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2004 Merrimack River Watershed Fish Population Assessment

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Introduction

Fish population surveys were conducted at sixteen stations in the Merrimack River Watershed in Massachusetts using techniques similar to Rapid Bioassessment Protocol V as described originally by Plafkin et al. (1989) and later by Barbour et al. (1999) (See Figure 1). Standard Operating Procedures are described in *Fish Collection Procedures for Evaluation of Resident Fish Populations* (MassDEP 2006 CN 75.1). Surveys also included a habitat assessment component modified from that described in Barbour et al (1999).

Methods

Fish populations in the Merrimack River watershed were sampled during August and September of 2004 by electrofishing using a Smith Root Model 12 battery powered backpack electrofisher. A reach of between 80m and 100m was sampled by passing a pole-mounted anode ring, side to side through the stream channel and in and around likely fish holding cover. All fish shocked were netted and held in buckets. Sampling proceeded from an obstruction or constriction, upstream to an endpoint at another obstruction or constriction such as a waterfall or shallow riffle. Following completion of a sampling run, all fish were identified to species, measured, and released. Results of the fish population surveys can be found in Table 1. It should be noted that young-of-the-year (yoy) fish from most species (with the exception of salmonids) are not targeted for collection. Young-of-the-year fishes that are collected are noted in Table 1.

Habitat Assessment

An evaluation of physical habitat quality is critical to any assessment of ecological integrity (Karr et al. 1986; Barbour et al. 1999). Habitat assessment supports understanding of the relationship between physical habitat quality and biological conditions, identifies obvious constraints on the attainable potential of a site, assists in the selection of appropriate sampling stations, and provides basic information for interpreting biosurvey results (US EPA 1995). Before leaving the sample reach habitat qualities were scored using a modification of the evaluation procedure in Barbour et al. (1999). The matrix used to assess habitat quality is based on key physical characteristics of the water body and riparian area. Most parameters evaluated are instream physical attributes often related to overall land use and are potential sources of limitation to the aquatic biota (Barbour et al. 1999). The ten habitat parameters are as follow: instream cover for fish, epifaunal substrate, embeddedness, sediment deposition, channel alteration, velocity/depth combinations, channel flow status, right and left (when facing downstream) bank vegetative protection, right and left bank stability, right and left bank riparian vegetative zone width. Habitat parameters are scored, totaled, and, when appropriate, compared to a reference station to provide relative habitat ranking (See Table 2).

Data Analysis

The RBP V protocol (Plafkin et al. 1989 and Barbour et al. 1999) calls for the analysis of the data generated from fish collections using an established Index of Biotic Integrity (IBI) similar to that described by Karr et al. (1986). Since no formal IBI for Massachusetts currently exists, the data provided by this sampling effort were used to qualitatively assess the general condition of the resident fish population as a function of the overall abundance (number of species and individuals) and species composition classifications listed below (See Tables 1 and 2).

1. Tolerance Classification - Classification of tolerance to environmental stressors similar to that provided in Plafkin et al. (1989), Barbour et al. (1999), and Halliwell et al. (1999). Final tolerance classes are those provided by Halliwell et al. (1999).

2. Macrohabitat Classification – Classification by common macrohabitat use as presented by Bain and Meixler (2000) modified regionally following discussions between MassDEP and MA Division of Fish and Game (DFG) fishery biologists.

3. Trophic Classes - Classification which utilizes both dominant food items as well as feeding habitat type as presented in Halliwell et al.(1999).

Station Habitat Descriptions and Results

Tadmuck Brook (TA01) upstream from Lowell Road in Westford

Tadmuck Brook is a small second order stream with a drainage area of approximately 4.7 km^2. It was sampled on the south side of Lowell Road just upstream of a breached dam. Eight of ten habitat parameters scored in the "optimal" category. Velocity-depth combinations and channel flow status scored "marginal" and "poor" respectively. This appeared to be due to very low flows on the date of the sampling. The final habitat score was 161 (See Table 2). The watershed upstream of the sampling station is a mix of forest, forested wetland, and medium density residential.

Fish species captured in order of abundance included brown bullhead *Ameiurus nebulosus*, fallfish *Semotilus corporalis*, and redfin pickerel *Esox americanus*. Although fish habitat was rated as "optimal" only six fish were collected. All fish present are classified as being either tolerant or moderately tolerant of pollution, however, water quality data (temperature, dissolved oxygen, and pH) collected by DWM during 2004 appeared normal and met Class B standards (MassDEP 2006).

It should be noted that benthic macroinvertebrate assessment revealed an invertebrate community described as being "quite healthy" (Mitchell 2007). It is unclear why there are so few fish present in Tadmuck Brook, however, flow conditions on the date of the sampling suggest that periodic low flows may be an issue. Future monitoring should include re-sampling TA01 and sampling an additional station upstream.

Bridge Meadow Brook (BR01) downstream from Tyngsborough Elementary School access road in Tyngsborough

The sampled reach of this second order stream was of low gradient and contained a mix of riffles, pools, and shallow runs. The terminal end of the reach was located just downstream of a beaver pond. Three of the seven primary habitat parameters scored low in the "optimal" category. Instream cover for fish and channel alteration, scored "sub-optimal". Velocity depth combinations and channel flow status scored in the "marginal" category. All secondary parameters scored "optimal" except for riparian vegetative zone width in the left zone, which scored "sub-optimal". The final habitat score was 150 (See Table 2). The watershed upstream of the sampled reach is mostly newer medium density residential developments. The southern third of the watershed is a large forested wetland and there are also a number of small ponds and beaver ponds located a short distance upstream from the sampled location. The upstream drainage area is approximately 8.2 km^2.

