Assessment of Fish Communities and Habitat in the Charles River Watershed

Final Report

This project is funded by the Massachusetts Environmental Trust.

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1.0 INTRODUCTION

The Charles River Watershed, located in Eastern Massachusetts, is one of the most densely populated in New England (Figure 1-1), where growth and development in the watershed is greatest along the I-495 corridor and in the upper reaches of the river. The landscape of the watershed varies regionally with greater open space/forested areas with low to medium density residential uses in the western half of the watershed to less open space areas, greater commercial and industrial areas and medium to high density residential in the eastern portion of the watershed. Rapid development has placed unsustainable demands on our natural resources for land and drinking water, which have affected the ecological integrity of the watershed and created poor water quality conditions in the river and its tributaries, reduced flows in the river, diminished groundwater supplies, damaged fisheries and wildlife habitat, introduced non-native flora and fauna species to the river, and eliminated or reduced fish and wildlife communities.

In 1999, the Charles River had its lowest flow levels since the U.S. Geological Survey (USGS) started monitoring flow in 1937. Flow level not only affects the amount of channel under water, but also directly influences stability of the bank and substrate and the availability of food for aquatic organisms. It affects the distribution of macroinvertebrates and fish. It has an impact on an organism's ability to gather food, meet respiratory requirements, avoid competition and predation, and colonize or vacate certain habitats. As flow diminishes, the dangers to the ecosystem increase. Lowered discharge of groundwater may induce the downstream drift of benthic organisms for escape and dispersal. Low flow can severely alter the riparian zone, create pond-like conditions, and reduce habitat and diversity of species. Low flow can also alter the biological integrity of rivers and streams. Changes in temperature and oxygen can, in turn, lead to the demise of certain aquatic species. Over the past century, fish in the Charles River have been negatively impacted by development and urbanization that has reduced streamflows in the river and tributaries, removed, damaged, or altered aquatic habitat, and discharged pollutants from industries and urban centers to the river.

CRWA received a grant of $20,679 from the Massachusetts Environmental Trust (MET) to better understand the effects of low flow on ecosystem integrity, and in particular, fish communities, in the Charles River. This biological study focused on fish because they are long-lived, sensitive to wide range of stresses and compared to macroinvertebrates, easy to identify and the relationship between fish and stream health are better understood and valued by the public. Streamflows adequate to maintain fisheries also tend to be sufficient to maintain macroinvertebrates and other aquatic life. Collaborating with Todd Richards of the Massachusetts Division of Fish and Wildlife (DFW), CRWA, in the summers of 2002 and 2003, performed a comprehensive assessment of the current fish communities in the Charles River and its tributaries. This project was an invaluable opportunity for state environmental decision-makers, CRWA, and the public to better understand the biological integrity of the Charles River, learn about the current river fish communities and begin work on developing the target fish community in the Charles River and estimating the minimum stream flows necessary to support them.

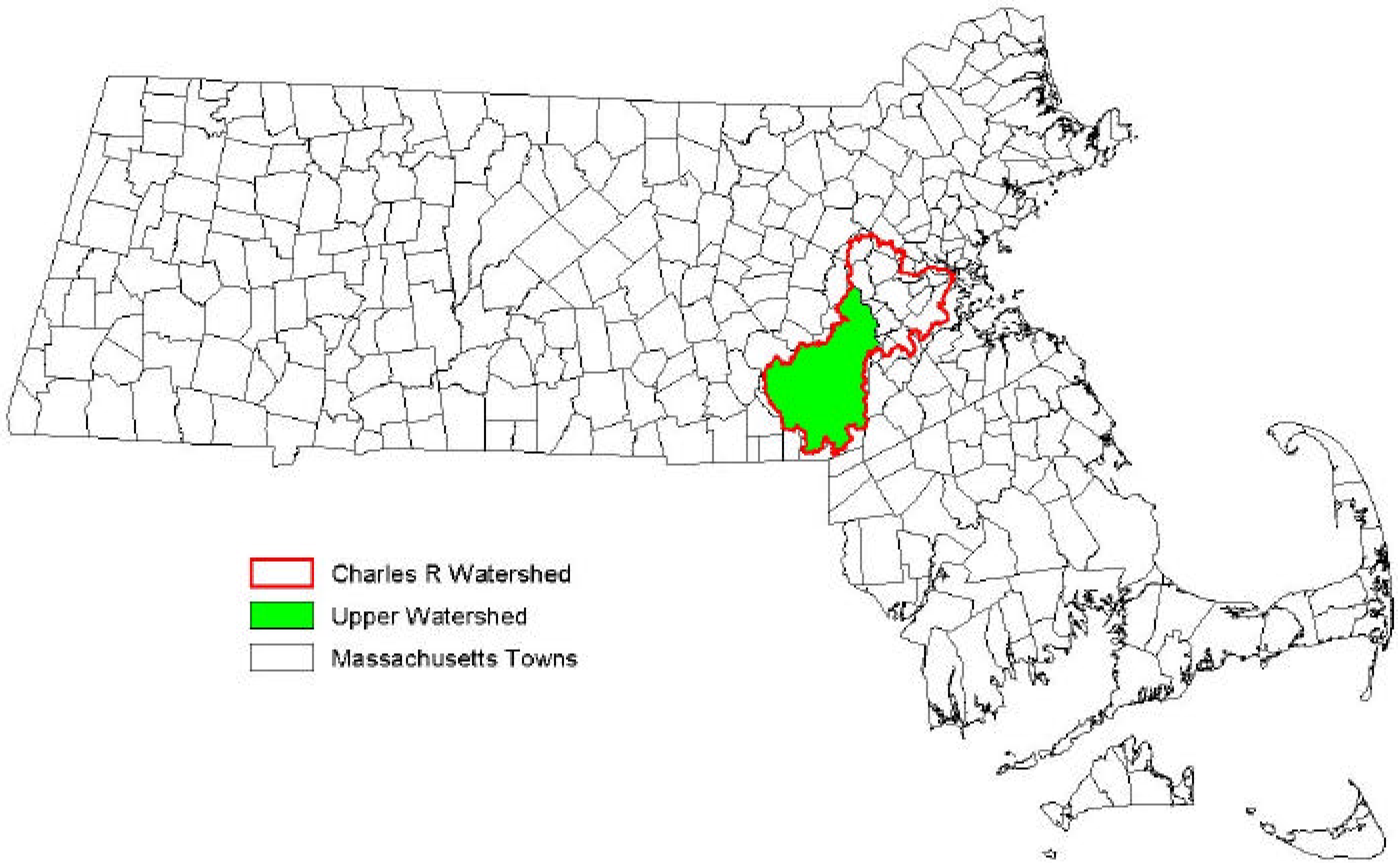


Figure 1-1. Charles River Watershed

This information can be utilized in long-term management planning and decision-making about the river. This final report summarizes fish and habitat assessment work conducted under the auspices of MET and DFW.

2.0 SCOPE OF WORK

DFW's work is based on the premises that biological integrity is a balanced integrated, adaptive community, and that rivers should have river fish communities as opposed to lake- or pond-type fish communities. Through fieldwork, DFW and CRWA assessed the current community of fish species actually found in the mainstem and selected tributaries of the Charles.

Goals of the project were to:

- assist DFW with its assessment of current fish communities in the river;
- begin the development of a target fish community for the Charles River;
- develop stream flow recommendations to restore and protect river fish; and
- incorporate these flow regimes in management and permitting decisions affecting the river.

CRWA performed the following tasks under this grant.

Task 1. Coordinate with DFW. As suggested by DFW, CRWA provided DFW with background information about current river conditions and issues. CRWA also sought pertinent historical data on the Charles River from the DFW Library. CRWA attended several meetings and communicated regularly by telephone and email with DFW, the Massachusetts Riverways Program, and MA Executive Office of Environmental Affairs to ensure that the efforts of the groups were coordinated.

Task 2. Expand Site Selection for Fish Studies. The objective was to identify sites that represent the relative proportions of different fish habitats (riffle, pool, and run). CRWA assisted DFW in developing a list of predominant habitats where fish sampling should be conducted through the use of Geographic Information Systems (GIS) mapping, previous field experience, our water quality data and consultation with local officials. In most cases, CRWA verified the site location and characteristics and accessibility of the sites, looking for riffles, dams and other obstructions to fish passage. CRWA documented observations according to DFW protocol, taking notes and photographs at each location. Information gathered by CRWA was used by DFW in its decisions on fish survey locations.

Task 3. Prioritize Fish Sampling Sites. CRWA assisted DFW in prioritizing those sampling locations identified in Task 2. CRWA and DFW jointly developed ranking criteria and reasons for rankings were noted.

Task 4. Assist with Fish Sampling. CRWA staff assisted DFW in conducting fish sampling. DFW trained CRWA staff in proper sampling technique including quality assurance and quality control (QA/QC) measures. CRWA did not have to develop a separate quality assurance project plan.

