

# 2012 SOUTH RIVER FISH COMMUNITIES AND PHYSICAL HABITAT ASSESSMENT, FRANKLIN COUNTY, MASSACHUSETTS



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For

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Greenfield, MA

**Franklin Regional Council of Governments**  
Greenfield, MA

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**2012 SOUTH RIVER FISH COMMUNITIES AND PHYSICAL HABITAT  
ASSESSMENT, FRANKLIN COUNTY, MASSACHUSETTS**

DRAFT REPORT

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## EXECUTIVE SUMMARY

The South River flows through the Franklin County communities of Ashfield and Conway in western Massachusetts. Historic and contemporary modifications to the river and its floodplain have included construction of dams, channel straightening, and riparian tree removal. Their effects, even those of dams long-ago removed, persist into the present, and include increased rates of sedimentation and bank erosion. These effects can have consequences for landowners and native fish, alike. The Franklin Regional Council of Governments was awarded a 604b grant to perform a comprehensive assessment of the South River to provide information on the causes of erosion, channel instability, and habitat degradation. This assessment included a geomorphic study that resulted in the development of conceptual restoration designs for the four highest-ranked priority sites and final designs and cost estimates for the highest ranked restoration priority site (Field 2013). In order to inform the development of projects that seek to benefit both landowner property and river health, a comprehensive assessment of river habitat and fish communities was performed as an attendant study to the geomorphic assessment. This study represents the most comprehensive description of these conditions in the South River watershed to date and also serves as a benchmark for future evaluations of both the potential success of restoration efforts, as well as of any further degradation. This report details the methods, findings, and recommendations of this study.

Survey reaches were selected following reconnaissance surveys of the entire watershed and consultation with the geomorphic assessment consultant (Field Geology Services). Fish and habitat survey reaches were selected to represent a range of geomorphic conditions and habitat impact levels. Eleven reaches were selected from the South River, including six “impact” reaches that received geomorphic needs scores of 23 or higher (five scored 30 or higher) and five “reference” reaches that scored 18 or lower. Reaches were also selected across most of the length of the South River to examine the relative influence of major longitudinal gradients in river conditions on fish communities versus local variation in habitat conditions. Physical habitat, fish communities, and water chemistry were sampled from the 11 survey reaches in the South River in August 2012. Physical habitat surveys were performed in accordance with the Physical Habitat Characterization protocols of the US Environmental Protection Agency’s Wadeable Streams Assessment Field Operations Manual. Fish community surveys followed Massachusetts Division of Fisheries and Wildlife stream electrofishing surveys protocols.

Physical habitat conditions in the South River ranged widely, but a general trend in increasingly degraded conditions occurs in a downriver direction. A number of measured environmental variables showed such a trend, including bank stability, instream woody debris load, riparian tree cover, width-to-depth ratio, percent glide habitat, and water temperature. These longitudinal trends are a function of both natural processes and human alteration of the river, and they exhibit a stronger influence on fish community composition than does local variation in habitat conditions.

Limiting factors in the upper river, where they occur, include a lack of instream complexity and cover, and elevated sediment loading. Much of the upper river supports intact habitat and summer water temperatures that are favorable for supporting wild trout populations. Fish communities in the upper river reflect this capacity and are dominated by wild trout and other

intolerant species. The lower River, particularly below the town of Conway, suffers from localized effects of channel straightening and increased sediment production, and also from cumulative effects from upriver impacts. Fish communities were heavily dominated by tolerant fish species, and wild trout were almost absent. Limiting factors in much of the lower river include low habitat quality and complexity (lack of deep pools, instream cover, clean gravels, etc.), and high water temperatures. These degraded conditions are most evident in straightened and channelized sections of the river. These attributes create conditions that are likely also potentially allowing juvenile Atlantic salmon to out-compete wild trout in the lower and middle reaches of the river.

The upper river would benefit from land conservation and riparian protection and improvement projects. Wild trout populations are supported by current conditions, and any improvements to habitat only stand to improve local conditions, and minimize cumulative impacts to downriver sections. Such work could be informed by a comprehensive riparian zone study that explicitly identifies reaches most in need of increased stream shading. The lower river would benefit from restoration projects recommended in the Geomorphic Assessment (Field 2013) that would help restore a more natural planform to the river and promote the creation of habitat features conducive to supporting wild fish. Further assessment of summertime trout distribution over a wider range of summer conditions and water temperatures will assist with further determining distribution and abundance of wild trout in the lower river and further identify limiting factors. Restoration and protection of riparian areas along the entire river are highly recommended and will be critical to the long-term improvement of habitat conditions in the lower river.

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## INTRODUCTION

The South River flows through the Franklin County communities of Ashfield and Conway in western Massachusetts. Historic and contemporary modifications to the river and its floodplain have included construction of dams, channel straightening, and riparian tree removal. Their effects, even those of dams long-ago removed, persist into the present, and include increased rates of sedimentation and bank erosion. These effects can have consequences for both landowners and native fish. Accelerated bank erosion and channel migration lead to loss of property and occasionally threaten homes and infrastructure, and also deleteriously affect native fish communities by reducing river habitat quality and complexity. Rivers that are frequently adjusting to our attempts at controlling their behavior have unstable banks that contribute large amounts of fine sediment to the channel and decrease the quality of spawning habitat for native fish. Channel widening also occurs, resulting in shallower water during low flows and higher water temperatures, only exacerbated by the removal of river-side trees that provide shade from direct sun.

These issues have long been known to occur along the South River. The Massachusetts Department of Environmental Quality/Division of Watershed Management's (DWM) 2000 water quality assessment report for the Deerfield River Watershed recommended for the South River "an evaluation of habitat quality conditions related to erosion and instream deposition/sedimentation in the South River" (DWM 2004). This same report also recommended continued monitoring of fish populations in the South River. In 2011, The Franklin Regional Council of Governments was awarded a 604b grant to perform a comprehensive assessment of the South River to provide information on the causes of erosion, channel instability, and habitat degradation. This assessment included a geomorphic study that resulted in the development of conceptual restoration designs for the four highest-ranked priority sites and final designs and cost estimates for the highest ranked restoration priority site (Field 2013). Restoration efforts intended to reduce erosion and improve channel stability can also benefit river habitat by halting or reversing the harmful processes discussed above. Consequently, restoration actions implemented in the South River watershed may potentially benefit both landowners and the river's ecology, alike. To the extent possible, restoration efforts

should consider this win-win possibility. In order to inform the development of projects that seek this double bottom line, a comprehensive assessment of river habitat and fish communities was performed as an attendant study to the geomorphic assessment. This study was performed to help identify potential opportunities to both improve geomorphic condition for protection of property and infrastructure and improve habitat for native fish communities. This study represents the most comprehensive description of these conditions in the South River watershed to date and also serves as a benchmark for future evaluations of both the potential success of restoration efforts, as well as of any further degradation. This report details the methods, findings, and recommendations of this study.

## **STUDY AREA**

The South River is one of several major tributaries to the Deerfield River in western Massachusetts. The river drains a total watershed area of 26.3 sq mi, comprising forest (77%), agriculture (12.5%), and residential (6.1%) land uses. The river has its source at Ashfield Lake in the hill town of Ashfield, and flows for 15.8 miles to the Deerfield River. The river first flows in a generally easterly direction from Ashfield, confluenting with Creamery and Poland brooks before entering the town of Conway. In Conway, the river turns north, flowing through a wide valley before turning east again and flowing through a deep, narrow valley for the last few miles before entering the Deerfield River. Along its course to the Deerfield River, the South River flows through various valley topographies exhibiting a range of gradients and valley widths. Consequently, the river exhibits a range of natural channel morphologies and attendant habitat conditions; this range of conditions was expanded upon Euro-American settlement and industrialization of the watershed.

## METHODS

### SURVEY REACHES

Survey reaches were selected following reconnaissance surveys of the entire watershed and consultation with the geomorphic assessment consultant (Field Geology Services). The following criteria were also used to select the physical habitat and fish community assessment reaches:

- Reaches should be distributed throughout the South River.
- Reaches should occur in both unstable reaches with degraded habitat (channelized, modified reaches with heavy bank erosion and/or sand/gravel deposits) and stable reaches with intact aquatic habitat.
- To the extent possible, unstable and stable reaches would be paired to facilitate statistical comparisons of conditions between these reach types.

Following geomorphic surveys, the geomorphic assessment consultant assigned an index score to each of ten geomorphic elements within each assessment reach and developed from these ranking a composite “geomorphic needs score” (Field 2013). Composite index scores could range from 0 (lowest need) to 50 (highest need). These scores were used to assist with selecting fish and habitat survey reaches across a range of geomorphic conditions (Table 1). Eleven reaches were selected from the South River, including six “impact” reaches that received geomorphic needs scores of 23 or higher (five scored 30 or higher) and five “reference” reaches that scored 18 or lower. Reaches were also selected across most of the length of the South River to examine the relative influence of major longitudinal gradients in river conditions on fish communities versus local variation in habitat conditions. Accordingly, reaches were distributed throughout the South River from river mile 2.6 to river mile 12.5. While the project initially sought to pair impacted and reference sites, a lack of least disturbed channel morphology and habitat conditions in the Conway sections of the river largely precluded this approach. Accordingly, least disturbed “reference” conditions were more common in the upper sections of the river, while the more impacted reaches generally occurred in the middle and lower sections on the river.

## **FIELD ASSESSMENT**

Physical habitat, fish communities, and water chemistry were sampled from the 11 survey reaches in August 2012. First, each survey reach was marked and the reach length of 150 m was measured. Waypoints were acquired for the start and end of each reach using a GPS unit.

### **INSTREAM PHYSICAL HABITAT AND RIPARIAN ASSESSMENT**

Instream and riparian field data collection was performed between August 13 and 26, 2012. Physical habitat surveys were performed in accordance with the Physical Habitat Characterization protocols of the EPA's Wadeable Streams Assessment Field Operations Manual (EPA 2004). Each selected reach measured at least 150-m. The physical habitat assessment consisted of three components: channel and riparian cross-sectional characterizations, a thalweg profile, and a woody debris tally. At each of 11 channel cross sections within each monitoring reach, channel dimensions, bank height, and riparian overhead cover (densiometer) were measured to determine the amount of shading provided by riparian cover.

A thorough characterization of the streambed substrate was performed along these cross sections. Substrate size and embeddedness of particles were measured on each cross section to quantify substrate conditions in each reach in relation to its potential to support a diverse benthic community. Riparian vegetation attributes were also recorded on each cross section. The thalweg profile consisted of measuring water depths and classifying habitat units at 10 equally-spaced intervals between each pair of cross sections to produce comprehensive descriptions of the types, sizes, and quality of aquatic habitats occurring in each reach. A Rapid Habitat Assessment was also performed in each reach, including ocular estimates of a number of habitat parameters.

### **TEMPERATURE MONITORING**

To determine whether water temperature is a potentially limiting factor to aquatic life in the South River watershed, a series of nine temperature loggers were deployed along the mainstem of the South River. Logger locations were largely selected to overlap with physical and biological sampling reaches. Loggers were deployed in early July 2012 and retrieved in October

2012. Temperature logger deployment and retrieval protocols followed Continuous Temperature Monitoring Standard Operating Procedures described by MA DEP (MA DEP 2005).

## **FISH COMMUNITY ASSESSMENT**

Fish communities were surveyed from each reach using backpack electrofishing equipment. Standard single-pass surveys were performed in each reach using protocols employed by the Massachusetts Division of Fisheries & Wildlife (MDFW; Alicia Norris, personal communication). Fish were sampled by pulsed DC current electrofishing. Crews of three to four people conducted single pass electrofishing surveys through the sample reaches. The crew member wearing the backpack used two ring probes to electroshock fish. The rest of the crew members carried buckets and/or dipnets to collect fish that are influenced by the electric current. All portions and habitats in the stream were sampled, including habitat features such as woody debris, submerged aquatic vegetation, undercut banks, and overhanging vegetation. All netted fish were held in buckets until completion of the sampling run, at which time all fish were identified to species, measured to the nearest millimeter, and released back into the reach from they were captured.

## **WATER CHEMISTRY SAMPLING**

Water temperature ( $^{\circ}\text{C}$ ), dissolved oxygen saturation (percent), dissolved oxygen concentration (mg/L), conductivity ( $\mu\text{S}/\text{cm}$ ), and specific conductance ( $\mu\text{S}/\text{cm}$ ) were measured at each reach at the time of fish community. Water temperature, dissolved oxygen, conductivity, and specific conductance were measured in situ with a multi-parameter YSI Pro Model 2030 water chemistry meter. Specific conductance is conductivity normalized to  $25^{\circ}\text{C}$ , thereby allowing more direct comparison of conductivity between water bodies or within a particular waterbody at different times.

## **DATA ANALYSIS**

Physical habitat data were summarized for each site by calculating reach-wide means for a large number of physical habitat attributes. Water temperature data were summarized from each location using several metrics: mean daily water temperature, maximum daily water temperature,



average 7-day average maximum water temperature, and maximum 7-day average maximum water temperature. Each temperature metric was calculated for each location using the same range of monitoring dates (July 13 through September 26, 2012).

Fish community and physical data were entered into Excel spreadsheets and summarized using descriptive statistics and graphical summaries. Fish community data were summarized in a manner similar to those employed by MA DEP in their evaluation of fish community conditions in Massachusetts streams. This approach focuses on a more qualitative description of the general condition of the fish community as a function of overall species richness and total fish abundance, collective community tolerance to disturbance, and relative abundance of different trophic classes and microhabitat-use assemblages.

When appropriate, regression and correlation analysis was used to examine the data for relationships between physical and biological conditions. The results of the data analysis include concise summaries of the current biological and physical habitat conditions throughout the South River watershed, comparisons of these conditions in less stable reaches to those in more stable river/stream reaches, and inferences regarding the likely causes of any measured impairments to these communities. Importantly, these data will serve as a baseline for determining long-term improvements in ecological conditions in the South River watershed.

