Assessment of Pre-restoration Habitat Conditions and Fish Populations in Branch Brook

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Wells National Estuarine Research Reserve

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Cover Photograph: Fish ladder at KKWWD treatment plant, Route 1, Kennebunk, ME.

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Introduction

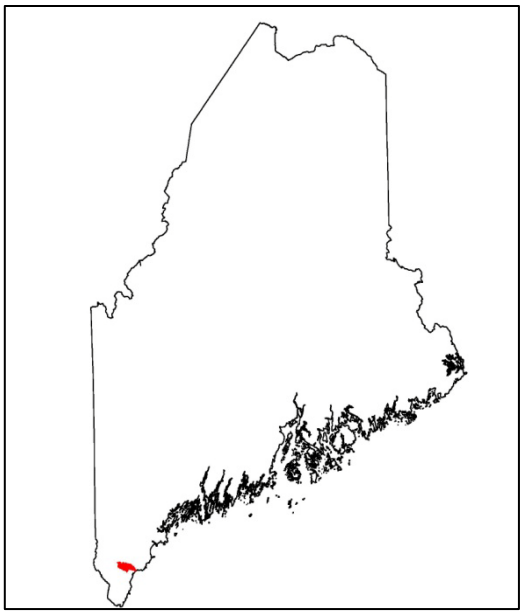
The Wells National Estuarine Research Reserve (WNERR) is currently collaborating with the Kennebunk, Kennebunkport, and Wells Water District (KKWWD) to restore fish passage at the District operated dam on Branch Brook in Kennebunk, ME. The fish ladder has been inoperable for at least a decade, resulting in a complete barrier at the dam for fish migrating upstream from the lower brook and estuary. In 2012 WNERR received funding from the Maine Coastal Program to conduct monitoring of pre-restoration habitat conditions and fish populations in the brook.

Project Goals

We were interested in identifying what species of resident and diadromous fish are present throughout the Branch Brook watershed, with a particular focus on those with the potential to benefit from restoration of fish passage at the dam. We also were interested to assess stream habitat conditions throughout the watershed and inventory potential resident and anadromous spawning areas.
To collect this information we used a combination of weekly fyke net sets, icthyoplankton tows, seining, gill netting, electrofishing, continuous water quality monitoring, and a combination of protocols to assess in-stream and riparian conditions.

Fish Species

Branch Brook supports a self sustaining population of wild brook trout, and has not been part of the Maine IF&W stocking program since 1991. In 1956 the Maine Department of Fish and Game conducted fish counts at the Branch Brook fish ladder from May to November (Maine Department of Fish and Game, 1956). Their data identified brook trout (15) and white sucker (4), as well as a large number of sea lamprey (693). In 1995 WNERR researchers conducted a survey of fish species and habitat in Branch Brook and the Little River (Orringer, Reid, & Sullivan, 1995). This study identified the presence of 8 anadromous fish species in the estuary. These included alewife, blueback herring, sea lamprey, brook trout, Atlantic tomcod, rainbow smelt, Atlantic salmon, and striped bass. They also documented sea lamprey, American eel, and brook trout at study sites upstream of the KKWWD dam. This study also documented several sites with mixed riffle and pool habitat dominated by spawning



Branch Brook Locus Map

substrate suitable for brook trout spawning.

Geography

Branch Brook is located in southern Maine at coordinates 43.38,-70.59. It drains an area of 15 mi^2 in the towns of Kennebunk, Sanford, and Wells. The brook includes 21 miles of perennial stream habitat, which begin near the Sanford Municipal Airport and ends at the confluence with the Merriland River, forming the Little River estuary. The watershed contains 29 acres of pond habitat. Branch Brook is situated over significant sand and gravel aquifers and supplies a portion of the drinking water for 6 towns in southern Maine.

