

Technical Memorandum

**2010
Probabilistic Monitoring
Fish Population Survey**

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Introduction

In late summer and early fall of 2010, fish population surveys were conducted in northeastern and eastern Massachusetts at twenty-seven stations 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 MassDEP Method CN 075.1 *Fish Collection Procedures for Resident Fish Populations* (MassDEP 2006a). Fish surveys also included a habitat assessment component modified from that described in Barbour et al. 1999.

Methods

Fish Collections

Fish collections were conducted by electrofishing using either a Smith Root Model 12 battery-powered backpack electrofisher or a Smith Root Model 1.5KVA barge-mounted electrofisher powered by a Honda Model EU 2000i generator. A reach of between 70m and 100m was sampled by passing one or more pole mounted anode ring(s) 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, a sub-sample were measured and weighed, after which all fish were 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) were not targeted for collection. Young of the year fishes that were collected, intentionally or not, are noted in Table 1. Scientific names of fishes are taken from American Fisheries Society Special Publication 29 (Nelson et.al. 2004).

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 helps to support 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 during the 2010 fish population surveys, habitat qualities were scored using a modification of the evaluation procedure in Barbour et al. (1999). The matrices used to assess habitat quality are based on stream flow, 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 for moderate to high flowing streams are as follows: 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, and, right and left bank riparian vegetative zone width. For moderate to low gradient streams, instream cover for fish is replaced with bottom substrate/available cover, epifaunal substrate is replaced with pool substrate characterization, embeddedness is replaced with pool variability, and velocity-depth combinations is replaced with channel sinuosity. 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 (richness) as well as individuals) and species composition (classifications listed below).

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 Massachusetts Department of Fish and Game (MA 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

MA09A-111, Shawsheen River, approximately 850 meters downstream of Winthrop Avenue (Route 114) in Lawrence.

The Shawsheen River originates near Hanscom Field in Bedford and flows north forty kilometers, dropping twenty three meters in elevation before reaching its confluence with the Merrimack River in Lawrence. It meanders through broad floodplains and extensive freshwater wetlands that provide excellent habitat for beaver, mink, muskrat and several species of waterfowl (MADEP 2003). A total of four locations on the Shawsheen River were sampled in 2010. The Shawsheen River downstream of Route 114 in Lawrence (MA09A-111) is a fourth order stream with a drainage area of approximately 198 Km². This station is located just a short distance upstream from the confluence of the Shawsheen with the Merrimack River

The sampled reach was low-gradient, deep, and meandering with silt and sand substrates predominating. Only one of the seven primary habitat parameters (channel alteration) scored in the “optimal” category. Bottom substrate/available cover, pool substrate characterization, pool variability, sediment deposition, and channel sinuosity scored “suboptimal”, and channel flow status scored “marginal”. For secondary parameters, bank vegetative protection and riparian vegetative zone width scored “optimal”, and bank stability scored “suboptimal”. The final habitat score was 143 out of 200 (See Table 2). The watershed upstream is a diverse mix of landuses including, forested, wetland, residential, commercial, and industrial.

Deep pools made fish sampling very difficult and it was impossible to get a representative sample. Fish species captured in order of abundance included, fallfish *Semotilus corporalis*, American eel *Anguilla rostrata*, bluegill *Lepomis macrochirus*, redbreast sunfish *Lepomis auritus*, white sucker *Catostomus commersoni*, largemouth bass *Micropterus salmoides*, tessellated darter *Etheostoma olmstedii*, and one individual each of yellow bullhead *Ameiurus natalis*, chain pickerel *Esox niger*, and sea lamprey *Petromyzon marinus* (See Table 1). The fish assemblage present is typical of larger low-gradient streams. Numbers were relatively low, but this was most likely due to “poor” sampling efficiency.

In the Massachusetts Surface Water Quality Standards (MSWQS), the Shawsheen River is classified as Class B Treated Water Supply, Warm Water from its source downstream to the mile point 18 and as a Class B Warm Water from mile point 18 downstream to its confluence with the Merrimack River in Lawrence. (MassDEP 2006b). MA09A-111 is located within this Class B Warm Water segment.

MA09A-181, Shawsheen River, approximately 15 meters upstream of Mill Street, Tewksbury

Located upstream of MA09A-111, Shawsheen River upstream of Mill Street in Tewksbury (MA09A-181) is a fourth order stream with a drainage area of approximately 145.5 Km². The sampled reach was of moderate gradient with rocky to gravelly substrates, contained a fast deep riffle section, and ended in a broad run. Four of the seven primary habitat parameters scored in the “optimal” category. Epifaunal substrate, embeddedness, and channel flow status scored “suboptimal”. For secondary parameters, bank vegetative protection scored “optimal”, bank stability scored “suboptimal” and riparian vegetative zone width scored “optimal” and “sub-optimal” in the right and left zones, respectively. The final habitat score was 154 out of 200 (See Table 2). The watershed upstream is a mix of landuses including, forested, residential, commercial, and industrial.

Fish species captured, or (observed as is the case for American eel), in order of abundance included American eel, fallfish, white sucker, yellow perch *Perca flavescens*, redbreast sunfish, creek chubsucker *Erimyzon oblongus*, yellow bullhead, and one individual each of redfin pickerel *Esox americanus*, and largemouth bass (See Table 1). Large numbers of American eel were noted as being observed but not collected and sampling efficiencies were noted as being fair. The fish community was dominated by American eel, a species whose numbers may be declining in New England waters. The United States Fish and Wildlife Service (USFWS) have initiated a review of the status of the species to determine if it warrants listing under provisions of the Endangered Species Act (ESA) (USFWS 2011). Fallfish, a moderately tolerant, regional fluvial dependant species were the most abundant fish actually collected. Their presence and the presence of creek chubsucker, an intolerant fluvial species, suggests a stable flow regime and good water quality.

In the MSWQS, the Shawsheen River is classified as Class B Treated Water Supply, Warm Water from its source to the mile point 18 and as Class B Warm Water from mile point 18 to its confluence with the Merrimack River. MA09A-181 is located within the Class B Warm Water segment.

MA09A-115, Shawsheen River, approximately 170 meters downstream of Salem Road (Route 129), Wilmington/Billerica

Located upstream of MA09A-181, Shawsheen River downstream of Route 129 (MA09A-115) is a third order stream with a drainage area of approximately 95 Km². The sampled reach was essentially a straight low gradient sandy bottomed run with a couple of deep slow pools near the banks. The Middlesex Canal is located just upstream and this section of the river may have been channelized as a result of construction of the canal in 1800. Five of the seven primary habitat parameters scored in the “suboptimal” category. Bottom substrate/available cover and channel sinuosity scored “marginal” and “poor” respectively. For secondary parameters, bank vegetative protection scored “optimal”, riparian vegetative zone width scored “optimal” and “suboptimal” in the right and left zones respectively and bank stability scored “suboptimal”. The final habitat score was 129 out of 200 (See Table 2). The watershed upstream is a diverse mix of landuses including, forested, residential, commercial, and industrial.

Fish species captured in order of abundance included American eel, redfin pickerel, chain pickerel, redbreast sunfish, yellow perch, largemouth bass, white sucker, creek chubsucker, fallfish, blacknose dace *Rhinichthys atratulus*, and pumpkinseed *Lepomis gibbosus*. (See Table 1). As noted at MA09A-181, the United States Fish and Wildlife Service (USFWS) has initiated a review of the status of American eel to determine if it warrants listing under provisions of the Endangered Species Act (ESA) (USFWS 2011). Although the fish community is diverse and includes a mix of fluvial specialist/dependants and macrohabitat generalists, most species were represented by only three or less individuals. Sampling efficiencies were rated as “poor” due to the width of the river at the sampling location. It should also be noted that the generator ran out of gas just prior to completion of the sampling run.

In the MSWQS, the Shawsheen River is classified as Class B Treated Water Supply, Warm Water from its source to the mile point 18 and as a Class B Warm Water from mile point 18 to its confluence with the Merrimack River. MA09A-115 is located within the Class B Warm Water segment.

MA09A-149, Shawsheen River, approximately 100 meters upstream of Middlesex Turnpike in Bedford.

Shawsheen River upstream of Middlesex Turnpike in Bedford (MA09A-149) is a third order stream with a drainage area of approximately 70.5 Km². The river originates near Hanscom Field in Bedford and flows north. It meanders through broad floodplains and extensive freshwater wetlands that provide excellent habitat for beaver, mink, muskrat and several species of waterfowl (MADEP 2003).

The sampled reach was located in a wetland and comprised a straight, medium depth, low gradient channel, with silt and sand substrates. The sampled reach flowed parallel with the road. None of the seven primary habitat parameters scored in the “optimal” category. Four of the parameters (bottom substrate/available cover for fish and invertebrates, pool substrate characterization, channel alteration, and channel flow status) scored “suboptimal”. Sediment deposition scored “marginal” and pool variability and channel sinuosity scored poor. For secondary parameters, bank vegetative protection scored “optimal”, bank stability scored “suboptimal” and riparian vegetative zone width scored “optimal” and “poor” in the left and right zones respectively. The final habitat score was 111 out of 200 (See Table 2). The watershed upstream is a mix of landuses including, forested, residential, commercial, and industrial.