## **RESULTS**

### **PHYSICAL HABITAT CONDITIONS**

Physical habitat conditions varied widely among reaches, and results from both natural variation in geomorphic character and the level of impact to the reach (Table 2). Wetted and bankfull widths increased predictably from upriver to downriver (Figure 2). Wetted width averaged 6.1 m across all reaches and ranged from 2.4 m below Emmett Road to 11.8 m upriver of the lower Reeds Bridge Road bridge. Bankfull width averaged 11.0 m and ranged from 3.2 m to 18.9 m (Table 2). Mean water depth did not vary among locations, averaging 0.1 m across 10 of the 11 reaches, despite large differences in channel dimensions between upper and lower reaches. Consequently, wetted width-to-depth ratios increased significantly from upriver to

downriver (Figure 2). As a result, the lower sections of the South River are generally wide and shallow during baseflows, a condition that has likely been exacerbated by erosion and threatens the ecological integrity of the river.

Frequencies of riffle, pool, and glide habitats also varied among reaches (Table 2). Percent glide habitat generally increased from upriver to downriver, likely primarily as a result of generally decreased channel gradient in the lower sections of the river below Conway; however, it must be noted that significant differences in channel gradient occur even within the upper, middle, and lower portions of the watershed. The highest percent glide habitat was measured in two reaches that had historically been straightened – F2 alongside the Conway town fields and F5 in south Ashfield.

Substrate composition varied among reaches (Figure 3), but was generally dominated by coarse materials (gravel-sized or larger), averaging 67% streambed coverage among all 11 reaches. Mean particle sizes ranged widely from 45 mm to 995 mm, and appeared to show some longitudinal trending (Figure 2), as the largest mean particle sizes occurred in the lower and middle reaches of the river, while the smallest sizes occurred in the upper reaches. The largest particle sizes occurred in reach F4 at river mile 8.3 below Brester Road, a reach characterized as having a steeper gradient and a confined channel (Table 2) and included in the study to represent least disturbed conditions for this channel type (Table 3). This geomorphic condition produces a higher stream power through this section, which mobilizes and transports smaller sediment through this reach to lower-gradient downriver sections.

Substrate embeddedness was generally high throughout the river, averaging 46.7% and ranging from 27.3% to 70.2% (Table 2). Embeddedness was lowest in reaches F4 and F6, both occurring in the higher-gradient and more confined mid-sections of the river, where stream power is higher and better able to transport suspended sediment. Substrate embeddedness was highest in reaches F2 (70.2%), F5 (60.6%), and F7 (57.2%), all classified as impacted reaches for this study (see Appendix 2). Each of these reaches shows evidence of significant recent or historic disturbance, and a consequent dominance by wide, shallow stream habitat. F2 and F5, as previously discussed, were historically channelized and are currently dominated by shallow glide habitat with little instream cover or habitat complexity. Reach F7 occurs on the downriver side

of Burton Hill Road. The riparian zone has been cleared of trees through most of this reach; resulting in bank slumping, channel widening, and loss of habitat complexity.

Habitat characteristics related to streambank condition and erosion, including bank stability and vegetative cover also varied among reaches and exhibited some longitudinal trending (Figure 2). The bank stability index, rated between 0 (poor) to 20 (optimal), averaged 11.6 across all study reaches. Bank stability was rated as marginal in three of the six impact reaches, but sub-optimal or optimal in all five reference reaches. Bank vegetative protective cover (also rated on a scale of 0 to 20) also received a moderate average rating across all study reaches (10.6), and ranged from a low of 4 (poor) in reach F7 to 16-17 (optimal) in reaches F10 and F11.

Canopy cover was generally adequate across the study reaches, averaging 74.4% (Table 2). However, several reaches – F2 and F7 in particular – had low canopy cover, and it should be noted that such conditions are commonplace in the lower watershed.

Large woody debris (LWD) was generally scarce to absent from the river channel in the lower and middle sections of the river (see Appendix 2). Impacted reaches averaged 0.3 pieces LWD/100 m of river, while reference reaches averaged 5.1 pieces LWD/100 m (Table 3). In addition to LWD, a number of habitat variables appear to differ significantly between impacted and reference reaches (Table 3); however, these differences may result from a larger number of impacted reaches occurring in lower portions of the South River, while most reference reaches occur in the middle and upper river. As such, many of these differences may primarily be driven by longitudinal position along the river's length. As an example, large woody debris loading appears to be much higher in reference reaches than in impacted reaches. Because reference reaches occur in the upper river where channel dimensions are smaller, woody debris can accumulate more easily because the pieces need not be as large as they would in larger channels.

Instream cover for fish in the form of LWD, boulders, root wads, undercut banks, and overhanging vegetation was generally low across the reaches (Figure 4). Fish cover indexes (rated from 0 to 4) for each of these elements were generally less than 1 across all reaches, suggesting that lack of available cover is a potential limiting factor to native fish, particularly in the lower South River.

## **WATER TEMPERATURE**

Average daily water temperatures for the period July 13 through September 26 ranged from 59.7°F at the uppermost station to 68.9°F at the lowermost station (Table 4). Average daily maximum water temperatures ranged from 62.9°F to 74.4°F at these same two stations. Maximum 7-day-average maximum temperatures showed the largest range of values among sites, ranging from 66.7°F at the uppermost station to 81.4°F at the lowermost station. Average daily (Spearman rho = -0.9833,  $p < 0.0001$ ), average daily maximum (Spearman rho = -0.9333,  $p = 0.0004$ ), and maximum 7-day average maximum (Spearman rho = -0.9500,  $p = 0.0002$ ) water temperatures were all highly correlated with river mile along the South River.

River water temperatures exhibited a distinct longitudinal trend (Figure 5). Warming rates of river water temperatures were highest in the upper river between temperature monitoring stations T9-T8 (Emmett Road to Double Edge Theatre) and T8-T7 (Double Edge Theatre to Burton Hill Road; Figure 6). Cool-water inputs from Creamery and Pumpkin Hollow Brooks significantly reduced rates of warming in the sections of river each tributary intercedes. Warming rates were generally lowest in the lower section of the river, likely as a result of larger volumes of water requiring longer periods of time to warm at a given air temperature, as well as water temperatures being closer to ambient air temperatures.

## **FISH COMMUNITY CONDITIONS**

Eleven fish species were sampled from across the 12 reaches assessed in this survey (including Creamery Brook, which was sampled for fish, but not physical habitat). The number of species sampled among reaches ranged from 4 to 8. Total number of fish sampled ranged from 49 from reach F1 to 267 from reach F3 (Table 5). Five coldwater-obligate and pollution intolerant species were sampled during the survey, including brook trout, brown trout, juvenile Atlantic salmon, longnose sucker, and slimy sculpin. The longnose sucker is listed as a species of special concern by the Commonwealth of Massachusetts.

As observed with a number of physical habitat variables and water temperature metrics, metrics used to describe fish community condition exhibited longitudinal trends (upstream

versus downstream; Figure 7). The number of salmonid species (brook trout, brown trout, and Atlantic salmon) ranged from 0 to 3. Atlantic salmon, captured from reaches F2, F3, and F4, were the only salmonid captured below river mile 10, although a brook trout was observed evading capture immediately below the confluence with Pumpkin Hollow Brook.. Brook trout were sampled only above river mile 10 and brown trout were sampled only above river mile 11.3.

The number of cold-water obligate/pollution intolerant species also generally increased in an upriver direction, as did the number of trout and salmon individuals sampled (Table 6, Figure 7). Where sampled, brown trout and Atlantic salmon abundance was generally low across all reaches, ranging from 2 to 8 and 1 and 7 individuals, respectively. Brook trout were the most abundant salmonid species, as numbers ranged from 9 to 33 individuals sampled among 6 of the 7 reaches from which they were captured. Brook trout abundance was generally highest in reaches supporting the lowest water temperatures, and brook trout were absent from the warmest reaches (Figure 8)

Among measured environmental variables, fish community metrics showed significant correlations only with those exhibiting longitudinal condition gradients themselves. The number of trout and salmon species, number of cold-water species, and number of trout/salmon individuals metrics were all highly correlated with wetted width, width-to-depth ratio, and maximum 7-day average maximum water temperature (Table 7). The number of trout and salmon individuals sampled was significantly correlated with fish cover index scores (Table 7).

## COMPREHENSIVE REACH DESCRIPTIONS

### REACH F1 (RIVER MILE 2.6) - IMPACTED



Reach F1 occurred immediately upriver of the Reeds Bridge Road bridge at river mile 2.6. This study reach occurred within the Geomorphic Assessment Reach 7A, one of the most impaired segments in the watershed (Field 2013). This reach occurs in a section of river transitioning from a wide to narrow floodplain immediately before entering the steep V-shaped valley through which the river flows for the last two miles before entering the Deerfield River. As such, the channel gradient and confinement have both increased relative to the upriver sections flowing through the Conway agricultural zone, providing less opportunity for lateral channel movement. A very narrow floodplain occurs on river left through this reach.

This reach is wide and shallow, supporting low habitat complexity or instream cover. Wetted thalweg depth averaged only 0.1 m, despite an average wetted width of 11.8 m. Pool habitat is scarce (4% of reach habitat), and that available is shallow and filling with sediment. Despite a large mean substrate particle size of 319 mm, substrate embeddedness by fines and sand was 48%. Large woody debris was absent from the reach, and fish cover index scores were among the lowest measured across all habitat assessment reaches.

Water temperatures measured from this reach were the highest recorded in the watershed (Table 4). The maximum 7-day average maximum water temperature was 81.36°F, while the

average daily maximum water temperature during the monitoring period was 74.4°F, nearly 3 degrees F warmer than the next temperature monitoring station at river mile 4.8.

Only four species of fish were sampled from this reach of the river, the lowest richness observed among all reaches sampled in this study. Furthermore, the fish community sampled from this reach was heavily dominated by species tolerant to degraded habitat and water quality conditions, including longnose dace and blacknose dace. Two specimens tentatively identified as longnose sucker were also captured in this reach, representing the only species classified as “intolerant” to be sampled from this section of the river. Reach F1 was the only location from which no salmon or trout were sampled. However, the Massachusetts Division of Fisheries & Wildlife (MDFW) collected one brook trout from this reach during a 2010 fish survey, so occasional use of the reach by brook trout occurs, perhaps during more favorable summertime temperatures.

High summer-time water temperatures and poor habitat conditions measured in this reach are exemplary of much of the lower river below Conway. The Geomorphic Assessment completed in conjunction with this habitat study provides significant detail and insight into the processes that have produced these degraded conditions in the lower river and offers solutions that would benefit river habitat.

## REACH F2 (RIVER MILE 5.4) - IMPACTED



Reach F2 occurred at the lower end of a section of river approximately 300 m below the Main Street bridge in Conway Center. This reach was selected to exemplify the unsuitable habitat conditions prevalent in the lower river as a result of historic straightening of river segments. This study reach occurred within the Geomorphic Assessment Reach 10E (Field 2013), a section of river that is characterized as low-gradient (0.73%; Field 2013) and unconfined, which will produce in a meandering channel planform. In its current straightened condition, the river is attempting create meanders via bar development and lateral erosion. This section of river has been identified as a priority restoration location with a total needs score of 31 (Field 2013).

The study reach occurring in this straightened section of river was dominated by shallow pool and glide habitats. In-stream habitat complexity was low, and channel widening due to lateral bank scour resulted in the highest bankfull width-to-depth ration measured among all habitat assessment reaches. Large woody debris was absent from the reach. Bank erosion was rated as moderate, but the true extent and capacity for lateral erosion was likely concealed by late-summer overhanging vegetation. Substrate embeddedness (70.2%) was the highest measured among all reaches, partially influenced by the low gradient and lower-velocity habitats



which allow, but also a consequence of elevated erosion rates in this reach as a result of the channel being maintained in an unstable condition (as described in Field 2013).

Maximum daily water temperature measured another 0.6 miles downriver from this reach averaged 71.6°F during the monitoring period, representing a rate warming of 1.26°F/river mile between temperature monitoring station T2 and habitat assessment reach F1 (temperature monitoring station T1; Figure 5).

Fish community sampling in this reach resulted in the capture of six fish species. The community was heavily dominated by disturbance tolerant species, including blacknose dace, creek chub, and longnose dace. A single slimy sculpin and two juvenile Atlantic salmon were also sampled from this reach. These community characteristics are consistent with the unfavorable habitat conditions measured in this reach, and are likely representative of community conditions throughout the lower South River within the Conway agricultural zone. In addition to degraded instream habitat conditions, riparian areas are lacking mature trees throughout much of this length of river. The Geomorphic Assessment suggests the potential for these areas in the lower river with reduced riparian tree cover to produce conditions unsuitable for trout (Field 2013), and the results of this report corroborate this concern.

### **REACH F3 (RIVER MILE 5.6) - IMPACTED**



Reach F3 extended from immediately below the confluence with Pumpkin Hollow Brook downriver to approximately 100 m below the Main Street bridge. This habitat assessment reach occurs at the upper end of the Geomorphic Assessment Reach 10. Field (2013) describes this short section of river immediately below the confluence of Pumpkin Hollow Brook as confined by glacial deposits and channel incision. This reach was included in the fish and habitat survey because the upper end of this reach immediately below Pumpkin Hollow Brook has been identified as a priority restoration area (Field 2013). Conceptual restoration plans include the installation of instream deflectors that will potentially increase habitat complexity in the upper end of the reach.

While only ~100 m upstream of the upper end of habitat assessment reach F2, this reach exhibits different habitat characteristics, including larger channel substrate and a more discrete riffle-pool morphology. Habitat was more heterogeneous than immediately downriver, consisting of relatively equal proportions of riffle, pool, and glide habitats. However, pools were small, shallow, and were dominated by fine sediment. No woody debris occurred within the reach. A general lack of instream cover resulted in the lowest fish cover index score among all reaches sampled.

Seven fish species were sampled from this reach, including two intolerant species: slimy sculpin and Atlantic salmon. However, this reach was still numerically dominated by tolerant fish species, including blacknose dace, creek chub, and longnose dace (Table 5).

#### **REACH F4 (RIVER MILE 8.3) - REFERENCE**



Reach F4 occurs at river mile 8.3, approximately 300 m downriver of the Route 116 bridge immediately east of Brester Road. This section occurs within Geomorphic Assessment reach 17B, characterized as a steeper, confined channel supporting a step-pool morphology (field 2013). This reach was selected as a reference habitat reach for steeper-gradient sections, as the steep valley walls and mature forested provide a local buffer against any significant channel or riparian alteration. Owing to the higher gradient (1.7%), the increased stream power that occurs in this section effectively transports smaller substrates to downstream reaches, resulting in dominance by cobble and boulder substrates. These large substrates provide complexity in the stream channel necessary to support diverse fish communities; as such, this reach received one of the highest fish cover index scores in the study. Despite a lack of woody debris in the immediate assessment reach, large wood pieces were observed in and spanning over the channel immediately upriver.