Executive Summary

We documented 13 species of fish in both the estuarine and freshwater reaches of Branch Brook, four of which were identified as having restoration potential at the start of the project (Table 1). Brook trout were the most abundant fish species sampled in freshwater habitat. We assessed stream habitat and riparian conditions at 10 locations in Branch Brook. Of these 10 sites, 4 contained gravel spawning substrates and riffle habitat favored by brook trout and sea lamprey, and these were located either upstream of the dam near the headwaters, or downstream of the dam on a tributary. Suitable spawning conditions for blueback herring were more limited, due to predominantly shallow water depths at most sites. However, habitat at one site between the dam and the head of tide offers deeper slow moving water with organic and silt substrates.

Table 1. Branch Brook Species List (target species in orange)

Scientific Name	Common Name
Alosa aestivalis	blueback herring
Ameiurus nebulosus	brown bullhead
Anguilla rostrata	American eel
Apeltes quadracus	fourspine stickleback
Catostomus commersonii	white sucker
Gasterosteus aculeatus	threespine stickleback
Lepomis gibbosus	pumpkinseed
Lepomis macrochirus	bluegill
Margariscus margarita	pearl dace
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Microgadus tomcod	Atlantic tomcod
Morone saxatilis	striped bass
Notemigonus crysoleucas	golden shiner
Petromyzon marinus	sea lamprey
Pungitius pungitius	ninespine stickleback
Salmo trutta	brown trout
Salvelinus fontinalis	brook trout

The presence of migratory fish downstream of the KKWWD dam, and the occurrence of spawning habitat upstream, demonstrates that restoration of fish passage will benefit target species, and that these benefits could be seen in the short term if fish currently utilizing the lower river are allowed upstream access.

Sampling Locations

Fisheries monitoring was conducted at 5 sites in the estuarine reach of Branch Brook and the Little River. Habitat assessment was conducted in freshwater reaches at four sites downstream of the KKWWD dam, at four sites upstream of the dam, and at two sites on a tributary stream downstream of the dam. Water quality monitoring stations were deployed at two locations downstream of the dam, and at one upstream location. See insert for a map of site locations and watershed features.

Methods

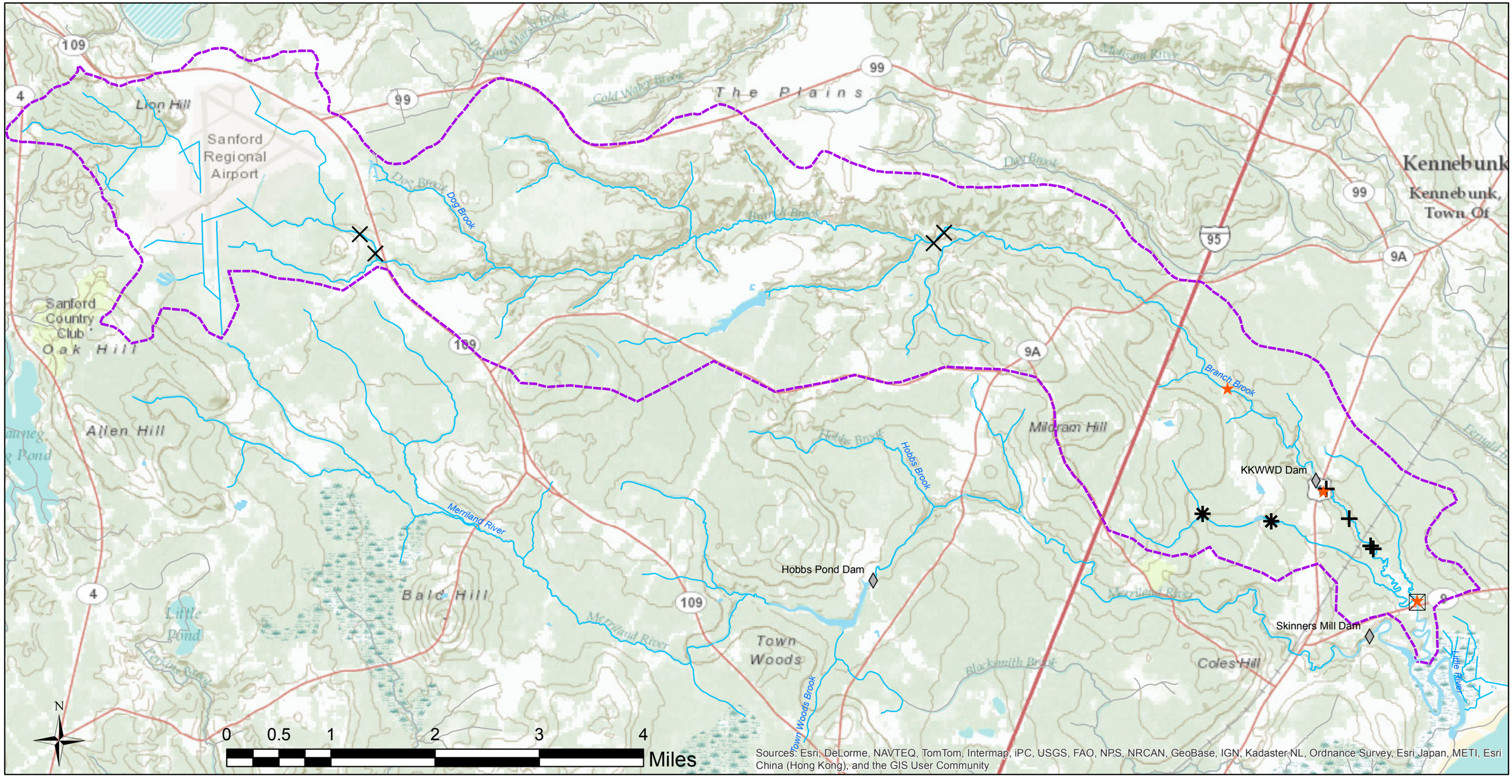
Fisheries Assessment
The fisheries assessment was designed to document the presence/absence of five species expected to benefit from restored fish passage, during multiple life stages. These include brook trout, alewife, American eel, sea lamprey, and blueback herring.