Fish species captured included primarily redbfin pickerel and American eel. Creek chubsucker, banded sunfish *Enneacanthus obesus*, fallfish, chain pickerel, yellow bullhead, redbreast sunfish, and tessellated darter were also present. (See Table 1). Incredibly difficult wading and limited visibility resulting from the presence of thick mud and subsequent cloudy water made fish collection difficult at best. The fish assemblage present is typical of low gradient streams. Numbers were relatively low but this may have been due to less-than-ideal sampling conditions.

In the MSWQS, the Shawsheen River is classified as Class B Treated Water Supply, Warm Water from its source to the mile point 18 and as Class B Warm Water from mile point 18 to its confluence with the Merrimack River. MA09A-149 is located within the Class B Treated Water Supply, Warm Water section of the river.

MA09A-159, Saugus River approximately 275 meters downstream of Salem Street in Lynnfield and Wakefield

Located within the North Coastal Watershed, the Saugus River originates as the outflow of Lake Quannapowitt in Wakefield. It flows into and through a large wetland (Reedy Meadow) then flows south and east through Saugus and ultimately into Lynn Harbor. Saugus River (MA09A-159) is a third order stream with a drainage area of approximately 29 Km² (USGS 2009). The sampled reach was of low gradient with sand and silt substrates predominating.

Only two of the seven primary habitat parameters (pool variability and channel alteration) scored in the “optimal” category. All other primary parameters scored “sub-optimal”. For secondary parameters, bank vegetative protection scored optimal, bank stability scored suboptimal, and riparian vegetative zone width scored “suboptimal” and “marginal” on the left and right banks respectively. The final habitat score was 145 out of 200 (See Table 2). The watershed (with the exception of wetlands) is heavily developed, residentially, with some commercial and industrial landuse present as well.

Fish species captured in order of abundance included large numbers of American eel, (>100 collected and/or observed), yellow perch, redbfin pickerel, white sucker, pumpkinseed and one each of bluegill and yellow bullhead (See Table 1). Sampling efficiencies were good to excellent. The fish community was dominated by American eel, a species whose numbers may be declining in New England waters. The United States Fish and Wildlife Service (USFWS) have initiated a review of the status of the species to determine if it warrants listing under provisions of the Endangered Species Act (ESA) (USFWS 2011). Yellow perch, a macrohabitat generalist, was the next most abundant species collected. This is most likely due to the close proximity of Reedy Meadow and Lake Quannapowitt. The presence of white

sucker, a tolerant fluvial species, suggests a stable flow regime. Sedimentation in the form of very fine silt and muck was definitely a problem in some of the pools.

The MSWQS divide the Saugus River into four distinct segments for classification purposes. From its source to the “canal which discharges into Hawkes Pond (river mile 10.5)” it’s listed as Class B Treated Water Supply. From the aforementioned canal to Saugus Iron Works at Bridge Street (river mile 5.1), it’s listed as a Class B Warmwater. From the Saugus Iron Works at Bridge Street to the Boston Street Bridge (river mile 3.1) it’s listed as Class SB shellfishing, and from Boston Street Bridge to the mouth it’s listed as Class SB shellfishing, outstanding resource water, CSO. Saugus River MA09A-159 is located within the second segment which is classified as Class B Warmwater.

MA09A-143, Proctor Brook approximately 60 meters downstream of Caller Street in Peabody

Also located within the North Coastal Watershed, Proctor Brook originates in West Peabody south of Mount Pleasant, and flows east through the towns of Peabody and Salem. It picks up flow from four relatively small tributaries before emptying into the North River near Beverly Harbor. Proctor Brook at MA09A-143, downstream of Caller Street in Peabody, is a second order stream with a drainage area of 25 Km². The sampled reach was situated within a concrete-walled channel. The stream was straight, of low gradient, and contained mostly hard sand and gravel substrates.

Only one of the seven primary habitat parameters (pool substrate characterization) scored in the “optimal” category. Sediment deposition scored “suboptimal” and all other primary parameters scored “marginal” or “poor”. For secondary parameters, bank vegetative protection scored “suboptimal”, bank stability scored “optimal” and “suboptimal” on the right and left banks respectively, and riparian vegetative zone width scored “poor”. The final habitat score was 81 out of 200 (See Table 2). The watershed is heavily developed residentially, commercially and industrially. There are two golf courses present and only fifteen percent of the watershed is forested.

Fish species captured in order of abundance included large numbers of American eel, (>100 collected and/or observed), golden shiner *Notemigonus crysoleucas*, and one pumpkinseed. (See Table 1). Sampling efficiencies were good to excellent. The fish community was dominated by American eel, a species whose numbers may be declining in New England waters. The United States Fish and Wildlife Service (USFWS) have initiated a review of the status of the species to determine if it warrants listing under provisions of the Endangered Species Act (ESA) (USFWS 2011). Golden shiner and pumpkinseed, both macrohabitat generalists, were the only other fish present. This station contained very little fish holding cover other than shopping carts and debris in the form of trash. It is likely that high flows scour the reach regularly. Proctor Brook is unlisted and therefore classified by default as a Class B Warmwater in the MSWQS.

MA09A-158, Johnson Creek approximately 390 meters upstream of Main Street in Groveland

Located within the Merrimack River Watershed, Johnson Creek originates as the outlet of Johnsons Pond in Groveland. Johnson Creek flows north through South Groveland, picks up flow from Argilla Brook and then discharges to the Merrimack River. MA09A-158 is located upstream of the confluence of Argilla Brook and just downstream of a drained impoundment. Johnson Creek is a small third order stream at this location with a drainage area of approximately 16 Km². The stream was moderate to high gradient with mostly rock, cobble, gravel, and sand substrates.

Two of the seven primary habitat parameters (Instream cover for fish, and epifaunal substrate) scored within the “optimal” category. With the exception of channel flow status which scored “marginal”, the remainder of the primary habitat parameters scored “suboptimal”. For secondary parameters, bank vegetative protection and riparian vegetative zone width scored “optimal”, however, bank stability scored only “poor” due to large areas of eroded bank being present. All erosion appeared fairly fresh. It appears that spring flooding (or possibly the draining of the impoundment located just upstream) have impacted this reach and high flows could be problematic for some time to come. The final habitat score was 145 out of 200

(See Table 2). The watershed is approximately fifty percent forested with residential and a small amount of cropland and sand and gravel mining making up the most of the remaining land use.

Fish species captured in order of abundance included pumpkinseed, American eel, golden shiner, fallfish white sucker, chain pickerel, tessellated darter, black crappie, banded sunfish, blacknose dace, and yellow bullhead (See Table 1). Sampling efficiencies were only fair due to a couple of deep pools and a few impenetrable blowdowns.

Sampling conducted by MA DFG downstream in Johnson Creek during the summer of 2002 resulted in the collection of a similar assemblage, however, their sample was dominated by white sucker. The presence of many macrohabitat generalists is most likely due to the highly impounded nature of this system.

Although Johnson Pond and its tributaries are listed as Class A Water Supplies in the MSWQS, Johnson Creek is unlisted and therefore classified by default as a Class B Warmwater.

MA09A-128, Cobbler Brook east of Hansom Drive, approximately 1.2 Km downstream of Harriman Road in Merrimac

Located within the Merrimack River Watershed, Cobbler Brook originates on or near the Massachusetts and New Hampshire border on the south side of Highlands Hill in Merrimac. It flows southeast through the Town of Merrimac and discharges to the Merrimack River near Merrimacport. At MA09A-128 Cobbler Brook is a 2nd order stream with a drainage area of approximately 2.25 Km². The stream at the sampling location was low to moderate gradient with mostly silty substrates. The “rail-trail” that is located just upstream of the sampled site has created a small wetland impoundment.

None of the seven primary habitat parameters scored within the “optimal” category. Channel alteration scored “suboptimal”, five other primary habitat parameters scored “marginal”, and sediment deposition scored poor. For secondary parameters, all scored in the “optimal” category. The presence of a small wetland impoundment and large agricultural fields (which appear to extend right to the banks of the brook) located a short distance upstream may be the source of the fine silt which was prominent in the lower portion of the sampled reach. The final habitat score was 114 out of 200 (See Table 2). The watershed is heavily forested (~70 percent) with some agricultural and residential landuses present as well.

Fish species captured in order of abundance included American eel, banded sunfish, chain pickerel, brown bullhead *Ameiurus nebulosus*, and a single creek chubsucker. (See Table 1). Most fish were captured in the few deeper pools that were present and sampling efficiencies were noted as being good. Sampling conducted by MA DFG at two locations upstream from MA09A-128 during 2006 resulted in the collection of not only large numbers of brook trout (an intolerant cold water fluvial specialist), but blacknose dace and fallfish (two additional fluvial fish) as well (MA DFG 2008). The discrepancies between the three assemblages are almost certainly due to habitat and flow problems.