The fish community in this reach was similar to that sampled in reach F3, but also included the capture of 4 longnose suckers. Longnose and blacknose dace were once again numerically dominant species, but slimy sculpin abundance was higher than in reach F3. Importantly, sampling efficiency in this reach was reduced, as sampling was performed as a rain event increased streamflow and turbidity. Capture efficiencies in this reach were no doubt lower than in all other reaches.

#### **REACH F5 (RIVER MILE 10.0) - IMPACTED**



Fish and habitat assessment reach F5 occurs at river mile 10.0. This section of river occurs upriver of the confluence with Poland Brook, and is characterized as occurring in a wide, lower-gradient valley relative to upriver and downriver sections (Field 2013). This reach occurs within Geomorphic Assessment reach 18G, much of which has historically been straightened and channelized (Field 2013). Habitat assessment reach F5 was established to characterize habitat and fish community attributes under these modified conditions.

Among reaches in the upper portions of the South River, F5 had the highest proportion of glide habitat and the lowest fish cover index score. The reach was dominated by gravel and cobble substrate which was heavily embedded with sediment (60% reach-wide embeddedness), resulting in unfavorable conditions for trout spawning. Water depths were uniformly shallow

through the reach, creating low habitat diversity for fish communities. Large woody debris was absent from the reach.

Five species of fish were sampled from this reach, and the sample was numerically dominated by blacknose dace. However, three intolerant species, including slimy sculpin, longnose sucker, and brook trout were all sampled from this reach. The three brook trout were all sampled from the upper end of the reach, where a scour pool has formed on river right, creating suitable cover for trout. Otherwise, the reach provides almost no suitable habitat for trout or salmon. Despite degraded habitat quality, water temperatures in this reach are likely suitable for supporting trout through the summer months, as evidenced by the low water temperatures measured at temperature monitoring station T6, located another 0.4 mile upriver. Daily maximum water temperatures at this station averaged nearly 3°F lower at this station than at station T5, located at river mile 8.5.

The geomorphic assessment identified this section of river as a strong candidate for opportunities for land conversation and restoration projects (Field 2013). Because water temperatures in this reach are likely suitable for supporting wild trout populations and habitat appears to be the primary limiting factor, such projects focused on restoring natural channel processes should restore habitat conditions more suitable for wild trout.



## REACH F6 (RIVER MILE 10.4) – REFERENCE



Reach F6 occurs downriver of the Creamery Brook confluence in a section of the South River that is constrained by a narrow valley. This section of the river exhibits a steep riffle-pool morphology occurring on a 1.9% channel gradient (Field 2013). An intact riparian zone provides ample stream shading and some bank erosion protection from increased sediment loads being delivered from Creamery Brook. Canopy cover was measured as 91%, the highest among all reaches included in the study. Instream habitat is dominated by a relatively even apportioning of riffle and pool habitat, although pool depths were generally shallow as a result of heavy silt and sand deposits.

Substrate consisted of a heterogeneous mixture of grain sizes, dominated by cobble and small boulder. Reach-wide embeddedness was generally low (28%), primarily as a result of the higher stream power's capacity to move sediments through this reach. Despite an absence of instream large woody debris, the instream fish cover index was among the highest in the study as a result of the heterogeneous substrate composition and high frequency of pools.

Water temperature monitoring station, T6, was co-located with this habitat assessment reach. Daily maximum water temperatures during the monitoring period averaged 66.1°F, and the maximum 7-day average maximum temperature was 71.4°F, both within the tolerance limits of brook trout. Despite these apparently favorable conditions, no brook trout were sampled from

this reach. In fact, only four fish species were sampled, and none of these were salmonids; blacknose dace numerically dominated the sample, while slimy sculpin and longnose dace were also relatively abundant. Four longnose suckers were also sampled from this reach. The absence of salmonids from the sample, while suggesting lower-than-expected abundance in this section of river, should not be interpreted to indicate an inability of this section of river to support these fish species. Brook trout were sampled both above and below this reach, and habitat attributes, while not optimal, can support trout. This section of river would undoubtedly benefit from occasional recruitment of large wood to produce a wider range of depth and velocity regimes. Rather than encouraging active restoration in these areas, simply leaving riparian zones intact in order to serve as natural sources of large wood would provide this function in the long term.

#### **REACH F7 (RIVER MILE 11.3) – IMPACTED**



Reach F7 occurs at river mile 11.3 in an active pasture on the downriver side of Burton Hill Road in Ashfield. This reach occurs within Geomorphic Assessment reach 20A, identified as having severely destabilized banks as a result of active grazing pressure and a lack of riparian vegetation (Field 2013). This reach was selected to represent heavily degraded habitat conditions in this section of the upper river, where agriculture firsts begins to significantly

impact the river along its course to the Deerfield River. This reach is paired with reach F9, occurring another 0.6 miles upriver, and as described later.

Reach F7 is the first habitat reach occurring above the confluence with Creamery Brook. Consequently, channel dimensions are notably smaller than those in reach F6 (See Appendix 2). Reach F7 was dominated by shallow riffle habitat. Banks show areas of active erosion and slumping, a consequence of active grazing and trampling by cattle, combined with a lack of any riparian vegetation. Canopy cover was 52%, the lowest measured among all survey reaches. Substrates were dominated by gravels and cobbles. Embeddedness was high at 57.2%. The fish cover index score was the second lowest among all survey reaches. Several deep plunge pools formed by aged instream structures associated with a small bridge crossing created much-needed habitat diversity in the reach. Consequently, fish abundance and richness was the highest among all reach in the upper river. While blacknose dace numerically dominated the sample, the intolerant species brook trout, longnose sucker, and slimy sculpin were all present. Two brown trout were also sampled from this reach, representing the downriver-most location this species was sampled. These results suggest that habitat and water quality conditions are generally favorable for supporting wild trout in this section of river above of the confluence of Creamery Brook. As such, any efforts to improve habitat conditions in locally degraded reaches such as the reach F7 cow pasture should result in significant benefits to trout populations.



## REACH F8 (RIVER MILE 11.4) – REFERENCE



Reach F8 occurs on the upstream side of Burton Hill Road at river mile 11.4. This reach occurs within the Geomorphic Assessment reach 20B. Although significant bank erosion occurs in this reach, it was assigned to the reference reach class because a sinuous planform and riffle-pool morphology has been maintained through this reach. However, for purposes of assessing the potential condition of reach F7 relative to its current degraded state, it was decided to choose another reference reach further upriver to represent a more stable channel condition with more favorable habitat conditions for wild trout (reach F9).

Significant bank erosion is occurring at the lower end of the reach, in particular, where an absence of riparian vegetation along an outside bend is resulting in property loss. This reach received the third lowest bank stability index rating (8 of 20, marginal). Shallow riffle habitat dominated the reach, interceded by shallow pools and glides. Substrate was dominated by gravel and cobble, with embeddedness averaging 57.2% through the reach. Canopy cover was high through most of the reach (excepting the lawn on river left at the lower end), but the bank protective vegetation index was marginal. This was the first reach within which large woody debris accumulation in the channel was measured; LWD frequency averaged 5.3 pieces/100 m.

Daily maximum water temperature in this reach averaged 66.5°F, 0.5°F warmer than that measured just downriver of the confluence with Creamery Brook, suggesting a slight cooling

effect of Creamery Brook on the South River under hydrologic and climatic conditions similar to those during summer 2012.

Five species of fish were sampled from this reach. Slimy sculpin were the most abundant fish, followed closely by blacknose dace. Three juvenile Atlantic salmon were sampled, as well as 13 brook trout. Two longnose suckers were also sampled from this reach. Reach F8 was the lowest reach in which the number of intolerant fish sampled exceeded the number of tolerant fish sampled. Despite obvious encroachment of agriculture and infrastructure on the riparian corridor and river channel along this longer section of the South River, habitat and water quality are still generally favorable for wild fish. Projects that seek to restore and conserve riparian areas in this section of river are highly encouraged.

#### **REACH F9 (RIVER MILE 11.9) – REFERENCE**



Reach F9 occurs at river mile 11.9 immediately downriver of the Double Edge Theatre in Ashfield. This reach occurs within the Geomorphic Assessment reach 20D, characterized as having a well-developed floodplain, lower gradient, and riffle-pool morphology. Reach F9 was selected as a reference to represent potentially attainable conditions in reach F7. Reach F9 supported an even mix of riffle and pool habitats, including several pools that were deep and provided cover in the form of root wads and/or undercut banks. Substrate was dominated by

gravels and cobble, and while reach-wide embeddedness was moderately high at 45%, gravel substrates observed at pool tail outs appeared sufficiently clean to support trout spawning.

A bank stability index of 14 out of 20 was among the highest recorded for the study, as was the rapid habitat assessment index of 14.6 out of 20. The fish cover index was the highest measured in the study, supported by a prevalence of deeper pools, undercut banks, and large woody debris.

The fish community responded favorably to these habitat conditions, as seven species of fish were sampled, including four intolerant species and two trout species. Thirty-three brook and eight brown trout were sampled from this reach, the highest number of either species recorded from any reach. Slimy sculpin were the dominant species, and brook trout closely followed as the second most abundant. Several age classes of brook trout were sampled, and sizes ranged from 70 to 260 mm. The habitat features supported in this reach exemplify those that restoration efforts elsewhere should seek to produce. The abundance of wild trout and use of the reach by several age classes of these fish are testimony to these conditions. Importantly, these results also suggest good survival of wild fish in these upper reaches despite the severe floods experienced a year earlier during Tropical Storm Irene.

## REACH F10 (RIVER MILE 12.4) – IMPACTED



Reach F10 occurs at river mile 12.4 on the downriver side of Emmett Road in Ashfield. This reach occurs in the Geomorphic Assessment Reach 20F, and was selected to further represent a disturbed channel condition in the upper watershed, impacted by drain tiles, channel straightening, and a lack of a riparian zone on river right (partially missing on river left). Both wetted and bankfull channel dimensions are less than 5 m through this reach, as it appears that some channel incision has occurred through sediments deposited on a wide valley floor.

This reach exhibits a riffle-pool morphology, and while generally shallow, a few deeper pools also occurred within the reach. While trees are absent from the right-bank riparian zone, late summer growth of tall grasses provided ample shading and overhead cover for instream habitat. Consequently, the fish cover index scored in the range of most of the reference sites. Some large woody debris also occurred in the channel. Substrate was dominated by cobble and gravel, and reach-wide embeddedness was moderately high at 43.3%.

With an average daily maximum of 66.7°F, water temperatures measured at the Emmett Road crossing at the upper end of this reach were very favorable for maintenance of wild trout populations (Table 4). Fish community surveys revealed a dominance by sculpin and salmonids: all three salmonids were sampled at this site, only one of two sites (other being F11 on the upriver side of Emmett Road) at which this occurred. The fish survey results suggest that



sensitive fish species continue to thrive in the upper reaches of the South River; disturbance to the channel and riparian zone in these upper reaches has greater consequences for downriver reaches where effects such as increased rates of warming and sediment loading are potentially cumulative. As such, efforts to improve riparian conditions should be the focus of restoration and conservation activities in the upper river.

#### **REACH F11 (RIVER MILE 12.5) – REFERENCE**



Reach F11 occurs on the upriver side of Emmett Road at river mile 12.5. This reach was selected to represent reference conditions for reach F10 occurring on the downriver side of the road crossing. In contrast to reach F10, reach F11 is flanked by mature forest (although the buffer width is narrow along a section of the river left bank) and has not been straightened. Despite this more natural planform, frequencies of riffles and pools were similar to those in reach F10, and substrate conditions were slightly less favorable, partially the result of the higher sinuosity in this reach having a higher capacity for sediment storage. Large woody debris loading was the highest measured in the study (17.3 pieces/100 m). Immediately upriver of this reach is a series of beaver dams impounding the South River. These dams appear to impound a significant amount of sediment, and their occasional failures potentially result in periodic influxes of large sediment loads into this reach. An area of mass wasting was also observed at

the upriver end of the reach, which also appears to have recently delivered a large quantity of fine sediment in the reach.

Fish community conditions in this reach were almost identical to those measured from reach F10. Slimy sculpin appeared to be slightly more abundant, and were utilizing the abundant large woody debris for cover. Brook trout were also relatively abundant in this reach, and both brown trout and Atlantic salmon were captured. Only one species classified as tolerant, blacknose dace, was sampled from this reach, and was represented only by 6 specimens, suggesting a low abundance relative to their numbers sampled further downriver.

## DISCUSSION

The South River is a dynamic system, whose tendency to migrate, erode banks, and threaten property and infrastructure has only increased with past management of the river and its floodplain. While much of the South River corridor has been developed for agriculture or rural residential land uses, and the river continues to adjust to legacy effects of dams long gone, much of the corridor remains intact, particularly in the upper and middle reaches. Impacts to the river's condition and functioning are less pronounced in these upper reaches, except where channel straightening or riparian tree removal has resulted in obvious changes. To add to this trend, smaller rivers, by simple virtue of transporting less water, do not have the same power as do larger rivers, and are therefore not as prone to erosion problems as are their larger downriver counterparts. This assessment of the South River characterizes these longitudinal trends in river conditions and characteristics: channel dimensions, substrate, bank vegetation, bank stability, and water temperature. While we cannot precisely parse the effects of human disturbance from natural longitudinal gradients, the observed longitudinal trends in this study, such as warming water temperatures or increased incidence of eroding banks, have no doubt been altered by development of the watershed.

This study sought to sample from a range of habitat and channel stability conditions throughout the river and to characterize biological communities across this range of conditions. By establishing sample sites throughout the length of the river and locally pairing sites as conditions allowed, the relative effects of longitudinal gradients versus localized variation in habitat conditions on biological communities could be examined. This study suggests that longitudinal gradients in river conditions, perhaps largely the water temperature regime, clearly have larger effects on biological communities than does local variation at the neighboring-reach scale. This is evidenced in the finding that while significant differences in some habitat attributes occurred between impacted-reference paired reaches (F7 vs F9 and F10 vs F11), fish community composition was almost identical.

In its current condition, the lower South River from the lower Reeds Bridge Road Bridge upriver through Conway generally lacks large woody debris and other instream cover, exhibits a wide channel that supports very shallow baseflows, and has warm water during summer months.

