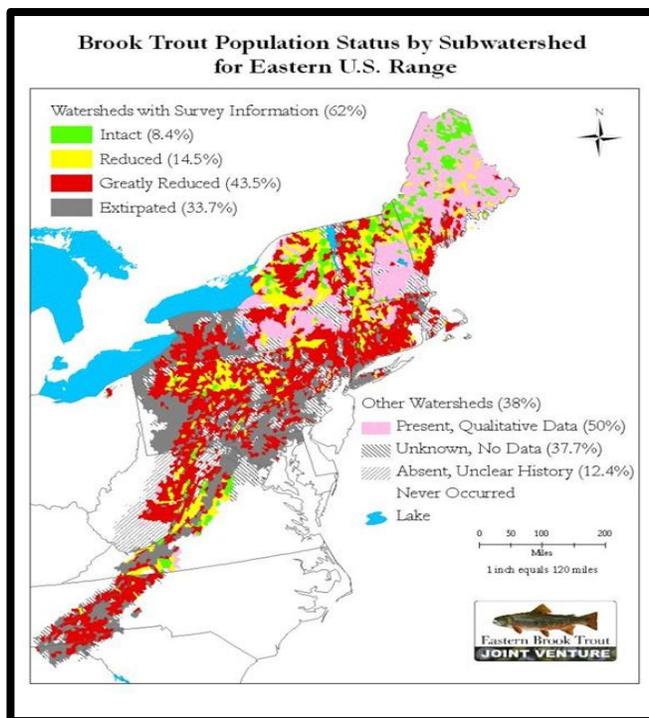


Figure 2. Brook trout status across their native range (EBTJV, 2006).

population data was gathered and analyzed from state, federal and non-governmental sources. This data identified habitats with known, unknown, and extirpated brook trout populations across their native range. A status map was developed to display this effort (Figure 2) at the HUC 12-digit level¹.

The USGS has utilized codes to define systems of drainage within the landscape at various sizes from large to small (i.e. 4-digit through 12-digit codes; respectively). The smaller the HUC number, the larger the area encompassed within the unit. A HUC-12 in

New Hampshire (NH) typically ranges between 10 to 40K acres, roughly equating to

a USGS Quad sheet. This study showed that New Hampshire had the highest percentage (70%) of subwatersheds categorized as present qualitative because they lacked quantitative information

¹ HUC stands for Hydrologic Unit Code, there are six HUC categories; HUC-2 (region) HUC-4 (subregion) HUC-6 (basin) HUC-8 (subbasin) HUC-10 (watershed) HUC-12 (subwatershed); these units have been delineated by the USGS Water Resources of the United States.

from the last ten years (1996-2006). The data was further analyzed along with available USGS habitat data to make predictions about the status of brook trout populations in areas where data was not yet available (Thieling 2006). This model did not truly represent the populations in the northeast. The scale at which the predictions were made was too large to show the true picture of what was happening on the ground at the local level. It indicated most of the populations of brook trout within the northeast were intact and state biologists declared otherwise. As a result, new assessments are ongoing at a smaller scale called catchments. The quantity of catchments varies within a HUC-12 subwatershed. In some cases, there have been greater than twenty catchments in a HUC-12, as is the case for Bath (Figure 3). It all depends on the quantity of brooks and tributaries that exist within the catchment drainage. This finer unit displays a more accurate picture of brook trout habitat and population condition present at the local level. The surveys completed in the town of Bath were done at the midpoint of each catchment.

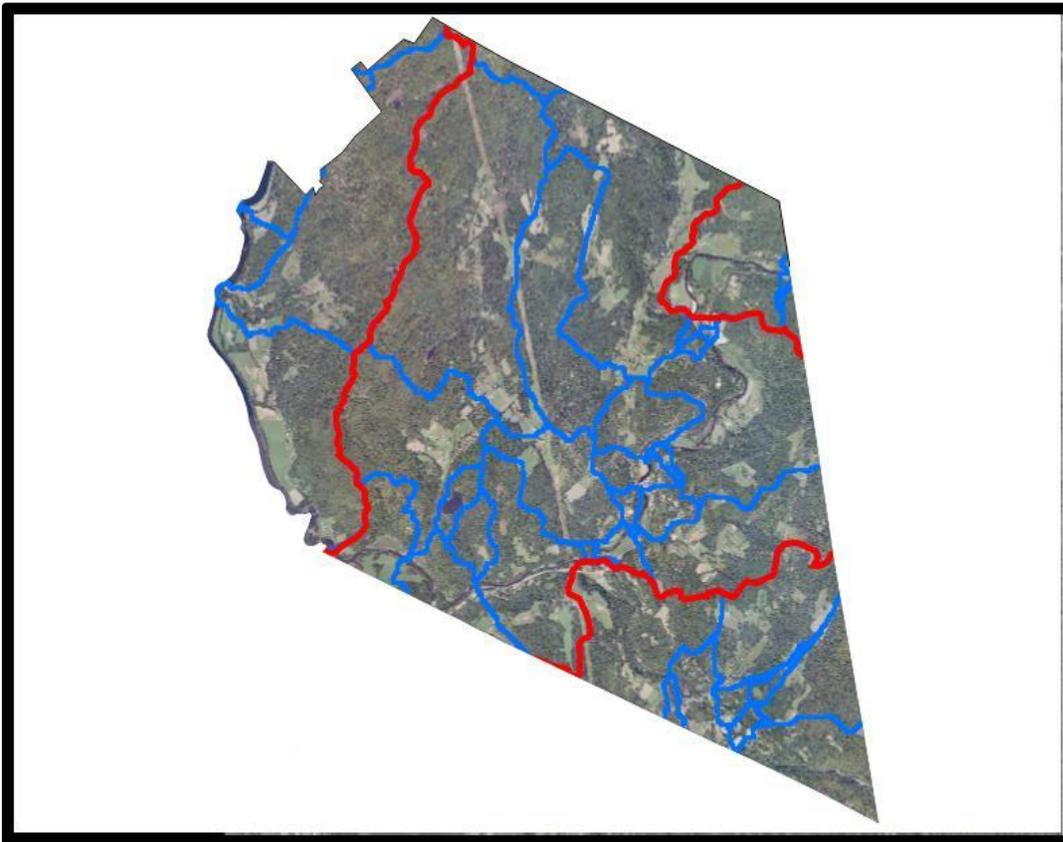


Figure 3. Subwatershed (red) and catchments (blue) boundaries within the town of Bath.

Habitat Features for Healthy Trout Populations

Water Quality Parameters

Good water quality is important to sustaining populations of various species of aquatic organisms within a freshwater ecosystem. While some species are tolerant of changes to water quality and habitat alterations, some known as indicator species are not and can be impacted by subtle changes to their habitat. As stated previously, brook trout serve as one of those important indicator species.