Measuring total length of a brook trout (*Salvelinus fontinalis)* captured in the fyke net.

In-migrating adults were targeted using weekly fyke net deployments from May 2nd through June 27th. The net was deployed upstream of the Route 9 bridge for three consecutive 24 hour periods each week and oriented to catch fish migrating upstream. The net was tended every 24 hours, and removed from the stream each week after the third sampling day. Fish were identified by species, and measured for total length and weight. Fin clips were taken from all brook trout, and photos were taken of each. The fin clips were sent to Dr. Ben Letcher at the USGS Conte Lab for genetic analysis (to be conducted at a later date) and comparison to anadromous brook trout populations from other systems. In the future it may be possible to identify genes that determine anadromous behavior.

Great care was taken to reduce stress for captured trout, and there were no known mortalities.

Icthyoplankton sampling was conducted on outgoing tides at the Route 9 bridge on Branch Brook from May 8th to August 27th. A 500 micron bongo



Branch Brook
Fish Passage Restoration
Monitoring Sites

Habitat Assessment Sites
- + Downstream
- × Upstream
- ✱ Tributary

- ★ Water Quality Monitoring Station
- ⊠ Fyke Net
- ◊ Dam
- Watershed Boundary

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net was deployed at mid-depth for approximately one hour per week. Ichthyoplankton samples were separated from detritus and invertebrates, identified by species, and length measurements were recorded. Seining was conducted in both Branch Brook and the Little River for juvenile river herring once per week.

Tending the fyke net. Water quality station visible in background.

Gill netting was conducted in the Little River and Branch Brook targeting river herring. Nets were set for 30-45 minutes at a time and tended regularly. Captured fish were weighed and total lengths were recorded.

Water Quality

Water quality monitoring stations were established at three locations in Branch Brook, and deployed continuously from May 2nd to December 4th. In-situ loggers measured depth, water temperature, specific conductance, and salinity at two locations downstream of the KKWWD dam (Route 9 and Route 1), and at one location upstream of the dam (Harriseckett Road). Though loggers were deployed continuously, salinity, depth, and temperature data is not available for the entire project period at Route 9 and Route 1 stations due to equipment damage and competing project needs. Temperature loggers were substituted for the multi parameter loggers when necessary.