Fish species captured in order of abundance included yellow bullhead *Ameiurus natalis*, pumpkinseed *Lepomis gibbosus*, golden shiner *Notemigonus crysoleucas*, redfin pickerel *Esox americanus*, largemouth bass *Micropterus salmoides*, chain pickerel *Esox niger*, bluegill *Lepomis macrochirus*, and yellow perch *Perca flavescens*. All fish collected are classified as tolerant or moderately tolerant macrohabitat generalists. Flow was extremely low on the date of the sampling, and most fish were captured in the one large pool located just downstream of the road at the terminal end of the sampled reach. Pre-dawn water quality data (temperature, dissolved oxygen, and pH) was collected by DWM on three dates during 2004. Dissolved oxygen concentrations were below Class B criteria on two of the sampling dates. (MassDEP 2006).

The overall low numbers of fish and the absence of fluvial fishes is troubling. It is possible that periodic low flow events related to the beaver activity may have resulted in the loss of fluvial fishes with re-population being hindered due to the upstream impoundments. Low dissolved oxygen concentrations and fish migrating downstream from the ponds may preclude a balanced fish community at this location. In light of the large amounts of recent development within the watershed, and the recent beaver activity, it is unlikely that Bridge Meadow Brook will rebound any time soon. Future monitoring should include re-sampling BR01 and sampling additional stations especially if there is a reduction in beaver activity.

Deep Brook (DBR05) downstream of Ledge Road in Chelmsford

The sampled reach of this first order stream was a moderate to high gradient reach and contained a mix of riffles, runs, and pools. It should be noted that flows were very low on the date of the sampling. In addition to this reach, an additional reach located upstream was qualitatively sampled specifically to look for wild brook trout.

Only two of the seven primary habitat parameters scored in the "optimal" category. Embeddedness and velocity-depth combinations scored "sub-optimal". Epifaunal substrate, channel flow status, and sediment deposition scored "marginal". All secondary parameters scored "optimal" except for riparian vegetative zone width in the left zone, which scored "sub-optimal". This sub-optimal score was due to residences. The lower-most section of the sampled reach was heavily sedimented. The final habitat score was 140 (See Table 2). The watershed upstream of the sampled reach is mostly medium density residential (newer construction), forested, and mining land uses. The drainage area upstream of the sampled location was approximately 1.4 km^2.

Fish species captured in order of abundance included banded sunfish *Enneacanthus obesus*, pumpkinseed, redfin pickerel, golden shiner, yellow bullhead, chain pickerel, and bluegill. All fish collected are classified as tolerant or moderately tolerant macrohabitat generalists. Flow was extremely low on the date of the sampling. Pre-dawn water quality data (temperature, dissolved oxygen, and pH) were collected by DWM on three dates during 2004. Although classified as a Class B, water quality easily met Class B coldwater fishery standards (MassDEP 2006). It should be noted that Deep Brook is classified as a Coldwater Fishery Resource (CFR) by MassWildlife (MassWildlife 2007).

Mass DEP DWM last sampled Deep Brook in 1990. At that time the fish population survey resulted in the collection of seventeen native brook trout. The absence of trout in 2004 is alarming, particularly in light of the cold well-oxygenated water available in Deep Brook. There has been a large amount of residential and road construction in the watershed in recent years and heavy sediments in pools and very low flows may be responsible for what seems to be the loss of brook trout. Additional fish population monitoring should be conducted to document the possible presence of naturally reproducing brook trout in other sections of Deep Brook.

Black Brook (BB05) upstream from Westford Street in Lowell

The sampled reach of this second order stream was a low to moderate gradient reach and contained a mostly shallow riffle and run habitat. Only one of seven primary habitat parameters (channel alteration) scored in the "optimal" category. Embeddedness , sediment deposition, and channel flow status scored "sub-optimal". Instream cover for fish, epifaunal substrate, and velocity-depth combinations scored "marginal". For secondary parameters, bank vegetative protection scored "sub-optimal" and "marginal" on the left and right banks respectively. Bank stability scored "sub-optimal", and riparian vegetative zone width scored "sub-optimal" and "poor" in the left and right zones respectively. The sub-optimal scoring in the secondary parameters are mostly the result of residential development on the right side of the brook and commercial development on the left. The final habitat score was 116 (the lowest of the 2004 Merrimack River Watershed sites).

Fish species captured in order of abundance included chain pickerel, yellow bullhead, and white sucker. All fish present are classified as being either tolerant or moderately tolerant of pollution; however, water quality data (temperature, dissolved oxygen, and pH) collected by DWM during 2004 appeared normal and met Class B standards (MassDEP 2006). Fish were also collected at BB05 and one other station on Black Brook in 1990.

Although equipment problems were noted during the 1990 fish survey, again very few fish were collected or observed. The low total fish abundance and relative absence of fluvial fish species despite what appears to be good water quality is most likely the result of the poor habitat noted at this station.

Peppermint Brook (PE01A) downstream of Lakeview Ave in Dracut

Peppermint Brook is a large first order stream of moderate gradient containing mostly shallow riffles, runs and pools. Flow was extremely low on the date of the survey and most water was contained in stagnant pools. The drainage area upstream from the sampling station is approximately 4.5 km^2. Three of seven primary habitat parameters scored in the "optimal" category. Epifaunal substrate, sediment deposition, and velocity-depth combinations scored "sub-optimal". Channel flow status scored "marginal". For secondary parameters, bank vegetative protection scored "optimal" and "sub-optimal" on the right and left banks respectively. Bank stability scored "marginal", and riparian vegetative zone width scored "optimal" and "sub-optimal" in the left and right zones respectively. The sub-optimal scoring in the secondary parameters are mostly the result of steep eroded banks on the left-hand side of the stream and banks with very little vegetation on both sides. The stream is noted as being "totally trashed". The final habitat score was 134, which is the third lowest score of the 2004 Merrimack Fish Population sites. The upper part of the watershed is forested with a little commercial landuse. The brook flows through a large wetland and then into a medium to high density residential neighborhood.