In contrast, even the most heavily degraded reaches in the upper river maintain cool summer water temperatures and sufficient habitat complexity and cover to support wild trout.

Corresponding longitudinal trends in fish community composition was highly evident: brook trout are effectively scarce in the lower river, but are abundant even in heavily disturbed reaches in the upper river such as reach F7. Furthermore, as the richness and abundance of intolerant fish species increased in an upriver direction, tolerant species trended in the opposite direction. Blacknose dace were the dominant species throughout the lower and middle river, but exhibited an abrupt decrease in dominance above reach F7, just upriver of the confluence with Creamery Brook.

This study demonstrated that the upper South River supports wild populations of both brook trout and brown trout. Multiple year classes, including young-of-the-year fish, of each species were sampled. In contrast, brook and brown trout are scarce in the lower South River, at least during the summer months. Competition with and displacement by juvenile Atlantic salmon is one plausible explanation (Jackson and Zydlewski 2009). Both brook and brown trout have co-evolved with Atlantic salmon in their native ranges, so under favorable environmental conditions, both trout species should be expected to co-exist with juvenile Atlantic salmon. However, as juvenile Atlantic salmon have a higher tolerance for elevated water temperatures than do brook trout, under temperature duress and high Atlantic salmon densities, brook trout may be at a competitive disadvantage. While Atlantic salmon abundance was generally low in the river (and result exclusively from stocking efforts) during these 2012 surveys, previous surveys by MDFW have shown that Atlantic salmon abundance has been much higher (2010 MDFW data, Alicia Norris, personal communication), suggesting that the lack of stocking this past year following Tropical Storm Irene has resulted in temporarily reduced numbers of juvenile salmon in the river. In fact a 2010 fish survey by MDFW of a 100-m section of the South River on the west side of Conway captured 147 juvenile Atlantic salmon. At these numbers, and considering a lack of instream habitat complexity through much of the river, juvenile Atlantic salmon may be suppressing brook trout numbers through much of the middle and lower river. DEP/DWM's 2000 Deerfield River Watershed Assessment also calls into question the potential effect of juvenile Atlantic salmon on native brook trout and other fishes (DWM 2005). Most



likely, an interplay between unfavorable habitat conditions and some inter-specific competition precludes regular use of the lower South River by brook and brown trout.

2012 was a particularly hot and dry summer, likely producing less favorable habitat conditions for wild trout in the lower river than during cooler, wetter summers. Pumpkin Hollow Brook potentially serves as an important thermal refuge for trout in parts of the lower river, and provides a local source of individuals to seasonally utilize the South River when conditions are more favorable. While no brook trout were captured in the Conway section of the river during this survey, one brook trout was clearly observed evading capture in reach F3 within meters of the confluence with Pumpkin Hollow Brook. This fish was undoubtedly seeking the cool water inputs into the South River from Pumpkin Hollow Brook.

Despite two centuries of modification and manipulation, much of the South River continues to provide valuable habitat for sensitive aquatic species. A 2006 survey by the Deerfield River Watershed Association suggested that most all of the South River supports minimally or non-impaired macroinvertebrate communities (Cole 2007). The results of the present study suggest that a strategy for protecting and enhancing wild trout populations in the South River could partially focus on conserving and restoring riparian conditions in the upper South River. The upper river experiences the highest rates of water temperature warming. Improvement of riparian conditions and attendant stream shading may reduce these warming rates, thereby improving the capacity of downriver reaches to support intolerant fish species. The lower river, by virtue of widespread reduction in habitat complexity and quality, would benefit from projects that seek to improve river functioning and help return the river to more natural geomorphic state; these efforts would produce the habitat elements such as deep pools and instream cover that are requisite for healthy fish communities, and also provide capacity to support larger numbers of salmon and trout. The Geomorphic Assessment developed by Field Geology Services (Field 2012) provides a road map for such efforts. This study helps inform the virtue and necessity of those proposed efforts, and also serves as a baseline against which progress towards improving ecological conditions in the South River watershed can be measured.

## CONCLUSIONS AND RECOMMENDATIONS:

- Physical habitat conditions in the South River range widely, but a general trend in increasingly degraded conditions occurs in a downriver direction. These longitudinal trends exhibit a stronger influence on fish community composition than does local variation in habitat conditions.
- Limiting factors in the upper river, where they occur, include a lack in instream complexity and cover, and elevated sediment loading. Much of the upper river supports intact habitat, and summer water temperatures are favorable for supporting wild trout populations. Fish communities in the upper river reflect this capacity and are dominated by salmonids and other intolerant species.
- The lower River, particularly below the town of Conway, suffers from localized effects of channel straightening and increased sediment production, and also from cumulative effects from upriver impacts. Limiting factors in much of the lower river include low habitat quality and complexity (lack of deep pools, instream cover, clean gravels, etc.), and high water temperatures. These degraded conditions are most evident in straightened and channelized sections of the river. These attributes create conditions that are likely also potentially allowing juvenile Atlantic salmon to out-compete wild trout in the lower and middle reaches of the river.
- The upper river would benefit from land conservation and riparian protection and improvement projects. Wild trout populations are supported by current conditions, and any improvements to habitat only stand to improve local conditions, and minimize cumulative impacts to downriver sections. Such work could be informed by a comprehensive riparian zone study that explicitly identifies reaches most in need of increased stream shading.
- The lower river would benefit from restoration projects recommended in the Geomorphic Assessment (Field 2013) that would help restore a more natural planform to the river and promote the creation of habitat features conducive to supporting wild fish.

- Further assessment of summertime trout distribution over a wider range of summer conditions and water temperatures will assist with further determining distribution and abundance of wild trout in the lower river and further identify limiting factors.
- Restoration and protection of riparian areas along the entire river are highly recommended and will be critical to the long-term improvement of habitat conditions in the lower river.

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Table 1. List of reaches from which fish and physical habitat were sampled from the South River in August 2012.

Reach Code	River Mile	Water-body	Location Description	Impact/ Ref	Geomorph Segment	Total Needs Score	Channel Type	Lat	Long
F1	2.6	South R	above lower Reeds Bridge	I	7A	32	C, L	42.541879	-72.693838
F2	5.4	South R	300 m below Main St bridge	I	10E	31	UC, L	42.511447	-72.694315
F3	5.6	South R	100 m blw Main St Br to P. Hollow	I	10E	31	C, M	42.509613	-72.697086
F4	8.3	South R	300 m DS Rt 116 Br blw Brester Rd	R	17B	10	C, H	42.516993	-72.729413
F5	10.0	South R	Alden Gray property	I	18G	31	UC, L	42.514236	-72.754365
F6	10.4	South R	1/6 mile DS Bullitt Rd	R	19C	24	C, H	42.509616	-72.759135
F7	11.3	South R	DS side Burton Hill Road	I	20A	31	UC, M	42.509643	-72.772036
F8	11.4	South R	US side Burton Hill Road	I/R	20B	18	UC, L	42.510579	-72.773967
F9	11.9	South R	behind Double Edge Theatre	R	20D	12	UC, L	42.514473	-72.778298
F10	12.4	South R	Downstream of Emmet Road	I	20F	23	UC, L	42.520587	-72.780777
F11	12.5	South R	Upstream of Emmet Road	R	20G	7	UC, L	42.521799	-72.780588
F12	0.1	Creamery Bk	50 m above confluence with SR	I	NA	NA	C, M	42.509064	-72.772583

Channel type: Classified according to major South River channel types identified in Field 2013: C = confined, U = unconfined, L = low energy, M = moderate energy, H = high energy.

Table 2. Mean, minimum, and maximum values of physical habitat attributes measured from 11 reaches in the South River in August 2012.

Variable	Mean	Min	Max
Mean Water Depth	0.1	0.1	0.2
Wetted Width	6.1	2.4	11.8
W:D Ratio	51.6	20.8	117.6
Bankfull Width	11.0	3.2	18.9
Bankfull Height	0.7	0.4	0.9
Bankfull W:D Ratio	15.3	8.6	24.2
SD Thalweg Depth	12.8	7.0	20.6
Percent Glide Habitat	21.0	0.0	65.0
Percent Riffle Habitat	42.6	5.0	57.0
Percent Pool Habitat	35.8	4.0	55.0
Percent Cascade Habitat	0.6	0.0	7.0
Embeddedness	46.7	27.3	70.2
% Sand/Fines	17.8	2.0	29.5
% Coarse Substrate	67.6	51.4	88.6
Mean Particle Size	240.0	45.3	994.9
Fish Cover Index (0-4)	0.4	0.2	0.6
Bank Stability Index (0-20)	11.7	7.0	16.0
Bank Veg Prot Index (0-20)	10.6	4.0	17.0
% Canopy Cover	74.4	42.4	91.4
Mid-Stream Can Cov	70.9	39.6	88.8
Rip Veg Zone Width Index	8.6	0.0	18.0
Pieces LWD/100 m	2.5	0.0	17.3
Rapid Hab Assess	12.3	8.7	16.2

Table 3. Impacted and reference reach group means of physical habitat attributes measured from 11 reaches in the South River in August 2012.

Habitat Variable	Impacted (n = 6)		Reference (n = 5)	
	Mean	SD	Mean	SD
MeanWaterDepth	0.1	0.0	0.1	0.0
WettedWidth	7.2	3.6	4.8	2.1
WDRatio	59.3	32.6	42.5	12.8
BankfullWidth	12.6	6.2	9.0	5.2
BankfullHeight	0.7	0.2	0.6	0.2
BankfullWDRatio	16.8	5.3	13.6	3.9
SDThalwegDepth	12.1	4.7	13.6	1.8
PercentGlideHabitat	34.3	19.8	5.0	6.6
PercentRiffleHabitat	39.1	21.9	46.8	4.9
PercentPoolHabitat	26.6	12.6	46.8	8.3
PercentCascadeHabitat	0.0	0.0	1.4	3.1
Embeddedness	53.6	11.1	38.5	10.1
Sand/Fines	19.4	7.6	15.9	12.3
CoarseSubstrate	64.6	9.0	71.3	16.4
MeanParticleSize	184.1	128.1	307.0	401.0
FishCoverIndex	0.3	0.1	0.6	0.0
BankStabilityIndex	10.8	3.3	12.8	2.6
BankVegProtIndex	9.8	4.4	11.6	3.0
CanopyCover	65.5	17.7	85.1	4.6
Mid-StreamCanCov	61.3	17.9	82.4	4.3
RipZoneWidthIndex	7.5	5.8	12.2	4.0
PiecesLWD	0.3	0.8	5.1	7.2
RapidHabAssess	10.4	2.1	14.5	1.2

Table 4. Water temperature metrics calculated from 9 temperature monitoring stations in the South River, summer 2012.

Temp Station	Habitat Reach	River Mile	Avg Daily Mean (°F)	Avg Daily Max (°F)	Max 7D Avg Max (°F)
T1	F1	2.6	68.87	74.4	81.36
T2		4.8	67.61	71.62	78.51
T3	F3	5.65	67.04	69.97	76.37
T4		7.3	67.11	72.09	78.66
T5	F4	8.5	65.57	68.89	75.56
T6	F6	10.4	63.16	66.13	71.4
T7	F8	11.35	62.24	66.54	71.21
T8	F9	11.95	60.97	64.42	68.89
T9	F11	12.45	59.67	62.91	66.67



Table 5. Fish community composition from 11 South River and 1 Creamery Brook sample site surveyed in August 2012.

Common Name	PT	Temp	Reach Code											
			F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12
Atlantic salmon	I	C		2	7	6				3		1	1	3
Blacknose dace	T	CW	19	36	159	65	69	48	103	33	21	3	6	101
Brook trout	I	C					3		9	13	33	19	22	15
Brown trout	I	C							2		8	3	3	
Common Shiner	M	CW	5	9	9	1			8					1
Creek chub	T	CW		51	35	3	4		9		2			
Longnose dace	M	CW	23	19	38	35		14	2			1		6
Longnose Sucker	I	C	2			4	2	4	9	2	1			
Pumpkinseed	M	W									1			
Slimy sculpin	I	C		1	16	22	22	23	12	35	38	50	86	27
White sucker	T	CW			3									
Grand Total			49	118	267	136	100	89	154	86	104	77	118	153

Table 6. Fish community attributes calculated from fish surveys in the South River, August 2012.

Community Attribute	Reach Code											
	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12
# Salmonid Species	0	1	1	1	1	0	2	2	2	3	3	2
# Coldwater/Intolerant Species	1	2	2	3	3	2	4	4	4	4	4	3
# Salmon/Trout Sampled	0	2	7	6	3	0	11	16	41	23	26	18

Table 7. Correlations between select environmental variables and fish community metrics measured from 11 sampling stations along the South River in August 2012.

Environmental Variable	# Salmonid Sp.		# Cold-Water Sp.		# Tr/Sal Indiv	
	Pearson r	P Value	Pearson r	P Value	Pearson r	P Value
Wetted Width	<b>-0.7705</b>	<b>0.0028</b>	<b>-0.8368</b>	<b>0.0007</b>	<b>-0.734</b>	<b>0.0051</b>
W/D Ratio	<b>-0.8012</b>	<b>0.0015</b>	<b>-0.8122</b>	<b>0.0012</b>	<b>-0.648</b>	<b>0.0155</b>
% Glides	-0.3466	0.148	-0.4208	0.099	-0.5056	0.0563
% Embeddedness	0.1078	0.3762	0.009661	0.4888	-0.03271	0.462
Fish Cover Index	0.3928	0.116	0.5009	0.0583	0.5678	0.0342
Max 7D Avg Max Temp	<b>-0.7529</b>	<b>0.0155</b>	<b>-0.8511</b>	<b>0.0037</b>	<b>-0.7437</b>	<b>0.0172</b>

**Map Placeholder**

Figure 1. Map of summer 2012 fish and physical habitat sampling stations in the South River.