Task 5. Process Data. CRWA assisted DFW in data entry and review. CRWA staff and interns traveled to DFW offices in Westborough to process the data. In addition, CRWA assisted DFW in confirming the identification of preserved fish species collected in the field.

Task 6. Continue Habitat Assessments. In fiscal year 2002 under a previous MET grant (*Low Flow and Habitat Assessments in the Upper Charles River Watershed Project*), USGS trained CRWA staff on how to perform habitat assessments, following the procedures described in Section 5 of EPA's Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, second edition, 1999 (EPA-841-B-99-002). CRWA is now knowledgeable about proper field techniques and QA/QC requirements. For the previous grant, CRWA conducted habitat assessments at three sites in the upper watershed under four different flow regimes. For this grant, CRWA extended its current inventory of assessments by conducting single habitat assessments at 12 priority fish sampling sites, as identified in Task 3. CRWA examined river sites for characteristics such as vegetation, land use, sediment/substrate, available cover, channel alteration, bank stability, and protection. CRWA took digital photographs to document the habitat types.

Task 7. Promote Public Education. CRWA promoted public awareness and education of the current fish community in the Charles River and the effects of low flow on the fisheries population through written materials and presentations to students at universities, high schools, and elementary schools and citizens affiliated with community groups and other organizations. CRWA wrote a newsletter article describing the project, for distribution to over 5,000 readers. In addition, information about the project was included on our web site, www.charlesriver.org. Our outreach efforts complimented ongoing CRWA efforts to educate the public about effects of low flows on habitat and to promote water conservation and replenishment throughout the upper watershed.

Task 8. Promote Improved Environmental Conditions. Results of CRWA's habitat assessment fieldwork and the DFW/CRWA survey of the Charles River fish community indicate that the watershed's aquatic habitat is being seriously affected by low flows. As part of this project, CRWA focused the attention of DEP, the Department of Environmental Management, Massachusetts Environmental Policy Act Unit, developers, and municipalities on various legal and technical mechanisms that can be used to improve flow conditions in the river, thereby promoting a shift in the fish population to represent one found in a more natural riverine system.

Task 9. Prepare Final Report. This report describes collaboration between CRWA and DFW.

Task 10. Conduct Project Evaluation. CRWA conducted an evaluation of the project based on the questions and criteria listed below. The evaluation is submitted to MET within this final report.

With the completion of this study, CRWA is prepared to conduct the next steps in restoring the biological integrity of the watershed. Funded by the US Environmental Protection Agency's Watershed Initiative Program, CRWA will assist in developing the expected riverine (target) fish community based on historical records of fish in the Basin and the identification of the community appropriate for a natural river in southern New England and/or appropriate reference river. Using the Ipswich and Quinebaug River target fish development studies as models, CRWA will work with DFW, MA Riverways Program, and other fisheries experts in the development of the Charles River target fish community.

3.0 BACKGROUND

3.1 Study Area

The Charles River watershed, one of 33 sub-basins in Massachusetts, is located completely within Commonwealth boundaries. The 80-mile long river begins at Echo Lake in Hopkinton and flows through 23 communities before discharging to Boston Harbor (Figure 1-1). The watershed with its 35 communities comprises an area of 308 square miles (mi^2). Topography of the watershed varies from flat terrain to low rounded hills and the landscape includes rural settings with small pockets of development in the western portion of the watershed to increasing population and urbanization moving eastward to completely ultra urban settings in Boston and Cambridge. The most recognized section of the Charles River is the last nine miles, which includes a 17.1-mile linear parkland on both riverbanks. Known as the Charles River Basin, it was created by the construction of a dam at the Museum of Science in 1910. To reduce the possible effects of development including increased flooding and degradation of water quality, the US Army Corps of Engineers acquired and protect 8,103 acres of wetlands in the upper and middle watershed communities, known as the Charles River Natural Valley Storage Area. The largest of the wetland tracts consists of the Medfield-Millis marshlands, which extend 6 miles and include over 2,600 acres of wetland areas and flow easement land. Along the length of the river, there are 20 dams and a 350-foot drop from headwaters to the harbor. Historically, the dams were implemented for water supply and for the power needs of sawmills and other industries. The impoundments, especially the Moody Street Dam in Waltham and the New Charles River Dam in Boston, created long reaches of slow-moving, deep waters with more pond-like hydrologic characteristics than riverine characteristics. These impoundments have had a profound ecological impact on the fisheries and other aquatic species communities.

3.2 Historical Studies

In Massachusetts, very little published information is available about freshwater fisheries prior to the early 1800s. Only sixty years ago was the first in-depth freshwater fish survey of Massachusetts conducted, which only included the western portion of the state. Historical records of freshwater fisheries in Massachusetts show that the fisheries were more abundant from the 1600s to 1800s with the greatest species quantities of herrings, sturgeons, Striped Bass and Atlantic Salmon (Hartel, 2002). The decline of fish species in Massachusetts has been attributed to deforestation for timber and agriculture by the mid-1800s, construction of dams for water supply and power for industries, and the disposal of industrial and urban waste. Currently, in Massachusetts, fish species richness is low and dominated by macrohabitat generalists, which are fish species adapted to different hydrological habitats (Halliwell et. al., 1999). Also, Massachusetts has a low number of native fish species, 50 species out of a total of 83 native and introduced species (Hartel, 2002*)*. Most of the introduced fish are game fish including sunfish, black bass, pike and several catfish.

Since the 1950s, fisheries studies have been conducted periodically by state agencies. In 1969, the MA Division of Fisheries and Game conducted a fish survey in the Charles River (Bergin, 1969). The agency collected 4,213 fish representing 29 species; of which 11.7% were game fish, 31.3% were pan fish and 57% were trash fish. The five most abundant fish species were redfin pickerel, white suckers, brown bullheads, pumpkinseed and bluegills. In 1975, the Massachusetts Division of Fisheries and Wildlife, in conjunction with the Marine Fisheries, the former Metropolitan District Commission (MDC), now known as the Department of Conservation and Recreation (DCR), and Camp Dresser & McKee, conducted a fish survey in the Charles River Basin to determine the relative abundances of different species. The survey area from Watertown Dam to the old Charles River Dam included 12 sampling stations. DFW and the others sampled 21 species where carp, white suckers, and goldfish were dominant by weight and they found that the most abundant fish were pumpkinseeds, banded killifish and tidewater silversides (MDC, 1978). The Massachusetts Division of Fisheries and Wildlife again assessed the fish populations in the summer 1981, this time in several additional impoundments besides the Charles River Basin including Moody Street Pool in Waltham, Cordingly Pool in Newton and Wellesley, Silk Mill Pool from Dover through Dover/Dedham to Newton/Wellesley (MA DFW, 1981). Out of 435 fish collected in the Charles River Basin, the most abundant fish were the golden shiner (114), white perch (94), alewives (75), tomcod (63), and pumpkinseed (58). In the Moody Street Pool, the golden shiner fish dominated this impoundment in 1981, making up 62% of the samples caught, while the next dominant species, white perch, made up only 18%. At Cordingly Dam Pool in Newton and Wellesley, the most abundant fish species out of the 12 collected were carp, American eel, bluegill, and pumpkinseed. The farthest upstream site, Silk Mill Pool, produced 11 species of fish with the most abundant fish being bluegill, white perch, largemouth bass, and pumpkinseed.

3.3 Fish Classification

Fish are vertebrate animals that live in water, breathe through gills and have median fins with skeletal supports. Fish are classified into one of three macrohabitat classes or categories based on their need or lack of need for free-flowing water during their life cycle. Fish requiring free-flowing water for their entire life cycle are known as "fluvial specialists." They live predominantly in rivers and streams, however, occasionally fluvial specialists are found in reservoirs. Examples of fluvial specialists are blacknosed dace, brown trout, and creek chubsucker. Fish, such as white sucker, that need free-flowing water for a specific stage of their life cycle are called "fluvial dependents." These fish species are found in a variety of habitats but they require access or use of stream habitats at a specific point in their life cycle. The most tolerant and adaptable of the fish classes is "macrohabitat generalists." Macrohabitat generalists can live in a wide range of habitats including lakes, streams and reservoirs and do not require free-flowing water for any part of their life cycle. Some of the most common macrohabitat generalists are common carp, largemouth bass, and redbreast sunfish. Appendix A has a table of different fish species of New England and their habitat classification. Conducting an assessment of the current fish community in the Charles River watershed and determining the macrohabitat class of each species helps determine the health of the fish community and the conditions of their habitat compared to other rivers in New England.