Habitat Assessment

Four study reaches between the dam and the head of tide were chosen at random. Additionally, six sites that are already being assessed as part of a separate ongoing study were included for comparison. Four of these are located upstream of the dam, and two are located on a tributary that joins Branch Brook at the estuary, downstream of the dam. See map insert.

Electrofishing was utilized as part of the stream habitat assessment. Each reach was sampled once just prior to other in-stream data collection. Electrofishing teams started at the downstream end of the reach and worked their way up, sampling pools, riffles, areas of cover, and other likely habitat. Stunned fish were transferred to aerated buckets and held until processing. Each fish was identified by species and total length and weight was recorded. Once processing was complete, fish were returned to the stream, and efforts were made to return them to the approximate locations where they were captured.

In-stream and riparian habitat conditions were assessed using a protocol developed by WNERR (Thornton & Brown, 2012). At each of the

study reaches visual percent cover estimates were made for each riparian vegetation type, tree canopy, aquatic vegetation, stream substrate type, and bank conditions. Riffle, run, and pool habitat area was measured and mapped. Pools were rated using a pool classification that incorporate depth and cover observations, and pool water quality was measured. GPS coordinates were recorded for each piece of large woody debris. Five substrate transects were established at even intervals along the study reach, and dominant and sub-dominant substrate types were identified and measured. Water velocity and discharge were measured using a Swoffer current meter and following USGS protocol (Sauer & Turnipspeed, 2010). Dissolved oxygen, temperature, pH, and specific conductivity were recorded at the upstream and downstream ends of the study reach. Channel width and wet width were measured, and depth transects established at each end of the study reach. Potential spawning substrates were identified for resident and anadromous species, total area measurements were taken for each type, and observations were made of the degree of embeddedness of these substrates. Stream and stream bank gradients were recorded using hand levels and clinometers.

Large woody debris snag

Results

The goal of this project was to inventory resident and migratory fish species on Branch Brook, to establish the presence of species with restoration potential, and to document the location of potential spawning areas for resident and anadromous fish.

Twelve species of fish were sampled in the fyke net, including 4 of the target species: brook trout, blueback herring, American eel, and sea lamprey, as well as three other species of interest: Atlantic tomcod, brown trout, and bluegill. No larval stages of target species were identified in the larval fish samples. However, elvers were found in 4 separate samples from May 17th to June 18th. No juvenile stages of target species were identified with seining, and no adults were identified with gill netting. Atlantic tomcod were sampled with seining in Branch Brook, and striped bass were sampled with gill nets in both Branch Brook and the Little River. Electrofishing surveys at the four downstream mainstem study sites identified small numbers of juvenile brook trout, juvenile sea lamprey, and American eel (Figure 1). Electrofishing surveys at the four upstream sites found a relatively high abundance of brook trout, which accounted for approximately 94% of individuals sampled (Figure 2). These fish appeared to be primarily juveniles, with a combined average length of 93 mm. Surveys at the two tributary sites found similarly high abundance of brook trout which accounted for approximately 84% of

samples (Figure 3). The average length of brook trout in the tributary stream was 87 mm.