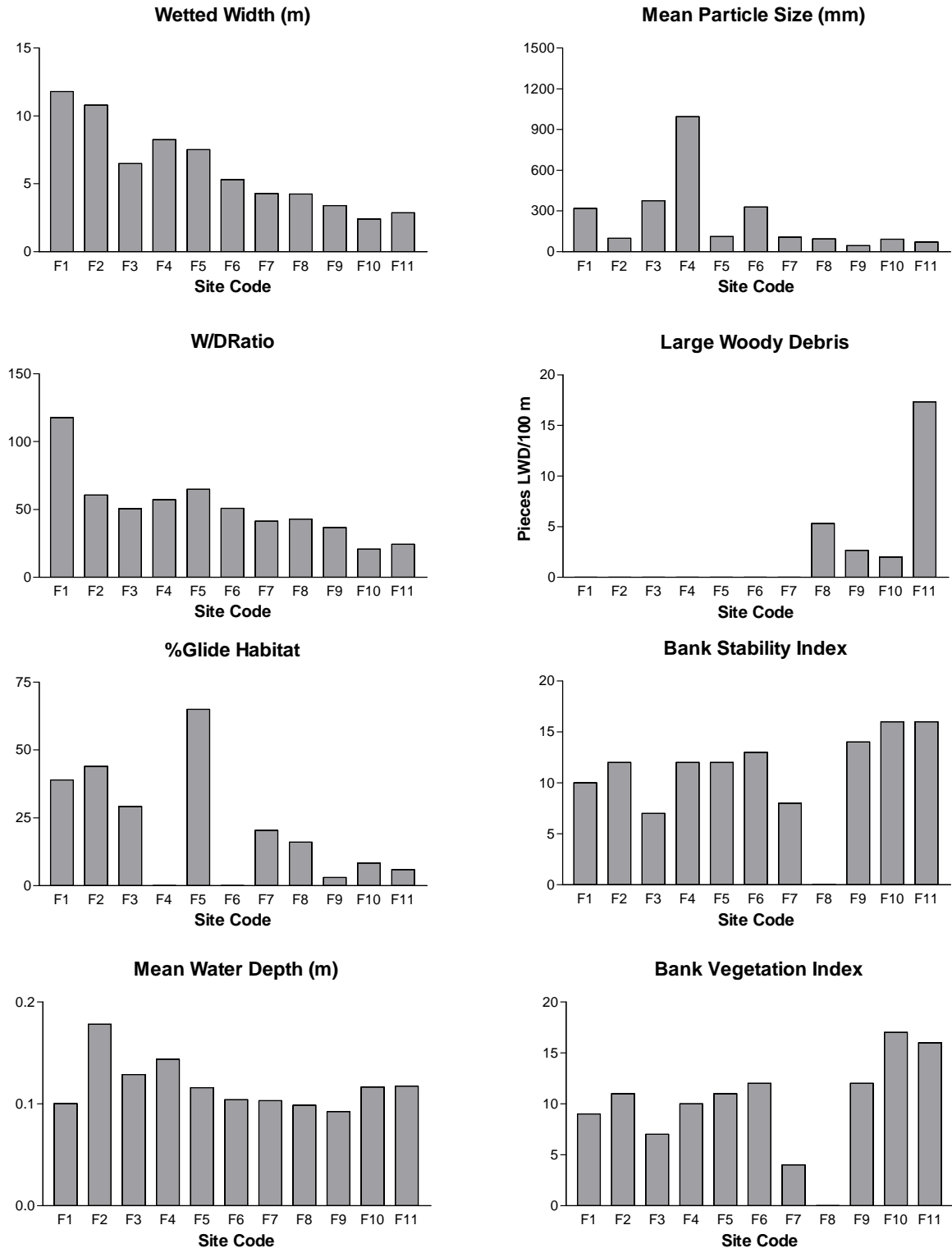


Figure 2. Habitat attributes measured in 2012 that exhibited apparent longitudinal trends along the South River.

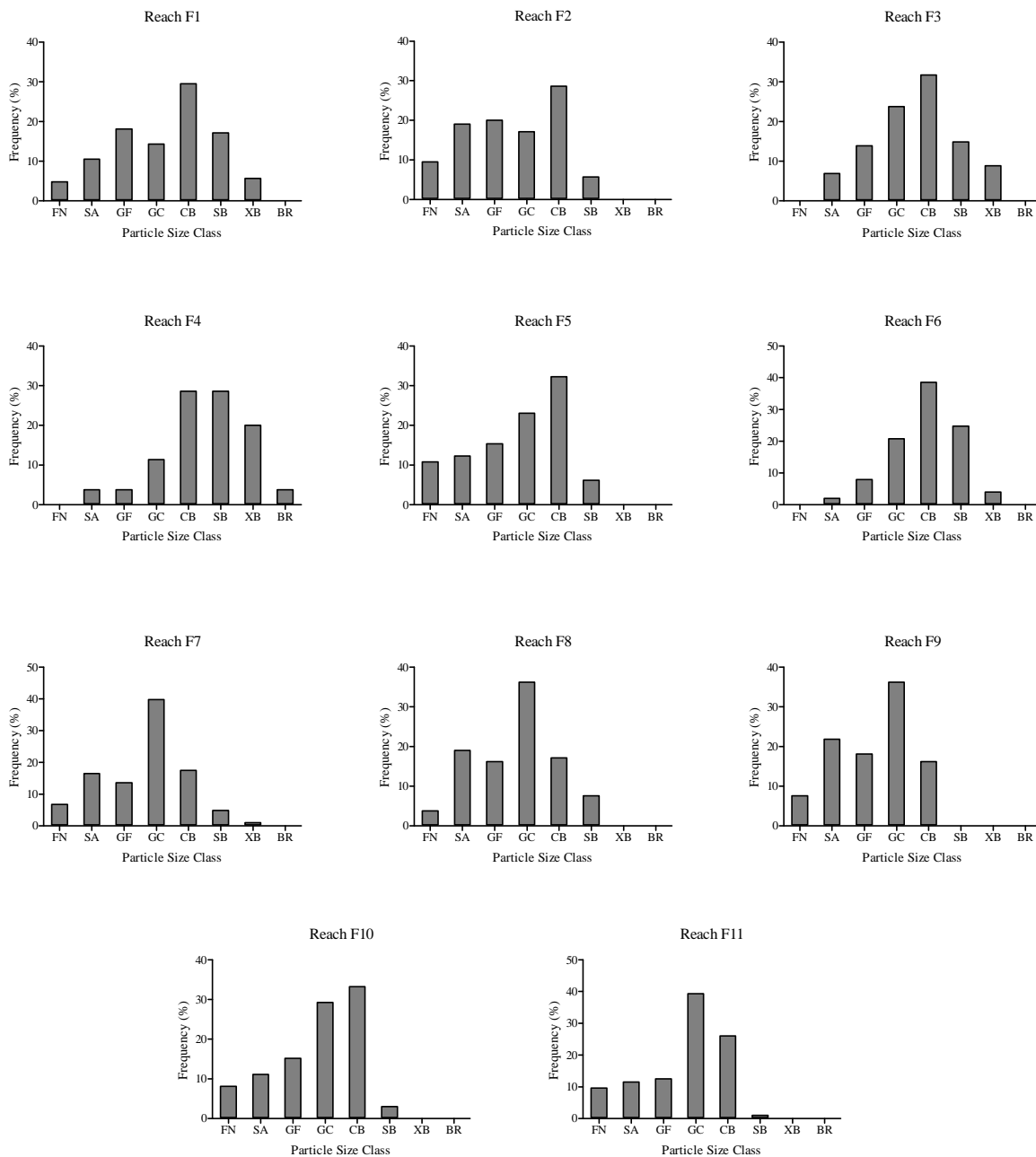


Figure 3. Substrate size class frequencies measured during habitat assessments of the South River in August 2012.

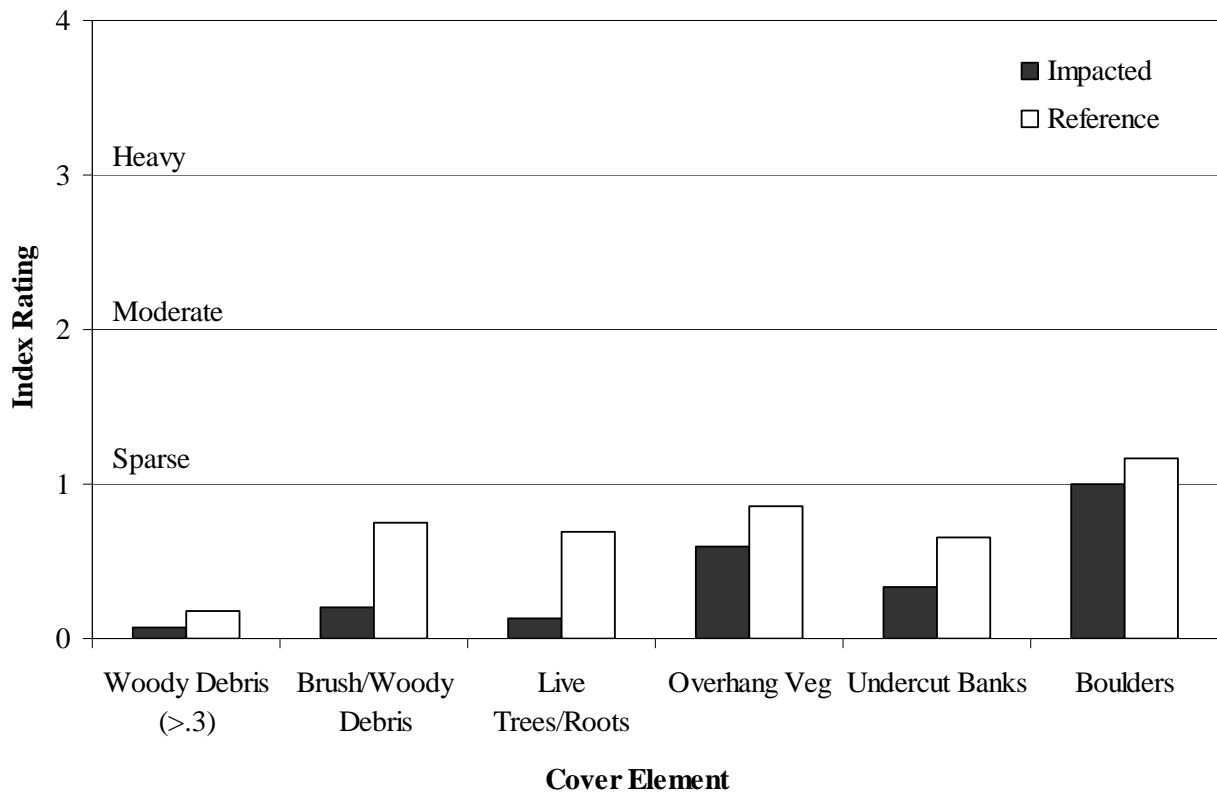


Figure 4. Fish cover index ratings for six cover elements assessed during physical habitat assessments of the South River in August 2012.

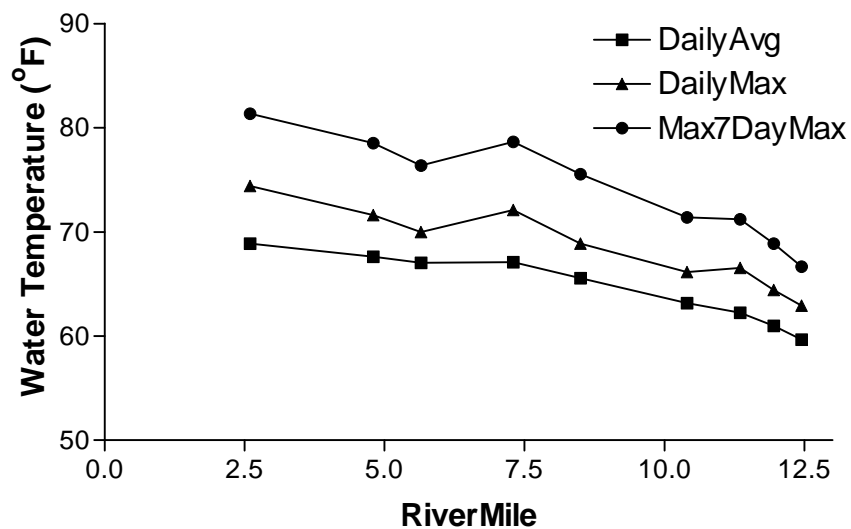


Figure 5. Water temperature metrics by river mile along the South River, summer 2012.

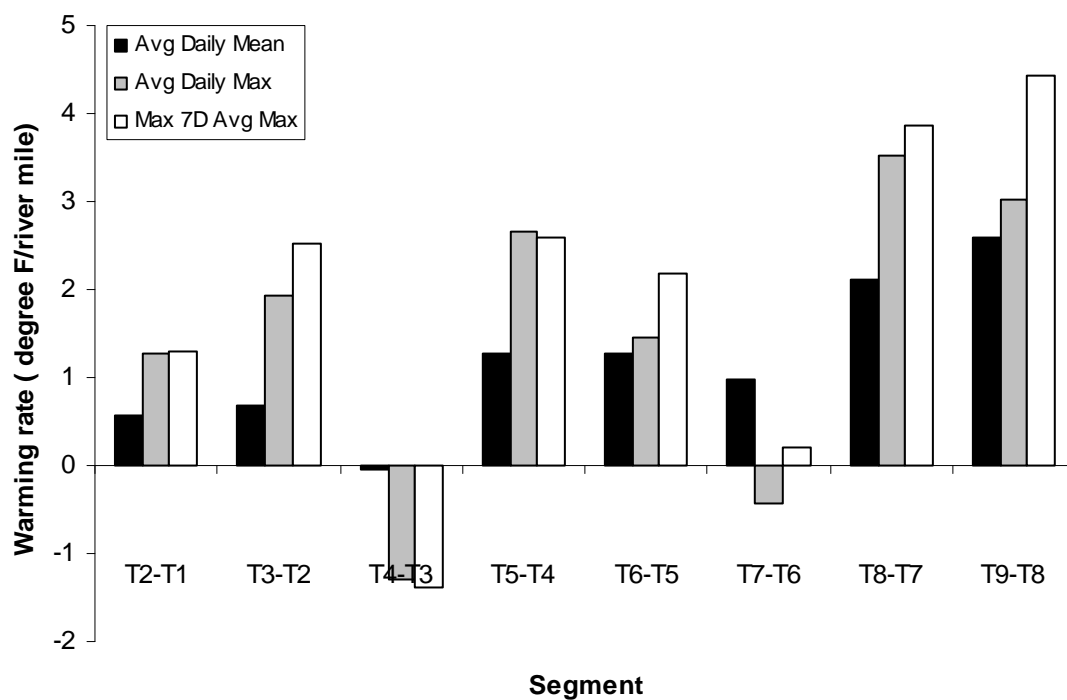


Figure 6. Summer 2012 water temperature warming rates calculated between temperature monitoring stations on the South River.