4.0 FISHERIES ASSESSMENT

4.1 Potential Sampling Locations

CRWA assisted DFW in identifying possible river, tributary, and pond locations for fish surveys. The goal was to select sites that represent the relative proportions of different fish habitats - riffle, pool, run, pond and impoundments, in the watershed. For example, if 60% of the fish habitat is riffle, then 60% of the sample sites should be at riffle locations. The river or mainstem sampling locations had to be free-flowing, absent of any nearby impoundment or dam, and approximately 100 meters in length. It was also expected that sampling would be conducted throughout the watershed. The potential sites were prioritized based on relative importance to other sites, habitat type, level of degradation, and access. CRWA staff estimated the river depth at each potential sampling location to determine the appropriate sampling methodology, which is discussed further below. CRWA developed a list of predominant habitats where fish sampling should be conducted through the use of GIS, previous field experience, our historical water quality data and consultation with local officials. CRWA staff verified the location, characteristics, and accessibility of the sites, looking for riffles, dams and other obstructions to fish passage. CRWA documented observations according to DFW protocol, taking notes and photographs at each location. Information gathered by CRWA was used by DFW in its decisions on fish survey locations.

CRWA staff conducted site visits at 25 locations throughout the watershed; of which 14 sites were located on the mainstem and 11 sites were on tributaries. The tributaries considered for this study were Hopping Brook in Medway, Miscoe and Mine Brooks in Franklin, Mill River in Norfolk, Stop River in Medfield, Bogastow Brook in Holliston, Millis and Sherborn, and Muddy River in Brookline and Boston. Table 4-1 lists the potential monitoring sites and their habitat type. Riffle was the most common habitat type with six mainstem sites and eight tributary sites. The remaining sites on the mainstem were four run sites, two impoundment sites, one pond site and one pool site and on the tributaries were two run sites and one riffle/pool site. Appendix B includes a table that describes the site locations, characteristics, access points, and additional comments.

4.2 Sampling Methodology

To assess the current fish community at a representative site, electro-shocking is conducted to determine the type of species and the relative abundance of species. To shock the fish and render them immobile, an electrical current is run through the water, momentarily stunning the fish, which are then swept up in nets. Fish shocking can be conducted while wading (backpack sampling), or from a barge or boat. The electrodes are attached to a large backpack, which holds an electrical generator. Backpack sampling is usually conducted at average depths of less than two feet and at stream widths of less than 350 feet. It consists of a single upstream pass by a team of three to five people, without block nets. This approach has been shown to give a representative sample of the fish assemblage (Simonson and Lyons, 1995). For average depths between one and a half and two feet and stream widths less than 100 feet, barge shocking is the preferred methodology. Shocking is conducted from a boat when the average depth is greater than or equal to two feet and a suitable paved or unpaved ramp is nearby. After the fish are shocked, they are captured with fish nets and then deposited into water-filled buckets where they are identified, counted, and measured for total length before being released. Most fish recover quickly from the shock and can be returned to the stream after counting with no ill effects.

During each sampling event, one or two individuals of certain fish species captured were preserved in 10-percent formalin for later confirmation of identification by DFW laboratory analysis (known as a voucher sample), and archived in a DFW reference collection. DFW attempted to preserve a representative set of fish species in the Charles River watershed.

In addition to the fish measurements, field observations were documented including sample date and time, stream name, town name, site description, length of sampling reach, air and water temperatures, water clarity and general weather conditions. The sampling gear type was also recorded including backpack and battery pack identification numbers, number of amperes and volts used, pulse frequency and width settings, and the electrofishing effort such as the distance covered as well as the length of time of current sent through water. Figure 4-1 shows a photo of staff from DFW and CRWA sampling for fish.

Main Stem Sites	Location At or Between	Town	River Mile	Basin (DFWELE)	Type
Charles @ Milford Pond (upper end)	d/s of Dilla St. Bridge	Milford	2.1	Charles Headwater	pond
Charles @ Howard St.	u/s of Milford Wastewater Treatment Plant (WWTP) discharge	Milford	4.8	Charles Headwater	riffle
Charles @ Depot Street	d/s of Box Pond outlet; u/s of Depot Street	Bellingham	8.6	Charles Headwater	riffle
Charles @ N. Bellingham Dam	u/s of dam	Bellingham	12.8	Charles Headwater	pool
Charles @ Walker St.	d/s of bridge	Medway/Franklin	18.4	Upper Charles	riffle
Charles River @ CRPCD outfall	d/s of Populatic Pond; u/s of Mill River	Medway/Norfolk	20.2	Upper Charles	run
Charles @ Pleasant St.	d/s of bridge	Millis	21	Upper Charles	riffle
Charles @ Bridge/Farm St.	d/s of Bogastow Brook, and Medfield WWTP	Dover/Sherborn	33.4	Middle Charles	run
Charles @ Rte 16	u/s of S. Natick Dam	Natick	36.1	Middle Charles	impoundment
Charles @Central Ave.	u/s of Cochrane Dam	Needham	42.6	Middle Charles	run
Charles @ Dover Gage	d/s of Cochrane Dam; at USGS gage site, Mill St.	Dover	44.7	Middle Charles	riffle
Charles @ Havey Beach	in Dedham loop; d/s of Mother Brook	Dedham	54	Middle Charles	run
Charles @ Woerd Ave.	in Lakes District; u/s of Moody St. Dam	Waltham	65.3	Middle Charles	impoundment
Charles @ Calvary St.	near Bleachery Dam	Waltham	68	Lower Charles	riffle

Tributary Sites	Location At or Between	Town	River Mile	Basin (DFWELE)	Type
Hopping Brook @ West St	near confluence w/Charles	Medway		Hopping Brook	riffle
Miscoe Brook @ South St.	'pristine' watershed area	Franklin		Mine Brook	riffle
Mine Brook @ Pond St.	Between Pine and Beech St.	Franklin		Mine Brook	riffle/pool
Mill River @ River Rd.	u/s of confluence w/Charles	Norfolk		Mill River	riffle
Stop River @ South St.	d/s of WWTPs; u/s of large wetland area	Medfield		Stop River	riffle
Stop River @ Causeway St.	near confluence w/Charles; d/s of large wetland area	Medfield		Stop River	riffle
Bogastow Brook @ Central St.	d/s of urban area; d/s of confluence w/Jar Brook	Holliston		Bogastow Brook	riffle
Bogastow Brook @ Middlesex St	undeveloped area	Millis		Bogastow Brook	riffle
Bogastow Brook @ Orchard St (Rte. 115)	d/s of Bogastow Pond	Sherborn		Bogastow Brook	riffle
Muddy River @ Netherlands Rd.	at town water building	Brookline		Muddy River	run
Muddy River @ Agassiz Bridge	in the Back Bay Fens	Boston		Muddy River	run

u/s - upstream
d/s - downstream

Table 4-1. Potential Fish Sampling Sites in the Charles River Watershed

Figure 4-1. Photograph of Fish Sampling

4.3 Results

The Charles River watershed fish assessment study commenced in the summer of 2000 and ended in 2003. CRWA's involvement in the fish study began in 2002, when the majority of fish sampling was just beginning. Out of 28 sampling sites, five sites, Beaver Brook in Bellingham, Dug Pond in Natick, Stony Brook and Cherry Brook, both in Weston, and Charles River in Medway, were monitored in 2000 and 2001 (Table 4-2 and Figure 4-2). Twelve sampling sites were located on the mainstem while 16 sites were located on tributaries. The majority of the fish sampling sites were located in the upper and middle watershed – stream reaches between river miles 0 and 60. East of the town of Weston, no tributaries were sampled. The most widely used method of fish sampling was backpack shocking, which was most suitable for the shallower waters during the summer and early fall sampling months. Some boat and barge shocking were conducted in the deeper waters of the mainstem and several ponds. Table 4-2 also lists the fish shocking method employed at each site.

At 28 sampling sites in the watershed, a total of 3,320 fish, comprising 25 different fish species, were collected. The five most abundant species in the mainstem and tributaries, were bluegill (25.9%), redfin pickerel (11.5%), largemouth bass (10.7%) American eel (9.7%), and redbreast sunfish (8.8%) (Table 4-3) (Figure 4-3). The least abundant fish species, less than 0.1%, were hybrid bluegill/pumpkinseed, rainbow trout and swamp darter. The results of the assessment showed that the riverine habitat of the Charles River watershed is better suited for fish species, known as macrohabitat generalists, that do not require free-flowing waters for any part of their life cycles and can live in streams, ponds and reservoirs,. All five of the most abundant species are classified as macrohabitat generalists. Generalists dominated both the mainstem and tributaries, comprising 95% of all fish collected (Figure 4-4). Two percent of the fish collected were riverine-type fish, known as fluvial specialists, that need free-flowing waters throughout their entire life cycle, while fluvial dependents, fish needing free-flowing water for only part of their life cycle, made up 3% of the fish collected. The four fluvial specialist species found in the mainstem and tributaries were three trout species, brown, brook, and rainbow, and creek chubsucker. The only fluvial dependent fish species collected in the mainstem and tributaries were white sucker and blueback herring. All fish sampling results are located in Appendix C.