Although instream cover for fish was rated low in the "optimal" category (17), flows were very low on the day of the survey and silt in pools got stirred up during sampling, which caused visibility problems. Fish collection efficiency was estimated at around 50%. Fish species captured in order of abundance included yellow bullhead, fallfish *Semotilus corporalis*, pumpkinseed, white sucker, bluegill, largemouth bass, golden shiner and common shiner *Luxilus cornutus*. There were thousands of young-of-the-year fallfish also noted. Three fluvial species were collected, although yellow bullhead, a tolerant macrohabitat generalist, dominated the sample. Pre-dawn water quality data (temperature, dissolved oxygen, and pH) were collected by MassDEP on three dates during 2004. Dissolved oxygen concentrations were below Class B criteria on one of the sampling dates. (MassDEP 2005 and 2006).

While the presence of three fluvial species is usually indicative of a stable flow regime, streamflow was extremely low on the date of the sampling and two of the three fluvial species were represented by just eleven individual fish. Sampling inefficiencies with regard to turbid conditions make it very hard to predict impacts but it seems that the deeper pools located within the sampled reach were definitely serving as refugia for fishes displaced from the dry stream. Future sampling should include stations located further upstream.

Trout Brook (TRB02) either side of Kenwood Street in Dracut

The sampled reach of this small second order stream was of moderate gradient and contained a mix of riffles, runs, and pools. Three of seven primary habitat parameters scored in the "optimal" category. Instream cover for fish scored "sub-optimal". Sediment deposition, velocity-depth combinations, and channel flow status scored "marginal". For secondary parameters, bank vegetative protection scored "sub-optimal". Bank stability scored "optimal" and "sub-optimal" on the left and right banks respectively and riparian vegetative zone width scored "marginal". The less-than-optimal scoring of secondary parameters is mostly due to the presence of residences on both sides of the brook. The pools downstream of Kenwood Street contained heavy deposits of fine silt. The final habitat score was 133 which was the second lowest of the 2004 Merrimack River watershed sites. (See Table 2). The Trout Brook watershed upstream from the sampled reach is approximately 3.2 km^2 and is a mix of forested, agricultural, medium density residential and commercial land-uses. Agricultural and residential land-uses predominate.

The fish community included only redfin pickerel. Pre-dawn water quality data (temperature, dissolved oxygen, and pH) were collected by DWM on three dates during 2004. Although classified as Class B, water quality easily met Class B coldwater fishery standards (MassDEP 2006).

In light of the amount of sediment found in pools downstream of the road, erosion from the agricultural fields may be impacting the fish community at this site. Any future fish population monitoring should be concentrated further upstream and should include an expanded reconnaissance survey to search for trout.

Richardson Brook (RBR01A) upstream of Methuen Street in Dracut

The sampled reach of this third order stream was of moderate gradient and contained mostly riffle and run habitat. Four of seven primary habitat parameters scored in the "optimal" category. Channel alteration and channel flow status scored "sub-optimal", and velocity depth combinations scored "marginal". For secondary parameters, bank vegetative protection and bank stability scored "optimal". Riparian vegetative zone width scored "sub-optimal" and "poor on the right and left banks respectively. The poor scoring was due to the presence of a residential driveway that parallels the brook in the left riparian zone. The final habitat score was 155 (See Table 2). Just upstream from the sampled reach, Richardson Brook picks up flow from both an un-named tributary (which drains a wetland area) and from Trout Brook.
The watershed upstream from the sampling station is approximately 10.87 km^2 , includes Trout Brook, and is a mix of forested, agricultural, medium density residential and commercial land-uses.

Despite stable instream cover for fish in the form or boulders and rocks, only nine redfin pickerel and seven yellow bullhead were collected at RBR01A. Pre-dawn water quality data (temperature, dissolved oxygen, and pH) collected by DWM during 2004 appeared normal and met Class B standards (MassDEP 2006).

Although riparian vegetative zone width scored poor on the left bank, instream cover for fish was rated low in the optimal category. The absence of fluvial fishes is surprising in light of the riffle run habitat that was present. The pond and wetland located just upstream may be influencing the fish population of Richardson Brook. Any future fish population monitoring should be concentrated further upstream and should included an expanded reconnaissance survey to search for trout or other fluvial fishes.

Trull Brook (TB02) downstream of River Road in Tewksbury

Trull Brook, a large second order stream, drains an area of approximately 11.2 km^2 . The brook drains a large wetland and it's watershed contains a mix of high and medium density residential, forested and open wetland, and recreational (golf courses) land uses. Trull Brook was sampled approximately one kilometer from it's confluence with the Merrimack River, just upstream from the golf course, between the golf course and River Road. The reach was of moderate gradient and contained a good mix of riffle run and pool habitat. All ten habitat parameters scored in the "optimal" category and the total habitat score of 185 was the highest of the 2004 Merrimack survey (See Table 2). It should be noted that there was a large dry erosion channel which joined the stream on the left bank which appeared to have originated as the result of the discharge of a storm drain off River Road. This channel has the potential of causing significant sedimentation in Trull Brook.

Despite excellent habitat and stable instream cover for fish in the form or boulders and rocks, only thirteen fish were collected at TB02. Fallfish (n=7) and American eel, both fluvial dependant species, dominated the fish sample. Other species collected included largemouth bass and golden shiner which are both considered macrohabitat generalists more common in lakes and ponds or slow moving stretches and backwaters of rivers and streams. Water quality data (temperature, dissolved oxygen, and pH) collected by DWM one occasion during 2004 appeared normal and met Class B standards (MassDEP 2006). It should be noted that the data were "qualified" for the following reason: "one or more methods….not followed" (MassDEP 2005).