There are many things that reveal the status of water quality, ranging from the type of organisms that live in a particular habitat to the chemical and/or physical parameters within the sample area. Water temperature is one of the primary variables that affect the presence of wild brook trout. Brook trout are rarely found in streams that have average summer temperatures exceeding 20°C. The greatest source of heat comes from the absorption of solar radiation on the water's surface. The more direct sunlight a body of water receives, the warmer the water will become. Additionally, lower water levels and decreased flow rates, often associated with summertime conditions, increase the stream's susceptibility to temperature increases. This is a result of both solar radiation to the water, as well as heat transfer from exposed boulders and bare streambanks. Bodies of water with higher rates of turbidity are also more susceptible to increases in water temperature because suspended organic particles absorb large amounts of solar energy. Increased water temperatures can lead to the depletion of dissolved oxygen (DO), the necessary form of oxygen required for aquatic survival. Most aquatic life requires levels greater than 5mg/l. Organisms with a low threshold for increased water temperature and decreased oxygen levels will migrate to areas with more desirable conditions. If they are unable to migrate due to habitat fragmentation, some sensitive species will not survive (Wetzel, 1975). This threat emphasizes the importance of well-established riparian buffers, vegetated strips existing along the stream edges that usually contain trees and shrubs. They offer shade, which maintains cooler water temperatures, and they stabilize the soil, which reduces erosion and turbidity.

Macroinvertebrate composition is another variable used to determine water quality. The presence or absence of certain macroinvertebrate species can indicate the level of water quality in a river or stream because some macroinvertebrates are tolerant toward pollution and some are not. In order to evaluate water quality in a particular area, long-term data collection is necessary.

Water quality meters are used to gather data on temperature, pH, conductivity and dissolved oxygen. The Bath Conservation Commission is committed to conducting long term habitat surveys, which would be beneficial to understanding and characterizing the aquatic environments within their town.

Stream Crossings

Improperly designed stream crossings can disrupt connectivity, resulting in a long lasting impact



Figure 4. Improperly designed crossing on Lower Childs Brook, Bath, NH.

on aquatic organisms, possibly interrupting their lifecycle. Inadequate stream crossings have many negative impacts on aquatic habitats. They can lead to increased rates of erosion, constricted stream flow through the structure, and increased water velocities, which all result in greater scour forces (Figure 4). Scoured materials can redeposit downstream potentially aggrading the streambed covering spawning beds and filling in pools and macroinvertebrate habitat. Although

stream crossings should be avoided as often as possible, there are situations in which they are deemed necessary. When determining the appropriate stream crossing design, you should consider the geomorphology and ecology of the stream. The ability for fish to migrate to more desirable locations for spawning, thermal refuge, and feeding is critical for genetic integrity and species survival. Although the cost of a properly designed crossing is expected to be greater upfront, it is also expected that it will save money over time by increasing the longevity of the structure and reducing costs associated with short-term structure maintenance. For further detail on how to adequately assess and implement a stream crossing consult the *New Hampshire Stream Crossing Guidelines* (May 2009).

Riparian Buffers

Intact riparian buffers are indispensable to the protection of water quality and the abundance of aquatic organisms. These areas serve many important purposes for stream health and quality including establishing streambank stability, wildlife habitat, shade and thermal refuge. These areas reduce nutrient loading and pollution associated with eutrophication through the process of

nutrient uptake through the roots of vegetation (i.e. trees, shrubs, grasses) and are an important part of the nitrogen cycle (Magee 2006). Adequate riparian buffers provide natural armoring along streambanks by stabilizing the soils with rooted material, which protect the area from erosion and scour during flood events. Not only do buffers offer stabilization, they also provide habitat for a variety of wildlife species. It also insures that wood additions to the stream (i.e. trees, logs, twigs, leaves) will occur naturally over time. Trees provide shade, which help regulate stream temperatures and prevent extreme highs. Fallen trees uptake excess nitrogen and act as collectors for organic matter. Wood also benefits aquatic organisms by transforming and creating habitat. Under the right circumstances, pools are created downstream of fallen trees that got pinned by other trees or boulders. Pools are an important habitat feature used by brook trout and other aquatic organisms. They provide cover/protection from predators, thermal refuge and habitat for larger brook trout. Insufficient buffers lead to erosion, scour, flash flooding, habitat homogeneity and increased water temperatures, which inevitably lead to property damage, species decline and other environmental concerns.

Study Methods

Brook Trout

Between July 25 and July 27, 2011, New Hampshire Fish and Game Department personnel and

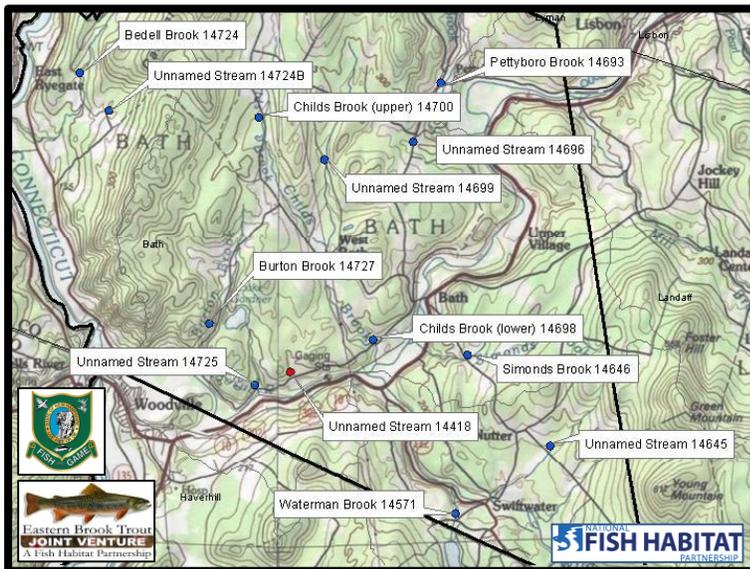


Figure 5. Locations surveyed in Bath, NH during summer 2011. A blue dot indicates brook trout were present and red indicates absent.

local volunteers, sampled thirteen headwater streams within the Ammonoosuc River Watershed (Figure 5). The streams in Bath were sampled at the center of each catchment, unless that location was inaccessible. If the midpoint wasn't reachable, the closest accessible location was chosen instead. Sampling was conducted using a Smith-Root backpack electrofisher, which temporarily stuns fish with

electricity making it possible to capture them with dip nets (Figure 6). One hundred meters of the stream was surveyed at each sampling location. All fish collected were identified, weighed

to the nearest gram, and measured to the nearest millimeter. After the fish were processed, they were returned to the stream.

Macroinvertebrates and Water Quality

To determine the health of aquatic communities, we utilized the Volunteer Biological Assessment Program (VBAP), developed by the NH Department of Environmental Services (NH DES). It consists of water quality and macroinvertebrate sampling, which have varying levels of pollution tolerance. Using this value, VBAP calculates a biotic score that indicates water quality; a score ranging between 0.0 – 3.5 indicates excellent water quality, >3.5-4.8 indicates good water quality, and >4.8 indicates poor water quality.

Habitat Surveys

In addition to the fish sampling, a habitat assessment was conducted at each site, which included collecting data on instream habitat, water quality, riparian buffers and surrounding land use. Observations were also made on stream crossings and fish passability. The survey form used was developed by the NH Fish and Game Department and is used in all of their EBTJV assessments.



Figure 6: Fish sampling using backpack electrofishing units, 2011.