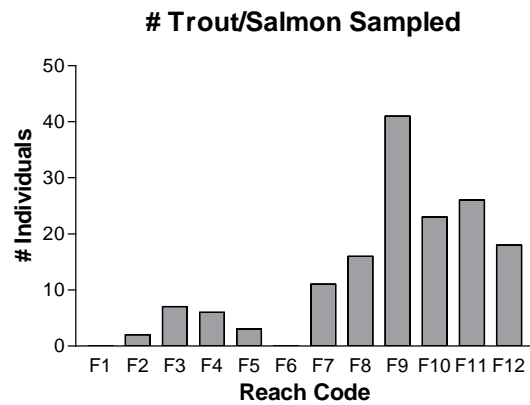
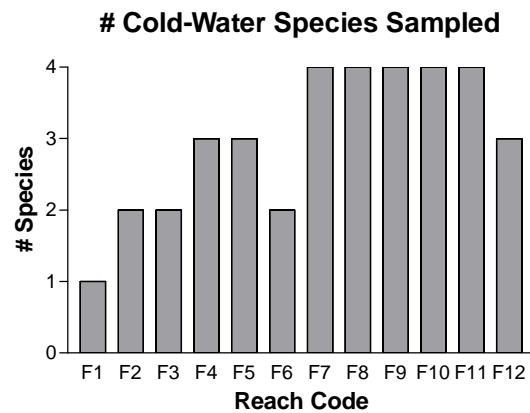
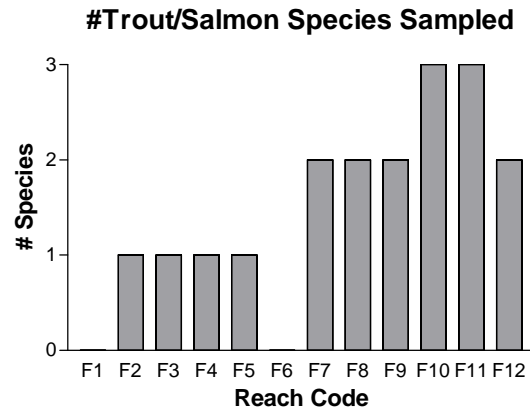


Figure 7. Fish metrics calculated from fish surveys performed in 11 reaches in the South River and 1 reach in Creamery Brook in August 2012.

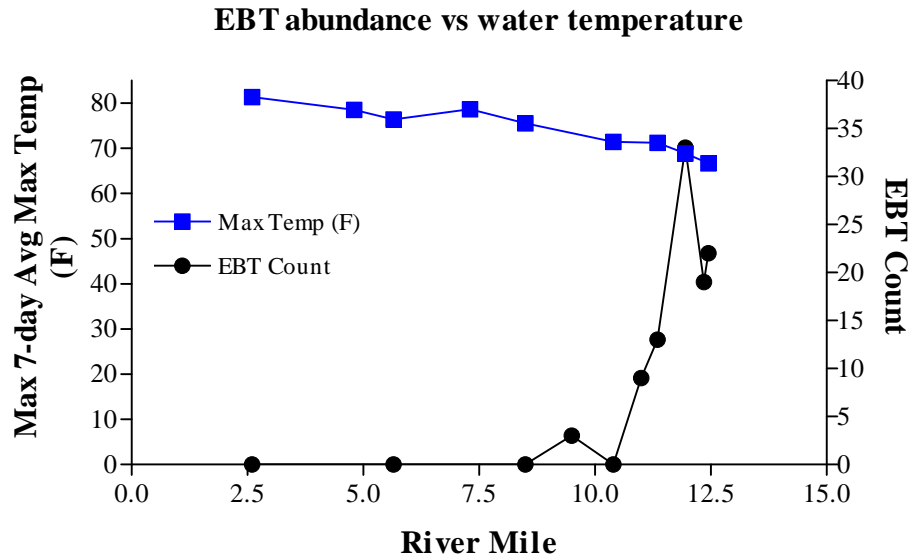


Figure 8. Number of brook trout captured plotted against maximum 7-day average maximum water temperatures in the South River, August 2012.

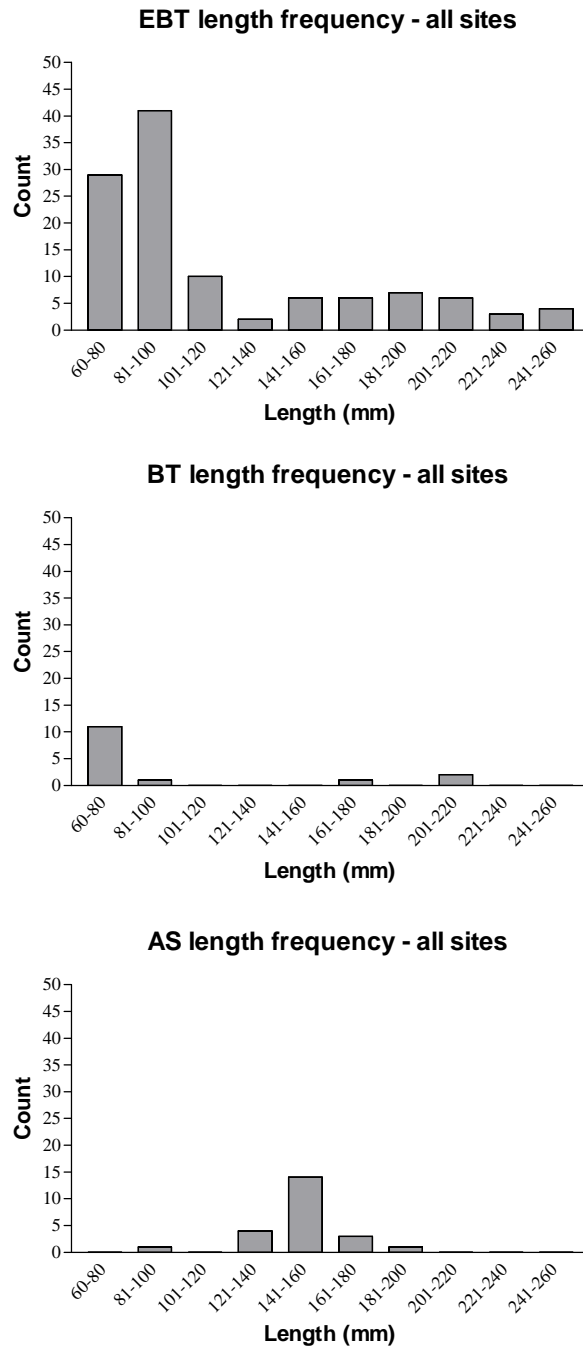


Figure 9. Length frequencies of trout and salmon sampled from the South River in August 2012. EBT = eastern brook trout, BT = brown trout, and AS = Atlantic salmon.

## Appendix 1. Reach Assessment Summaries

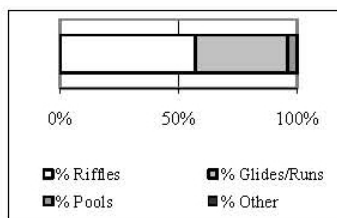
## Reach Assessment Summary

Stream Name: <b>South River</b>	Reach ID: F1
Location: abv lower Reeds Bridge Road bridge crossing	Latitude: 42.541879
County, State: Franklin, MA	Longitude: -72.693838
Date sampled: 8/13/2012	Reach Length: 150 m
Field Lead: M Cole	

### Physical and Chemical Conditions Summary

#### Instream Physical Characteristics

Wetted Width (m)	11.8
Bankfull Width (m)	18.0
Wetted W/D Ratio	117.6
Mean Water Depth (m)	0.1
% Riffles	57.0
% Glides/Runs	39.0
% Pools	4.0
% Other	0
Fish Cover Rating (0-4)	0.4

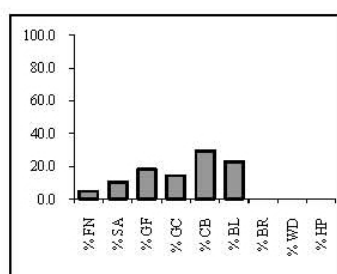


Downstream End - Facing Upstream



#### Substrate

% Fines (FN)	4.8
% Sand (SA)	10.5
% Gravel, Fine (GF)	18.1
% Gravel, Coarse (GC)	14.3
% Cobble (CB)	29.5
% Boulder (BL)	22.9
% Bedrock (BR)	0.0
% Wood (WD)	0.0
% Hardpan (HP)	0.0
% Embeddedness	48.1
Mean Particle Size (mm)	319.0
Large Wood Tally (pieces/100 m)	0.00



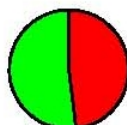
Upstream End - Facing Downstream



#### Bank Conditions

Bank Stability Rating (1-20)	10
Bank Protective Veg Rating (1-20)	0
Incised Bank Height (m)	0

Embeddedness



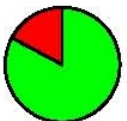
#### Riparian Zone Characteristics

Overhead Cover (%)	83
Mid Channel Overhead Cover (%)	77
Riparian Buffer Width (m)	17

#### Chemical Characteristics

Water Temperature (°C)	
Dissolved Oxygen (%)	
Dissolved Oxygen (mg/L)	
Specific Conductance (µS/cm)	
Time of measurement	

Canopy Cover



### Fish Community Survey Summary

Common Name	Function	PT	Temp	Listed Status	E-fishing Count
Atl. salmon	Top Carnivore	I	C	Not Listed	
Blacknose dace	Generalist Feeder	T	CW	Not Listed	19
Brook trout	Top Carnivore	I	C	Not Listed	
Brown trout	Top Carnivore	I	C	Not Listed	
Common Shiner	Generalist Feeder	M	CW	Not Listed	5
Creek chub	Generalist Feeder	T	CW	Not Listed	
Longnose dace	Benthic Insectivore	M	CW	Not Listed	23
Longnose Sucker	Benthic Insectivore	I	C	Spec. Concern	2
Pumpkinseed	Generalist Feeder	M	W	Not Listed	
Slimy sculpin	Benthic Insectivore	I	C	Not Listed	
White sucker	Generalist Feeder	T	CW	Not Listed	
# Salmonid Species					0
# Coldwater/Intolerant Species					1
# Salmon/Trout Sampled					0

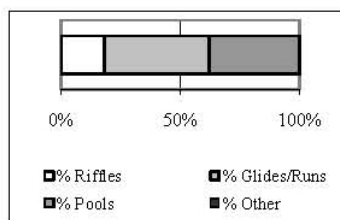
## Reach Assessment Summary

Stream Name: <b>South River</b>	Reach ID: <b>F2</b>
Location: <b>300 m DS Rte 116 Bridge in Conway center</b>	Latitude: <b>42.511447</b>
County, State: <b>Franklin, MA</b>	Longitude: <b>-72.694315</b>
Date sampled: <b>8/13/2012</b>	Reach Length: <b>150 m</b>
Field Lead: <b>M Cole</b>	

### Physical and Chemical Conditions Summary

#### Instream Physical Characteristics

Wetted Width (m)	10.8
Bankfull Width (m)	18.9
Wetted W/D Ratio	60.6
Mean Water Depth (m)	0.2
% Riffles	18.0
% Glides/Runs	44.0
% Pools	38.0
% Other	0
Fish Cover Rating (0-4)	0.3

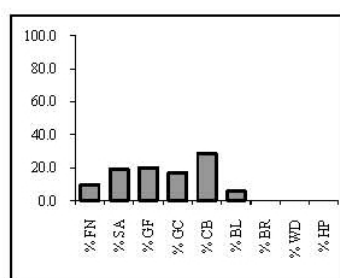


Downstream End - Facing Upstream



#### Substrate

% Fines (FN)	9.5
% Sand (SA)	19.0
% Gravel, Fine (GF)	20.0
% Gravel, Coarse (GC)	17.1
% Cobble (CB)	28.6
% Boulder (BL)	5.7
% Bedrock (BR)	0.0
% Wood (WD)	0.0
% Hardpan (HP)	0.0
% Embeddedness	70.2
Mean Particle Size (mm)	98.9
Large Wood Tally (pieces/100 m)	0.00



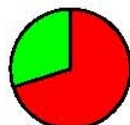
Upstream End - Facing Downstream



#### Bank Conditions

Bank Stability Rating (1-20)	12
Bank Protective Veg Rating (1-20)	0
Incised Bank Height (m)	0

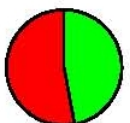
Embeddedness



#### Riparian Zone Characteristics

Overhead Cover (%)	47
Mid Channel Overhead Cover (%)	40
Riparian Buffer Width (m)	10

Canopy Cover



#### Chemical Characteristics

Water Temperature (°C)	
Dissolved Oxygen (%)	
Dissolved Oxygen (mg/L)	
Specific Conductance (µS/cm)	
Time of measurement	

### Fish Community Survey Summary

Common Name	Function	PT	Temp	Listed Status	E-fishing Count
Atl. salmon	Top Carnivore	I	C	Not Listed	2
Blacknose dace	Generalist Feeder	T	CW	Not Listed	36
Brook trout	Top Carnivore	I	C	Not Listed	
Brown trout	Top Carnivore	I	C	Not Listed	
Common Shiner	Generalist Feeder	M	CW	Not Listed	9
Creek chub	Generalist Feeder	T	CW	Not Listed	51
Longnose dace	Benthic Insectivore	M	CW	Not Listed	19
Longnose Sucker	Benthic Insectivore	I	C	Spec. Concern	
Pumpkinseed	Generalist Feeder	M	W	Not Listed	
Slimy sculpin	Benthic Insectivore	I	C	Not Listed	1
White sucker	Generalist Feeder	T	CW	Not Listed	
# Salmonid Species					1
# Coldwater/Intolerant Species					2
# Salmon/Trout Sampled					2



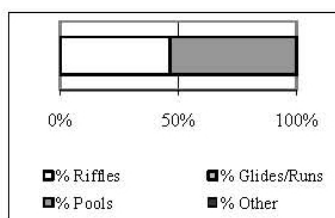
## Reach Assessment Summary

Stream Name: <b>South River</b>	Reach ID: F4
Location: 300 m DS 116 Bridge east of Brester Road	Latitude: 42.516993
County, State: Franklin, MA	Longitude: -72.729413
Date sampled: 8/14/2012	Reach Length: 150 m
Field Lead: M Cole	