Cobbler Brook is classified as Class B Cold Water in the MSWQS and is also on the Massachusetts Department of Fish and Game (MA DFG) Coldwater Fishery Resource List (MA DFG 2007).

MA09A-174, Little River, approximately 300 meters upstream of Route 495 in Haverhill

Located within the Merrimack River Watershed, Little River at MA09A-174 is a fourth order stream with a drainage area of approximately 60 Km² (USGS 2009). The river originates in New Hampshire and flows south to its confluence with the Merrimack River in Haverhill. The sampling location was low gradient and deep which made fish collection very difficult.

Only one of the seven primary habitat parameters (channel alteration) scored in the “optimal” category. Most scored “sub-optimal” and channel sinuosity scored “marginal”. For secondary parameters, bank vegetative protection and riparian vegetative zone width scored “optimal” and bank stability scored

“optimal” and “suboptimal” on the left and right banks, respectively. The final habitat score was 147 out of 200 (See Table 2). Landuse is primarily forested and residential in New Hampshire and a mix of forested, residential, industrial, and commercial in Massachusetts.

Fish species captured in order of abundance included fallfish, American eel, largemouth bass, redbin pickerel, eastern blacknose dace, white sucker, and an unidentified sunfish (See Table 1). Fallfish dominated the sample however, and the total number of fishes was extremely low (n= 28). This may be due to “poor” sampling efficiency resulting from the low gradient nature of the reach and a large deep pool which comprised most of the lower end of the reach. The dominance by fallfish, a moderately tolerant, regional fluvial dependant species suggests a stable flow regime and good water quality.

The Massachusetts Department of Fish and Game (MA DFG) sampled a station located a short distance upstream in 2006. They found a similar assemblage also dominated by fallfish (MA DFG 2008).. Little River is listed as Class B Warm Water in the MSWQS.

MA09A-118, Deep Brook approximately 150 meters downstream of Ledge Road in Chelmsford

Another Merrimack River tributary, Deep Brook at MA09A-118, downstream of Ledge Road, is a small second order stream with a drainage area of approximately 2.4 Km². The lower end of the sampled reach was low to moderate gradient and the upper end was moderate to high gradient. It should be noted that flows were extremely low on the date of the sampling.

For the moderate to high gradient section of the reach, only one of the seven primary habitat parameters (channel alteration) scored in the “optimal” category. Instream cover for fish scored “suboptimal”. Sediment deposition and velocity depth combinations scored “marginal” and channel flow status scored “poor”. Epifaunal substrate and embeddedness were not scored. For secondary habitat parameters bank vegetative protection and riparian vegetative zone width scored “optimal” and bank stability scored “marginal”. The lower-most section of the sampled reach was heavily sedimented. The final habitat score for the upper section (moderate to high gradient) of the reach was 95 of a possible 160. The habitat score for the lower section (low to moderate gradient) of the reach was 120 (See Table 2). The watershed upstream of the sampled reach is mostly medium density residential, forested, and sand and gravel mining land uses.

Fish species captured in order of abundance included banded sunfish, white sucker (n=2), and one each of pumpkinseed, golden shiner, and brown bullhead. All fish collected are classified as tolerant or moderately tolerant macrohabitat generalists. Flow was extremely low on the date of the sampling.

It should be noted that although Deep Brook is classified as a Coldwater Fishery Resource (CFR) by MassWildlife (MassWildlife 2007), it is classified as a Class B, warmwater in the MSWQS. Deep Brook easily met Class B coldwater fishery standards for temperature and dissolved oxygen when it was sampled by DEP in 2004. In addition, when Mass DEP DWM sampled Deep Brook in 1990, the fish population survey resulted in the collection of seventeen native brook trout. The absence of trout in 2004 and again in 2010 is disheartening, particularly in light of the cold well-oxygenated water available in Deep Brook. Although the majority of the watershed is still forested (67%), there has been residential development and road construction in the watershed in recent years and the sedimentation noted in pools and very low flows may be responsible for what seems to be the loss of brook trout.

MA09A-101, South Branch Souhegan River approximately 670 meters downstream of Jones Hill Road in Ashby

Located within the Merrimack River Watershed, South Branch Souhegan River originates as the outlet of Watatic Pond in Ashburnham and Ashby. Flows from Stodge Meadow Pond, as well as Marble and Ward Ponds, feed Watatic Pond. The South Branch Souhegan River leaves Watatic Pond then flows north through a series of six very small ponds/impoundments before picking up flow from an unnamed tributary which joins from the west. Just downstream from this confluence at MA09A-101, South Branch Souhegan River is a third order stream with a drainage area of approximately 22.4 Km². It is of moderate to high gradient with boulder, cobble, and sand substrates. There were a number of blown down large trees present which most likely resulted from spring flooding in 2010. Five of the seven primary habitat parameters scored in the “optimal” category. Sediment deposition scored “suboptimal” and channel flow status scored “marginal”. For secondary parameters, bank vegetative protection and riparian vegetative zone width scored “optimal” and bank stability scored “suboptimal” and “marginal” on the right and left banks, respectively. The final habitat score was 166 out of 200 (See Table 2). The watershed is mostly forested with some residential land use. Bank erosion from recent high flows has resulted in a number of large trees falling into and across the stream, as well as an increase in sediment deposition.

The fish assemblage in order of abundance, included a balanced mix of fallfish, brook trout *Salvelinus fontinalis*, white sucker, and common shiner *Luxilus cornutus*. A single yellow bullhead was also collected. (See Table 1). During the summer of 2000, the Massachusetts Department of Fish and Game (MA DFG) sampled two reaches located further upstream on the South Branch Souhegan River. They found brook trout (along with a number of macrohabitat generalists) at one location, and very few fish at the other location.

Although there was a fair amount of streamside erosion and subsequent deposition due to apparent high spring flows, the presence of multiple year classes of brook trout, an intolerant species, as well as three other fluvial specialists/dependants, suggests a stable flow regime and excellent water and habitat quality. Detrimental effects of the recent floods may take a couple of years to be clearly seen in the fish community. Being unlisted, the South Branch Souhegan River is classified by default as Class B Warmwater in the MSWQS. It is on the MA DFG's Coldwater Fishery Resource List (MA DFG 2007). South Branch Souhegan River should be re-classified as Class B Cold Water during the next revision of the MSWQS.

MA09A-107, Beaver Brook approximately 100 meters upstream of Summer Street in Chelmsford

Located within the SuAsCo Watershed, Beaver Brook originates as the outlet of Tadmuck Swamp in Westford. It flows northeast along the south side of Route 495 through South Chelmsford and Chelmsford Center and ultimately discharges into River Meadow Brook. Beaver Brook at MA09A-107 is located within a wetland in Chelmsford Center. It is a second (or small third) order stream with a drainage area of approximately 14 Km² at this location. The sampling reach is straight, low gradient with mostly sand, silt and clay substrates. Only one of the seven primary habitat parameters (channel flow status) scored in the “optimal” category. Pool substrate characterization, pool variability, and channel alterations scored “suboptimal” and the remainder of the primary parameters scored “marginal”. All secondary parameters scored “optimal”. The final habitat score was 137 out of 200 (See Table 2).

Fish were relatively scarce (n=29) and species captured in order of abundance included redbfin pickerel, white sucker, golden shiner and pumpkinseed (See Table 1). Fish habitat was limited within this reach, and this appears to be reflected in the fish sample. Although redbfin pickerel are common in low gradient streams, they are classified as macrohabitat generalists. White sucker (n=6) were the only fluvial species present in this reach. Landuse within the watershed is a mix of residential, forested, wetlands, commercial, and industrial. It should be noted that, aside from the riparian wetlands, the immediate watershed is entirely developed.

Beaver Brook is unlisted and therefore classified by default as a Class B Warmwater in the MSWQS.

MA09A-144, Nashoba Brook approximately 750 meters upstream from Route 2A/119, Acton

An Assabet River tributary, Nashoba Brook originates in a wetland located south of Route 495 near Nashoba Hill in Littleton. It flows southeast and receives flow from Butter and Nonset Brooks before turning to the south. It continues through North Acton and picks up additional flow from Nagog and Vine Brooks before discharging into Pond Brook just upstream from Warners Pond and the Assabet River in Concord. Nashoba Brook at MA09A-144 is a third or fourth order stream with a drainage area of approximately 34 Km². At the sampling station the brook flowed through a large wetland and was of low to moderate gradient with mostly sandy substrates. Flows were noted as being very high on the day of the sampling. The watershed upstream is a diverse mix of landuses including, forested, residential, commercial, industrial, and agricultural. Four of the seven primary habitat parameters scored in the "optimal" category. Pool substrate characterization and sediment deposition scored "suboptimal" and channel sinuosity scored "marginal". For secondary parameters, bank vegetative protection and bank stability scored "optimal" and riparian vegetative zone width scored "optimal" and "suboptimal" in the right and left zones, respectively. This was due to a railroad bed located in the left zone. The final habitat score was 167 out of 200 (See Table 2).