Stream Crossing Issues

Perched Culverts

A culvert is considered perched when the downstream end is positioned above the streambed, thereby creating a waterfall upon release (Figures 7 and 8). A perched culvert can result from long periods of erosion caused by crossings that are undersized or improperly placed during installation. Perches can range from a few inches to a few feet and can impede fish and other organisms.



Figure 7. Unnamed Stream, Bath NH (site#14725).



Figure 8. Waterman Brook, Bath, NH (site # 14571).

Undersized Culverts

An undersized culvert is a stream crossing that is too small to accommodate the variability in natural flow or the movement of sediment within a stream. Undersized crossings can increase stream flow, which cause sediment deposition (aggradation) at the upstream side of the crossing and scouring downstream of the crossing (Figures 9 and 10). They typically require frequent maintenance due to clogging, erosion and washouts likely to occur during high flow events. Erosion at stream crossing locations can alter stream habitat around both the inlet and outlet of a crossing, as well as areas downstream.



Figure 9. Upper portion of Childs Brook, Bath, NH (site # 14700).



Figure 10. Washout at Unnamed Stream, Bath, NH (site # 14699).

Slip lined Culverts

Slip lining is an inexpensive method to repair a deteriorating culvert. The culvert is restored by



Figure 11. Slip lined crossing on unnamed tributary, Bath, NH.

inserting a lining into the compromised pipe (Figure 11).

Although inexpensive, this method is not highly recommended. It further constricts stream flow by reducing the area within the culvert where the water needs to pass through. This reduction increases stream velocity leading to further scouring and erosion of the streambanks downstream. It is particularly problematic to implement a slip liner into an already undersized culvert. Slip lining

should not be considered a cost effective, long-term method of culvert restoration and should only be used as a last resort.

These aforementioned conditions (perched culverts, undersized crossings, erosion, and slip lining) were commonly found in headwater stream habitats within Bath. Headwater streams are extremely important to aquatic ecosystem connectivity and provide safe havens and spawning habitat. Keeping these streams connected through the implementation of appropriate stream crossings will ensure fish and other aquatic organism passage and should be a top priority for restoration efforts and the preservation of aquatic populations.

Bath Study Results

Macroinvertebrates, Water Quality and Brook Trout

Water quality results indicated that pH, dissolved oxygen (DO) levels and temperature were within acceptable limits for brook trout. The VBAP scores for the streams sampled in Bath were all found to have excellent to good water quality (Table I). Macroinvertebrate surveys were not conducted at Simonds Brook, Bedell Brook and two Unnamed Streams (#14724B and #14696). Twelve of the thirteen sample locations supported brook trout populations.

Table I. Summary of water quality, VBAP and brook trout (EBT) data for sites sampled in Bath, NH, 2011.

Brook Name	Site #	pH	DO (Mg/l)	Temp (°C)	VBAP Score	Total # Species	Total # EBT	EBT Density (EBT/m ²)
Bedell Brook	14724			21.4			62	1.03
Unnamed Stream (Bedell Bk. trib.)	14724B			16.1			68	0.85
Burton Brook	14727	7.08	8.4	15.6	3	2	73	0.29
Childs Brook (upper)	14700	7.42	7.3	20.7	4.3	2	44	0.4
Unnamed Stream (Gardner Lk.)	14725	7.32	8.5	15.5	3	2	4	0.03
Unnamed Stream (River Rd.)	14418	6.83	7.3	16	4	0	0	0
Unnamed Stream (Lang Rd.)	14699	7.54	7.6	17.4	3.8	1	23	0.23
Childs Brook (lower)	14698	7.58	7.6	18.3	3.4	2	10	0.04
Unnamed Stream (Pettyboro Bk. trib.)	14696			17.2		3	1	0.01
Pettyboro Brook	14693	7.01	9	14.8	3.4	3	22	0.09
Waterman Brook (Starch Factory Bk.)	14571	7.28	7.7	22.8	3.4	6	2	0.01
Simonds Brook	14646			17.8		1	27	0.23
Unnamed Stream (Windy Hill Rd.)	14645	7.08	7.6	17.1	3.8	2	35	0.35

Note: Streams are in order of geographic location from west to east.

A variety of fish species were observed, with brook trout being the most abundant (Figure 12).

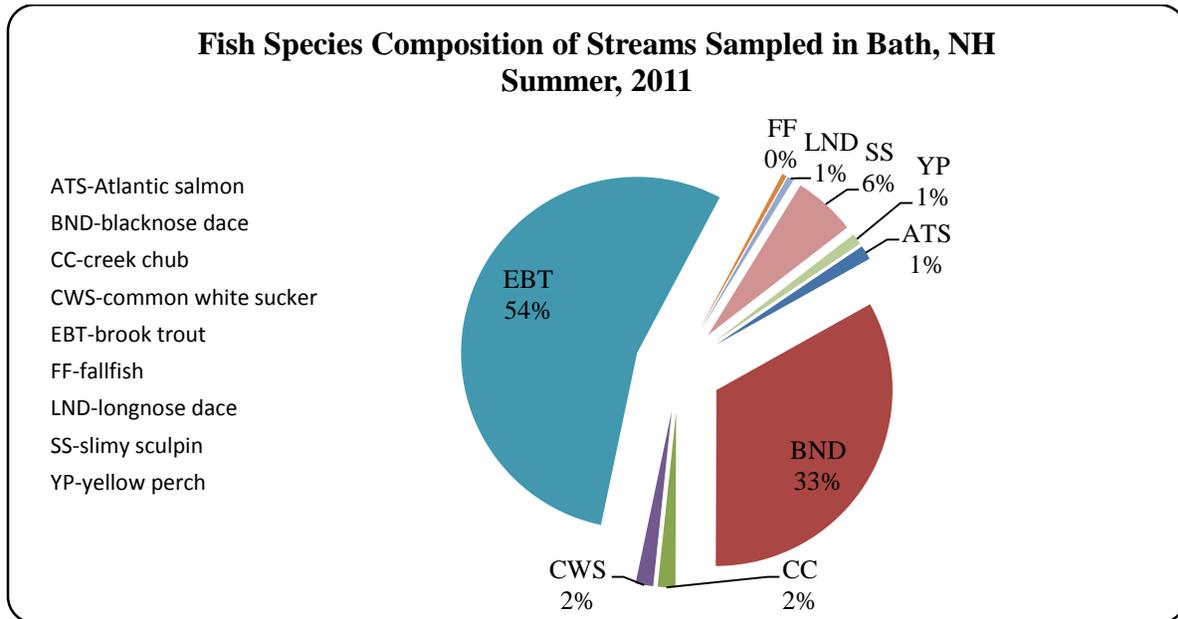


Figure 12. Fish species observed during sampling in Bath, NH (2011).

The presence of brook trout and slimy sculpin demonstrate the existence of good water quality and habitat in these headwater streams. Age structure varied among streams. All twelve streams that contained brook trout had both adults and juveniles (Figure 13). Bedell Brook and its tributary had the best overall habitat for brook trout and both supported large numbers of brook trout with, 62 and 68 sampled, respectively.