Although the presence and dominance by fallfish, a fluvial species, suggests adequate flows, the relatively low number of fish collected is alarming. The potential impacts of the storm drain off River Road should be addressed in an effort to prevent excessive sedimentation of Trull Brook during heavy rain events. Future fish population monitoring should include re-sampling the aforementioned location and possibly an expanded reconnaissance survey as well.

Bartlett Brook (BA01A) upstream and downstream of Route 113 in Methuen

Bartlett Brook is a third order stream which has a number of ponds and a large wetland in the upper and middle part of its watershed respectively. The sampled reach is near the lower end of the watershed just upstream of Mill Pond. The watershed contains a mix of medium density residential, forested and agricultural land uses.

Four of seven primary habitat parameters scored in the "optimal" category. Channel alteration scored sub-optimal due to the presence of old and current bridge abutments in the middle of the reach. Velocity-depth combinations and channel flow status scored marginal due to a relative absence of deep water habitats and a large amount of exposed substrates. For secondary parameters, bank vegetative protection and bank stability scored "sub-optimal". Riparian vegetative zone width scored "sub-optimal" on the right bank and "poor" on the left bank due to the presence of residenential properties on both sides of the brook. It was noted that there was an eroding drainage ditch located on the upstream (north) side of Route 113 running into the brook from the east. The final habitat score was 141 which was in the lower 25 percent of scores for 2004 Merrimack River watershed sites. (See Table 2).

Although instream cover for fish scored low in the optimal category and electrofishing collection efficiency was estimated at 85%, only twenty-eight fish were collected at BA01. Yellow bullhead, a tolerant macrohabitat generalist, heavily dominated the sample (n=18). Although three fluvial species (American eel, tessellated darter, and redfin pickerel) were collected, they totaled only 5 fish. Other macrohabitat generalists included largemouth bass and pumpkinseed. Pre-dawn water quality data (temperature, dissolved oxygen, and pH) collected by DWM during 2004 appeared normal and easily met Class B standards (MassDEP 2006).

The absence of deep water habitat and marginal channel flow status at BA01 suggest flow problems. The relatively low number of fluvial fish present support this assertion. The potential impacts of the drainage ditch include increased sedimentation of this reach and Mill Pond. Future fish population monitoring should investigate potential locations further upstream.

Fish Brook (FI01A and FI02) near confluence with Merrimack River upstream and downstream of footpath at sewer line crossing in Andover

The two sampled reaches of this large second order stream were of medium to high gradient and contained a mix of riffles, pools, and shallow runs. Both reaches were located just upstream from Fish Brooks' confluence with the Merrimack River. The watershed upstream of the sampled reaches is mostly forested with some medium density residential, commercial and transportation land uses. The southern (upper) third of the watershed drains Haggets Pond and a large wetland. The drainage areas upstream of FI01A and FI02 are 15.85 and 15.92 km^2 respectively.

Five of the six primary habitat parameters (epifaunal substrate not scored) scored in the "optimal" category at FI01A where sediment deposition scored high in the "sub-optimal" category. All six of the primary habitat parameters (epifaunal substrate not scored) scored in the "optimal" category at FI02. At FI01A all secondary parameters scored "optimal" on the left bank and "suboptimal" on the right due to the presence of recent pipeline or sewer line construction. At FI02 bank vegetative protection was "optimal" on both banks, bank stability scored high in the "suboptimal" category, and riparian vegetative zone width scored "optimal" and "marginal" in the left and right zones, respectively. This was due mostly to the presence of an access road on the right bank of Fish Brook at this location. The final habitat scores were 149 and 157 (out of a possible 180) at FI01A and FI02, respectively (See Table 2).

Despite excellent habitat and stable instream cover for fish, only thirteen fish were collected at FI01A and FI02 combined. American eel and redfin pickerel were collected at both station locations. In addition, three yellow bullhead and one young-of-the-year alosid *Alosa* sp. were also collected at FI02. Although American eel and redfin pickerel are both "fluvial" species, the paucity of fish was surprising. Although not collected at the same station as fish population assessment, pre-dawn water quality data (temperature, dissolved oxygen, and pH) collected by DWM on three occasions during 2004 revealed violations of the Class B warmwater standard for dissolved oxygen on all three sampling dates. It should be noted that two of the dissolved oxygen data points were "qualified" for the following reason: "one or more methods…not followed" (MassDEP 2006). Athough two of the three dissolved oxygen data points were qualified, they were very similar to the unqualified data point (MassDEP 2005).

The relatively low numbers of fish in Fish Brook may be the result of poor water quality. Low dissolved oxygen is most likely due to the large wetlands located upstream of FI01A and FI02. Future fish population monitoring should include re-sampling the aforementioned locations and possibly an expanded reconnaissance survey as well.

Bare Meadow Brook (BMB01A) downstream from Renfrew Street in Methuen

Bare Meadow Brook is a third order stream which flows north out of Methuen and then picks up considerable flow from Hawkes Brook before emptying into the Merrimack River near the Haverhill border and Kimball Island. Hawkes Brook drains wetlands in it's headwaters (and the westernmost part of the watershed) and land use in it's watershed is primarily forest and medium density residential. The Broad Meadow Brook watershed is a mix of forested, medium density residential, commercial, and industrial land uses. The drainage area upsteam of BMB01A was equal to that of EA01 at 18.3 km^2. these were the largest drainage areas of all sites surveyed. Five of seven primary habitat parameters scored in the "optimal" category. Epifaunal substrate and sediment deposition scored "sub-optimal". For secondary parameters, "bank vegetative protection" was optimal on both banks, "bank stability" scored "suboptimal" on both sides and "riparian vegative zone width" scored "optimal" and "sub-optimal" in the left and right riparian zones, respectively.