Fish species captured in order of abundance included creek chubsucker, golden shiner, redbfin pickerel, white sucker and a single brown bullhead. Creek chubsuckers are an intolerant fluvial specialist and their presence and dominance suggest excellent water quality and a stable flow regime. Sampling efficiencies were excellent to start but were rated as "poor" overall due to high water and the presence of a deep pool near the end of the reach. During the summers of 2000 and 2006, the Massachusetts Department of Fish and Game (MA DFG) sampled two reaches located a short distance from MA09A-144 (one upstream and one downstream). Both of their samples were dominated by macrohabitat generalists and their 2006 sample contained very few fish. Nashoba Brook is unlisted and therefore classified by default as a Class B Warmwater in the MSWQS.

MA09A-172, Unnamed Tributary known locally as "Coles Brook" approximately 160 meters upstream of Robinwood Road in Acton

"Coles Brook" originates near the intersection of Routes 2 and 27 in Acton. It flows east southeast to its confluence with Fort Pond Brook also in Acton. At MA09A-172, "Coles Brook" is a very small third order stream with a drainage area of only 4.3 Km². The sampled reach is of moderate gradient and flows through a residential area. Substrates are noted as gravel, sand, and cobble. Three of the seven primary habitat parameters scored in the "optimal" category. Instream cover for fish, sediment deposition and velocity depth combinations scored "suboptimal" and channel flow status scored "marginal". For secondary parameters, bank vegetative protection scored "optimal" and bank stability and riparian vegetative zone width scored "suboptimal". The final habitat score was 153 out of 200 (See Table 2). Although the stream flows through wooded wetlands, the watershed is developed residentially with some commercial and industrial landuse present as well.

Fish numbers were very low (n=14), and only fallfish and redbfin pickerel were present (See Table 1). The sample was dominated by fallfish, a moderately tolerant fluvial species indicative of both good water and habitat quality and a stable flow regime; however, fish habitat was limited due to low water levels."Coles Brook" is unlisted and therefore classified by default as a Class B Warmwater in the MSWQS.

MA09A-180, Elizabeth Brook approximately 50 meters downstream of Delaney Street, Stow

Elizabeth Brook downstream of Delaney Street at MA09A-180 is a small fourth order stream with a drainage area of approximately 38.6 Km² (USGS 2009). The brook originates west of Route 495 in Boxborough and initially flows south. It turns towards the east and then once again south flowing through a series of small impoundments. It receives a considerable amount of flow from Great Brook at Delaney Pond which is located a short distance upstream from the sampling location. The sampled reach is located at the northern (upstream) edge of Hiley Meadows and included two distinct gradient types. The lowermost section was low gradient with cobble, pebble, gravel, and sand substrates predominating. Within this section four of the seven primary habitat parameters scored in the "optimal" category. Bottom

substrate/available cover scored “suboptimal” and pool variability and channel sinuosity scored “marginal”. For secondary parameters, bank vegetative protection scored “optimal” and “suboptimal” on the left and right bank respectively, bank stability scored “optimal” on both banks, and riparian vegetative zone width scored “optimal” and “marginal” in the left and right zones respectively. The final habitat score was 150 out of 200 (See Table 2). The upper portion of the reach was higher gradient and braided into two channels. Both channels were essentially dry with the exception of some isolated pools on the eastern side channel. The watershed upstream of the sampling station includes primarily forested and residential landuses. There is a commercial/industrial property located adjacent to the sampled reach.

Fish species captured in order of abundance included redbfin pickerel, chain pickerel, and one individual each of American eel, yellow perch, largemouth bass and brown trout *Salmo trutta*. The brown trout appeared to be a stocked fish and the largemouth bass was young-of-the-year. (See Table 1). Low numbers of fish (n=18) are mostly likely attributable to the extremely low flows which were documented on the day of the sampling. The presence of macrohabitat generalists reflects the low gradient, highly impounded nature of Elizabeth Brook.

Elizabeth Brook is not listed and thereby classified by default as a Class B Warm Water in the MSWQS.

MA09A-152, Elizabeth Brook upstream of Wheeler Road, Stow

Elizabeth Brook upstream of Wheeler Road at MA09A-152 is a fourth order stream with a drainage area of approximately 43.8 Km² (USGS 2009). The brook originates west of Route 495 in Boxborough and initially flows south. It turns towards the east and then once again south flowing through a series of small impoundments. It receives a considerable amount of flow from Great Brook at Delaney Pond before flowing through Hiley Meadows and Wheeler Pond which is located just a short distance upstream from the sampled reach. The sampled reach consisted of moderate gradient riffle run sections which bracketed a large deep pool. Within the sampled reach, six of the seven primary habitat parameters scored in the “optimal” category. Channel sinuosity scored “suboptimal”. For secondary parameters, bank vegetative protection and bank stability scored “optimal” and riparian vegetative zone width scored “optimal” and “suboptimal” in the left and right zones respectively. The final habitat score was 169 out of 200 (See Table 2). It should be noted that the reach located just downstream of MA09A-152 was very low gradient, and that flows appear to slow considerably just downstream from Wheeler Road bridge. The watershed upstream of the sampling station is comprised primarily of forested and residential landuses. There is a golf course located just upstream from MA09A-152.

Fish species captured in order of abundance included largemouth bass, bluegill, yellow bullhead, American eel, pumpkinseed, redbfin pickerel, creek chubsucker, and black crappie *Pomoxis nigromaculatus* (See Table 1). Sampling efficiencies were noted as being fair to start, “poor” within the pool section and then fair again in the uppermost section of the reach.

The Massachusetts Department of Fish and Game (MA DFG) sampled the same location in 2001 using a barge shocker. They found a similar assemblage also dominated by macrohabitat generalists however they found many more individuals. High water in the large deep pool made shocking difficult and this may have accounted for the lower numbers of fish collected in 2010. The dominance by tolerant macrohabitat generalists in both years is indicative of the low gradient, highly impounded nature of this brook. Elizabeth Brook is not listed, and thereby is classified by default as Class B Warm Water, in the MSWQS.

MA09A-170, Hop Brook approximately 850 meters downstream of Peakham Road in Sudbury

Hop Brook originates as the outlet of Carding Millpond in Sudbury and flows north. It picks up flow from two unnamed tributaries before entering Stearns Millpond. After exiting the Stearns Millpond the brook turns east, picks up additional flow from Run Brook, then turns south and picks up flow from Dudley Brook. Hop Brook eventually turns back towards the east and flows through the Great Meadows National Wildlife Refuge where it joins the Sudbury River. Hop Brook at MA09A-170 is a 3rd order stream with a drainage area of approximately 37.8 Km². The sampled reach is of low gradient and flows through a narrow wetland which is located between a large commercial nursery and an industrial area owned by the Town of Sudbury Department of Public Works. Substrates are noted as being sand and silt with a small amount of gravel. Two of the seven primary habitat parameters (channel alteration and channel flow status) scored in the “optimal” category. The remaining five primary parameters scored suboptimal. For secondary parameters, bank vegetative protection and bank stability scored “optimal” and riparian vegetative zone width scored “optimal” and “suboptimal” in the left and right zones, respectively. The final habitat score was 158 out of 200 (See Table 2). The watershed upstream of MA09A-170 is a mix of forested and medium density residential landuses.

Fish species captured in order of abundance included fallfish, yellow bullhead, redbfin pickerel, largemouth bass, white sucker and one individual each of pumpkinseed and redbreast sunfish (See Table 1). Sampling efficiencies were noted as being good, however, overall fish numbers were low (n=40) given the available habitat. During the summer of 2007, the Massachusetts Department of Fish and Game (MA DFG) sampled two reaches in the vicinity of MA09A-170 (one located upstream and one downstream). They found similar assemblages and low numbers of fish at each location as well. The dominance by fallfish is indicative of good water quality and a stable flow regime, and in light of the amount of ponds and impoundments located upstream, the presence of macrohabitat generalists is not surprising. It is unclear what, if anything may be contributing to the apparent low numbers of fish.

Hop Brook (Sudbury) is classified by MassDEP as a Class B, warmwater, however, it is on the MA DFG Coldwater Fishery Resource List (MA DFG 2007). Additional sampling and or investigation into the historic records should be pursued prior to any re-classification of Hop Brook.

MA09A-154, Unnamed Tributary to the Sudbury River known locally as Cochituate Brook (two reaches), approximately 200 and 350 meters upstream of School Street in Framingham

The unnamed tributary locally known as Cochituate Brook originates as the outlet of Lake Cochituate and flows northwest to its confluence with the Sudbury River in Saxonville (a village in Framingham). Cochituate Brook at MA09A-154 is a 3rd order stream with a drainage area of approximately 52 Km². Two separate reaches were sampled at this location. Both reaches were shaded, straight, of moderate gradient, and appeared to be channelized. Substrates within the downstream reach were predominantly sand and silt. Within this reach, six of the seven primary habitat parameters scored in the “suboptimal” category and sediment deposition scored “marginal”. For secondary parameters, bank vegetative protection scored “optimal” and “marginal” in the left and right zones respectively, bank stability and riparian vegetative zone width scored “suboptimal” and “poor” in the left and right zones respectively. The reach was loaded with trash including discarded automotive parts (including oil filters and batteries), glass, and other debris. The final habitat score in the lower reach was 111 out of 200 (See Table 2).