Brook trout density is an important variable to review when prioritizing streams for

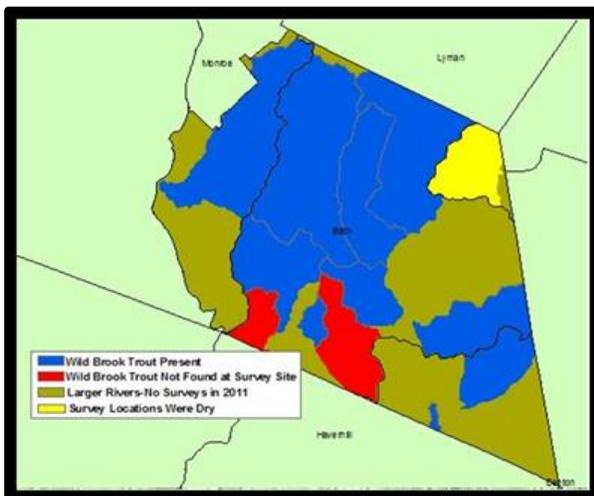


Figure 13. Summary indicating the presence of brook trout within the catchments surveyed in Bath, 2011.

conservation; the larger the density, the healthier the population of brook trout is that live in that location. Density is calculated using the total number of the species captured divided by the wetted surface area, which is derived from the length and average width measurements taken at the site at the time of the survey. Bedell Brook, both the mainstem and the tributary, had the highest brook trout densities among the streams sampled.

Specific Stream Improvement Recommendations

Watershed evaluations are needed to identify the condition of local brook trout populations and their habitats. Each survey location has been categorized into three different groups based on present habitat conditions and data analysis: **Protect**, to preserve genetic diversity and protect the habitat that supports existing, stable populations; **Enhance**, to improve and reconnect adjacent habitats that have been impacted or contain unstable populations; **Restore**, to reestablish habitats and develop ecosystem conditions that will sustain reintroduced populations (*Eastern Brook Trout Joint Venture; Conserving the Eastern Brook Trout: Action Strategies, 2011*). Restoration efforts should be implemented to repopulate regions where brook trout populations once thrived. Maintaining connectivity and improving habitat quality in all of the streams within Bath would benefit both fish populations and local ecosystems. Stream crossing evaluations would ensure fish can travel in and out of streams based on their seasonal needs. Combining fish data with a list of crossings that preclude passage will be essential in prioritizing where stream crossing restoration occurs. For the purpose of prioritizing the restoration actions, the waterways listed below are categorized into one or more of the groups listed above due to the fact that certain parts of the same habitat need more restoration work than others. Improvements to connectivity and spawning, foraging and refuge habitat would allow for more sustainable populations overall. Based on the data collected during this assessment, site specific local land use recommendations have been developed for protection, enhancement and restoration.

Bedell Brook (Cemetery mainstem) -14724

Status: Protect

The survey location for Bedell Brook is located on the downhill slope of Flint Cemetery (Bedell/Chamberlain Cemetery). The habitat upstream of the site is in excellent condition and is surrounded by a well-established, mixed forest. In the past, the sample area of Bedell Brook was ponded due to beaver activity. Since then, the beavers have been removed and the dam was breached, allowing the area to revert back to a stream. The buffer vegetation now consists primarily of tall grasses, shrubs and alder saplings. The riparian zone at this location is stable and has grown-in considerably in a short amount of time.

During the summer of 2011, parts of the brook were very low and intermittent (the stream flowed underground). This likely occurred due to the increased sediment in the impounded area when beavers were present. When the dam was breached, the water receded and some of the deposits remained, creating breaks in the original channel. Over time, the channel will likely evolve back to a more typical one with a variety of different habitat types present. During a later site visit on March 14, 2012, it was noted that snowmelt and spring rain had replenished the flow and reestablished stream connectivity. Although the flow of the brook within the site was not continuous at the time of the survey, Bedell Brook exhibited the highest brook trout density at 1.03 EBT/m² of the streams sampled (Table I). All brook trout sampled were caught in deeper sections located in the downstream half of the site. The brook trout population within this site remains intact despite periods of intermittency.

Recommendations:

1. Establish riparian buffer along stream by planting native trees and shrubs, where necessary that will stabilize the bank, provide shade to the stream and provide habitat for wildlife.
2. Continue to monitor flow and water temperature to insure habitat suitability for brook trout.

Unnamed Stream (Bedell Brook Tributary) - 14724B

Status: Enhance

The Bedell Brook tributary was the second most productive brook trout stream sampled with a density of 0.85 EBT/m² (Table I). The brook flows out of a softwood forest into a cow pasture, continues through a slightly undersized culvert, then into a hardwood forest. A large number of brook trout were observed in a scour pool on the downstream side of the culvert located below

the sample site. Currently, a small number of livestock have unrestricted access to parts of the stream in the sample site. The resulting trails caused erosion and weakened the streambanks in many locations by preventing the growth of native plants and shrubs. There are many seeps entering the brook on the river left side that originate from a wetland upstream. These seeps provide more suitable flows and cooler temperatures required for wild brook trout. An intermittent side tributary also enters the brook on the river left side just downstream of the site. Green algae were observed at various locations within the sample area. Nutrient content, light levels, pH, and temperature are all variables that affect algae production. The more nutrient-enriched a waterbody, typically the more prominent the algae growth. This algae is most likely the result of excess nutrients from cow waste and increased sun exposure.

Although the Bedell Brook tributary is very productive, allowing a more robust buffer zone to regenerate in the upper section and establishing one in the lower section will stabilize the rates of both aggradation and degradation in various parts of the stream. Restricting livestock access with fencing will successfully restore the riparian zone and increase streambed stability.

Recommendations:

1. Construct fencing along the streambank outside the buffer to prevent access and further damage from livestock.
2. Establish riparian buffer along stream by planting native trees and shrubs, where necessary that will stabilize the bank, provide shade to the stream and provide habitat for wildlife.

Burton Brook-14727

Status: Protect

Burton Brook is a small stream that feeds into the Ammonoosuc River. The survey location was accessed along Mount Gardner Road. The brook travels through fields with minimal riparian buffer upstream of the survey location; unlike the section surveyed which has a well-established riparian buffer consisting of trees and shrubs. The streambed consists of adequately sized substrate for spawning and high quality macroinvertebrate populations. Redds (brook trout nests) were found at the Burton Brook sample site which indicates the population are reproducing. There is a large amount of clay throughout the streambed which enables groundwater to seep in slowly, which maintains cool temperatures.

Although most of the habitat is in good condition, there are a few improvements that should be considered to ensure the future viability of Burton Brook. Large deposits of sand were observed within the floodplain and within the stream in areas where Mount Gardner Road was close to the brook. Sedimentation can drastically alter habitat and negatively impact spawning success. It can also impact macroinvertebrate communities which provide food for trout. Reducing the amount of road sanding during the winter or redirecting the runoff from the stream would help reduce the amount that washes into the floodplain and the streambed. Riparian buffers should be restored along the banks where necessary and through the fields both above and below the survey site. Well-established riparian areas have root systems that stabilize streambanks, reduce erosion rates, and protect the stream from increased sedimentation.

Recommendations:

1. Minimize or redirect road runoff/drainage of sand resulting from road maintenance.
2. Establish riparian buffer along stream by planting native trees and shrubs, where necessary that will stabilize the bank, provide shade to the stream and provide habitat for wildlife.