Figure 1. Species Abundance at 4 Downstream Sites

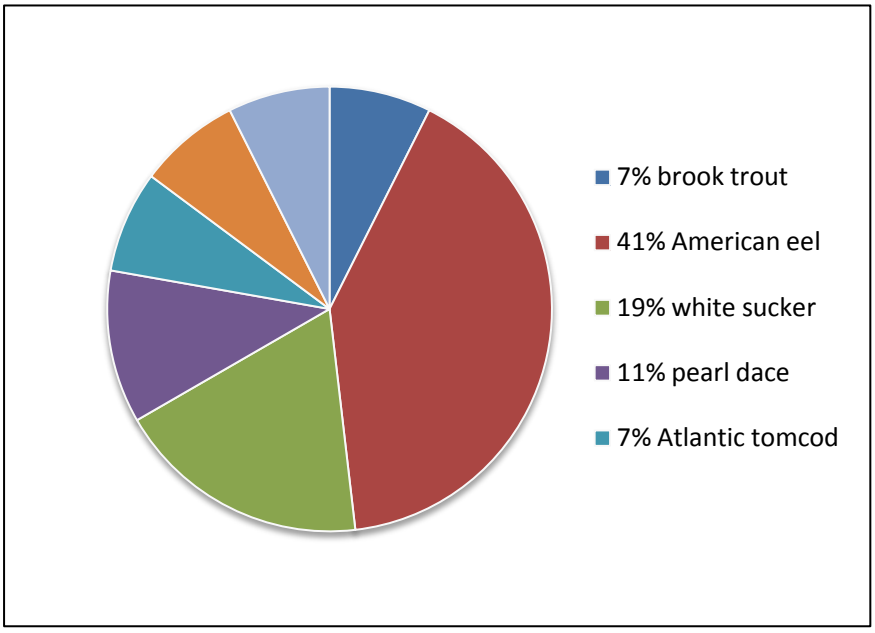


Figure 2. Species Abundance at 4 Upstream Sites

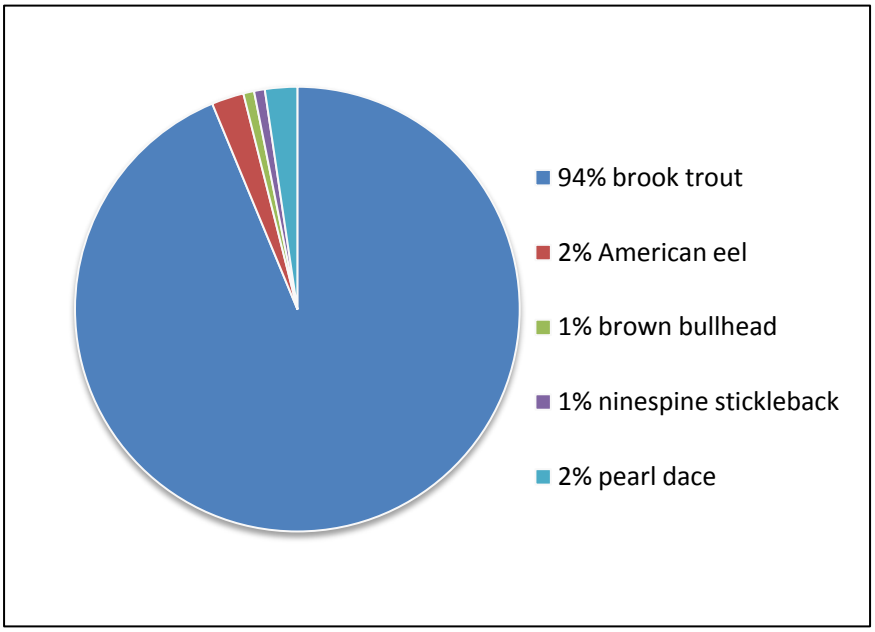
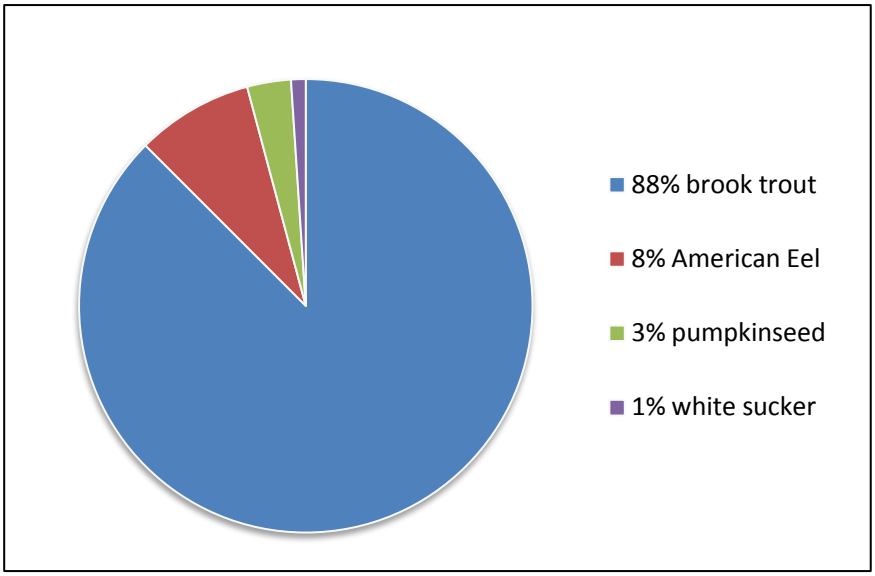