Although instream cover for fish was rated as being "optimal" the total number of fish collected was low (n=21). Fish collection efficiency was not estimated, however, it was noted that the water was highly colored and there were some deep pools. Fish species captured in order of abundance included blacknose dace, white sucker, American eel, common shiner, tessellated darter, and pumpkinseed. All species with the exception of pumpkinseed are considered to be tolerant to moderately tolerant "fluvial" species. This is indicative of a stable flow regime and a relative absence of ponds or impoundments within this sub-watershed. Pre-dawn water quality data (temperature, dissolved oxygen, and pH) collected by DWM on three dates during 2004 appeared normal and met Class B standards (MassDEP 2005 and 2006).

The relatively low numbers of fish may be the result of poor sampling efficiencies. Future fish population monitoring should include re-sampling of BMB01 and possibly an expanded reconnaissance survey as well.

Creek Brook (CR01) upstream from Lowell Avenue in Haverhill

Creek Brook is a large second order stream which flows south as the outflow from Crystal Lake and then picks up considerable flow from West Meadow Brook before emptying into the Merrimack River upstream from Stanley Island in Haverhill. West Meadow Brook drains some wetlands in it's headwaters (and the westernmost part of the watershed) and land use in it's watershed is primarily forest and medium to high density residential. The Creek Brook watershed is mostly the same with some industrial and open space recreational (golf course) land uses as well. The drainage area upstream from the sampling station is approximately 14.4 km^2. Six of seven primary habitat parameters scored in the "optimal" category. Sediment deposition scored "sub-optimal". For secondary parameters, bank vegetative protection was optimal on both banks, bank stability scored "suboptimal" on both sides and riparian vegative zone width scored "optimal" and "sub-optimal" in the left and right riparian zones, respectively.

Instream cover for fish was rated as being “optimal” and the total number of fish collected about average for the survey (n=44). Fish collection efficiency was not estimated. The fish sample was heavily dominated by blacknose dace (n=23). Nine American eel and six white suckers were also collected. Redfin pickerel, pumpkinseed, brown bullhead and bluegill were present but were represented by only one or two fish each. The three most dominant species are considered to be tolerant to moderately tolerant “fluvial” species. This is indicative of a stable flow regime. A heavy dominance by blacknose dace can sometimes be indicative of nutrient enrichment but usually numbers of dace (and other fish) are much higher in those instances. Pre-dawn water quality data (temperature, dissolved oxygen, and pH) were collected by DWM on three dates during 2004. Although classified as Class B, water quality easily met Class B coldwater fishery standards (MassDEP 2005 and MassDEP 2006).

Although water quality in Creek Brook met Class B coldwater fishery standards in 2004, there is no evidence to suggest that this brook contains trout or any other coldwater fishes, nor is it classified as a Coldwater Fishery Resource (CFR) by MassWildlife. Future fish population monitoring should include an expanded reconnaissance survey.

Johnson Creek (JC03A) downstream from Central Street Bridge in Groveland

The sampled reach of this large second order stream was of moderate gradient and contained a mix of mostly riffles and runs. Three of seven primary habitat parameters scored in the “optimal” category. Epifaunal substrate, embeddedness and velocity-depth combinations scored “sub-optimal”. Sediment deposition scored only “marginal”. For secondary parameters, bank vegetative protection and riparian zone width was “optimal” on both sides of the creek. Bank stability scored “marginal” on both sides due to steep banks. The final habitat score was 146 (See Table 2).

The watershed upstream of the sampled reach is mostly forested with some medium density residential and mining land use. There are two ponds upstream and one pond just downstream of the sampling station. Drainage area upstream from the sampling station is approximately 16.16 km^2.

Instream cover for fish was rated as being “optimal” but the total number of fish collected or observed was low (n=11). Fish collection efficiency was not estimated. The fish sample was heavily dominated by wild brook trout (n=9). One American eel and one yellow bullhead were observed and/or collected. Brook trout are an intolerant fluvial fish species that requires cold clean waters and are usually indicative of a stable flow regime. Pre-dawn water quality data (temperature, dissolved oxygen, and pH) were collected by DWM on three dates during 2004. Although classified as a Class B, water quality easily met Class B coldwater fishery standards (MassDEP 2005 and MassDEP 2006).

Although multiple age classes of wild brook trout were present and water quality in Johnson Creek met Class B coldwater fishery standards in 2004, it is not currently listed as a Coldwater Fishery Resource (CFR) by MassWildlife or classified as a coldwater fishery by MassDEP. Future fish population monitoring should include an expanded reconnaissance survey for the presence of brook trout.

Argilla Brook (AR01) west of Baldwin Terrace in Groveland

The sampled reach of this second order stream was of moderate gradient and contained a diverse mix of riffles, runs, and pools. Four of seven primary habitat parameters scored in the “optimal” category. Embeddedness and channel alteration scored “sub-optimal”. Sediment deposition scored only marginal. For secondary parameters, bank vegetative protection scored “sub-optimal” and “marginal” on the left and right bank respectively. Bank stability scored “sub-optimal” and “marginal” on the right and left banks respectively. Riparian zone width was “sub-optimal” on both sides of the brook. The final habitat score was 147 (See Table 4). Heavily used trails and steep eroded banks contributed to the less than optimal conditions.

The watershed upstream of the sampled reach is a mix of forested, medium density residential, and mining land use. There is a large forested wetland in the headwaters and a ponded area located just

upstream from the sampling location. Drainage area upstream from the sampling station is approximately 5 km^2.