Childs Brook (Upper Site) -14700

Status: Restore

This sample site is located on West Bath Road where two undersized culverts, placed in tandem, fail during most high water events. This site is in need of restorative action due to these inadequate crossings and their related habitat impacts. There is a large amount of aggradation (sediment deposition) occurring upstream of the culverts and the habitat is predominantly shallow. Here, very few EBT were sampled. The riparian buffer was minimal on the river right side due to an adjacent large field. A large pool exists downstream of the culverts. This pool was scoured out by the effect created when flow is constricted through the undersized crossings. The banks downstream are severely eroded and the stream becomes ponded due to a remnant beaver dam. Most of the brook trout captured were caught at the head-end of the pool where the overhanging vegetation was plentiful. Replacing the culverts with an appropriately designed crossing and restoring the buffer along the banks of Childs Brook will help restore connectivity, control erosion, stabilize banks, and reduce road maintenance.

Recommendations:

1. Establish riparian buffer along stream by planting native trees and shrubs, where necessary that will stabilize the bank, provide shade to the stream and provide habitat for wildlife.
 - a. This could also be achieved by reducing the amount of field mowing that currently occurs very close to the streambank.
2. Replace with appropriately designed stream crossing using the *New Hampshire Stream Crossing Guidelines* (2009).

Unnamed Stream (outlet of Gardner Lake) - 14725**Status: Restore**

This unnamed brook is an outlet of Gardner Lake and the survey location was along River Road. The road crossing is poorly designed and has caused both aggradation (above the crossing) and erosion (below the crossing). The culvert also has a high perch, essentially eliminating the ability for any fish to move upstream. There appears to be several stream crossings along River Road which exhibit similar impacts. There is an old dam immediately upstream of the crossing which reduces stream flow. As a result, sediment has deposited above and below the structure. While the stream continues to trickle through this buildup of sand and organic matter, upstream fish migration is limited. The perch on the undersized crossing has caused large amounts of scouring and sedimentation at the downstream end due to the increased flow coming out of the culvert. Replacing the culvert would restore connectivity as well as create better stream stability. This brook has higher water temperatures than other brooks in Bath, making it less desirable for brook trout populations. The higher water temperatures are likely from the surface release of water into the stream from Gardner Lake.

Recommendations:

1. Replace culvert with appropriately designed stream crossing using the *New Hampshire Stream Crossing Guidelines* (2009).
2. Restore stream connectivity by removing the dam.

Unnamed Stream (River Road) - 14418**Status: Restore**

An unnamed brook was sampled off River Road on the upstream side of a perched culvert. This brook flows out of a swamp/wetland complex. When the site was sampled, no trout were observed in the sample area. Upon further investigation downstream of the culvert, two brook

trout were captured in the outflow pool. The road culvert is perched about a foot and appears to be impassable to migrating fish. There is also a large amount of gravel deposited alongside the culvert and in the brook from the road. A PVC pipe upstream of the culvert also drains directly into the brook, and is covered with ferric algae (iron-loving) which thrives in the drainage pool as well. This stream is also heavily influenced by rain events and becomes intermittent (goes underground) under drought conditions. Replacing this crossing with an appropriately designed one with adequate roadside drainage would reduce the rate of erosion and scouring taking place in the outflow pool, as well as reduce the amount of sand and gravel entering the stream from the road. Efforts to monitor water temperature and flow throughout the summer should be made before a discussion of recolonization transpires.

Recommendations:

1. Replace with appropriately designed stream crossing using the *New Hampshire Stream Crossing Guidelines* (2009).
2. Continue to monitor flow and water temperature to insure habitat suitability for brook trout.

Unnamed Stream (Lang Road) - 14699

Status: Protect

The area surrounding the sample site on Lang Road has a thick, forested canopy and an intact protective buffer. These two variables provide shade during the summer months and minimize erosion. Small seeps were found throughout the stream. These are important because they provide thermal stability and enhance flow rates. Brook trout were the only fish found at this site. A variety of sizes were observed suggesting a healthy reproducing population exists. The limited adult habitat (significant undercut banks and large, deep pools) could be a natural condition due to the small size of the stream.

An undersized culvert with a slight perch (about 3 inches) also exists in the site. Based on the amount of erosion that exists near this culvert and the remnant drainage paths, it does not handle flows during high water events, causing the stream to flow over the road. An open bottom culvert or a small sized bridge would be appropriate alternatives to a culvert of equal size.

Recommendations:

1. Replace culvert with appropriately designed stream crossing using the *New Hampshire Stream Crossing Guidelines* (2009).

Childs Brook (Lower Site)-14698

Status: Enhance

The lower site on Childs Brook is located on River Road and consists predominantly of bedrock substrate. The stream flows through a gorge at the survey location. Strong flows and coarse substrate likely minimize the ability for any material, wood, sediment, etc., to take purchase and remain in this area. Although the habitat lacked a great deal of variability, brook trout were present. This was most likely due to good water quality resulting from many cascading waterfalls in this section. These waterfalls create oxygen, which is evident by the high dissolved oxygen (DO) reading recorded for this location (Table I). High DO values are extremely beneficial to aquatic life.

The adjacent area around the survey location consists of a well-established forest which provides plenty of shade. Areas above the survey location lacked this beneficial feature. Managed fields leave minimal riparian buffer between the two Childs Brook survey locations. Efforts should be made to reestablish the riparian areas in this section. The River Road crossing appears suitable for fish passage.

Recommendations:

1. Reestablish the riparian buffer upstream of the survey location by planting native trees and shrubs, where necessary that will stabilize the bank, provide shade to the stream and provide habitat for wildlife.

Unnamed Stream (Pettyboro Tributary) –14696

Status: Restore

This unnamed brook was sampled off Pettyboro Road, upstream of the culvert crossing. The brook flows through both a wetland and a well-established forest before entering Pettyboro Brook. Brook trout found at this site were only captured in the forested areas. The culvert below the survey location and the streambanks are undermined due to road runoff and the inability of the small culvert to handle high capacity flows. Rip rap and other material was used in the past to reinforce the structure. The crossing had also been slip lined which likely exacerbated erosive flows by further constricting and amplifying them. Severe scouring was documented below the crossing. The crossing was blocked with sediment at the time of the survey. Additionally, the perch at the outlet likely precludes fish passage.

Recommendations:

1. Replace culvert with appropriately designed stream crossing using the *New Hampshire Stream Crossing Guidelines* (2009).
2. Establish riparian buffer along stream by planting native trees and shrubs, where necessary that will stabilize the bank, provide shade to the stream and provide habitat for wildlife.

Pettyboro Brook Mainstem - 14693

Status: Protect

Pettyboro Brook contains a variety of stream habitat types including runs, riffles, and large pools. It is stocked annually with yearling brook trout. The riparian area surrounding the brook consists of trees, shrubs, and grasses. These features promote stability, good filtration, thermal refuge, and erosion control. One portion of the streambank was eroded due to weak, unstable soils lacking root structures. The brook is more exposed along the banks below the bridge crossing due to less streamside vegetation present. Large, hay fields exist in many sections outside Pettyboro Brook's banks. The landowner in the section sampled has made a conscious effort to allow the buffer to grow within their property.