Figure 3. Species Abundance at 2 Tributary Sites



At the four sites in the reach downstream of the KKWWD dam, riparian cover is abundant for the most part, with visual assessments finding on average 60-80% canopy cover. Large woody debris (LWD) was present at every site, with an average of 9 pieces per site. Approximately 30% of LWD was embedded in the stream substrate, and most LWD occurred in snags of several pieces. Stream banks were steep and often undercut. Each site had large deep pools with moderate cover, average water temperature of 17.2°C, and average dissolved oxygen percent saturation and concentration of 98.5 and 9.48 respectively. Runs and pools were the dominant habitat types. No riffle habitat was observed at downstream study sites. The dominant and sub-dominant substrate types at the downstream sites were sand and fines (clay/silt) respectively. No gravel substrates suitable for spawning resident or migratory fish were observed. Tidal influence prevented accurate water velocity readings at the two most downstream sites. However, water velocities at the two sites above tidal influence averaged 0.07 m/s. Average channel width was 8.14m and average wet width was 6.07 m. Average water depth from bank to bank was 0.52m, and ranged from 0.0 m to 1.65 m. Water depths fluctuated at the two tidally influenced sites and since depth measurements were not taken during a low tide, actual average depth is likely lower than reported.

At the two tributary sites visual assessments found on average 60-80% tree canopy cover. Large woody debris was present at both sites, with an average of 11 pieces per site. Approximately 31% of LWD was embedded in the stream substrate. Over 95% of LWD occurred in snags of two or more pieces. Stream banks were predominantly undercut. Runs and pools were the most common habitat types. Pools were typically shallow (0.33 m average depth) with moderate cover. Pools had an average water temperature of 17.3°C, and average dissolved

oxygen percent saturation and concentration of 81.3% and 7.83 mg/L respectively. Riffle habitat was observed at only one of the tributary sites. The dominant and sub-dominant substrate types were sand, and gravel (6-150 mm diameter) respectively. Both of the tributary sites contained areas of spawning substrate suitable for resident fish (30-80 mm diameter) (Raleigh, 1982) with a total of 100 m^2. Water velocities were below detection range for our flow meter, and therefore water velocity data was not recorded at the tributary sites. The average channel width was 4.4 m and average wetted width was 3.2 m. The average water depth from bank to bank was 0.07 m.

Table 2. Habitat Type Distribution

Habitat Parameter	Upstream Sites	Downstream Sites	Tributary Sites
total stream area (m^2)	1,094	1,475	340
# pools	14	9	11
total pool area (m^2)	172	607	183
mean pool depth (m)	0.44	1.02	0.33
mean pool DO (%)	97	98.6	81.3
mean pool DO (mg/L)	9.51	9.48	7.83
mean pool temp (C°)	16.4	17.2	17.3
# runs	8	7	5
total run area (m^2)	958	574	38
# riffles	2	0	2
total riffle area (m^2)	124	0	5
resident (30-80mm) spawning gravel area (m^2)	204	0	100
anadromous (15-115mm) spawning gravel area (m^2)	102	0	0