The upper reach was also comprised of mostly sand and silt substrates but also contained a small amount of gravel, pebble, and cobble. Within this reach, four of the seven primary habitat parameters scored in the “suboptimal” category while instream cover for fish, epifaunal substrate, and embeddedness scored “marginal”. For secondary parameters, bank vegetative protection scored optimal, bank stability scored “suboptimal” and riparian vegetative zone width scored “suboptimal” and “poor” in the left and right zones respectively. The upper reach also contained a fair amount of trash and debris. The final habitat score in the upper reach was 119 out of 200 (See Table 2). The watershed upstream of MA09A-154 is heavily developed both residentially and commercially.

Fish species captured in order of abundance at the lower reach included fallfish, yellow bullhead, and white sucker (See Table 1). Sampling efficiencies were fair, however, overall fish numbers were low (n=33). Fish species captured in order of abundance at the upper reach included fallfish, white sucker, yellow perch, largemouth bass, yellow bullhead and one individual each of golden shiner, redbreast sunfish and American eel. (See Table 1). Sampling efficiencies in the upper reach were fair as well, and aside from fallfish which were relatively abundant, overall numbers of other species were low. The dominance by fallfish is indicative of good water quality and a stable flow regime and in light of the presence of Lake Cochituate which is located a short distance upstream, the presence of macrohabitat generalists is not surprising. A general lack of adequate fish habitat appears to be contributing to the low numbers of fish in Cochituate Brook.

Unnamed tributary known as Cochituate Brook is not listed and therefore classified by default as a Class B, warmwater in the MSWQS.

MA09A-186, Stony Brook, 0.5 Km downstream of Sudbury Reservoir in Framingham

Stony Brook is a short riverine segment which originates as the outlet of Sudbury Reservoir in Southborough and flows south into Foss Reservoir # 3 in Framingham. Although Stony Brook is a fourth order stream with drainage area of approximately 59 Km², the entire length of this brook is only 0.64 Km. The sampled reach is of moderate gradient with substrates consisting almost entirely of boulders, cobble, pebble, and gravel. Five of the seven primary habitat parameters scored in the "optimal" category. Velocity depth combinations scored "suboptimal" and channel flow status scored "poor". For secondary parameters, bank vegetative protection scored "optimal" and "suboptimal" on the left and right bank respectively, bank stability scored suboptimal, and riparian vegetative zone width scored "optimal". The final habitat score was 164 out of 200 (See Table 2). The watershed upstream of MA09A-186 (and the Sudbury Reservoir) is mostly developed. The watershed includes downtown Marlborough and landuse is primarily residential (multiple densities), commercial, and industrial. Only 35 percent of the watershed is forested.

Fish species captured in order of abundance included yellow perch, largemouth bass, bluegill, yellow bullhead, and golden shiner (See Table 1). It should be noted that with the exception of young-of-the-year and year one fishes, older fish were absent. Given the high quality fish habitat which was present, the total absence of fluvial fish and older specimens of macrohabitat generalist species, is most likely the result of inadequate flows.

Although Stony Brook is unlisted in the MSWQS, it is classified as Class A (warmwater) due to the fact that it is tributary to Foss Reservoir # 3.

MA09A-185, Cold Harbor Brook approximately 100 meters upstream of Route 290 in Northborough

Located within the Assabet River Watershed, Cold Harbor Brook originates as the outlet of Rocky Pond in Northborough and flows southeast to its confluence with the Assabet River also in Northborough. Cold Harbor Brook at MA09A-185 is a second order stream with a drainage area of approximately 11.4 Km². The sampled reach is located within an on-ramp/off-ramp cloverleaf just upstream of Route 290 west. The reach appears to have been channelized and completely armored with large flat rocks. This most likely occurred around the time of the construction of the cloverleaf. Substrates predominantly consisted of boulders, sand and gravel. Only one of the seven primary habitat parameters (sediment deposition) scored in the "optimal" category. Instream cover for fish and velocity–depth combinations scored "suboptimal". Epifaunal substrate, embeddedness and channel flow status scored "marginal" and channel alteration scored "poor". All secondary parameters scored optimal. The final habitat score was 126 out of 200 (See Table 2). The watershed contains a mix of forested, residential, and agricultural landuse.

Only two species of fish were collected. Multiple age classes of blacknose dace dominated with three young-of-the-year white sucker making up the remainder of the sample (See Table 1). During the summer

of 2000, the Massachusetts Department of Fish and Game (MA DFG) sampled a reach located a short distance upstream from MA09A-185. Their samples were also heavily dominated by blacknose dace but also contained largemouth bass and bluegill which are both macrohabitat generalists. The presence and dominance by blacknose dace, a tolerant fluvial species suggests a stable flow regime, however habitat at MA09A-185 is definitely limited due to the channelization and armoring. High flows during storm events may be impacting the fish community as well.

Cold Harbor Brook is not listed, and therefore classified by default as a Class B, warmwater in the MSWQS.

MA09A-105, Cold Harbor Brook upstream from Crawford Street in Northborough

Located within the Assabet River Watershed, Cold Harbor Brook originates as the outlet of Rocky Pond in Northborough and flows southeast to its confluence with the Assabet River also in Northborough. Cold Harbor Brook at MA09A-105 is a second order stream with a drainage area of approximately 12 Km². The sampled reach is located 0.65 Km downstream of MA09A-185 which was described previously.

Substrates predominantly consisted of boulders, cobble, sand and gravel. Three of the seven primary habitat parameters scored in the “optimal” category. Instream cover for fish, channel alteration and velocity-depth combinations scored “suboptimal” and channel flow status scored “marginal”. For secondary parameters, bank vegetative protection scored “optimal” and “suboptimal” on the right and left banks, respectively. Bank stability scored “suboptimal” and Riparian vegetative zone width scored “optimal” and “marginal” on the right and left banks, respectively. The final habitat score was 149 out of 200 (See Table 2). It should be noted that there is an old dam and small impoundment located just upstream from MA09A-105. The watershed contains a mix of forested, residential, and agricultural landuses.

The fish sample was composed entirely of multiple age classes of blacknose dace (See Table 1). As noted in the previous station description, during the summer of 2000 the Massachusetts Department of Fish and Game (MA DFG) sampled a reach located upstream. Their samples were also heavily dominated by blacknose dace but also contained largemouth bass and bluegill which are both macrohabitat generalists. The presence of blacknose dace, a tolerant fluvial species suggests a stable flow regime and fair water quality, however, it was noted that most of the flow present was a result of leakage from the dam located just upstream.

Cold Harbor Brook is not listed, and therefore classified by default as a Class B, warmwater in the MSWQS.

MA09A-145, Charles River approximately 600 meters downstream of Washington Street (Route 16) in Newton/Wellesley

The Charles River originates in the town of Hopkinton and flows southeast and then meanders to the northeast before emptying into Boston Harbor in Cambridge and Boston. The Charles River at MA09A-145 is a fourth order stream with a drainage area of approximately 562 Km². The sampled reach is located approximately 600 meters downstream of Newton Lower Falls Dam. The reach was a low gradient run with cobble, boulder, sand, and gravel substrates. Overhanging shrubs and vegetation are noted as being the predominant fish habitat present. Only two of the seven primary habitat parameters (sediment deposition and channel flow status) scored in the “optimal” category. Pool substrate characterization and channel alteration scored “suboptimal”. Bottom substrate/available cover scored “marginal”, and pool variability (the reach, as noted, was mostly run) and channel sinuosity scored “poor”. For secondary parameters, bank vegetative protection scored “optimal” and “marginal” on the right and left banks, respectively. Bank stability scored “optimal” and “suboptimal” on the right and left banks, respectively and riparian vegetative zone width scored optimal. The final habitat score was 124 out of 200 (See Table 2). The Charles River watershed is moderately developed overall, while the watershed

upstream in the immediate vicinity of MA09A-145, which is much more heavily developed, contains a mix of residential, commercial, and industrial landuses.

Fish species captured in order of abundance included bluegill, redbreast sunfish, American eel, pumpkinseed, largemouth bass, black crappie, and channel catfish *Ictalurus punctatus*. (See Table 1). The lack of fluvial fish species (other than the catadromous American eel) most likely results from not only the habitat sampled but the low gradient and highly impounded nature of the Charles River as a whole.

Charles River at MA09A-145 is classified as a Class B, warmwater in the MSWQS.