Instream cover for fish was rated as being "optimal" and the total of eighty-six fish were collected. Fish collection efficiency was not estimated. Fish species captured in order of abundance included fallfish golden shiner, blacknose dace, American eel, white sucker, pumpkinseed, common shiner, bluegill, sea lamprey *Petromyzon marinus*, and one each of redfin pickerel and yellow bullhead. Pre-dawn water quality data (temperature, dissolved oxygen, and pH) were collected by MassDEP on three dates during 2004. Water quality met Class B warmwater fishery standards (MassDEP 2005 and MassDEP 2006).

Although the fish population included a number of golden shiner, a macrohabitat generalist, the majority of fish collected are classified as fluvial specialists/dependants. The dominance by fluvial species is indicative of a stable flow regime, however, the presence of five different macrohabitat generalists reflects the presence of the small pond and forested wetland located upstream. Bank stability and erosion appear to be of concern within this reach and management practices to minimize erosion should be investigated.

East Meadow River (EA01) downstream of cart road (Thompson Road) in Haverhill

The sampled reach of this third order stream was of moderate gradient and contained a mix of riffles, runs, and one deep pool. Three of six primary habitat parameters scored in the "optimal" category. Embeddedness, velocity-depth combinations, and channel flow status scored "sub-optimal". Epifaunal substrate was not scored. For secondary parameters, bank vegetative protection scored "optimal" and "sub-optimal" on the left and right bank, respectively. Bank stability and riparian vegetative zone width scored "optimal" on both banks/zones. The final habitat score was 153 of a possible 180 (See Table 4).

The watershed upstream of the sampled reach includes mostly forested and non-forested wetlands. There is also a small pond or impoundment located upstream from the sampling location. The drainage area is approximately 18.3 km^2.

Instream cover for fish was rated as being low within the "optimal" category and a total of sixty-one fish were collected. Fish species captured in order of abundance included bluegill, American eel, pumpkinseed, redfin pickerel, and one largemouth bass. Pre-dawn water quality data (temperature, dissolved oxygen, and pH) collected by DWM on three occasions during 2004 revealed violations of the Class B warmwater dissolved oxygen standard on all three sampling dates (MassDEP 2005 and MassDEP 2006). It should be noted that one of the dissolved oxygen data points was "qualified" for the following reason: "one or more methods….not followed". Athough one of the three dissolved oxygen data points was qualified, the data point was similar to the unqualified data point (MassDEP 2005).

The fish population was heavily dominated by macrohabitat generalists. The dominance by macrohabitat generalists reflects the presence of the small pond and non-forested wetlands located upstream. Future monitoring should be conducted at other stations in order to document the presence (if any) of fluvial species.

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Table 1. List of fish population biomonitoring station locations and fish population data for the 2004 Merrimack River Watershed survey.

Station Description	Date	Species Code[1]																	Comments
		BND	CS	FF	GS	AE	RFP	WS	BB	YB	CP	BS	SL	EBT	B	LMB	P	YP	TD	
TA01, Tadmuck Brook, Westford, upstream from Lowell Road reach beginning at breached dam and continueing 150 m upstream.	11 Aug 2004	-	-	2	-	-	1	-	3	-	-	-	-	-	-	-	-	-	-	
BR01, Bridge Meadow Brook, Tyngsborough, downstream from elementary school entrance road off Chestnut Road.	11 Aug 2004	-	-	-	7	-	7	-	-	14	1	-	-	-	1	3	12	1	-	Very little flow. Most fish collected from pool just downstream of road crossing. Sampling efficiencies estimated at 50% due to water color in pool..
DBR05, Deep Brook, Chelmsford, downstream of Ledge Road.behind houses off Dunstable Road. Upstream of un-named tributary.	11 Aug. 2004	-	-	-	3	-	4	-	-	3	1	24	-	-	1	-	14	-	-	Deep very fine silt noted in lower part of sampled reach.
BB05, Black Brook, Lowell, off of and adjacent to Montgomery Ave just downstream from golf course.	11 Aug. 2004	-	-	-	-	-	-	2	-	11	11	-	-	-	-	-	-	-	-	
PE01A, Peppermint Brook, Dracut, 200 meters downstream from Lakeview Ave. Reach extended to riffle located approx 100 m downstream of bridge.	12 Aug 2004	-	1	18*	1	-	-	9(1)	-	27	-	-	-	-	3(1)	2	16	-	-	Very little flow and fine sediment made water very turbid when sampling. Sampling efficiencies rated as poor (<50%). B less than 50 mm and WS less than 60 mm considered YOY
TRB02, Trout Brook, Dracut, upstream and downstream of Kenwood Sreet.	12 Aug 2004	-	-	-	-	-	21	-	-	-	-	-	-	-	-	-	-	-	-	Shocking efficiency excellent, estimated pick-up 90%.

Table 1 (continued). List of fish population biomonitoring station locations and fish population data for the 2004 Merrimack River Watershed survey.