Recommendations:

1. Replace culvert with appropriately designed stream crossing using the *New Hampshire Stream Crossing Guidelines* (2009).

2. Establish riparian buffer along stream by planting native trees and shrubs, where necessary that will stabilize the bank, provide shade to the stream and provide habitat for wildlife.
 - a. This could also be achieved by reducing the amount of field mowing that currently occurs very close to the streambank.

Waterman Brook (Starch Factory Brook) - 14571
Status: Restore

Waterman Brook, (also known as Starch Factory Brook) is a high gradient stream that drains Upper Mountain Lake and Lower Mountain Lake before entering the Wild Ammonoosuc River. The survey site was located below the crossing on Goose Lane. This brook exhibited the highest species diversity of all the locations surveyed in Bath in 2011. Atlantic salmon, brook trout, common white suckers, blacknose dace, creek chubs, and longnose dace were among the species found. Atlantic salmon and blacknose dace were the most common and only two brook trout were captured. The warm water temperature found in this stream is likely associated with the large exposed water bodies in the headwaters and offers marginal habitat for wild brook trout. The Wild Ammonoosuc River was part of the Connecticut River Atlantic Salmon Restoration Program and was stocked with Atlantic salmon annually through 2011. The brook provides areas of thermal refuge during the summer when surface temperatures in the Wild Ammonoosuc increase. Beyond removing any dam structures at the two waterbodies upstream, there is little that can be done to significantly lower the water temperature in this brook. Maintaining or reestablishing the riparian buffers, where needed, along the entire length of the brook would help ensure a marginal population of wild brook trout could sustain itself in this stream.

A large perched culvert exists on Goose Lane. The culvert is too narrow and caused bank and streambed erosion. In an effort to reinforce the deteriorating culvert, concrete was poured along its bottom for the entire length of the culvert and around each end. This has caused the flow of the stream to be at a minimal depth, prohibiting fish movement. Replacing the crossing with one that can handle a larger, more dynamic flow regime, such as an open bottom culvert or a small bridge, would reduce erosion and sedimentation at this location. This would also enable upstream and downstream migration during a variety of flows.

Recommendations:

1. Replace culvert with appropriately designed stream crossing using the *New Hampshire Stream Crossing Guidelines* (2009).
2. Establish riparian buffer along stream by planting native trees and shrubs, where necessary that will stabilize the bank, provide shade to the stream and provide habitat for wildlife.

Simonds Brook - 14646**Status: Enhance**

Simonds Brook sample site is located off Hill Rd. While most of the sample area is shaded and protected by an adequate riparian buffer, part of the stream flows through an open pasture used for cattle. Cows have unrestricted access in and around the brook downstream of the crossing. This activity has collapsed the banks and created mud flats, which increase sedimentation and turbidity rates during high flows. Substrate within the stream is completely embedded. This reduces macroinvertebrate communities and wild brook trout spawning. Installing fencing would keep the cows away from the immediate banks of the stream and would allow a riparian buffer to reestablish. The buffer would stabilize the banks and streambed, resulting in less erosion and sedimentation. There is a sufficient riparian buffer upstream of the pasture. Here, the riparian area consists of trees, shrubs, and other woody materials. Although July was very dry and warm, Simonds Brook remained cool, 17.8 °C (64 °F), at the time of the survey. Twenty-seven brook trout (from multiple age classes) were sampled from Simonds Brook during the survey, most of which were captured in the forested area.

The Hill Road culvert is undersized and has caused a considerable amount of erosion at the downstream end of the crossing causing a small perch to develop. Replacing the stream crossing would increase habitat quality and passage for aquatic organisms within the brook. A crossing that promotes fish movement upstream and downstream would enable populations to migrate into more suitable locations.

The existence of a self-sustaining wild brook trout population and the ability to maintain cooler temperatures makes Simonds Brook a high priority stream for enhancement.

Recommendations:

1. Replace culvert with appropriately designed stream crossing using the *New Hampshire Stream Crossing Guidelines* (2009).
2. Install fencing to prevent livestock from entering the stream and negatively impacting the riparian buffer, streambank and streambed, which will restore stability over time.

3. Establish riparian buffer along stream by planting native trees and shrubs, where necessary that will stabilize the bank, provide shade to the stream and provide habitat for wildlife.

Unnamed Stream (Windy Hill Road) – 14645

Status: Enhance

The sample site on Windy Hill Road is well shaded by a mixed wood forest. The forest provides a protective buffer and large wood additions to the stream. The stream splits about 30 meters above the survey start point. A large remnant log jam has caused the stream flow to create a new, braided channel. The upstream side of the jam is shallow but still contains good habitat. Fallen trees provide instream habitat for various types of macroinvertebrates and fish.

The crossing on Windy Hill Road is undersized and prevents fish from moving upstream through the crossing. A six inch perch has developed over time on the downstream end of the culvert and erosion was evident. The culvert was starting to undercut and the soil on top of the culvert was loose and eroding as well. The crossing did not appear to affect the upstream end but it does impact connectivity. Installing an appropriately sized stream crossing would restore connectivity and perpetuate the population of brook trout throughout this stream.

Recommendations:

1. Replace culvert with appropriately designed stream crossing using the *New Hampshire Stream Crossing Guidelines* (2009).

General Recommendations for Future Action

Although most of the streams in Bath are in good condition and sustain healthy fisheries, opportunities exist to ensure that future generations will benefit from good water and enjoy wild brook trout in the town. Further assessments of land use on both public and private land should be conducted to identify other issues and potential solutions. Water quality and macroinvertebrate sampling should be continued on a regular basis to detect any changes. Long-term monitoring helps identify subtle changes that may be perilous to fish communities but not obvious to the human eye.

Headwater streams contain critical habitats that maintain stream health and aquatic population sustainability. The condition of headwater streams can influence the health of the larger rivers they flow into. The state of New Hampshire does not offer regulatory protection from development in these areas. Towns need to be proactive to protect them. The Bath Zoning Ordinance was adopted on March 14, 1989 and contains many sections that protect water quality (Appendix III). For example, the “Steep Slope Conservation District” section’s (Section VIII, F, 4), purpose is to “reduce damage to streams and lakes from erosion...[and] runoff of storm water caused by improper or excessive construction.” Properly designed crossings will work to ensure that the town is in compliance with this ordinance. A thorough culvert assessment should be conducted and stream crossings should be prioritized for replacement based on data collected during surveys (including fish, macroinvertebrate, and culvert data). Consult the *New Hampshire Stream Crossing Guidelines* for further details on how to adequately assess and implement culverts and other stream crossings (May 2009). The Bath Ordinance goes into great detail and addresses many other regulatory issues as well. For the entire document, please consult the *Proposed Zoning Ordinance – Bath, New Hampshire – Adopted March 14, 1989*.

Some additional guidelines that landowners can follow to protect water quality are Best Management Practices Resource Manuals for Agriculture and Forestry (BMP’s). For more information, landowners should contact the Bath Conservation Commission. Cost sharing for certain practices may be available.