MA09A-148, Charles River 50 meters downstream from Maple Street in Bellingham

The Charles River originates in the town of Hopkinton and initially flows southeast and then meanders to the northeast before emptying into Boston Harbor in Cambridge and Boston. The Charles River at MA09A-148 is a third order stream with a drainage area of 54 Km². This moderate gradient reach contains a series of riffles, runs, and pools. Substrates included a diverse mix of hard materials ranging from boulders to sand. Five of the seven primary habitat parameters scored in the “optimal” category. Epifaunal substrate and channel flow status scored “sub-optimal”. For secondary parameters, bank vegetative protection scored “optimal” and bank stability, and riparian vegetative zone width scored “optimal” and “marginal” on the right and left banks/zones, respectively. This was due to a parking lot located on the left side of the river. Instream cover for fish was scored “optimal” due to the presence of very stable habitat in the form of boulders, logs and undercut banks. The final habitat score was 162 out of 200. Fish sampling efficiency was rated as fair to good. The watershed upstream of the sampling station is comprised of a mix of wetland, forested, residential, industrial and commercial landuses.

The survey resulted in the collection of thirty five yellow bullhead, five largemouth bass, two fallfish, and one pumpkinseed. With the exception of the two fallfish, all other fish collected were tolerant to moderately tolerant macrohabitat generalists. In light of the excellent fish habitat present, the relative absence of fluvial fishes is a concern. Charles River MA09A-148 was previously sampled by DEPs DWM in 2007. At that time, although the sample was also dominated by yellow bullhead, numbers were much lower than in 2010, and fallfish were not collected. Water quality was reported to be excellent during the 2007 survey (Maietta, 2011). It should be noted that the sampled reach is located just downstream from a small impoundment created by the North Bellingham Dam as well as a very large wetland which extends approximately 4 Km upstream. Charles River at MA09A-145 is classified as a Class B, warmwater in the MSWQS.

MA09A-134, Unnamed tributary to the Charles River approximately 50 meters downstream of Farm Street in Dover

This unnamed tributary originates just east of the Charles River and flows through Lyman's Pond and a very small impoundment before discharging into the Charles River. The unnamed tributary at MA09A-134 is a very small 2nd order stream with a drainage area of only 0.75 Km². The sampled reach is of moderate gradient and flows through a predominantly forested area with a few residences. Substrates are noted as gravel, sand, cobble, pebble, boulder, and silt. Three of the seven primary habitat parameters scored in the “optimal” category. Instream cover for fish, epifaunal substrate, and channel flow status scored “suboptimal”, and velocity depth combinations scored “marginal”. For secondary parameters, bank vegetative protection scored “suboptimal” and bank stability and riparian vegetative zone width scored “optimal”. The final habitat score was 157 out of 200 (See Table 2).

A total of ten fish were collected. These included seven redbreast sunfish and three young-of-the-year largemouth bass. The absence of fluvial fishes and the overall low number of fish collected suggests possible issues resulting from low flow events. This unnamed tributary to the Charles River (MA09A-134) is not listed in the MSWQS and is therefore classified by default as a Class B, warmwater.

MA09A-164, Chicken Brook approximately 300 meters downstream of Winthrop Street in Medway

Chicken Brook, a tributary to the Charles River, originates near the Hopkinton line in the town of Holliston. It flows south through a number of very small ponds and or impoundments before joining the Charles River in Medway. Chicken Brook at MA09A-164 is a small third order stream with a drainage area of approximately 16.5 Km². The sampled reach is located just upstream of Park Pond, also in Medway. The reach was of moderate gradient and was predominantly made up of riffles and runs. Substrates were a mix of sand, gravel, pebbles and cobble. Only two of the seven primary habitat parameters (embeddedness, and channel alteration) scored in the “optimal” category. Instream cover for fish, epifaunal substrate, and sediment deposition scored “suboptimal” while velocity depth combinations and channel flow status only scored “marginal”. For secondary parameters, bank vegetative protection scored “optimal” and “marginal” on the right and left banks, respectively, and bank stability and riparian vegetative zone width scored “optimal” and “suboptimal” on the right and left sides of the stream, respectively. This was due to the presence of a very steep bank and ball fields located on the left side of the stream. The final habitat score was 146 out of 200 (See Table 2). The Chicken Brook watershed is moderately developed overall, with a mix of forested, residential, agricultural, and recreational landuses.

Fish species captured in order of abundance included redbreast sunfish, brown bullhead, largemouth bass, yellow bullhead, bluegill, redbfin pickerel, pumpkinseed, and black crappie (See Table 1). Many of the fish sampled were young-of-the-year. In 2007, MADEPs DWM conducted fish population assessment at another Chicken Brook station located approximately 1.5 Km downstream and found a very similar assemblage. The lack of fluvial fish species and large numbers of young-of-the-year generalists most likely result from low flow related impacts and the presence of impoundments both downstream and upstream of the sampled reach. Chicken Brook (MA09A-164) is not listed in the MSWQS and is therefore classified by default as a Class B, warmwater.

MA09A-176, Unnamed tributary approximately 200 meters upstream of Webb Brook Road in Billerica

The unnamed tributary known as Webb Brook is a first order tributary to the Shawsheen River. Webb Brook at MA09A-176 is a very small first order stream with a drainage area of only 1.25 Km². The sampled reach is of moderate gradient and flows through a predominantly residential area with some forest. Substrates in the lower portion of the reach are mostly sand and gravel, while in the upper portion of the reach larger substrates such as pebble, cobble, and boulder predominate. Only one of the seven primary habitat parameters (channel alteration) scored in the “optimal” category. Instream cover for fish, embeddedness, and velocity depth combinations scored “suboptimal”. Epifaunal substrate, sediment deposition and channel flow status scored “marginal”. For secondary parameters, bank vegetative protection scored “optimal”, bank stability scored “marginal”, and riparian vegetative zone width scored “optimal” and “suboptimal” in the left and right zones, respectively. It is noted that there was a fair amount of bank failure evident, possibly as a result of high spring flows in 2010. The final habitat score was 128 out of 200 (See Table 2).

Despite a fair amount of instream cover, fish were absent in this reach. In light of the location of this sampling station in the uppermost reaches of this first order tributary, the absence of fish is most likely due to low flow conditions during 2010 or previous summers. The unnamed tributary known as Webb Brook at (MA09A-176) may be an intermittent stream. It is not listed in the MSWQS and would therefore be classified by default as a Class B, warmwater were it determined to be a perennial stream (MassDEP 2006).

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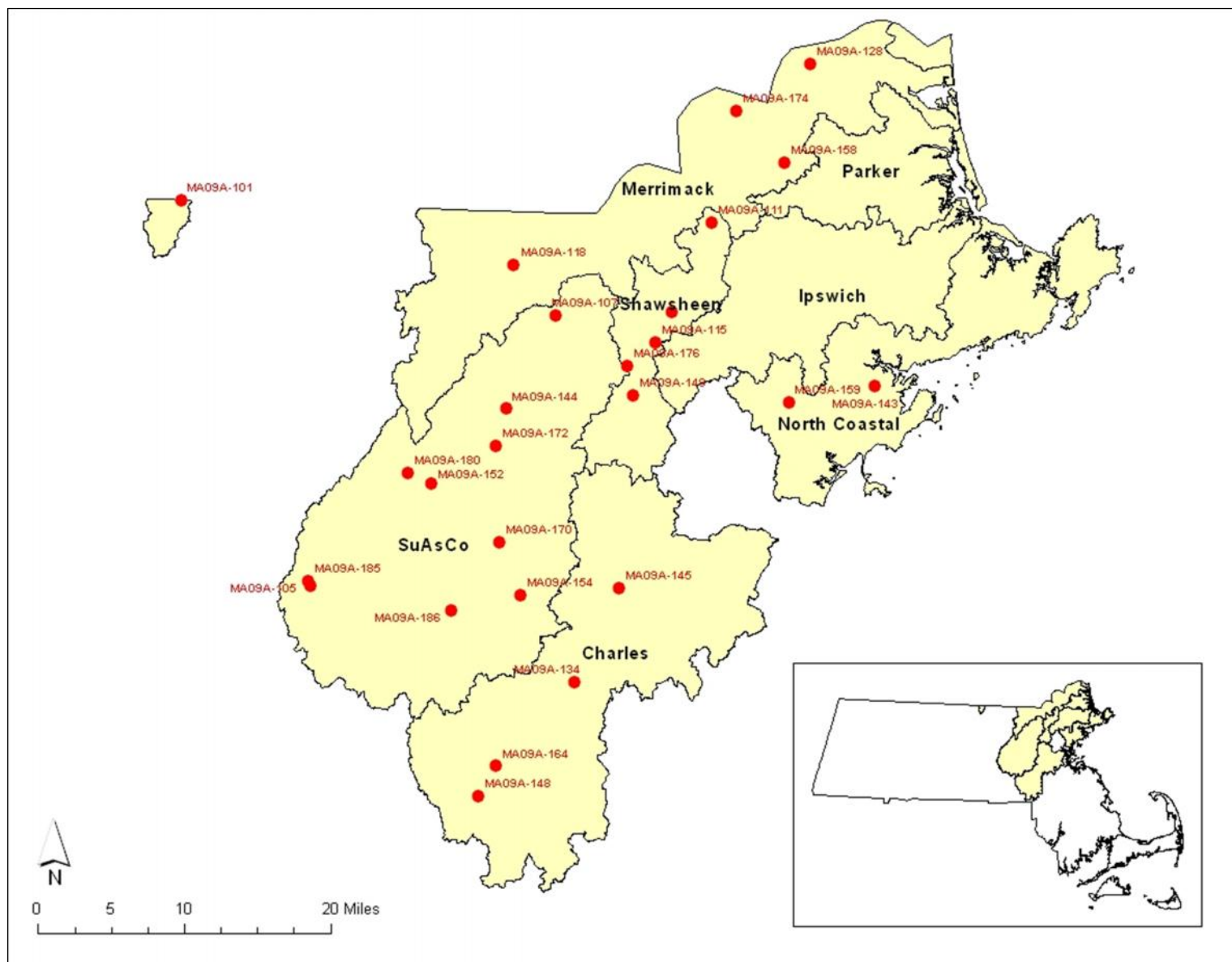


Figure 1. Probabilistic 2010 Fish Population Survey Locations.