Out of 3,320 fish collected, slightly more were collected from the mainstem than the tributaries, 1,783 fish versus 1,537 fish, respectively. Similar to the above combined overall results, the most dominant fish in the mainstem-only was bluegill (30.6%), however, the second most common fish was American eel (16.7%) followed by redbreast sunfish (11.6%), yellow perch (8.1%), and largemouth bass (7.9%) (Table 4-4). The largest fish collected in the mainstem were common carp, with an average length of 585 millimeters (mm), which made up 3.0% of fish sampled. Interestingly, no common carp were sampled from the tributaries. Other fish species collected only in the mainstem but not in the tributaries were smallmouth bass, white catfish, blueback herring, and brown trout, which each comprised less than 1% of mainstem samples.

SampleID	Waterbody Name	Date	Town	Location Description	Method
700	Beaver Brook	8/5/2000	Bellingham	200 meters downstream of abandoned railroad bed at Nason Street to railroad bed	Backpack Shocking
130	Dug Pond	8/22/2000	Natick	Gravel Access Ramp - off West St.	Boat Shocking
285	Dug Pond	8/22/2000	Natick	Gravel Access Ramp - off West St.	Gillnet
286	Dug Pond	8/22/2000	Natick	Gravel Access Ramp - off West St.	Seine
402	Stony Brook (1)	8/7/2001	Weston	Dump road crossing, downstream	Backpack Shocking
405	Cherry Brook	8/7/2001	Weston	Upstream of Conant Street	Backpack Shocking
366	Charles River	9/10/2001	Medway		Backpack Shocking
367	Charles River	9/10/2001	Medway	Riffle reach upstream of apartments	Backpack Shocking
503	Mine Brook (1)	9/10/2001	Franklin	From downstream of stone retaining wall to upstream by staff gauge	Backpack Shocking
684	Pearl Lake	6/21/2002	Wrentham		Boat Shocking
686	Charles River	7/24/2002	Bellingham	Upstream of Mellon Road	Backpack Shocking
687	Charles River	7/25/2002	Franklin	Downstream of Populatic Pond	Boat Shocking
688	Charles River	7/26/2002	Dover	Sites up and downstream of Central Street	Boat Shocking
691	Charles River	7/30/2002	Newton/Waltham	Start between Route 128 and Recreational Road going upstream	Boat Shocking
692	Charles River	7/31/2002	Watertown	Launched at Watertown Ramp	Boat Shocking
701	Charles River	8/5/2002	Bellingham	Downstream of Maple Street - 100 meter reach starts 130 meters from bridge	Backpack Shocking
702	Mine Brook (1)	8/5/2002	Franklin	Downstream of Route 140 - 100 meter reach downstream from bridge	Backpack Shocking
704	Hopping Brook	8/8/2002	Medway	150 meters downstream of road	Backpack Shocking
693	Charles River	8/13/2002	Newton/Watertown	Below Bemis Dam	Boat Shocking
694	Charles River	8/13/2002	Watertown	Started 80 meters below Watertown Dam, ended at Watertown Dam	Backpack Shocking
695	Charles River	8/16/2002	Wellesley	Downstream of Route 16	Barge Shocking
699	Trout Brook	8/27/2002	Dover	Downstream of Haven Street Bridge	Backpack Shocking
703	Chicken Brook	8/27/2002	Medway	From confluence with Charles River upstream to Village Street	Backpack Shocking
705	Stop River	8/27/2002	Medfield	Down stream from Noon Hill Street Bridge	Backpack Shocking
697	Fuller Brook	8/28/2002	Wellesley	Upstream of Cameron Street	Backpack Shocking
698	Stony Brook (1)	8/28/2002	Weston	Church Street	Backpack Shocking
815	Hopping Brook	9/4/2002	Bellingham	Upstream of intersection of Beech and West Streets	Backpack Shocking
816	Charles River	9/4/2002	Bellingham	Downstream of Maple Street	Backpack Shocking
817	Hopping Brook	9/4/2002	Holliston	Downstream of Fisher Street	Backpack Shocking
818	Miscoe Brook	8/12/2003	Franklin	Upstream of South Street	Backpack Shocking
819	Hopping Brook	8/12/2003	Medway	West Street upstream to power lines	Backpack Shocking
820	Dix Brook	8/12/2003	Franklin	From old RR Bed upstream to King Street	Backpack Shocking
821	Mine Brook (1)	8/19/2003	Franklin	Upstream of Pond Street	Barge Shocking
822	Mill River (1)	8/20/2003	Norfolk	Upstream of River Street	Barge Shocking
823	Eagle Brook	8/20/2003	Wrentham	Cul de Sac off Arlene Drive	Barge Shocking
824	Bogastow Brook	8/21/2003	Millis	Route 115	Backpack Shocking
825	Bogastow Brook	8/21/2003	Millis	Orchard Street	Backpack Shocking
826	Dix Brook	8/21/2003	Franklin	King Street upstream	Backpack Shocking