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Appendix I: Common Fish Species Found in Bath, New Hampshire

Information for the species descriptions was gathered from *The Audubon Society: Field Guide to North American Fishes, Whales & Dolphins*(1983) and fish species profiles from the NH Fish and Game Department website (draft 2011, final 2012).

Brook Trout



Brook trout also referred to as “squaretails” or “speckled trout,” have adapted to cold water streams, and are rarely found in waters that exceed an average daily temperature of 20°C (68°F) in July or August. Brook trout are powerful swimmers and are often found in steep, cascading mountain streams where no other fish are present. Though some individuals may live their entire lives in one small stream, surveys using radio tags have shown that brook trout can move many miles in search of thermal refuge, spawning habitat, or quality foraging areas. Brook trout are “sit and wait” predators, usually taking up residence in a pool or riffle where they feed on both aquatic and terrestrial invertebrates such as spiders and beetles, which are an important part of their diet in the spring. Brook trout seek out gravel beds with upwelling groundwater, often in small headwater streams, for spawning. Eggs are laid in small excavated nests in gravel (called redds), in the fall where they incubate through the winter and hatch in the early spring. Brook trout are more common in northern New Hampshire where cooler summer air temperatures maintain suitable summer water temperatures. Due to their sensitivity to habitat disturbances, brook trout are an important indicator species of the overall health of aquatic ecosystems in New England as well as in the rest of the species natural range. They are a highly valued sport fish

and food resource, as well as being highly admired as one of the most colorful freshwater fish species.

Atlantic Salmon



Atlantic salmon fry, the life stage just after hatching, have been stocked at rates dependent upon habitat quality and quantity in several tributaries to the mainstem Connecticut River. This effort was part of the federal program to restore the species in the Connecticut River and its tributaries. Juvenile salmon were once prolific throughout the Connecticut River watershed but impoundments and development have impacted water quality and aquatic habitat limiting their ability to live to reproductive age and spawn successfully. A salmon spends two to three years in cool, freshwater habitats such as riffles, rapids, and pools before attempting to return to the Atlantic Ocean. They are an anadromous species and do not necessarily die after spawning such as their Pacific cousin. They are partial to coastal waters along with freshwater streams and lakes and landlocked populations can be found in several of the New England states. Spawning takes place in the fall months when the salmon swim upstream into fresh, cool water streams and headwater tributaries. Atlantic salmon are a valued sport fish and food resource. The Atlantic Salmon Restoration Program was terminated in most of its partnering states in 2012. Hurricane Irene destroyed the White River National Fish Hatchery in 2011. This hatchery was the primary source of Atlantic salmon fry for the many states along the Connecticut River. States that had an alternative source for eggs continued stocking fry; New Hampshire was not one of those states. No stocking has occurred and there are no plans to reinstate this program at any time in the future.

Blacknose Dace



Blacknose dace are a common minnow species that are regularly found in springs and cool, clear, rocky creeks with moderate to swift flows. They are less streamlined than the longnose dace and take advantage of small pools and slower flowing water along the banks. Blacknose dace feed on a variety of invertebrates and algae. This species is often found and associated with brook trout although their higher temperature tolerance gives them a wider distribution throughout New Hampshire and the eastern portion of North America. The blacknose dace is considered to be tolerant of pollution and habitat alteration and can be found in both disturbed and undisturbed habitats. Blacknose dace spawn around two years of age during the spring and early summer months in shallow riffles over gravel.

Longnose Dace



Longnose dace, which are more streamlined than the blacknose dace, inhabit swift flowing riffle sections of rivers and streams with boulder, cobble, and gravel substrate. They prefer clear to turbid waters and feed almost exclusively on aquatic insects that also inhabit the riffle stream habitat. The streamlined shape and smaller sized airbladder has allowed the longnose dace to adapt to living along the bottom in the flowing current. Longnose dace spawning takes place during late May, early June. Males defend their territories where females lay adhesive eggs in

protective cavities between rocks. Longnose dace spawn around three years of age and can live up to five years of age. This species is a common species throughout Canada and North America.

Creek Chub



Creek chubs are a minnow species very similar to the fallfish. They are smaller and seldom reach lengths above five inches. They tend to inhabit areas with both moderate and minimal flow in small, clear to turbid streams and lakes with sand, gravel or rock substrate. Creek chubs can be differentiated from fallfish by their dark spot that is present at the front base of the dorsal fin (red arrow in photo). Creek chubs deposit their fertilized eggs in constructed gravel nests in the spring. They have a widespread population distribution throughout North America which makes them an important forage species for larger fish, birds, and piscivorous mammals. They are commonly used by anglers as bait.

Common Sunfish (Pumpkinseed Sunfish)



The common
called the

sunfish, also
pumpkinseed

sunfish, tends to inhabit cool, quiet, shallow waters in ponds, marshes, lakes and slow flowing streams with densely growing aquatic vegetation. This is a very common species and populations range from areas in Canada down along the eastern coast of the United States (US) and west into the upper Mississippi River system. The common sunfish is not a widely sought after species by anglers but can easily be caught due to its aggressive nature and willingness to take a variety of bait and tackle. Common sunfish found in the Bath, New Hampshire region most likely inhabit the warmer waters of lakes and ponds and generally wind up in streams and cooler, quicker moving water by accident.

Common White Sucker



The common white sucker has larger scales, thin lips with many papillae, and a more blunted snout than that of the longnose sucker. This species is common in New Hampshire and prefers to inhabit cool, clear streams with sand, gravel or rocky substrate. The common white sucker

has a wide distribution and populations range from Canada down through the eastern US to South Carolina and as far west as New Mexico. This species, much like the longnose sucker, feeds on larval insects, fish eggs, snails, crustaceans, worms and algae. They are more prominent throughout NH and grow to larger sizes (average is 10-18 inches) than that of the longnose sucker (average is <10 inches). Common white suckers spawn during the spring by depositing fertilized eggs in shallow riffles with moderate flow. During the spawning season, it is somewhat common for these suckers to be caught in dip and/or drop nets in order to be used as commercial bait.

Longnose Sucker



Longnose suckers reside mainly in medium to small sized streams with moderate flow and rocky substrate, as well as bog ponds. They are differentiated from the common white sucker by their smaller scales, more pronounced snout and backward flaring lower lip. This species is found in three major drainages within New Hampshire: Connecticut, Androscoggin and Pemigewasset. Like common white suckers, longnose suckers feed on larval insects, snails, crustaceans, worms and algae. Their average growth is less than that of the white sucker and usually maxes out at ten inches, except for lake and pond populations which tend to be larger (18 inches). Both species spawn in the spring by depositing their fertilized eggs in shallow riffles with moderate flow. Their spawning runs are often reported because this species travels up shallow brooks and the thrashing during breeding is quite loud.

Fallfish



The fallfish is New Hampshire's largest minnow and also one of the most common fish species in the state. It can grow to 255 mm (10") in length and can live to ten years of age or older. It can be found in nearly any river or stream, but is most abundant in medium sized rivers with a mix of rocky and gravel substrate. Male fallfish build nest mounds out of pebbles one stone at a time. Spawning is communal, although usually initiated by the nest builder, with a number of females and surrounding males using a single nest but larger individuals may move into smaller streams to spawn. Fallfish are generally considered good indicators of streams containing year round flow (Benjamin Nugent, 2012). This fish, as well as their eggs, are an excellent food source for other fish species, including trout. Brook trout can often be found lurking during spawning time.