Table 1. List of fish population survey station locations and results from the 2010 Probabilistic Fish Population Survey.

Site ID, Station Description	Date	Species Code ¹																			Comments	
		FF	YP	CCS	RFP	LMB	AE	RBS	CP	SL	GS	WS	CC	B	BS	BC	YB/ BB ³	EBT/ BT ⁴	TD	P		BND/ CS
MA09A-111, Shawsheen River approximately 850 meters downstream of Winthrop Avenue (Route 114) in Lawrence]	21 Sept 2010	50	-	-	-	3	26	6(1) ²	1(1)	1	-	6	-	11(1)	-	-	1(1)	-	3	-	-	CP ≤ 75mm RBS ≤ 60mm B < 55mm YB < 55mm considered YOY
MA09A-181, Shawsheen River, approximately 15 meters upstream of Mill Street, Tewksbury.	24 Sept 2010	43	10	5	1	1	>37(2)	7(2)	-	-	-	18	-		-		4	-	-	-	-	AE < 125 mm considered YOY many other AE observed RBS ≤ 50mm considered YOY
MA09A-115, Shawsheen River, approximately 170 meters downstream of Salem Road (Route 129), Wilmington/Billerica	21 Sept 2010	1	3	1	4	2	9	3	3	-	-	2	-	-	-	-	-	-	-	1	1	
MA09A-149, Shawsheen River approximately 100 meters upstream of Middlesex Turnpike in Bedford	24 Sept 2010	2	-	4	46	-	15	1	2	-	-	-	-	1(1)	4	-	2	-	1	-	-	B < 50mm considered YOY
MA09A-159, Saugus River approximately 275 meters downstream of Salem Street in Lynnfield and Wakefield	27 Aug 2010	-	12	-	10	-	100+	-	-	-	-	10	-	1	-	-	1	-	-	7	-	Large numbers AE yoy and adults were observed but not collected final numbers estimated
MA09A-143, Proctor Brook approximately 60 meters downstream of Caller Street in Peabody	09 Aug 2010	-	-	-	-	-	100+	-	-	-	33(24)	-	-	-	-	-	-	-	-	1	-	AE – multiple age classes observed from YOY to adult. Possible tidal influence at bottom of reach.

Table 1. List of fish population survey station locations and results from the 2010 Probabilistic Fish Population Survey.

Site ID, Station Description	Date	Species Code ¹																				Comments
		FF	YP	CCS	RFP	LMB	AE	RBS	CP	SL	GS	WS	CC	B	BS	BC	YB/ BB ³	EBT/ BT ⁴	TD	P	BND/ CS	
MA09A-158, Johnson Creek approximately 390 meters upstream of Main Street in Groveland	17 Aug 2010	10	-	-	-	-	21(4)	-	4	-	18	7	-	-	2	2	2	-	3	21	2	AE ≤ 11mm considered YOY
MA09A-128, Cobbler Brook east of Hansom Drive, approximately 1.2 Km downstream of Harriman Road in Merrimack	17 Aug 2010	-	-	1	-	-	9	-	4	-	-	-	-	-	7	-	3(BB)	-	-	-	-	
MA09A-174, Little River approximately 300 meters upstream of Route 495, Haverhill	09 Sept 2010	16(1) ²	-	-	2	3	4	-	-	-	-	1	-	-	-	-	-	-	-	-	1	FF ≤ 35mm considered YOY. One unidentified sunfish also collected
MA09A-118, Deep Brook approximately 150 meters downstream of Ledge Road in Chelmsford.	13 Aug 2010	-	-	-	-	-	-	-	-	-	1	2	-	-	23	-	1(BB)	-	-	1	-	
MA09A-101, South Branch Souhegan River approximately 670 meters downstream of Jones Hill Road in Ashby	13 Aug 2010	71(1)	-	-	-	-	-	-	-	-	-	28(4)	-	-	-	-	1	25(5)	-	-	13 (CS)	EBT < 70mm considered YOY FF < 40 mm considered YOY WS < 65mm considered YOY
MA09A-107, Beaver Brook approximately 100 meters upstream of Summer Street in Chelmsford	27 Aug 2010	-	-	-	17	-	-	-	-	-	4(4)	6(1)	-	-	-	-	-	-	-	2	-	GS < 45mm considered YOY
MA09A-144, Nashoba Brook approximately 750 meters upstream from Route 2A/119, Acton	26 Aug 2010	-	-	69 (3)	18	-	-	-	-	-	20	5	-	-	-	-	1(BB)	-	-	-	-	CCS ≤ 40mm considered YOY
MA09A-172, Unnamed Tributary known locally as 'Coles Brook' approximately 168 meters upstream of Robinwood Road in Acton	12 Aug 2010	11	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
MA09A-180, Elizabeth Brook approximately 50 meters downstream of Delaney Street, Stow.	28 Sept 2010	-	1	-	9	1	1	-	5	-	-	-	-	-	-	-	-	1(BT)	-	-	-	GS < 45mm considered YOY AE was observed but not captured

Table 1. List of fish population survey station locations and results from the 2010 Probabilistic Fish Population Survey.

Site ID, Station Description	Date	Species Code ¹																			Comments	
		FF	YP	CCS	RFP	LMB	AE	RBS	CP	SL	GS	WS	CC	B	BS	BC	YB/ BB ³	EBT/ BT ⁴	TD	P		BND/ CS
MA09A-152, Elizabeth Brook upstream of Wheeler Road, Stow	26 Aug 2010	-	-	1	1	17(1)	6	-	-	-	-	-	-	14(3)	-	1	10	-	-	5(2)	-	LMB, B, and P < 50mm considered YOY
MA09A-170, Hop Brook approximately 850 meters downstream of Peakham Road in Sudbury	22 Sept 2010	24	-	-	3	2(1)	-	1	-	-	-	2	-	-	-	-	7	-	-	1	-	LMB ≤ 65mm considered YOY
MA09A-154, Unnamed tributary to Sudbury River known locally as Cochituate Brook, approximately 200 meters upstream of School Street in Framingham.	10 Aug 2010	29(19)	-	-	-	-	-	-	-	-	-	1(1)	-	-	-	-	3(1)	-	-	-	-	FF ≤ 50mm WS ≤ 60mm YB ≤ 40mm considered YOY
MA09A-154(a), Unnamed tributary to Sudbury River known locally as Cochituate Brook, approximately 350 meters upstream of School Street in Framingham.	20 Aug 2010	78(40)	4	-	1	3(1)	1	1	-	-	1	7	-	-	-	-	3(2)	-	-	-	-	FF ≤ 50mm LMB < 65mm considered YOY
MA09A-186, Stony Brook 0.5 Km downstream of Sudbury Reservoir in Framingham	20 Aug 2010	-	53(7)	-	-	16(4)	-	-	-	-	2	-	-	8(8)	-	-	5	-	-	-	-	YP < 75 mm considered YOY LMB< 80 mm considered YOY B ≤ 50 mm considered YOY YB present
MA09A-185, Cold Harbor Brook approximately 100 meters upstream of Route 290 in Northborough	12 Aug 2010	-	-	-	-	-	-	-	-	-	-	3(3)	-	-	-	-	-	-	-	-	101 (21)	BND ≤ 33mm considered YOY WS ≤ 45 considered YOY
MA09A-105, Cold Harbor Brook upstream from Crawford Street in Northborough	12 Aug 2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	200(2)	BND ≤ 30mm considered YOY

Table 1. List of fish population survey station locations and results from the 2010 Probabilistic Fish Population Survey.