Table 4-2. Charles River Watershed Fish Sampling Sites

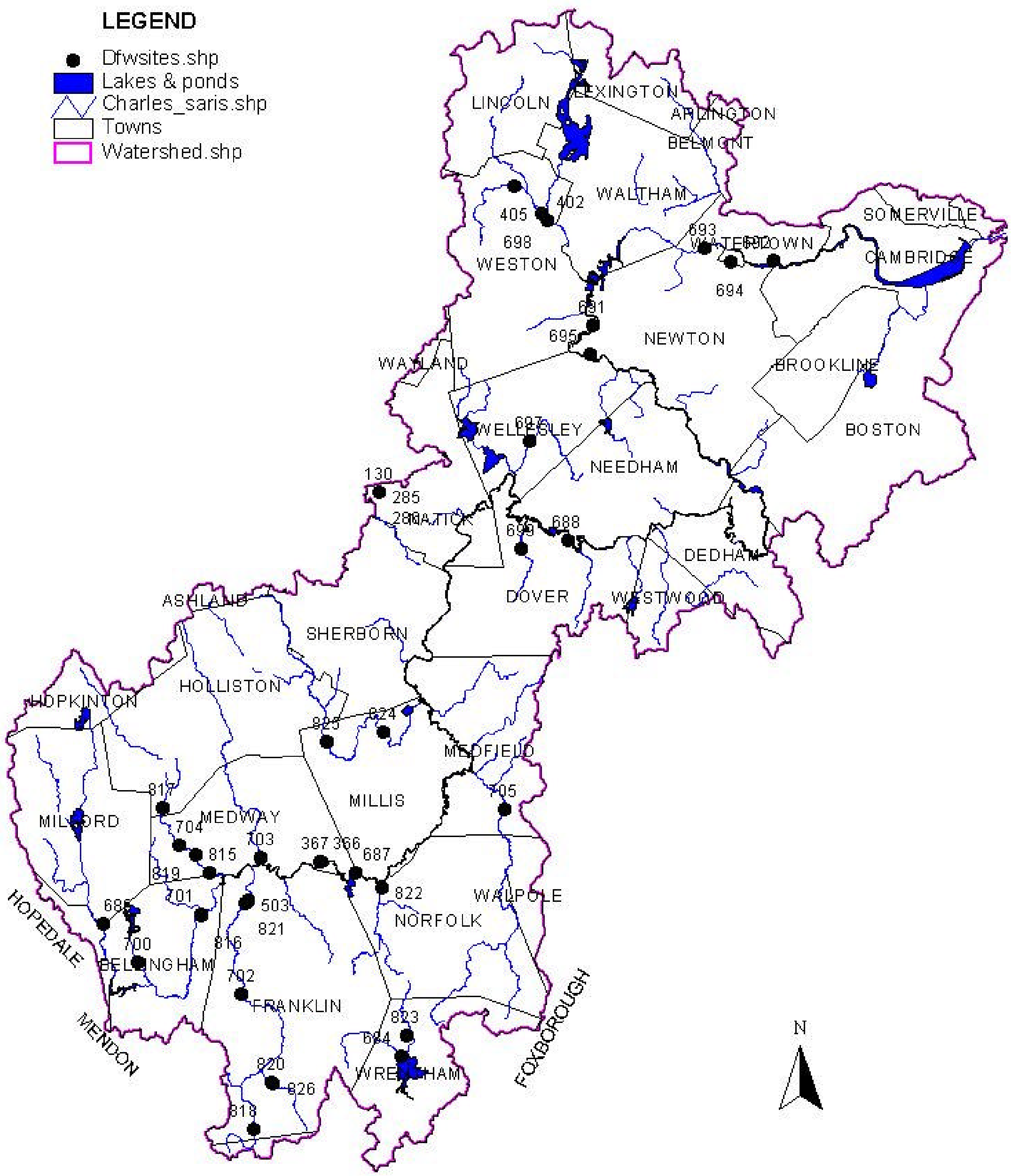


Figure 4-2. Charles River Watershed Fish Sampling Sites

Table 4-3. Charles River Watershed Fish Sampling Results 2000-2003

Fish Species	Macrohabitat Classification(1)	Mainstem Count	Tributary Count	Total Count	Relative Abundance	Pollution Tolerance(2)
Bluegill	MHG	545	316	861	25.9%	T
Redfin Pickerel	MHG	6	376	382	11.5%	
Largemouth Bass	MHG	140	216	356	10.7%	M
American Eel	MHG	298	24	322	9.7%	T
Redbreast Sunfish	MHG	207	85	292	8.8%	M
Pumpkinseed	MHG	92	139	231	7.0%	M
Yellow Perch	MHG	145	16	161	4.8%	M
Golden Shiner	MHG	90	44	134	4.0%	T
Yellow Bullhead	MHG	33	80	113	3.4%	T
Chain Pickerel	MHG	19	57	76	2.3%	M
White Sucker	FD	22	52	74	2.2%	T
Brown Bullhead	MHG	4	63	67	2.0%	T
White Perch	MHG	55	3	58	1.7%	
Common Carp	MHG	51	0	51	1.5%	T
Black Crappie	MHG	48	1	49	1.5%	M
Brown Trout	FS	1	32	33	1.0%	I
Smallmouth Bass	MHG	14	0	14	0.4%	
Creek Chubsucker	FS	0	12	12	0.4%	I
Brook Trout	FS	0	10	10	0.3%	I
Banded Sunfish	MHG	0	7	7	0.2%	
White catfish	MHG	6	0	6	0.2%	
Blueback Herring	FD	5	0	5	0.2%	
Swamp Darter	MHG	0	3	3	0.1%	I
Rainbow Trout	FS	2	0	2	0.1%	
Hy. Bluegill/Pumpkinseed	MHG	0	1	1	0.0%	
Blacknosed Dace	FS	0	0	0	0.0%	T
Fallfish	FS	0	0	0	0.0%	M
Spottail Shiner	MHG	0	0	0	0.0%	

(1) FS - Fluvial Specialist
FD - Fluvial dependent
MHG - Macrohabitat Generalist
(2) I - Intolerant
M - Moderate
T - Tolerant

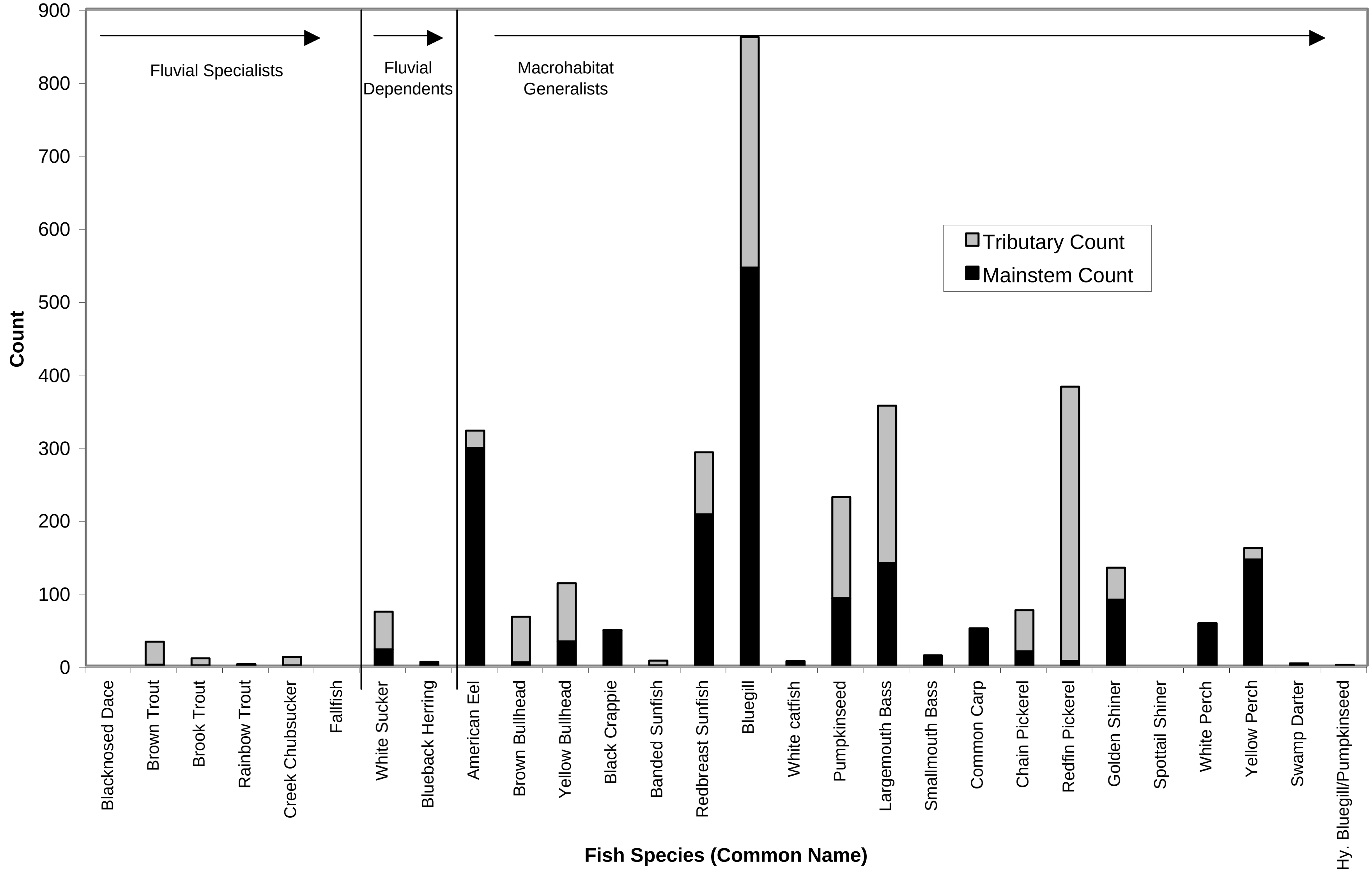
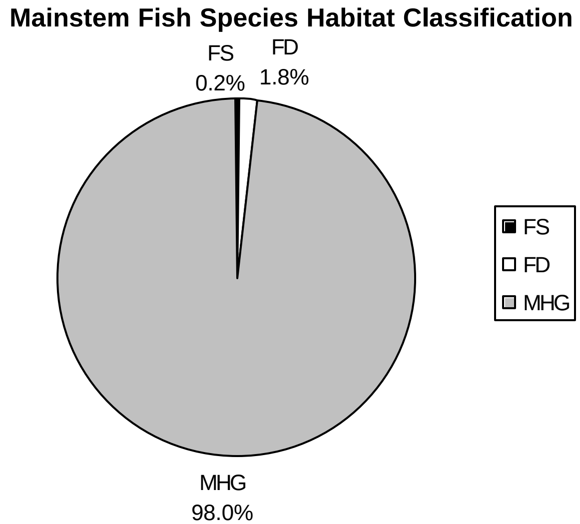
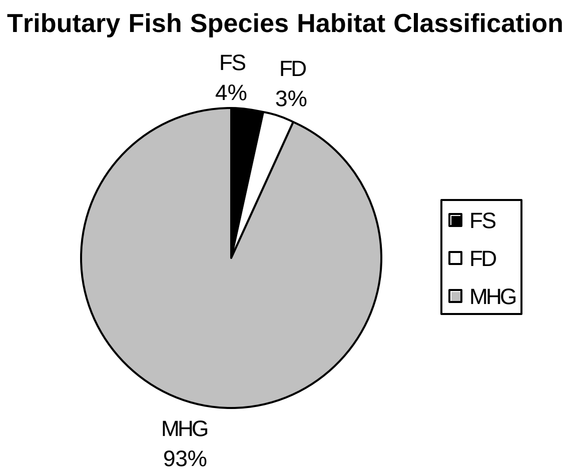