Smallmouth Bass



Smallmouth bass are a commonly sought after sport fish. This species, along with other bass species, spawn in the spring with nest building taking place during mid-May when water temperatures are between the high 50's and low 60's. Smallmouth bass typically spawn during the summer, closer to shore in areas with gravel and boulder substrate. Smallmouths will travel

to deeper water in order to reach cooler water as summer temperatures rise. Among other small organisms in shallow waters, smallmouth bass also feed on crayfish. Anglers typically use floating bugs, trolling, or casting with a plug or spinner with live bait being the most commonly successful method used to catch smallmouths. As the summer ends, smallmouth bass move back toward the shallows in order to eat and put on weight for the approaching winter months.

Slimy Sculpin



The unique appearance of the slimy sculpin makes it a very easy species to identify. They have large wing-like pectoral fins and a long dorsal fin that extends for most of the body. Similar to brook trout, sculpin inhabit cooler streams that have high to moderate flow with gravel, rocky, or sandy substrate but can also be found in deep, cool, lakes and ponds. Slimy sculpin are found in all major watersheds in New Hampshire with the exception of the coastal drainage. They consume smaller fish, aquatic macroinvertebrates and vegetation and act as a forage species for larger game fish such as lake trout and burbot. Like the brook trout, slimy sculpin populations are particularly sensitive to anthropogenic land uses that alter natural flow and increase sedimentation and embedded substrate.

Yellow Perch



The yellow perch was originally brought into New Hampshire in the early 1900's as an alternative to brook trout when anglers noticed population declines. Since that introduction, yellow perch populations have naturalized in many waterbodies throughout the region. Yellow perch are commonly found in ponds, lakes, and slow flowing rivers. They usually congregate in stands of aquatic vegetation along shorelines during the summer. They consume a wide variety of invertebrates and small fish species. Spawning takes place in the spring as water temperatures rise in the shallows. Eggs are laid in long ribbons, called scathes, over vegetation and branches of fallen trees. Each female is followed by a group of males, attempting to fertilize the eggs as they are extruded. The abundance of yellow perch in most waters makes them an important forage species for many predators, including loons, otters, and largemouth bass. Often, yellow perch are encountered in uncharacteristic habitats, such as shallow streams downstream from lakes and ponds. Yellow perch are a schooling fish that are not challenging to catch year round.

Appendix II: Terminology²

Adfluvial - fish species that inhabit lakes and ascend rivers or streams to spawn; i.e. common white suckers

Aggradation - accumulation of material, sediment, in or along a stream

Anadromous fish - migratory fish; ascending rivers from the ocean for spawning purposes

Anthropogenic - of, relating to, or resulting from the influence of human beings on nature

Bed load Material - material which is moved along a river bed by rolling and pushing (traction load), and saltation (method of particle transport via liquid or wind; lifting and moving of the particle before it hits the bottom again), usually at a velocity much less than that of the river

Cohort - age class

Fluvial - fish species that inhabit rivers or streams

Forage - food for animals especially when taken by browsing or grazing

Fry - the life stage of a fish just after hatching

Headwater Streams - smaller tributaries that carry water from the upper reaches of the watershed to the main channel of the river, rarely named, given little attention although they are extremely important to the survival of a healthy mainstream ecosystem (See *Headwater Streams* section of the Bath NRI).

Hydraulic connectivity - gives aquatic organisms ability to move through an area - connectedness of a stream system

Macro-invertebrates – organisms without a backbone that are large enough to see without a microscope (i.e. mayflies, stoneflies, midges)

Mainstem - the main course of a river or stream

Natural barriers/delays - anything in nature that impinges movement of fish species and other aquatic organisms. It depends partially on behavior and swimming abilities/capabilities. (i.e. waterfalls, landslides, organic material jams, channel constriction, extreme flows and extreme temperatures)

Perturbations - an alteration of function, induced by external or internal mechanisms

Piscivorous - organism that feeds on fish

Prolific - reproducing freely

Riparian Buffer – vegetated area that protects the waterbody

Riparian Zone – area adjacent to a waterbody that both influences the waterbody and is influenced by the waterbody

Salmonid - salmon, trout

Stream Characteristics - channel forming (riffles, pools, runs, glides, side channels *over space and time*), water temperature, woody material, sediment, bed load material

Substrate - the base on which an organism lives

Turbid - thick or opaque with agitated sediment

Unnatural barriers/delays (anthropogenic) – man-made items that impinge movement of fish and other aquatic organisms. (i.e. dams, pollution, unnatural excessive turbidity, temperature increase due to riprap or other anthropogenic project, water removal, landslides, debris jams, inadequate road crossings)

Watershed - the limits of an area from which water flows naturally in a given direction

² Most terminology adapted from the Merriam-Webster Dictionary (online edition)

Appendix III. Excerpts from the Proposed Zoning Ordinance – Bath, New Hampshire – Adopted March 14, 1989

Below are the relevant sections of the ordinance that pertain to the conservation of water quality.

Section III: Purpose and Intent (4, 5, and 8)

- A.4. To protect and preserve natural resources and the natural and scenic beauty*
- A.5. To retain and protect agricultural and silvicultural lands, wildlife habitat and recreational opportunity*
- A.8. To implement the Bath Master Plan*

Section VI: General Provisions

A: Land and Lots

- 9. Septic Systems: 125' from surface water: 100' from wetland area*
- 10. A minimum of 200' required along a waterway for more than one dwelling unit with deeded access to said waterway*

B: Development Provisions

- 3. "... The Conservation Commission shall serve as advisees when construction will result in significant alteration of any natural resource including, but not limited to, waterways, wildlife habitats and forests."*

Section VIII: Districts

B: The Town shall be divided as shown on the official zoning maps

- 3. Rural/Agricultural District*
"... to maintain and foster agricultural pursuits and to encourage the most appropriate use of land..."

F: Conservation Overlay Districts

"Conservation overlay districts comprise those areas with characteristics that require conservation and land management practices which minimize environmental degradation... Where any provisions of these District Ordinances are in conflict with the underlying district regulations or other local ordinances or with New Hampshire State law, the more stringent provision shall apply..."

- 3. Protection of Village Water Supply*
"This ordinance establishes a protective radius of 200 feet to prevent pollution of the aforementioned water supply through surface or underground sources..."
- 4. Flood Plain Conservation*
"... No development shall be allowed within the boundaries of the Flood Hazard Area..."
- 5. Steep Slope Conservation District*
 - a.1. Reduce damage to streams and lakes from erosion, runoff of storm water caused by improper or excessive construction ...*
 - a.2. Preserve vegetative cover, wildlife habitat, scenic views, and protect unique and unusual natural areas and maintain ecological balance...*
- 5.) Wetlands Conservation*
 - a.5. Protect wildlife habitats and maintain ecological balance*

Section IX: Cluster Development

A: Purpose

“...The intent of this Ordinance is to preserve productive and potentially productive agricultural and forest lands, wetlands, wildlife habitat, streams, natural and scenic features of the town...”