### Physical and Chemical Conditions Summary

#### Instream Physical Characteristics

Wetted Width (m)	8.3
Bankfull Width (m)	17.5
Wetted W/D Ratio	57.3
Mean Water Depth (m)	0.1
% Riffles	43.0
% Glides/Runs	0.0
% Pools	50.0
% Other	7
Fish Cover Rating (0-4)	0.6

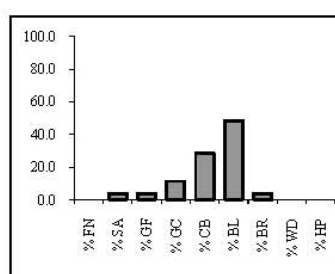


Downstream End - Facing Upstream



#### Substrate

% Fines (FN)	0.0
% Sand (SA)	3.8
% Gravel, Fine (GF)	3.8
% Gravel, Coarse (GC)	11.4
% Cobble (CB)	28.6
% Boulder (BL)	48.6
% Bedrock (BR)	3.8
% Wood (WD)	0.0
% Hardpan (HP)	0.0
% Embeddedness	27.3
Mean Particle Size (mm)	994.9
Large Wood Tally (pieces/100 m)	0.00



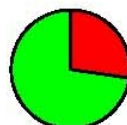
Upstream End - Facing Downstream



#### Bank Conditions

Bank Stability Rating (1-20)	12
Bank Protective Veg Rating (1-20)	0
Incised Bank Height (m)	0

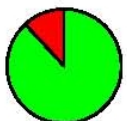
Embeddedness



#### Riparian Zone Characteristics

Overhead Cover (%)	88
Mid Channel Overhead Cover (%)	82
Riparian Buffer Width (m)	18

Canopy Cover



#### Chemical Characteristics

Water Temperature (°C)	
Dissolved Oxygen (%)	
Dissolved Oxygen (mg/L)	
Specific Conductance (µS/cm)	
Time of measurement	

### Fish Community Survey Summary

Common Name	Function	PT	Temp	Listed Status	E-fishing Count
Atl. salmon	Top Carnivore	I	C	Not Listed	6
Blacknose dace	Generalist Feeder	T	CW	Not Listed	65
Brook trout	Top Carnivore	I	C	Not Listed	
Brown trout	Top Carnivore	I	C	Not Listed	
Common Shiner	Generalist Feeder	M	CW	Not Listed	1
Creek chub	Generalist Feeder	T	CW	Not Listed	3
Longnose dace	Benthic Insectivore	M	CW	Not Listed	35
Longnose Sucker	Benthic Insectivore	I	C	Spec. Concern	4
Pumpkinseed	Generalist Feeder	M	W	Not Listed	
Slimy sculpin	Benthic Insectivore	I	C	Not Listed	22
White sucker	Generalist Feeder	T	CW	Not Listed	
# Salmonid Species					1
# Coldwater/Intolerant Species					3
# Salmon/Trout Sampled					6

## Reach Assessment Summary

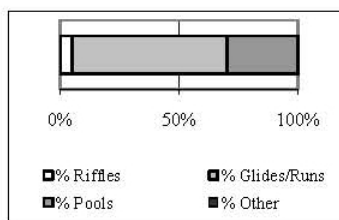
Stream Name: **South River**  
 Location: upper end Alden Gray property  
 County, State: Franklin, MA  
 Date sampled: 8/14/2012  
 Field Lead: M Cole

Reach ID: F5  
 Latitude: 42.514236  
 Longitude: -72.754365  
 Reach Length: 100 m

### Physical and Chemical Conditions Summary

#### Instream Physical Characteristics

Wetted Width (m)	7.5
Bankfull Width (m)	11.6
Wetted W/D Ratio	64.8
Mean Water Depth (m)	0.1
% Riffles	5.0
% Glides/Runs	65.0
% Pools	30.0
% Other	0
Fish Cover Rating (0-4)	0.3

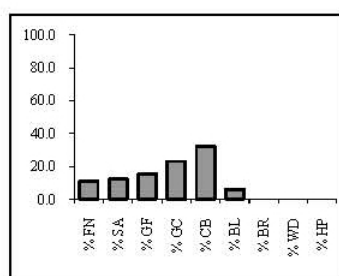


Downstream End - Facing Upstream



#### Substrate

% Fines (FN)	10.8
% Sand (SA)	12.3
% Gravel, Fine (GF)	15.4
% Gravel, Coarse (GC)	23.1
% Cobble (CB)	32.3
% Boulder (BL)	6.2
% Bedrock (BR)	0.0
% Wood (WD)	0.0
% Hardpan (HP)	0.0
% Embeddedness	60.6
Mean Particle Size (mm)	112.0
Large Wood Tally (pieces/100 m)	0.00



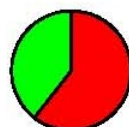
Upstream End - Facing Downstream



#### Bank Conditions

Bank Stability Rating (1-20)	12
Bank Protective Veg Rating (1-20)	0
Incised Bank Height (m)	0

Embeddedness



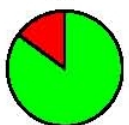
#### Riparian Zone Characteristics

Overhead Cover (%)	85
Mid Channel Overhead Cover (%)	83
Riparian Buffer Width (m)	7

#### Chemical Characteristics

Water Temperature (°C)	
Dissolved Oxygen (%)	
Dissolved Oxygen (mg/L)	
Specific Conductance (µS/cm)	
Time of measurement	

Canopy Cover



### Fish Community Survey Summary

Common Name	Function	PT	Temp	Listed Status	E-fishing Count
Atl. salmon	Top Carnivore	I	C	Not Listed	
Blacknose dace	Generalist Feeder	T	CW	Not Listed	69
Brook trout	Top Carnivore	I	C	Not Listed	3
Brown trout	Top Carnivore	I	C	Not Listed	
Common Shiner	Generalist Feeder	M	CW	Not Listed	
Creek chub	Generalist Feeder	T	CW	Not Listed	4
Longnose dace	Benthic Insectivore	M	CW	Not Listed	
Longnose Sucker	Benthic Insectivore	I	C	Spec. Concern	2
Pumpkinseed	Generalist Feeder	M	W	Not Listed	
Slimy sculpin	Benthic Insectivore	I	C	Not Listed	22
White sucker	Generalist Feeder	T	CW	Not Listed	

# Salmonid Species

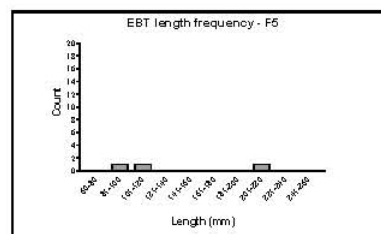
1

# Coldwater/Intolerant Species

3

# Salmon/Trout Sampled

3





## Reach Assessment Summary

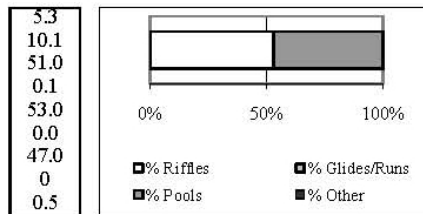
Stream Name: **South River**  
 Location: 1/6 mile DS Bullitt Road  
 County, State: Franklin, MA  
 Date sampled: 8/14/2012  
 Field Lead: M Cole

Reach ID: F6  
 Latitude: 42.509616  
 Longitude: -72.759135  
 Reach Length: 150 m

### Physical and Chemical Conditions Summary

#### Instream Physical Characteristics

Wetted Width (m) 5.3  
 Bankfull Width (m) 10.1  
 Wetted W/D Ratio 51.0  
 Mean Water Depth (m) 0.1  
 % Riffles 53.0  
 % Glides/Runs 0.0  
 % Pools 47.0  
 % Other 0  
 Fish Cover Rating (0-4) 0.5

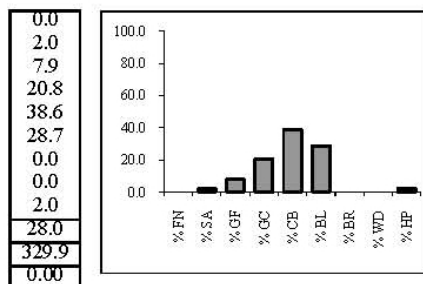


Downstream End - Facing Upstream



#### Substrate

% Fines (FN) 0.0  
 % Sand (SA) 2.0  
 % Gravel, Fine (GF) 7.9  
 % Gravel, Coarse (GC) 20.8  
 % Cobble (CB) 38.6  
 % Boulder (BL) 28.7  
 % Bedrock (BR) 0.0  
 % Wood (WD) 0.0  
 % Hardpan (HP) 2.0  
 % Embeddedness 28.0  
 Mean Particle Size (mm) 329.9  
 Large Wood Tally (pieces/100 m) 0.00



Upstream End - Facing Downstream



#### Bank Conditions

Bank Stability Rating (1-20) 13  
 Bank Protective Veg Rating (1-20) 0  
 Incised Bank Height (m) 0

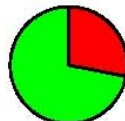
#### Riparian Zone Characteristics

Overhead Cover (%) 91  
 Mid Channel Overhead Cover (%) 89  
 Riparian Buffer Width (m) 7

#### Chemical Characteristics

Water Temperature (°C)  
 Dissolved Oxygen (%)  
 Dissolved Oxygen (mg/L)  
 Specific Conductance (µS/cm)  
 Time of measurement

Embeddedness



Canopy Cover



### Fish Community Survey Summary

Common Name	Function	PT	Temp	Listed Status	E-fishing Count
Atl. salmon	Top Carnivore	I	C	Not Listed	
Blacknose dace	Generalist Feeder	T	CW	Not Listed	48
Brook trout	Top Carnivore	I	C	Not Listed	
Brown trout	Top Carnivore	I	C	Not Listed	
Common Shiner	Generalist Feeder	M	CW	Not Listed	
Creek chub	Generalist Feeder	T	CW	Not Listed	
Longnose dace	Benthic Insectivore	M	CW	Not Listed	14
Longnose Sucker	Benthic Insectivore	I	C	Spec. Concern	4
Pumpkinseed	Generalist Feeder	M	W	Not Listed	
Slimy sculpin	Benthic Insectivore	I	C	Not Listed	23
White sucker	Generalist Feeder	T	CW	Not Listed	
# Salmonid Species					0
# Coldwater/Intolerant Species					2
# Salmon/Trout Sampled					0

## Reach Assessment Summary

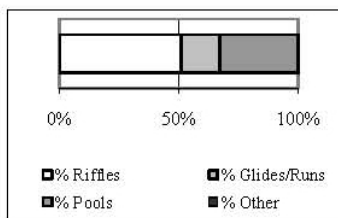
Stream Name: **South River**  
 Location: **US Side Burton Hill Road**  
 County, State: **Franklin, MA**  
 Date sampled: **8/15/2012**  
 Field Lead: **M Cole**

Reach ID: **F8**  
 Latitude: **42.510579**  
 Longitude: **-72.773967**  
 Reach Length: **150 m**

### Physical and Chemical Conditions Summary

#### Instream Physical Characteristics

Wetted Width (m)	4.2
Bankfull Width (m)	7.1
Wetted W/D Ratio	43.0
Mean Water Depth (m)	0.1
% Riffles	51.0
% Glides/Runs	16.0
% Pools	33.0
% Other	0
Fish Cover Rating (0-4)	0.5

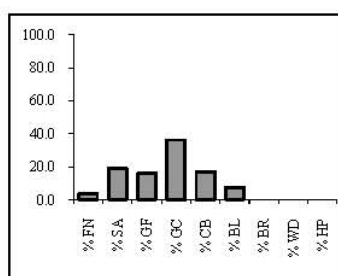


Downstream End - Facing Upstream



#### Substrate

% Fines (FN)	3.8
% Sand (SA)	19.0
% Gravel, Fine (GF)	16.2
% Gravel, Coarse (GC)	36.2
% Cobble (CB)	17.1
% Boulder (BL)	7.6
% Bedrock (BR)	0.0
% Wood (WD)	0.0
% Hardpan (HP)	0.0
% Embeddedness	45.2
Mean Particle Size (mm)	94.3
Large Wood Tally (pieces/100 m)	5.33



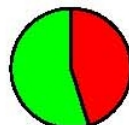
Upstream End - Facing Downstream



#### Bank Conditions

Bank Stability Rating (1-20)	0
Bank Protective Veg Rating (1-20)	0
Incised Bank Height (m)	1

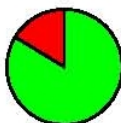
Embeddedness



#### Riparian Zone Characteristics

Overhead Cover (%)	84
Mid Channel Overhead Cover (%)	83
Riparian Buffer Width (m)	0

Canopy Cover



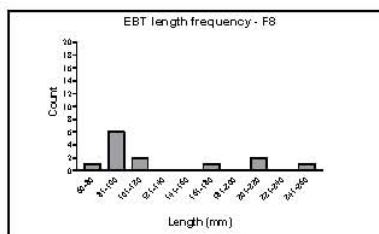
#### Chemical Characteristics

Water Temperature (°C)	
Dissolved Oxygen (%)	
Dissolved Oxygen (mg/L)	
Specific Conductance (µS/cm)	
Time of measurement	

### Fish Community Survey Summary

Common Name	Function	PT	Temp	Listed Status	E-fishing Count
Atl. salmon	Top Carnivore	I	C	Not Listed	3
Blacknose dace	Generalist Feeder	T	CW	Not Listed	33
Brook trout	Top Carnivore	I	C	Not Listed	13
Brown trout	Top Carnivore	I	C	Not Listed	
Common Shiner	Generalist Feeder	M	CW	Not Listed	
Creek chub	Generalist Feeder	T	CW	Not Listed	
Longnose dace	Benthic Insectivore	M	CW	Not Listed	
Longnose Sucker	Benthic Insectivore	I	C	Spec. Concern	2
Pumpkinseed	Generalist Feeder	M	W	Not Listed	
Slimy sculpin	Benthic Insectivore	I	C	Not Listed	35
White sucker	Generalist Feeder	T	CW	Not Listed	