Figure 4-3. Charles River Watershed Fish Sampling Results





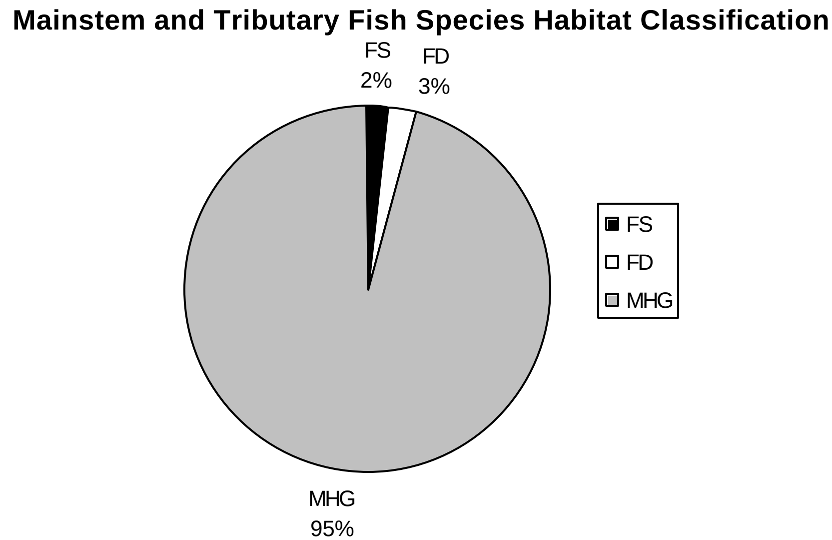


Figure 4-4. Macrohabitat Classification of Charles River Watershed Fish Species

Table 4-4. Mainstem Fish Survey Results

Common Name	Scientific Name	Count	Average Length (mm)	Standard Deviation	Relative Abundance
Bluegill	Lepomis macrochirus	545	136	36	30.6%
American eel	Anguilla rostrata	298	239	97	16.7%
Redbreast sunfish	Lepomis auritus	207	99	27	11.6%
Yellow perch	Perca flavescens	145	155	35	8.1%
Largemouth bass	Micropterus salmoides	140	189	125	7.9%
Pumpkinseed	Lepomis gibbosus	92	120	27	5.2%
Golden shiner	Notemigonus crysoleucas	90	127	32	5.0%
White perch	Morone Americana	55	176	42	3.1%
Common carp	Cyprinus carpio	51	585	83	2.9%
Black crappie	Pomoxis nigromaculatus	48	213	30	2.7%
Yellow bullhead	Ameiurus natalis	33	128	31	1.9%
White sucker	Catostomus commersoni	22	245	145	1.2%
Chain pickerel	Esox niger	19	228	105	1.1%
Smallmouth bass	Micropterus dolomieu	14	105	56	0.8%
Redfin pickerel	Esox americanus americanus	6	123	20	0.3%
White catfish	Ameiurus catus	6	211	147	0.3%
Blueback herring	Alosa aestivalis	5	53	12	0.3%
Brown bullhead	Ameiurus nebulosus	4	213	74	0.2%
Brown trout	Salmo trutta	1	334	0	0.1%

Almost all of the fish collected in the mainstem were macrohabitat generalists, comprised 98% of fish in the river, while less than 1% of the fish needed free-flowing water for its entire life cycle (fluvial specialists) (Figure 4-4). The three fluvial specialist fish species found in the river were one brown trout and two rainbow trout.

Although still dominated by macrohabitat generalists (93%), the tributaries had slightly higher percentages of fluvial specialists (4%) and fluvial dependents (3%) than the mainstem (Figure 4-4). Out of the 54 fluvial specialists collected, over half were brown trout, followed by creek chubsucker and brook trout. The most abundant fish species in the tributaries were redfin pickerel (24.5%), bluegill (20.6%), largemouth bass (14.1%), pumpkin seed (14.1%), and redbreast sunfish (5.5%) (Table 4-5). The largest fish in the tributaries, American eel, had an average length of 336 mm, while brown trout was second largest with an average length of 279 mm. Five fish species, creek chubsucker, brook trout, banded sunfish, swamp darter and hybrid bluegill/pumpkinseed, were only collected in the tributaries and not in the mainstem.

5.0 HABITAT ASSESSMENTS

5.1 Definition and Habitat Categories

A habitat assessment is defined as the evaluation of the structure of the surrounding physical habitat that influences the quality of the water resource and the condition of the resident aquatic community (Barbour et al. 1996). Under a previous MET project, USGS trained CRWA staff to perform habitat assessments (CRWA, 2002), following the procedures described in Section 5 of EPA's Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition (EPA-841-B-99-002) (Barbour, et al. 1999). For a habitat assessment, the site is examined for physical characteristics such as vegetation, land use, sediment/substrate, available cover, channel alteration, bank stability, and protection, and field data sheets are filled out (Figure 5-1). The in-stream and riparian habitat is rated by the following categories:

- epifaunal substrate/available cover;
- embeddedness;
- velocity/depth regime;
- sediment deposition;
- channel flow status;
- channel alteration;
- frequency of riffles;
- bank stability;
- vegetative protection; and
- riparian zone width.

Table 4-5. Tributary Fish Survey Results

Common Name	Scientific Name	Count	Average Length (mm)	Standard Deviation	Relative Abundance
Redfin pickerel	Esox americanus americanus	376	115	38.7	24.5%
Bluegill	Lepomis macrochirus	316	129	47.4	20.6%
Largemouth bass	Micropterus salmoides	216	163	86.6	14.1%
Pumpkinseed	Lepomis gibbosus	139	123	39.6	9.0%
Redbreast sunfish	Lepomis auritus	85	96	34.1	5.5%
Yellow bullhead	Ameiurus natalis	80	122	43.2	5.2%
Brown bullhead	Ameiurus nebulosus	63	227	98.8	4.1%
Chain pickerel	Esox niger	57	173	110.4	3.7%
White sucker	Catostomus commersoni	52	200	200.3	3.4%
Golden shiner	Notemigonus crysoleucas	44	110	25.7	2.9%
Brown trout	Salmo trutta	32	279	45.6	2.1%
American eel	Anguilla rostrata	24	336	93.5	1.6%
Yellow perch	Perca flavescens	16	164	89.8	1.0%
Creek chubsucker	Erimyzon oblongus	12	142	53.5	0.8%
Brook trout	Salvelinus fontinalis	32	279	45.6	2.1%
Banded sunfish	Enneacanthus obesus	7	77	4.0	0.5%
Swamp Darter	Etheostoma fusiforme	3	50	3.5	0.2%
White perch	Morone Americana	3	265	2.9	0.2%
Black crappie	Pomoxis nigromaculatus	1	200	0.0	0.1%
Hybrid Bluegill/Pumpkinseed	Lepomis macrochirus X Lepomis gibbosus	1	684	0.0	0.1%

EPA RAPID BIOASSESSMENT
HABITAT ASSESSMENT FIELD DATA SHEET
COMBINED HIGH AND LOW GRADIENT FORMS

STREAM NAME		LOCATION
LAT__________ LONG__________		RIVER BASIN
INVESTIGATORS		FORM COMPLETED BY
DATE ____/____/____	TIME____:____ AM PM	REASON FOR SURVEY

HABITAT ASSESSMENT SCORE (FOR CURRENT WATER STAGE)

(High Gradient)		(Low Gradient)	
1. Epifaunal substrate/Available cover	____	1. Epifaunal substrate/Available cover	____
2a. Embeddedness	____	2b. Pool Substrate	____
3a. Velocity /depth Regime	____	3b. Pool variability	____
4. Sediment deposition	____	4. Sediment deposition	____
5. Channel flow status	____	5. Channel flow status	____
6. Channel alteration	____	6. Channel alteration	____
7a. Frequency of riffles	____	7b. Channel sinuosity	____
8. Bank stability	____	8. Bank stability	____
9. Vegetative protection	____	9. Vegetative protection	____
10. Riparian Zone Width	____	10. Riparian Zone Width	____
HIGH GRADIENT TOTAL	____	**LOW GRADIENT TOTAL**	____

COMMENTS

____

____

____

____

____

Ver. 09/07/01

Figure 5-1. Habitat Assessment Field Data Sheet

According to USGS, the Charles River is a combination of a high-gradient and low-gradient stream. A high-gradient stream is riffle/run prevalent in moderate to high gradient landscapes. Substrate in this stream is primarily composed of coarse sediment particles (i.e., gravel or larger) or frequent coarse particle aggregations along stream reaches. Below are brief descriptions of the condition categories or habitat parameters for low and high-gradient stream. For further details, see EPA's protocol (Barbour, et. al. 1999).

- *Epifaunal substrate/available cover* includes the relative quantity and variety of natural structures in the stream, such as cobble (riffles), large rocks, fallen trees, logs and branches, and undercut banks, available as refugia, feeding, or sites for spawning and nursery functions of aquatic macrofauna. Habitat diversity is increased when there is a wide variety and abundance of submerged structures in the stream.
- *Embeddedness* refers to the extent to which rocks (gravel, cobble, and boulders) and snags are covered or sunken into the silt, sand, or mud of the stream bottom. More available habitat surface area is provided when a lesser extent of rocks and snags are covered with fine sediment. To avoid confusion with sediment deposition (another habitat parameter), observations of embeddedness should be taken in the upstream and central portions of riffles and cobble substrate areas.
- An ideal stream will have a variety of patterns in *velocity and depth regimes*: 1) slow-deep, 2) slow-shallow, 3) fast-deep, and 4) fast-shallow.
- *Sediment deposition* measures the amount of sediment that has accumulated in pools and the changes that have occurred to the stream bottom as a result of deposition. High depths of deposition are symptoms of an unstable and continually changing environment that becomes unsuitable for many organisms.
- The degree to which the channel is filled with water refers to *channel flow status*. When water does not cover much of the streambed, the amount of suitable substrate for aquatic organisms is limited.
- *Channel alteration* occurs when the shape of the stream is straightened, deepened, or diverted into concrete channels. It reduces the amount of natural habitats available to fish and macroinvertebrates.
- Measurement of the *frequency of riffles (or bends)* determines the occurrence of heterogeneity in the stream. Riffles are a source of high-quality habitat and diverse fauna. For areas where distinct riffles are uncommon, a run/bend ratio can be used as a measure of meandering or sinuosity. A high degree of sinuosity provides for diverse habitat and fauna.
- *Channel vegetative protection* reduces the amount of erosion, controls in-stream scouring, and provides stream shading, which is better habitat for fish and macroinvertebrates. It measures the amount of vegetative protection afforded to the stream bank and the near-stream portion of the riparian zone.
- *Riparian Vegetative Zone Width*, measured from the edge of the stream bank out through the riparian zone, serves as a buffer to pollutants entering a stream from runoff, controls erosion, and provides habitat and nutrient input into the stream.