Station Description	Date	Species Code[1]																	Comments
		BND	CS	FF	GS	AE	RFP	WS	BB	YB	CP	BS	SL	EBT	B	LMB	P	YP	TD	
RBR01A, Richardson Brook, Dracut, reach beginning upstream of a new road off of Methuen Street	12 Aug. 2004	-	-	-	-	-	9	-	-	7(5)	-	-	-	-	-	-	-	-	-	Shocking efficiency very good, estimated pick-up 85%.. Bullhead less than 53 mm considered young of the year (YOY)
TB02, Trull Brook, Tewksbury, downstream of River Road reach beginning just upstream from golf course	19 Aug 2004	-	-	7	1	3	-	-	-	-	-	-	-	-	-	2	-	-	-	
BA01A, Bartlett Brook, Methuen, downstream and upstream of Rte 113	12 Aug. 2004	-	-	-	-	1	3	-	-	18	-	-	-	-	-	4	1	-	1	Shocking efficiency very good, estimated pick-up 85%.. One unidentified sunfish collected possibly a hybrid
FI01A, Fish Brook, Andover, near confluence with Merrimack River upstream of footpath at sewer line crossing.	19 Aug 2004	-	-	-	-	3	2	-	-	-	-	-	-	-	-	-	-	-	-	
FI02, Fish Brook, Andover, near confluence with Merrimack River downstream of footpath at sewer line crossing.	23 Sept 2004	-	-	-	-	2	3	-	-	3	-	-	-	-	-	-	-	-	-	One young of the year alosid also collected. High flows and dark colored water made collection difficult.
BMB01A, Bare Meadow Brook, Methuen, downstream from Renfrew Street.	17 Aug. 2004	6	-	-	-	5	-	5	-	-	-	-	-	-	-	-	1	-	(1)	Tesselated darter less than 40 mm considered young of the year
CR01, Creek Brook, Haverhill, up[stream from Lowell Avenue.	14 Aug 2004	23	-	-	-	9	2	6	1	-	-	-	-	-	1	-	2	-	-	
JC03, Johnson Creek, Groveland, downstream of Center Street bridge.	17 Aug. 2004	-	-	-	-	1	-	-	-	1	-	-	-	9	-	-	-	-	-	Multiple age classes of EBT appeared to be representative of a reproducing population
AR01A,Argilla Brook, Groveland, west of circle at end of Baldwin Terrace downstream of footpath and bridge.	17 Aug. 2004	13	5	17	15	12	1	8	-	1	-	-	3	-	5	-	6	-	-	

Table 1 (continued). List of fish population biomonitoring station locations and fish population data for the 2004 Merrimack River Watershed survey.

Station Description	Date	Species Code[1]																	Comments
		BND	CS	FF	GS	AE	RFP	WS	BB	YB	CP	BS	SL	EBT	B	LMB	P	YP	TD	
EA01, East Meadow River Haverhill beginning 150 m downstream of cartroad at end of Thompson Road	19 Aug 2004	-	-	-	-	20(5)	10	-	-	-	-	-	-	-	20(6)	(1)	11	-	-	AE, RFP, bluegill, and largemouth bass less than 100, 33, 40, and 65 mm respectively, considered young of the year

[1] SPECIES CODE | COMMON NAME | SCIENTIFIC NAME | TOLERANCE/ MACROHABITAT CLASSIFICATION

SPECIES CODE	COMMON NAME	SCIENTIFIC NAME	TOLERANCE/ MACROHABITAT CLASSIFICATION
AE	American eel	*Anguilla rostrata*	Tolerant / Fluvial dependant (Catadromous)
SL	sea lamorey	*Petromyzon marinus*	Moderately tolerant / Fluvial dependant (Anadromous)
BND	Eastern blacknose dace	*Rhinichthys atratulus*	Tolerant / Fluvial specialist
CS	common shiner	*Luxilus cornutus*	Moderately tolerant / Fluvial dependant
FF	fallfish	*Semotilus corporalis*	Moderately tolerant / Fluvial specialist
GS	golden shiner	*Notemigonus crysoleucas*	Tolerant / Macrohabitat generalist
WS	white sucker	*Catostomus commersonii*	Tolerant / Fluvial dependant
RFP	redfin pickerel	*Esox americana*	Moderately tolerant / Macrohabitat generalist
CP	chain pickerel	*Esox niger*	Moderately tolerant / Macrohabitat generalist
BB	brown bullhead	*Ameiurus nebulosus*	Tolerant / Macrohabitat generalist
YB	yellow bullhead	*Ameiurus natalis*	Tolerant / Macrohabitat generalist
EBT	brook trout	*Salvelinus fontinalis*	Intolerant / Fluvial Dependant
BS	banded sunfish	*Enneacanthus obesus*	Intolerant/ Macrohabitat generalist
B	bluegill	*Lepomis macrochirus*	Tolerant / Macrohabitat generalist
LMB	largemouth bass	*Micropterus salmoides*	Moderately tolerant / Macrohabitat generalist
P	pumpkinseed	*Lepomis gibbosus*	Tolerant / Macrohabitat generalist
YP	yellow perch	*Perca flavescens*	Moderately tolerant / Macrohabitat generalist
TD	tessellated darter	*Etheostoma olmstedi*	Moderately tolerant / Fluvial specialist

[2] number in parentheses indicate young-of-the-year (not included in count totals)

Table 2. . . Habitat assessment summary for fish population stations sampled during the 2004 Merrimack River Watershed fish population survey. For primary parameters, scores ranging from 16-20 = optimal; 11-15 = suboptimal; 6-10 = marginal; 0-5 = poor. For secondary parameters, scores ranging from 9-10 = optimal; 6-8 = suboptimal; 3-5 = marginal; 0-2 = poor. Refer to Table 1 for a listing and description of sampling stations.