# Salmonid Species	2
# Coldwater/Intolerant Species	4
# Salmon/Trout Sampled	16



## Reach Assessment Summary

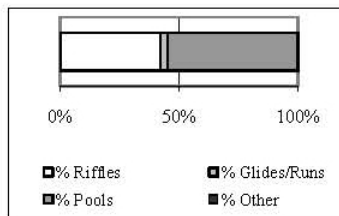
Stream Name: **South River**  
 Location: **DS Double Edge Theatre**  
 County, State: **Franklin, MA**  
 Date sampled: **8/15/2012**  
 Field Lead: **M Cole**

Reach ID: **F9**  
 Latitude: **42.514473**  
 Longitude: **-72.778298**  
 Reach Length: **150 m**

### Physical and Chemical Conditions Summary

#### Instream Physical Characteristics

Wetted Width (m)	3.4
Bankfull Width (m)	5.5
Wetted W/D Ratio	36.8
Mean Water Depth (m)	0.1
% Riffles	42.0
% Glides/Runs	3.0
% Pools	55.0
% Other	0
Fish Cover Rating (0-4)	0.6

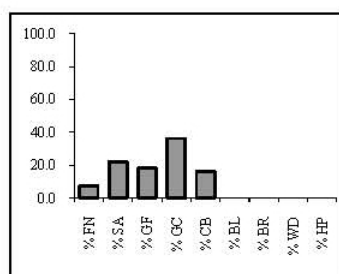


Downstream End - Facing Upstream



#### Substrate

% Fines (FN)	7.6
% Sand (SA)	21.9
% Gravel, Fine (GF)	18.1
% Gravel, Coarse (GC)	36.2
% Cobble (CB)	16.2
% Boulder (BL)	0.0
% Bedrock (BR)	0.0
% Wood (WD)	0.0
% Hardpan (HP)	0.0
% Embeddedness	48.9
Mean Particle Size (mm)	45.3
Large Wood Tally (pieces/100 m)	2.67



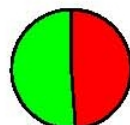
Upstream End - Facing Downstream



#### Bank Conditions

Bank Stability Rating (1-20)	14
Bank Protective Veg Rating (1-20)	0
Incised Bank Height (m)	0

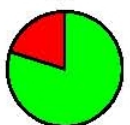
Embeddedness



#### Riparian Zone Characteristics

Overhead Cover (%)	80
Mid Channel Overhead Cover (%)	77
Riparian Buffer Width (m)	12

Canopy Cover



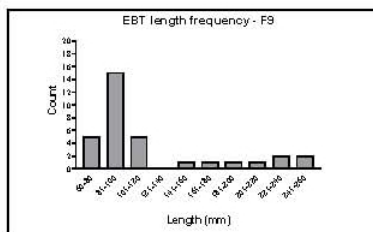
#### Chemical Characteristics

Water Temperature (°C)	
Dissolved Oxygen (%)	
Dissolved Oxygen (mg/L)	
Specific Conductance (µS/cm)	
Time of measurement	

### Fish Community Survey Summary

Common Name	Function	PT	Temp	Listed Status	E-fishing Count
Atl. salmon	Top Carnivore	I	C	Not Listed	
Blacknose dace	Generalist Feeder	T	CW	Not Listed	21
Brook trout	Top Carnivore	I	C	Not Listed	33
Brown trout	Top Carnivore	I	C	Not Listed	8
Common Shiner	Generalist Feeder	M	CW	Not Listed	
Creek chub	Generalist Feeder	T	CW	Not Listed	2
Longnose dace	Benthic Insectivore	M	CW	Not Listed	
Longnose Sucker	Benthic Insectivore	I	C	Spec. Concern	1
Pumpkinseed	Generalist Feeder	M	W	Not Listed	1
Slimy sculpin	Benthic Insectivore	I	C	Not Listed	38
White sucker	Generalist Feeder	T	CW	Not Listed	

# Salmonid Species	2
# Coldwater/Intolerant Species	4
# Salmon/Trout Sampled	41





## Reach Assessment Summary

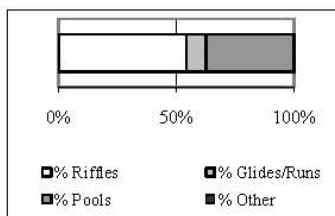
Stream Name: **South River**  
 Location: DS side Emmit Road  
 County, State: Franklin, MA  
 Date sampled: 8/16/2012  
 Field Lead: M Cole

Reach ID: F10  
 Latitude: 42.520587  
 Longitude: -72.780777  
 Reach Length: 150 m

### Physical and Chemical Conditions Summary

#### Instream Physical Characteristics

Wetted Width (m)	2.4
Bankfull Width (m)	3.2
Wetted W/D Ratio	20.8
Mean Water Depth (m)	0.1
% Riffles	54.2
% Glides/Runs	8.3
% Pools	37.5
% Other	0
Fish Cover Rating (0-4)	0.5

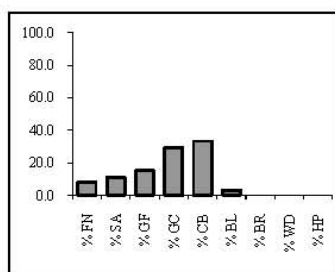


Downstream End - Facing Upstream



#### Substrate

% Fines (FN)	8.1
% Sand (SA)	11.1
% Gravel, Fine (GF)	15.2
% Gravel, Coarse (GC)	29.3
% Cobble (CB)	33.3
% Boulder (BL)	3.0
% Bedrock (BR)	0.0
% Wood (WD)	0.0
% Hardpan (HP)	0.0
% Embeddedness	43.3
Mean Particle Size (mm)	91.9
Large Wood Tally (pieces/100 m)	2.00



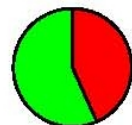
Upstream End - Facing Downstream



#### Bank Conditions

Bank Stability Rating (1-20)	16
Bank Protective Veg Rating (1-20)	0
Incised Bank Height (m)	0

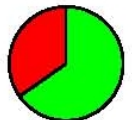
Embeddedness



#### Riparian Zone Characteristics

Overhead Cover (%)	65
Mid Channel Overhead Cover (%)	62
Riparian Buffer Width (m)	7

Canopy Cover



#### Chemical Characteristics

Water Temperature (°C)	
Dissolved Oxygen (%)	
Dissolved Oxygen (mg/L)	
Specific Conductance (µS/cm)	
Time of measurement	

### Fish Community Survey Summary

Common Name	Function	PT	Temp	Listed Status	E-fishing Count
Atl. salmon	Top Carnivore	I	C	Not Listed	1
Blacknose dace	Generalist Feeder	T	CW	Not Listed	3
Brook trout	Top Carnivore	I	C	Not Listed	19
Brown trout	Top Carnivore	I	C	Not Listed	3
Common Shiner	Generalist Feeder	M	CW	Not Listed	
Creek chub	Generalist Feeder	T	CW	Not Listed	
Longnose dace	Benthic Insectivore	M	CW	Not Listed	1
Longnose Sucker	Benthic Insectivore	I	C	Spec. Concern	
Pumpkinseed	Generalist Feeder	M	W	Not Listed	
Slimy sculpin	Benthic Insectivore	I	C	Not Listed	50
White sucker	Generalist Feeder	T	CW	Not Listed	

# Salmonid Species

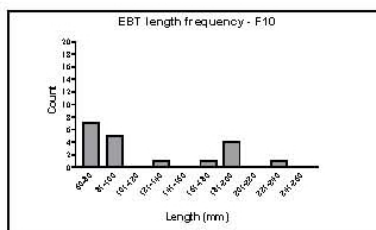
3

# Coldwater/Intolerant Species

4

# Salmon/Trout Sampled

23



## Reach Assessment Summary

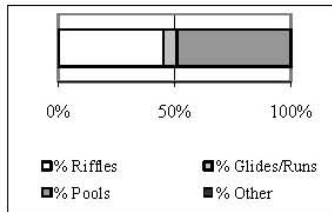
Stream Name: **South River**  
 Location: US side Emmit Road  
 County, State: Franklin, MA  
 Date sampled: 8/16/2012  
 Field Lead: M Cole

Reach ID: F11  
 Latitude: 42.521799  
 Longitude: -72.780588  
 Reach Length: 150 m

### Physical and Chemical Conditions Summary

#### Instream Physical Characteristics

Wetted Width (m)	2.9
Bankfull Width (m)	4.9
Wetted W/D Ratio	24.3
Mean Water Depth (m)	0.1
% Riffles	45.0
% Glides/Runs	6.0
% Pools	49.0
% Other	0
Fish Cover Rating (0-4)	0.6

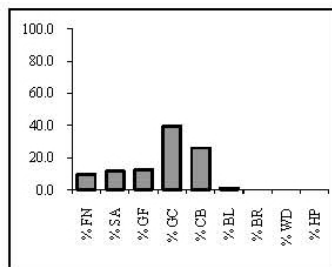


Downstream End - Facing Upstream



#### Substrate

% Fines (FN)	9.6
% Sand (SA)	11.5
% Gravel, Fine (GF)	12.5
% Gravel, Coarse (GC)	39.4
% Cobble (CB)	26.0
% Boulder (BL)	1.0
% Bedrock (BR)	0.0
% Wood (WD)	0.0
% Hardpan (HP)	0.0
% Embeddedness	43.0
Mean Particle Size (mm)	70.6
Large Wood Tally (pieces/100 m)	17.33



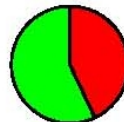
Upstream End - Facing Downstream



#### Bank Conditions

Bank Stability Rating (1-20)	16
Bank Protective Veg Rating (1-20)	0
Incised Bank Height (m)	0

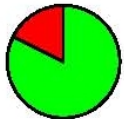
Embeddedness



#### Riparian Zone Characteristics

Overhead Cover (%)	82
Mid Channel Overhead Cover (%)	81
Riparian Buffer Width (m)	13

Canopy Cover



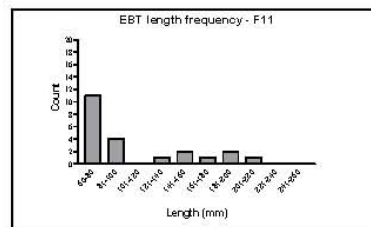
#### Chemical Characteristics

Water Temperature (°C)	
Dissolved Oxygen (%)	
Dissolved Oxygen (mg/L)	
Specific Conductance (µS/cm)	
Time of measurement	

### Fish Community Survey Summary

Common Name	Function	PT	Temp	Listed Status	E-fishing Count
Atl. salmon	Top Carnivore	I	C	Not Listed	1
Blacknose dace	Generalist Feeder	T	CW	Not Listed	6
Brook trout	Top Carnivore	I	C	Not Listed	22
Brown trout	Top Carnivore	I	C	Not Listed	3
Common Shiner	Generalist Feeder	M	CW	Not Listed	
Creek chub	Generalist Feeder	T	CW	Not Listed	
Longnose dace	Benthic Insectivore	M	CW	Not Listed	
Longnose Sucker	Benthic Insectivore	I	C	Spec. Concern	
Pumpkinseed	Generalist Feeder	M	W	Not Listed	
Slimy sculpin	Benthic Insectivore	I	C	Not Listed	86
White sucker	Generalist Feeder	T	CW	Not Listed	

# Salmonid Species	3
# Coldwater/Intolerant Species	4
# Salmon/Trout Sampled	26



Appendix 2. Summary of habitat attributes measured from the South River in August, 2012.

Variable	Site Code										
	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11
Mean Water Depth	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Wetted Width	11.8	10.8	6.5	8.3	7.5	5.3	4.3	4.2	3.4	2.4	2.9
W:D Ratio	117.6	60.6	50.5	57.3	64.8	51.0	41.5	43.0	36.8	20.8	24.3
Bankfull Width	18.0	18.9	16.2	17.5	11.6	10.1	8.0	7.1	5.5	3.2	4.9
Bankfull Height	0.9	0.8	0.9	0.9	0.8	0.8	0.5	0.5	0.5	0.4	0.4
Bankfull W:D Ratio	19.8	24.2	17.9	20.1	14.3	12.0	15.7	13.4	10.0	8.6	12.3
SD Thalweg Depth	7.0	20.6	12.6	15.8	9.9	11.6	13.1	13.4	14.9	9.4	12.2
Percent Glide Habitat	39	44	29	0	65	0	20	16	3	8	6
Percent Riffle Habitat	57	18	48	43	5	53	52	51	42	54	45
Percent Pool Habitat	4	38	23	50	30	47	28	33	55	38	49
Percent Cascade Habitat	0	0	0	7	0	0	0	0	0	0	0
Embeddedness	48.1	70.2	41.9	27.3	60.6	28.0	57.2	45.2	48.9	43.3	43.0
% Sand/Fines	15.2	28.6	6.9	3.8	23.1	2.0	23.3	22.9	29.5	19.2	21.2
% Coarse Substrate	66.7	51.4	79.2	88.6	61.5	88.1	63.1	61.0	52.4	65.7	66.3
Mean Particle Size	319.0	98.9	376.2	994.9	112.0	329.9	106.7	94.3	45.3	91.9	70.6
Fish Cover Index (0-4)	0.4	0.3	0.2	0.6	0.3	0.5	0.3	0.5	0.6	0.5	0.6
Bank Stability Index (0-20)	10	12	7	12	12	13	8	9	14	16	16
Bank Veg Prot Index (0-20)	9	11	7	10	11	12	4	8	12	17	16
% Canopy Cover	82.8	47.1	70.4	88.1	85.0	91.4	42.4	83.7	79.9	65.3	82.4
Mid-Stream Can Cov	77.0	39.6	64.4	82.2	83.4	88.8	41.6	83.3	76.7	61.9	81.1
Rip Veg Zone Width Index	17	10	4	18	7	7	0	11	12	7	13
Pieces LWD/100 m	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.3	2.7	2.0	17.3
Rapid Hab Assess	11.8	8.9	9.4	15.1	8.7	13.5	9.8	13.3	14.6	14	16.2



Appendix 3. Fish species sampled from the South River



Brook trout (*Salvelinus fontinalis*)



Brown trout (*Salmo trutta*)



Atlantic salmon (*Salmo salar*)



Blacknose dace (*Rhinichthys atratulus*)



Longnose dace (*Rhinichthys cataractae*)



Common shiner (*Luxilus cornutus*)





Slimy sculpin (*Cottus cognatus*)



Longnose sucker (*Catostomus catostomus*)



Pumpkinseed (*Lepomis gibbosus*)

Not pictured: White sucker (*Catostomus commersoni*), creek chub (*Semotilus atromaculatus*)