The rating scale for the habitat parameters ranges from poor to optimal. A poor rating scores between 0 and 5; marginal score occurs between 6 and 10; sub-optimal scores from 11 to 15; and an optimal rating ranges between 16 and 20. The total habitat score for the riffle site is calculated by adding the individual parameter scores. The total possible score is 200. Total scores from each site are compared to one another. In addition, the individual condition category scores are compared. The completed habitat assessment forms in Appendix C has the rating scale of different habitat parameters.

5.2 Habitat Assessments in the Fisheries Study Area

With funding from a previous MET grant (FY2002), USGS staff trained CRWA staff on the procedures for conducting habitat assessments according to US EPA bioassessment protocols in the summer of 2001. In the fall 2001 and spring 2002, CRWA conducted habitat assessments at three sites, Mine Brook in Franklin and the Charles River at Echo Lake in Milford and near the USGS Medway Gage, during different seasons to compare habitat conditions under varying flow regimes (CRWA, 2002). To supplement habitat assessments previously conducted in the upper watershed, CRWA conducted habitat assessments at various potential fish sampling sites in the summer of 2002.

5.2.1 Charles River Watershed Habitat Assessment Sites

CRWA selected nine main stem sites and seven tributary sites of varying hydrological type for conducting habitat assessments. The 16 sites, located in the upper and middle watersheds, are presented in Table 5-1. The most prevalent waterbody type assessed was riffle with 9 out of 16 monitoring sites. Three habitat assessments were conducted on run-type sites. An assessment was conducted at each of the four remaining waterbody types: pond, pool, riffle/pool and impoundment. During each habitat assessment, CRWA field investigators scored the site for each of the ten parameters and noted any physical observations on the data sheet forms. Field investigators also photographed the sites.

5.2.2 Habitat Assessment Results

The habitat conditions in the Charles River watershed during the summer were predominantly suboptimal with seven mainstem sites and five tributary sites (Tables 5-2 and 5-3). In general, the suboptimal sites were located in low to medium density residential areas with small areas of commercial and industrial uses. Out of the remaining four sites, three sites were optimal and one site was marginal. Of a possible 200 points, habitat assessment scores ranged from a low of 96 at the Charles River at Havey Beach in Dedham to a high of 172 at the Charles River Dover Gage. The latter score reflected very optimal conditions for wildlife and fisheries habitat while the former score indicated borderline suboptimal/marginal conditions. Impacts to the river and its surrounding habitat in the Town of Dover have been very minimal. Land use near the Dover Gage is predominantly open space with small pockets of low-density residential and agricultural uses.

Table 5-1. Habitat Assessment Sites in the Charles River Watershed

Waterbody	Specific Location	Town	Habitat Type
Charles River	Milford Pond and Dilla Street Bridge	Milford	pond
Charles River	Howard Street	Milford	riffle
Charles River	Depot Street	Bellingham	riffle
Charles River	North Bellingham Dam	Bellingham	pool
Hopping Brook	West Street	Medway	riffle
Miscoe Brook	South Street	Franklin	riffle
Mine Brook	Pond Street	Franklin	riffle/pool
Bogastow Brook	Central Street	Holliston/Millis/Sherborn	riffle
Bogastow Brook	Middlesex Street	Holliston/Millis/Sherborn	riffle
Bogastow Brook	Orchard Street – Upstream	Holliston/Millis/Sherborn	riffle
Bogastow Brook	Orchard Street – Downstream	Holliston/Millis/Sherborn	riffle
Charles River	Bridge Street/Farm Rd.	Dover	run
Charles River	Route 16	Natick	impoundment
Charles River	Central Avenue	Needham	run
Charles River	Dover Gage	Dover	riffle
Charles River	Havey Beach	Dedham	run

	Charles River Milford Pond/Dilla Street	Charles River Howard Street	Charles River Depot Street	Charles River North Bellingham Dam	Charles River Bridge St./Farm Rd.	Charles River Route 16	Charles River Central Avenue	Charles River Dover Gage	Charles River Havey Beach
	High and Low Gradient	High and Low Gradient	High and Low Gradient	High and Low Gradient	High Gradient	High Gradient	High and Low Gradient	High Gradient	High and Low Gradient
	8/19/02	8/19/02	8/19/02	8/19/02	8/12/02	8/12/02	8/16/02	8/16/02	8/16/02
Epifaunal Substrate/Available Cover	17	18	18	16	11	18	12	20	9
Embeddedness and/or Pool Substrate Characterization	16	17	13	11	14	11	13	17	7
Velocity/Depth Regime and/or Pool Variability	9	9	18	10	5	5	3	15	9
Sediment Deposition	16	12	6	10	17	17	9	17	5
Channel Flow Status	15	12	14	15	16	17	15	15	15
Channel Alteration	16	15	16	15	18	20	15	19	17
Frequency of Riffles and/or Channel Sinuosity	7	10	11	14	13	7	8	19	8
Bank Stability	19	14	17	20	7	19	19	20	10
Vegetative Protection	16	13	18	16	14	14	18	20	12
Riparian Zone Width	11	8	15	18	15	10	11	10	4
High Gradient Total	142	128	146	145	130	138	123	172	96
Habitat Condition Rating	Suboptimal	Suboptimal	Suboptimal	Suboptimal	Suboptimal	Suboptimal	Suboptimal	Optimal	Marginal

Table 5-2. Habitat Assessment Scores in the Charles River

	Hopping Brook West Street	Miscoe Brook South Street	Mine Brook Pond Street	Bogastow Brook Central Street	Bogastow Brook Middlesex Street	Bogastow Brook Orchard Street (Upstream)	Bogastow Brook Orchard Street (Downstream)
	High Gradient	High and Low	High Gradient	High Gradient	High Gradient	High Gradient	High Gradient
	8/19/02	8/19/02	8/19/02	8/12/02	8/12/02	8/12/02	8/12/02
Epifaunal Substrate/Available Cover	18	20	12	13	19	16	20
Embeddedness and/or Pool Substrate Characterization	19	13	11	8	13	10	17
Velocity/Depth Regime and/or Pool Variability	7	5	6	8	10	6	10
Sediment Deposition	15	15	12	8	14	5	12
Channel Flow Status	7	10	9	13	10	9	10
Channel Alteration	14	16	14	13	14	16	20
Frequency of Riffles and/or Channel Sinuosity	19	15	16	15	10	8	20
Bank Stability	14	20	18	20	16	17	20
Vegetative Protection	14	20	10	20	18	20	20
Riparian Zone Width	9	18	19	17	13	14	20
High Gradient Total	136	152	127	135	137	121	169
Habitat Condition Rating	Suboptimal	Optimal	Suboptimal	Suboptimal	Suboptimal	Suboptimal	Optimal

Table 5-3. Habitat Assessment Scores in Tributaries of the Charles River Watershed

On the other hand, the marginal conditions of the river at Havey Beach in Dedham are attributed to riverine and riparian habitat conditions impacted by stormwater pollution and erosive flows brought on and exacerbated by development. Land use in Dedham is predominantly medium density residential and commercial. The two other optimal sites were Miscoe Brook in Franklin, which CRWA observed as a 'pristine' watershed area in Franklin, and Bogastow Brook at the downstream location of Orchard Street with scores of 152 and 169, respectively.

In general, the tributary habitat assessment scores were slightly higher than the main stem scores. The average score for the tributary sites was 140 while the average mainstem score was 136. Also, there was no discernible difference observed between upper and middle watershed sites until the furthest downstream monitoring site at Havey Beach in Dedham. Out of the ten condition categories, described in the previous section, the highest individual categorical scores were in channel alteration, especially for main stem sites, and bank stability, especially for the tributaries. It was observed that the streams were slightly to moderately channelized, and the banks had minimal erosion or bank failure or were moderately stable. The average optimal scores were in the epifaunal substrate/available cover, vegetative protection, and riparian zone width categories. For both the main stem and tributaries, the scores for velocity/depth regimes were marginal to poor with habitats lacking variability in the regimes (four different types). In many cases, only two out of the four flow regimes were present. The completed habitat assessment field data sheets are located in Appendix D.