At the 4 upstream sites on the mainstem visual assessments found on average 40-60% tree canopy cover. Large woody debris (LWD) was present at every site, with an average of 10 pieces per site. Approximately 70% of LWD was embedded in the stream substrate. Over 83% of LWD occurred in snags of two or more pieces. Stream banks were predominantly undercut. Runs and pools were the most common habitat types. Pools were typically shallow (0.44 m average depth) with moderate cover. Pools had an average water temperature of 16.4°C, and average dissolved oxygen percent saturation and concentration of 97.0% and 9.51 mg/L respectively. Riffle habitat was observed at only one of the upstream sites. The dominant and sub-dominant substrate types at the downstream sites were sand and gravel (6-150 mm diameter) respectively. All but one of the upstream sites contained areas of spawning substrate suitable for resident fish (30-80 mm diameter) (Raleigh, 1982) with a total of 306 m^2. One of the upstream main stem sites had several areas with slightly larger spawning substrate (15-115 mm diameter) suitable for use by sea lamprey (Maitland, 2003). Water velocities at the upstream sites averaged 0.06 m/s. The average

Spawning substrate in a pool at a tributary site.

channel width was 5.47 m and average wetted width was 4.46 m. The average water depth from bank to bank was 0.18 m.

See Table 2 for a summary of habitat distribution across study sites.

Water temperature appeared to increase the closer a station was to the estuary. At the Harrisecket Road monitoring station the average temperature during the typically hottest months (July – September) was 16.2°C, with maximum and minimum readings of 19.4°C and 9.6°C respectively. At the Route 1 site the average water temperature during the same period was 17.1°C, with maximum and minimum readings of 22.3°C and 10.9°C respectively. At the Route 9 site the average water temperature during this period was 18.7°C, with maximum and minimum readings of 26.9°C and 11.2°C respectively.

Key Findings

Salinity data collected at the Route 9 monitoring station shows that while this site experienced an average salinity of only 1.1, it experiences daily tidal fluctuation with salinity exceeding 10 PSU (practical salinity units) approximately 3% of the time, with a maximum reading of 29.8 PSU. The occurrence of brook trout migrating upstream at this location suggests that these fish are exhibiting anadromous behavior. From May 3rd to June 28th, 19 brook trout were captured. Water temperatures during fyke net sampling periods averaged 13.6°C, and ranged from 21.3°C to 9.6°C. Temperature readings were within published tolerance levels for brook trout, 0-24°C, but routinely exceeded the optimum temperature for growth and survival, 15.6°C (Raleigh, 1982).

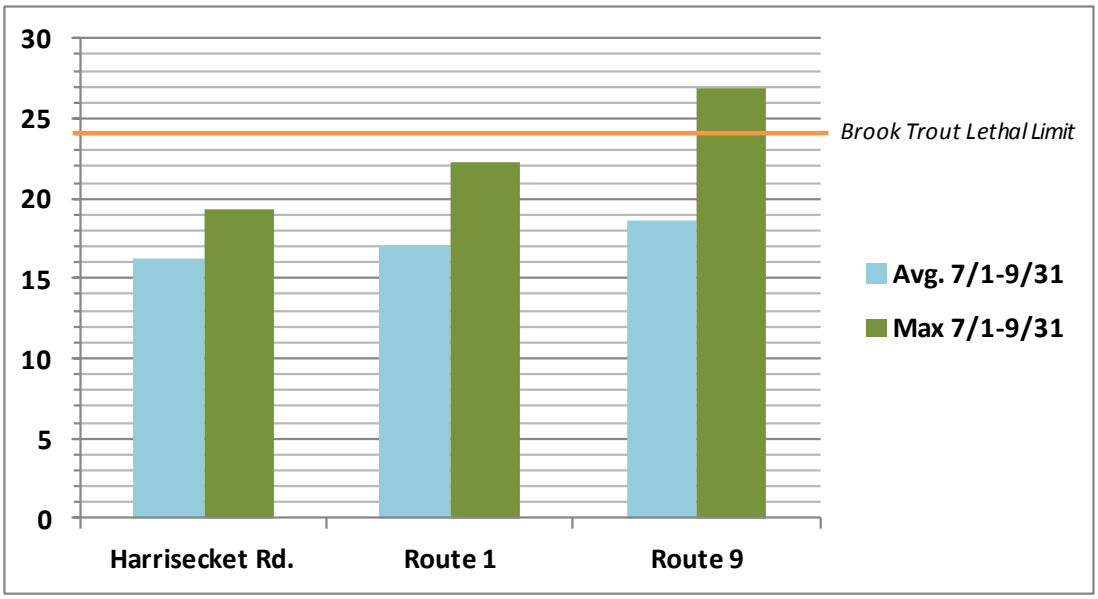
In the lower brook, abundance of pools and in-stream cover, as well as riparian shading, offers refuge for fish seeking to escape predation or adverse environmental conditions. The lower brook lacks appropriate habitat for brook trout spawning, with very little preferred substrate and a lack of riffle areas. Similarly, the lower brook does not appear to be well suited to sea lamprey spawning due to lack of available substrate for redd building. However, spawning adult sea lamprey were captured in the fyke net and juvenile sea lamprey were identified during elecrofishing surveys. It is therefore likely that there are locations downstream of the dam where spawning