Site ID, Station Description	Date	Species Code ¹																			Comments	
		FF	YP	CCS	RFP	LMB	AE	RBS	CP	SL	GS	WS	CC	B	BS	BC	YB/ BB ³	EBT/ BT ⁴	TD	P		BND/ CS
MA09A-145, Charles River approximately 600 meters downstream of Washington Street (Route 16) in Newton/Wellesley.	22 Sept 2010	-	-	-	-	3(1)	17(1)	22(4)	-	-	-	-	1(1)	25	-	2	-	-	-	13(10)	-	LMB ≤ 75mm RBS ≤ 60mm CC < 75mm P < 65mm AE ≤ 120mm considered YOY
MA09A-148, Charles River 50 meters downstream from Maple Street in Bellingham.	02 Sept 2010	2	-	-	-	5	-	-	-	-	-	-	-	-	-	-	35	-	-	1	-	
MA09A-134, Unnamed Tributary to the Charles River approximately 50 meters downstream of Farm Street in Dover	10 Aug 2010	-	-	-	-	3(3)	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	LMB < 50 mm considered YOY
MA09A-164, Chicken Brook approximately 300 meters downstream of Winthrop Street in Medway	10 Aug 2010	-	-	-	4	10(8)	-	29(14)	-	-	-	-	-	4	-	1	5(3) YB 12(12) BB	-	-	1	-	LMB < 60mm considered YOY YB ≤ 45mm considered YOY RBS < 40 mm considered YOY BB < 55mm considered YOY
MA09A-176, Unnamed tributary approximately 200 meters upstream of Webb Brook Road in Billerica.	19 Aug 2010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

¹ SPECIES CODE	COMMON NAME	SCIENTIFIC NAME	TOLERANCE/MACROHABITAT CLASSIFICATION
AE	American eel	<i>Anguilla rostrata</i>	tolerant fluvial dependant
B	bluegill	<i>Lepomis macrochirus</i>	tolerant / macrohabitat generalist
BB	brown bullhead	<i>Ameiurus nebulosus</i>	tolerant / macrohabitat generalist
BC	black crappie	<i>Pomoxis nigromaculatus</i>	moderately tolerant / macrohabitat generalist
BND	blacknose dace	<i>Rhinichthys atratulus</i>	tolerant fluvial specialist
BS	banded sunfish	<i>Enneacanthus obesus</i>	Intolerant macrohabitat generalist
BT	brown trout	<i>Salmo trutta</i>	intolerant / fluvial dependant
CC	channel catfish	<i>Ictalurus punctatus</i>	moderately tolerant / macrohabitat generalist
CCS	creek chubsucker	<i>Erimyzon oblongus</i>	moderately tolerant / fluvial specialist
CP	chain pickerel	<i>Esox niger</i>	tolerant / macrohabitat generalist
CS	common shiner	<i>Luxilus cornutus</i>	moderately tolerant/fluvial dependant
EBT	brook trout	<i>Salvelinus fontinalis</i>	intolerant / fluvial dependant
FF	fallfish	<i>Semotilus corporalis</i>	moderately tolerant / fluvial specialist
GS	golden shiner	<i>Notemigonus crysoleucas</i>	tolerant / macrohabitat generalist
LMB	largemouth bass	<i>Micropterus salmoides</i>	tolerant / macrohabitat generalist
P	pumpkinseed	<i>Lepomis gibbosus</i>	tolerant / macrohabitat generalist
RBS	redbreast sunfish	<i>Lepomis auritus</i>	moderately tolerant / macrohabitat generalist
RFP	redfin pickerel	<i>Esox americanus americanus</i>	moderately tolerant / macrohabitat generalist
SL	sea lamprey	<i>Petromyzon marinus</i>	moderately tolerant fluvial dependant
TD	tessellated darter	<i>Etheostoma olmsted</i>	moderately tolerant / fluvial specialist
YB	yellow bullhead	<i>Ameiurus natalis</i>	tolerant / macrohabitat generalist
YP	yellow perch	<i>Perca flavescens</i>	tolerant/macrohabitat generalist
WS	white sucker	<i>Catostomus commersoni</i>	tolerant / fluvial dependent

² numbers in parentheses indicate young-of-the-year, and is included in total number of fish noted.

³ BB where noted

⁴ BT where noted

Table 2: Habitat assessment summary for fish population stations sampled during the 2010 Probabilistic 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 (first 15 of 29)		MA09A-174 Little River	MA09A-180 Elizabeth Brook	MA09A-152 Elizabeth Brook	MA09A-181 Shawsheen River	MA09A-149 Shawsheen River	MA09A-145 Charles River	MA09A-170 Hop Brook	MA09A-111 Shawsheen River	MA09A-115 Shawsheen River	MA09A-148 Charles River	MA09A-144 Nashoba Brook	MA09A-159 Saugus River	MA09A-107 Beaver Brook	MA09A-176 Unnamed Tributary (to Webb Brook)	MA09A-143 Proctor Brook
Primary Habitat Parameters		Score (0-20)														
INSTREAM COVER (for Fish)					17						18				15	
BOTTOM SUBSTRATE/ AVAILABLE COVER ¹		12	13	17		11	8	15	12	9		17	13	8		6
EPIFAUNAL SUBSTRATE					12						14				8	
POOL SUBSTRATE CHARACTERIZATION ¹		12	18	16		13	12	13	12	12		13	13	13		16
EMBEDDEDNESS					11						16				14	
POOL VARIABILITY ¹		12	10	17		5	5	11	14	13		17	16	14		4
CHANNEL ALTERATION		19	18	17	18	11	15	18	18	13	19	19	18	14	18	1
SEDIMENT DEPOSITION		13	17	18	17	8	16	12	13	13	19	13	13	8	9	12
VELOCITY-DEPTH COMBINATIONS					16						18				15	
CHANNEL SINUOSITY ¹		10	8	12		3	1	15	13	1		10	15	6		0
CHANNEL FLOW STATUS		15	16	17	15	15	18	18	9	15	12	20	15	16	7	10
Secondary Habitat Parameters		Score (0-10)														
BANK VEGETATIVE PROTECTION	left	9	10	10	9	9	5	10	9	10	9	10	9	10	9	6
	right	10	8	9	9	9	10	10	9	10	9	10	9	10	9	8
BANK STABILITY	left	9	9	10	8	8	7	9	7	8	5	10	7	9	4	7
	right	6	9	9	8	8	9	9	7	8	9	10	7	9	4	9
RIPARIAN VEGETATIVE ZONE WIDTH	left	10	10	10	5	9	9	10	10	8	5	8	6	10	9	1
	right	10	4	7	9	2	9	8	10	9	9	10	4	10	7	1
Total Score		147	150	169	154	111	124	158	143	129	162	167	145	137	128	81

Table 2 (continued): Habitat assessment summary for fish population stations sampled during the 2010 Probabilistic 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 (remaining 14 of 29)		MA09A-128 Cobbler Brook	MA09A-154 Cochituate Brook (upstream reach)	MA09A-154 Cochituate Brook (downstream reach)	MA09A-158 Johnson Creek	MA09A-118 Deep Brook	MA09A-101 South Branch Souhegan River	MA09A-172 Unnamed tributary (to Coles Brook)	MA09A-105 Cold Harbor Brook	MA09A-185 Cold Harbor Brook	MA09A-134 Unnamed Tributary (to Charles River)	MA09A-186 Stony Brook (in Framingham)	MA09A-180 Elizabeth Brook (alternate high gradient)	MA09A-128 Cobbler Brook (alternate high gradient)	MA09A-164 Chicken Brook
Primary Habitat Parameters		Score (0-20)													
INSTREAM COVER (for Fish)			7	15	19	12	18	15	15	15	15	18	15	12	13
BOTTOM SUBSTRATE/ AVAILABLE COVER ¹		9				13									
EPIFAUNAL SUBSTRATE			10	11	18	N/A	18	17	18	10	11	20	18	N/A	15
POOL SUBSTRATE CHARACTERIZATION ¹		7				8								N/A	
EMBEDDEDNESS			10	11	14	N/A	18	18	18	7	18	19	16	N/A	16
POOL VARIABILITY ¹		7				5								N/A	
CHANNEL ALTERATION		14	12	11	15	18	20	19	15	1	19	19	14	15	19
SEDIMENT DEPOSITION		5	13	6	15	7	15	15	19	18	19	18	18	5	15
VELOCITY-DEPTH COMBINATIONS			13	12	15	7	17	15	13	12	10	14	13	11	10
CHANNEL SINUOSITY ¹		8				18									
CHANNEL FLOW STATUS		8	14	15	9	5	10	8	6	7	11	5	1	6	8
Secondary Habitat Parameters		Score (0-10)													
BANK VEGETATIVE PROTECTION	left	9	9	9	9	9	9	9	8	9	8	10	9	9	5
	right	9	9	4	9	9	9	9	10	9	8	7	9	9	10
BANK STABILITY	left	9	7	8	2	5	4	7	8	10	9	8	9	9	7
	right	9	7	2	2	5	8	6	7	10	9	8	9	9	10
RIPARIAN VEGETATIVE ZONE WIDTH	left	10	7	7	9	9	10	8	3	9	10	9	10	10	8
	right	10	1	0	9	9	10	7	9	9	10	9	7	10	10
Total Score		114	119	111	145	95** 120 ²	166	153	149	126	157	164	148	105*	146

¹ low to moderate gradient habitat sheet
* of a possible 180

² low gradient section of reach
** of a possible 160

N/A not assessed