6.0 PUBLIC EDUCATION AND OUTREACH

Throughout the duration of the project, CRWA has promoted public awareness and education of the current Charles River fish community and of the impacts of low flow in the river to the fisheries population by presenting our work in written materials, CRWA's website, and presentations. In CRWA's *Streamer* Winter 2002 edition, CRWA wrote a newsletter article describing the project and preliminary sampling results, which was distributed to over 6,000 readers including 5,000 members (Appendix E). CRWA anticipates writing another article summarizing the project results and findings in the *Streamer* Summer 2004 edition. In addition, the newsletter article in PDF format and background information about the project is available on CRWA's web site, www.charlesriver.org. Several web pages with photos are devoted to this study and other fisheries-related projects in the watershed. CRWA has also presented our work and findings about the current fish community and low flows of the Charles River to various groups, such as university, high school and elementary school students, environmental organizations, and other community groups. Examples of where we have presented the study and preliminary results include Boston University's Environmental Management class, Cambridgeport School 3rd and 4th graders, Boston College's Environmental Studies class, Massachusetts Audubon Society and Worcester Polytechnic Institute.

Over the past year, CRWA has implemented three other projects associated with fish passage issues, which have also complimented CRWA efforts to educate the public about the effects of low flows and habitat alteration on fish species population and diversity. In May and June of 2003, CRWA organized a volunteer fish counting project at Watertown Dam, located upstream of Galen Street in Watertown, to enumerate anadromous fish species, such as alewife and blueback herring, swimming upstream and past the dam. Anadromous fish live most of their life cycle in the ocean, yet as adults they return to the freshwaters where they were born to spawn new offspring. Over 20 volunteers participated in counting effort and they determined that numerous fish accomplished passing the dam. On September 27, 2003, eighteen volunteers cleaned out the fish ladder at Moody Street Dam in Waltham, which is located three miles upstream of Watertown Dam. The volunteers removed trash, debris and soot from the six-foot deep concrete fish ladder consisting of baffles and a dozen bays. This effort was conducted in cooperation with staff of MA Department of Conservation and Recreation. Additionally, CRWA received a grant from MET this year to assist the Massachusetts Department of Conservation and Recreation in preparing permit applications associated with the partial breach of Bleachery Dam in Waltham.

7.0 PROJECT EVALUATION

As the final phase of this project, CRWA staff performed a project evaluation. The evaluation was broken down by goal, with an assessment of both specific tasks and of the broad goal each task supported. The project evaluation answered the questions below.

Goal 1: Assist DFW with its assessment of current fish communities in the river

- *Were DFW Quality Assurance/Quality Control requirements followed?*
  Under the direction and guidance of Todd Richards, DFW fisheries biologist, CRWA staff followed proper fish sampling techniques and quality assurance/quality control requirements.
- *Were CRWA-collected data accepted by DFW for use on its project?*
  DFW accepted fish sampling data collected with assistance from CRWA staff. DFW staff also approved data entered into EXCEL spreadsheets by CRWA staff.
- *If training was involved, was work performed in accordance with the training?*
  Trainings, both in fish sampling technique and laboratory analysis to confirm fish identity, were provided to CRWA staff by DFW and prior to the actual sampling events. Work was performed in accordance with this training.

Goal 2: Assist DFW in developing a target community for the Charles River

- *Did CRWA provide DFW with historical and current information on fish-related issues?*
  CRWA provided historical and current information to DFW about water quality, flow and habitat conditions. CRWA reviewed and summarized documents describing historical and current population trends of fish in the Charles. Since 1996 on a monthly basis, CRWA and our volunteers have been monitoring the water quality of the river on the third Tuesday of every month. This information identifies trends of

the river's health and the polluted areas of the river, which may need further monitoring. CRWA also shared its knowledge of the seasonal flow regime of the river and results from previous habitat assessments in the upper watershed with DFW to help determine which sites may be most suitable for monitoring.

- *What role did CRWA play in developing a target community?*
  So far, CRWA has assisted DFW in assessing the current fish community in the Charles River, identifying the predominant habitat-type class found in the river and comparing the current species to historical fish species. CRWA has compiled historical fish data for the Charles River. Upon completion of this project and with funding from EPA, CRWA will convene a technical advisory committee made up of representatives from CRWA, DFW, EPA, and other fisheries experts to develop a target fish community for the Charles River, specifying fish species that would be expected to exist in a healthy Charles River ecosystem, in terms of water quality, flow and habitat. The expected native, riverine (target) fish community will be based on historical records of fish in the river and the identification of the expected fish community appropriate for a natural, freshwater river in southern New England and/or appropriate rivers. DFW and CRWA will determine 'reference conditions' through research on both historical records and information from the current fish assessment.

Goal 3: Develop stream flow recommendations to restore and protect river fish

- *What are CRWA's technical recommendations? Have these recommendations been presented to decision-makers at local or state level?*
  Using both quantitative and qualitative data of flow, habitat assessments and fish surveys that have shown a highly impacted river especially in the dry, summer months, CRWA has recently recommended to MA Department of Environmental Protection (DEP) that they revise their current single, non-seasonal minimum streamflow limit of 0.30 cubic feet per square meter for permitting water withdrawals because it is not suited to a fall/winter/spring withdrawal, has little biological basis, and is indefensible from the perspective of ensuring a balance among competing water uses and preservation of the water resource itself. The Department should set higher, more protective minimum streamflows for different seasons and account for cumulative impacts of current withdrawals and any proposed withdrawal to ensure protection of the water resource with respect to water quality, navigation, water-based recreation, wetland habitat, and fish and wildlife. Finally, CRWA recommended to DEP that they work with DFW to devise seasonal minimum streamflows based on the streamflow requirements of the target fish community.

Goal 4: Incorporate these flow regimes in management and permitting decisions affecting the river

- *What information was presented to state or local officials as a result of this effort? What legal research and documentation was performed to support this effort? Are any changes to local or state policies proposed as a result of these efforts?*
  CRWA is presenting the results of the fisheries assessment to show that the

ecological integrity of the river has been altered and riverine habitat is currently better suited for lake, pond, and other impoundment type fish species. CRWA and other members of the ad-hoc Massachusetts In-Stream Flow Task Force determined that the Massachusetts Surface Water Quality Standards should be revised to include flow provisions and stronger habitat protection and we have proposed regulatory revisions to accomplish this that will soon be presented to state environmental officials and the U.S. Environmental Protection Agency. Additionally, CRWA is using the expertise we have gained from the project to strengthen habitat protection in the Charles River watershed by submitting written comments on pending Water Management Act permits for water withdrawals over 100,000 gallons per day, and on proposed development projects throughout the watershed. In the fall 2003, the Milford Water Company (MWC) submitted a draft permit to skim water near the headwaters of the Charles from Louisa Lake to the Milford Water Company or Echo Lake and the Department has issued a tentative decision to permit withdrawals using the single minimum streamflow limit of 0.30 cubic feet per square mile (cfsm). CRWA recommended to the state that they use the summertime Aquatic Base Flow (ABF) of 0.46 cfsm calculated using US Fish and Wildlife Service New England Flow Policy methodology and MWC's estimates of flow in Huckleberry Brook. CRWA also recommended that DEP should not allow any withdrawals from Louisa Lake in the fall months of September and October, which are normally low flow months, and instead the starting month for pumping should be revised to mid-November.

8.0 CONCLUSIONS AND FUTURE WORK

Under this MET-funded project, CRWA developed in-house technical expertise in conducting fish community assessments to characterize fish species diversity, relative abundance and length-frequency distribution of fish in the watershed. Training was provided by DFW, who gave information on proper site selection for surveys, different fish shocking techniques related to water depths, and measurements conducted in the field. In 2002 and 2003, CRWA assisted DFW in completing their five-year cycle fish community survey for the Charles River watershed and in determining the most suitable sites for conducting fish monitoring work. Also, CRWA conducted valuable research on fisheries classification, fish species diversity, and historical data on past Charles River fish communities. Survey results showed that the river and tributaries are dominated by fish species well-suited for slow moving, ponded waters than fish species requiring fluvial conditions. In the mainstem and tributaries, 95% of fish collected were macrohabitat generalist fish species.

With the current fish assessment results and general fisheries information gained from this work, CRWA is poised to develop the target fish community for the Charles River and implement fisheries restoration projects in the watershed. CRWA will convene a technical advisory committee to determine the target fish community for the Charles River, specifying fish species that would be expected to exist in a healthy Charles River ecosystem, in terms of water quality, flow and habitat. The expected native, riverine (target) fish community will be based on historical records of fish in the river and the identification of the expected fish community appropriate for a natural, freshwater river in southern New England and/or appropriate rivers. Based on the identified target fish community, CRWA will develop and implement recommendations aimed at restoring the target fish population of the Charles. Finally, CRWA will continue work on fish passage improvement projects, such as the permitting for a partial breach of Bleachery Dam in Waltham and fish ladder clean ups, and will monitor fish passage at the dams to determine the effectiveness of these improvement projects.

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