is occurring. Much of the lower reach of Branch Brook may not offer suitable spawning habitat for blueback herring, as they prefer to spawn above tidal influence (Bozeman & Van Den Avyle, 1989).

In contrast, upper reaches of the watershed and the lower tributary are well suited for brook trout spawning and rearing, with abundant cover, preferred substrates, and riffle/pool complexes. Habitat conditions upstream of the dam are also suitable to spawning needs for sea lamprey, with appropriate substrates for nest building occurring at one site. Our study sites in the upper watershed were not suitable for blueback herring spawning. However, prior habitat assessments conducted by the WNERR in the mainstem reaches just upstream of the dam identified areas that may be suitable for blueback herring spawning.

Two non-native fish species were documented in the fyke net surveys, brown trout and bluegill. The three brown trout were sampled in the fyke net. Maine IF&W does not stock brown trout in the Branch Brook but did stock them in the Merriland River in April 2012 (Maine Department of Inland Fisheries and Wildlife, 2012). It is likely that these fish are from a hatchery. The one bluegill sampled measured 39 mm in length, a juvenile. This indicates that bluegill are reproducing in the watershed.

Figure 4. Summer Stream Temperatures



It appears that the dam and associated impoundment is influencing downstream habitat conditions. Temperature readings at the water quality monitoring station immediately below the dam (Route 1 station) were an average of 0.9°C higher than at the upstream station, which is approximately 1.75km upstream of the impoundment. In addition, peak temperatures recorded at both sites occurred from 8/5 – 8/6 and were

approximately 3°C higher at the downstream site. It is likely that the impoundment's increased surface area (approximately 3 acres) and lack of canopy cover (based on visual observations) are the primary factors in the increase of water temperature. Peak temperatures at the Route 1 station and at the Route 9 station, 22.3°C and 26.9°C respectively, are approaching and in some cases exceeding lethal thresholds (24°C) for brook trout (Raleigh, 1982). See Figure 4 for average and maximum stream temperatures for summer months, July through September.

Recommendations

With the majority of suitable spawning habitat for target species located above the KKWWD dam, improved fish passage at the dam will be crucial to the successful recovery of anadromous fish in Branch Brook. With potentially lethal water temperatures for brook trout documented at the upstream and downstream ends of what is essentially all the available habitat in Branch Brook, it becomes even more critical that fish have access to upstream habitat in order to escape extreme summer conditions. While the lower brook does experience moderate shading and includes deep pools, tidal influx of warmer water from the estuary may still be causing increased stress for resident trout.

Juvenile bluegill

The presence of non-native introduced fish is of some concern, particularly if they have the potential to access upstream habitat via the fish ladder, which is a possibility for brown trout. This issue has been raised with the Maine Department of Inland Fisheries and Wildlife regional biologist, but the agency did not indicate that non-native species are a major concern due to lack of preferred habitat, making wild reproduction unlikely (Francis Brautigam, personal correspondence). Fisheries agencies should continue to be consulted regarding management of non-native species as fish ladder restoration moves ahead.

Continued monitoring of fish populations and habitat conditions will be necessary to evaluate the success of restoration efforts.

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