Stations	Tadmuck Brook	Bridge Meadow Brook	Deep Brook	Black Brook	Peppermint Brook	Trout Brook	Richardson Brook	Trull Brook	Bartlett Brook	Fish Brook	Fish Brook	Bare Meadow Brook	Creek Brook	Johnson Creek	Argilla Brook	East Meadow Brook
Primary Habitat Parameters	**Score (0-20)**															
INSTREAM COVER (for Fish)	17	15	17	10	17	15	16	19	16	18	19	18	16	17	18	16
EPIFAUNAL SUBSTRATE	17*	16	6	10	11	16	20	16*	16*	N/A	N/A	15	19	13	17	N/A
EMBEDDEDNESS	18	16	12	13	17*	18	18	17	16	17	18	17	17	11	12	14
CHANNEL ALTERATION	18	15	20	16	19	17	15	19	15	18	18	19	19	20	13	19
SEDIMENT DEPOSITION	18	16	10	13	12	10	19	18	16	15	18	13	12	6	10	18
VELOCITY-DEPTH COMBINATIONS	10	10	15	8	11	10	10	19	10	17	18	20	16	15	19	15
CHANNEL FLOW STATUS	3	6	8	11	6	10	11	18	10	16	17	20	20	17	19	14
Secondary Habitat Parameters	**Score (0-10)**															
BANK VEGETATIVE PROTECTION left	10	9	9	7	7	8	9	10	8	9	9	9	10	9	7	10
BANK VEGETATIVE PROTECTION right	10	9	9	4	9	7	10	10	8	6	9	9	9	9	5	8
BANK STABILITY left	10	10	9	8	3	9	9	10	8	10	8	6	7	5	5	10
BANK STABILITY right	10	10	9	7	5	7	9	10	8	6	8	6	8	5	8	9
RIPARIAN VEGETATIVE ZONE WIDTH left	10	8	7	7	10	3	1	10	2	10	10	10	9	10	7	10
RIPARIAN VEGETATIVE ZONE WIDTH right	10	10	9	2	7	3	8	9	8	7	5	8	8	9	7	10
Total Score	**161**	**150**	**140**	**116**	**134**	**133**	**155**	**185**	**141**	**149****	**157****	**170**	**170**	**146**	**147**	**153****

N/A not assessed
* scores taken from benthic macroinvertebrate field sheets
** of a possible 180

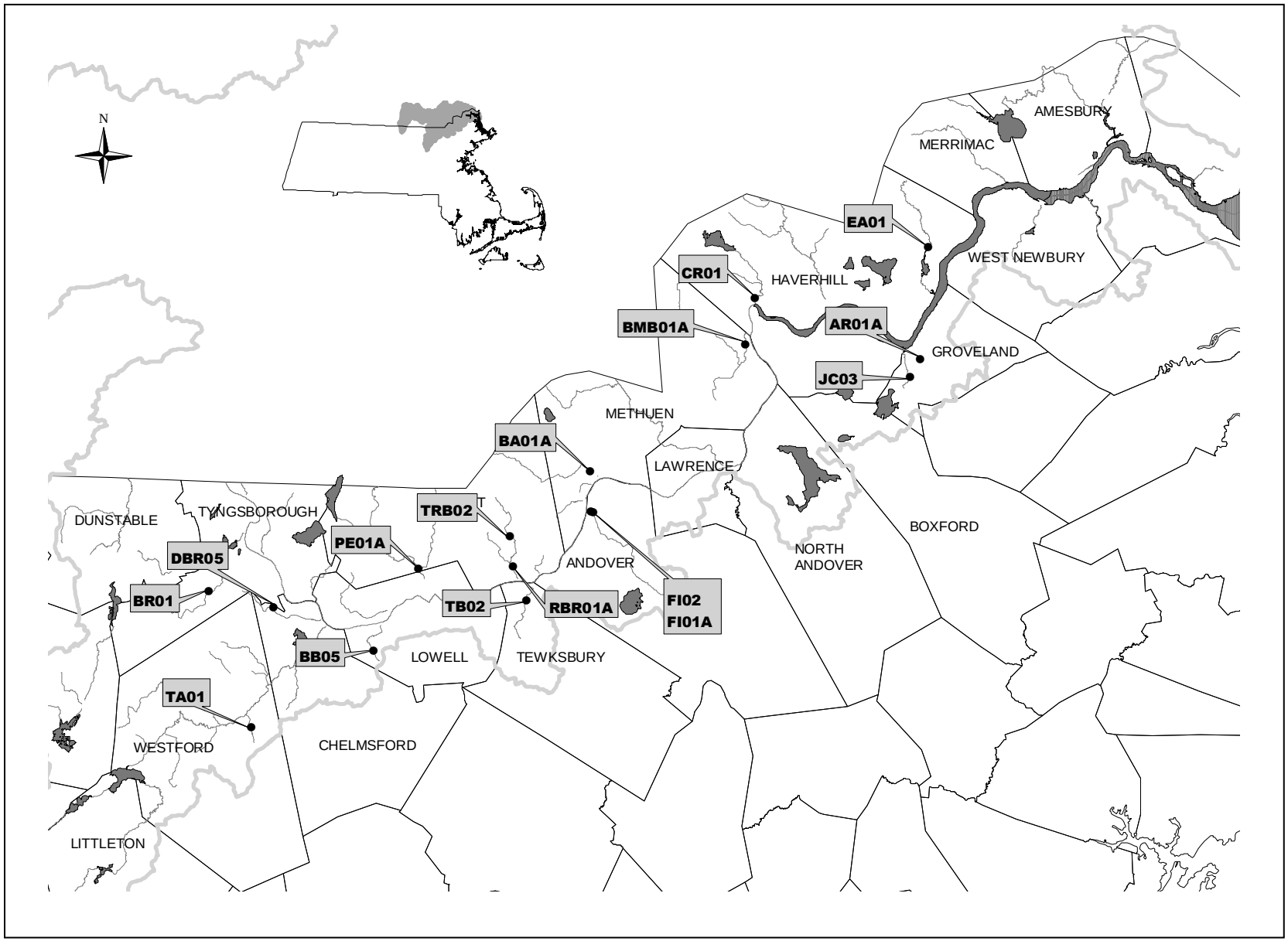

Figure 1. 2004 Merrimack River Watershed Fish Population Survey Station locations.